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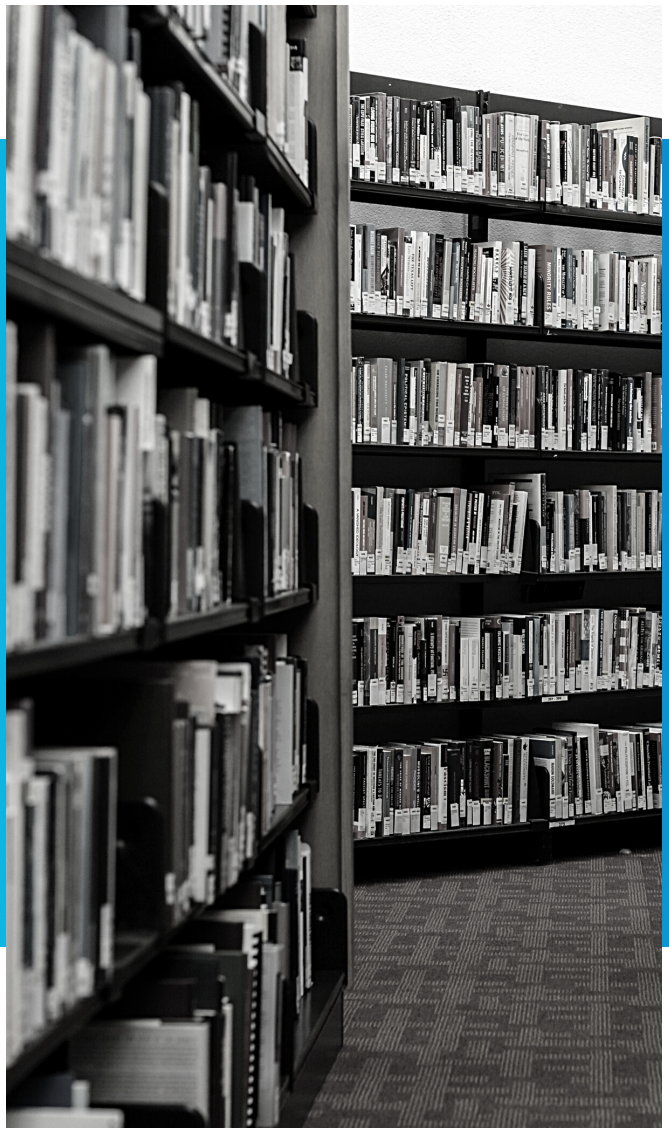

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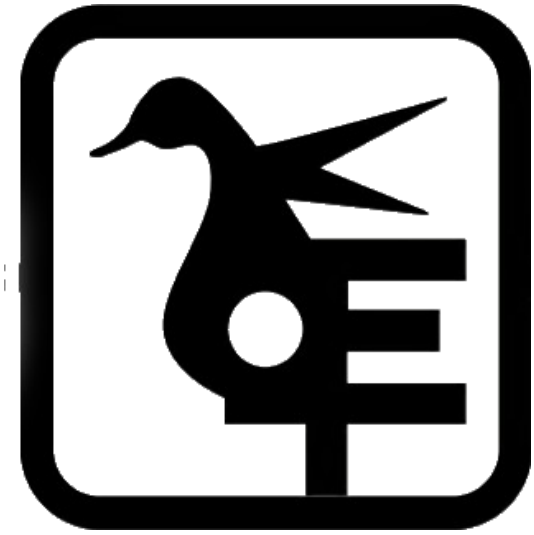

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Dr. B. B. Sharma
KET’s V. G. Vaze College of Arts, Science & Commerce Autonomous
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Research Promotion Committee

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***Dr. Preeta Nilesh,* ‘Celebrating A Ritual Folk Art: The Theyyam in Kerala’ in Ram Pande (ed.), ‘Folk Traditions and Culture, Heritage and History, Shodhak, August 2019, pp. 1-7. (ISBN 978-81-922830-2-9).**

Abstract:

Indian folklore generally has ecclesiastical leanings and are often associated with festivals, celebrations and rituals. Folktales glorify local heroes, places, customs and practices and their expression is in the local dialects. Most often folk performances are offerings to the local deities during religious celebrations. Whether for ethical purposes or entertainment, folklores have great value.

Theyyam or Theyyatom is one of the popular ritual folk arts of northern Kerala particularly practiced in the Kannur and Kasargod districts. Theyyam incorporates dance, mime, music and enshrines the rudiments of ancient tribal cultures which attached great importance to the worship of heroes and spirits of ancestors.

Theyyams are almost 400 in number and performed in front of shrines, sans stage or curtains. This folk form has been a great influence on the theatre and performing arts of Kerala.

The paper seeks to examine the origins of the Theyyam and explain how the performances propagate religion tradition and belief among the audiences. The study goes on to explain how this folk art brings about an internalization of the actor, audience and theatre. It also seeks to evaluate the contemporary status of Theyyam.

This study is based on standard secondary sources on the cultural history of Kerala.

Introduction

Folk traditions, legends and myths have always been cherished and they contribute greatly to our lives. They have attached cultural values and conventions and help in interpreting various aspects of our socio-political and economic lives. These oral traditions are effective teachers and provide a wealth of information, help to make strong the legitimacy of local rituals and practices and to preserve them. Often, they are performed as offerings to local deities at festivals.

According to scholars Renee Hulan and Renate Eigenbrod, oral traditions are "the means by which knowledge is reproduced, preserved and conveyed from generation to generation. Oral traditions form the foundation of Aboriginal societies, connecting the speaker and listener in communal experience and uniting past and present in memory".[1]

Theyyam is a folk-art form of northern Kerala particularly practiced in the Kannur and Kasargod districts. It is greatly influenced by tribal culture that celebrates local deities. It is a ritual performance; a mode of expression-more so an expression of protest against the powers that rule their lives. [2] Theyyam is a village cult celebrating local deities, mainly intended to propagate religion, Hindu mythology and belief even among the uneducated masses. It is a medium used by the tribal's to communicate with officiating deities and incorporates dance, mime and music to depict the worship of heroes and ancestors.

Theyyam worship uses meat and liquor as offerings to deities and metaphor and repetition to communicate strongly. There are almost 400 theyyams and they are performed in front of shrines, sans stage or curtains. [3]

Theyyams have been regarded by some scholars as a mark of protest and anger of the lower castes and classes against the system.[4]

Literature Survey:

There is abundant literature on theyyam. Theyyam has been studied as a form of worship, as a ritual, as a folk art, performance and as a product of culture. There are works in English and Malayalam on the theyyam.

While Ashley has studied the ritual aspects of the performance, Kurup's discussions are more about the theyyam being used as a tool to depict oppression and suppression against the lower castes. Damodaran looks at the theyyam as a tool for reconstructing the history of North Malabar. Freeman's is more of an anthropological study and he views the theyyam as a rite with

[1] 'Oral History As A Way Of Learning' in https://www.huffingtonpost.com/jane-jun/oral-history-as-a-way-of-_b_9763542.html (Accessed on May 15, 2018)

[2] See T.K.Leela, 'Goddesses of North Malabar. An Anthropological Study on Kinship and Ritual in North Malabar, Unpublished PhD Thesis, Department of Social Anthropology, University of Bergan, 2016, pp. 6-11, 43-49.

[3] Wayne Ashley, The Theyyam Kettu of Northern Kerala, *Drama Review,* 26 (2), 1979, pp. 59-72

[4] K.K.N.Kurup, *The Cult of Theyyam and Hero Worship in Kerala,* Calcutta, 1973.

an ability to maintain its relevance in a constantly changing and socially differentiating world.[5] Malayalam literature discusses the origins, ritualistic and mythical aspects of the theyyam, the folklore, the caste, class and gender aspects as also the use of costume, make-up, light and stage.[6]

Objectives:

The paper seeks to examine the origins of the Theyyam and explain how the performances propagate religion tradition and belief among the audiences. The study goes on to explain how there is an internalization of the actor, audience and theatre. It also seeks to evaluate the contemporary status of Theyyam.

This study is based on standard secondary sources on the cultural history of Kerala.

Sources and Origin of Theyyam

Theyyam has been discussed in detail in the Keralopathi, a historical document on the history and culture of Kerala. It is believed that Parsuramma, the sixth incarnation of Lord Vishnu sanctioned some festivals to the North Malabar region and theyyam originated from these festivals. The tribal communities were handed over the responsibility to perform the Theyyam.[7] The colonial elite had a rather condescending attitude to Theyyam and looked upon it as primitive while the reformists in Kerala referred to it as 'destructive and worth being destroyed'. The art, however, resisted reformist campaigns and adapted itself to changing socio-economic conditions.

Theyyam Performances:

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[5] Wayne Ashley, op.cit, Dilip Menon, 'The Moral Community of the Theyyattam: Popular Culture in Late Colonial Malabar', *Studies in History*, 9(2), 1993, pp. 187-217. Also see, K.K.N.Kurup, *The Cult of Theyyam and Hero Worship in Kerala,* Calcutta, 1973. J.R. Freeman Jr., *Purity and Violence: Sacred Power in the Teyyam worship of Malabar*, Unpublished PhD Thesis, University of Pennsylvania, 1991. Also see, J.J.Pallath, *Theyyam: An Analytical Study of the Folk Culture, Wisdom and Personality*. New Delhi, 1995 and Bhawani Cheerath-Rajagopalan and Rajesh Komath, Theyyam: The Other Gods, Bangalore, 2012. The book could be used as a reference for myths and rituals of the Theyyam with extensive use of photographs

[6] C.M.S. Chendera, Kalliyattam, National Book Stall, Kottayam, 1978, Namboodiri MV Vishnu 1998. *Teyyam*. National Book Stall, Kottayam, 1998, M.P.Ramachandran, Teyyam, National Book Stall, Kottayam, 1989.

[7] A.K. Nambiar, 'Development and Relevance of Ritual Arts', MLS, October- December 1989, pp. 61-65.

Theyyam dancers are well versed in the history, stories and characteristic traits of the deity they play. The dancers undergo rigorous training and grooming from the age of seven or eight and it takes them about eight or ten years to master the performance. Sons, nephews and relatives are the first students of every theyyam dancer and they not only learn dance but also assist make-up men and drummers. [8]

Theyyam performances are generally in front of the village shrine and also as ancestor worship with elaborate rites and rituals. They are performed on festival occasions in various shrines and temples in Kerala. They describe the socio-economic activities and reveal practices, beliefs and ideas of the tribal's and equally provide an insight into their spirituality, intellectual & cultural life. A typical performance goes on for eight to twelve hours with four hours of preparation time. While majority of the audience are believers, there are people who regard theyyam completely as a visual art.

A theyyam performance combines the playing of musical instruments, vocal recitations and dance.[9] Dancers are well versed in the history, stories and characteristic traits of the deity they play. While enacting myths and legends of local heroes and heroines, the thandava (aggressive) and lasya (graceful) modes of dance are adopted. The religious fervor lends vitality to the performance. While every deity in every shrine has a story of its own, the underlying myths are the same in most cases. [10] Musical instruments are played in a certain rhythm while dances move around with a sword and shield thus continuing cult of weapons.[11]

Costume and makeup are very characteristic of the performance. Every theyyam has its own make-up, costumes, headgear and a series of ritual practices. [12]The commonly used colours by artistes are red, orange, yellow, black and white as these help in playing up the aggressive features of the deity worshipped.[13]

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[8] "Encyclopedia Of Art And Culture In India Vol. 3 - Kerala" https://archive.org/.../2015.463706.Encyclopaedia-Of-Art-And-Culture-In-India-Vol-3--..(accessed on May 10, 2018).

[9] *Mathurubhoomi,* Malayalam Daily, 3 October 2003.

[10] Theyyams falling in the Chamundi category are incarnations of goddesses connected with mythological stories of demons.

[11] Folk musical instruments like the chenda, tuti, kuzhal and veekni are played in a certain rhythm and the dancers use a shield and sword in their hands, as a continuation of the cult of weapons. See, Gilles Tarabout, 'Malabar Gods, Nation-Building And World Culture: On Perceptions Of The Local And The Global' in Assayag, J & Fuller, C.J., (ed.), *Globalizing India Perspectives from Below,* London, 2005, p. 187.

[12] See M.G.S. Narayan, Cultural Symbiosis in Kerala, Trivandrum, 1972, p. 183.

[13] *Mathrubhoomi,* Malayalam Daily, 10 September 2000.

Theyyam artistes dance with a head-dress 50-foot-tall, walk through live embers and dance with lighted wicks stuck to their waist. With their striking costumes and headgear, they circumambulate the shrine dancing, running and walking to the tune of loud drumming and recitation. Their dance steps demonstrate fighting abilities and superhuman feats like rolling on glowing embers & tearing live birds, which is a show of strength, power & ritual violence.[14]
The songs sung at performances reflect episodes from local history and describe socio-economic activities and reveal practices, myths, beliefs and ideas of the community. They also provide an insight into spirituality, intellectual and cultural life of the tribal population.

Caste, class and gender dimensions of Theyyam:

Theyyam is a non-Brahmancial form of worship and represents the Dravidian culture with the same potential as any classical art form to denounce social oppression. [15] Theyyam dancers and singers are often from lower castes and classes. Cow-herds, farmers or cobblers perform these epics. The desire for upward social mobility is evident in these epics as these heroes become divine or achieve great material success, and their status goes up. It is an art of the poor and almost always performed by men. Male members are often dressed as women in elaborate costumes and exotic eye make-up.[16] Female members of the community, young and old, get together during the days of the performance to prepare garlands of ripe areca nut.
Theyyam is an excellent example of the co-existence of the rituals of the upper and lower castes. Liquor and meat offerings to Bhagawathi, Shiva and Vishnu co-existed with the *Saatvic* rituals practiced by the Namboodari Brahmins in temples. Theyyams are not performed in Brahmanical temples but the upper castes participate as organisers and audience. The continued patronage of the masses makes it a popular art. The audiences, irrespective of caste and religion ask the theyyam dancer for blessings like good health, fertility, success and prosperity. He wards off evil spirits from their lives, distributes turmeric powder, throws rice on the audience and 'blesses'

[14] V. Madhavikutty, *Theyyam*, Kottayam, 1981, p.11.
[15] K. K. N. Kurup, op.cit., pp.15, 29, 32
[16] In recent times, women have also started participating in the theyyam and they use the same make-up as the male artistes. *Deepika*, Malayalam Daily, 3 September 2001.

them after receiving offerings from them. The audience are always communicating with the performers from the beginning to the end. [17]

Status of theyyam today:

Deeply rooted in astrology and magic, the theyyam though not recognized as classical theatre, has a special place in Kerala. It has been a great influence on Malayalam theatre and the performing arts of Kerala.[18]

While art forms like Kathakali borrowed from theyyam, the theyyam could not achieve the status of a classical theatre. It continues to remain the art of the poor despite its close resemblance to Kathakali in make-up, costume and use of musical instruments.[19]

The dancers were invited to participate in the Republic Day Parade in New Delhi in 1960 and since then, theyyams are performed at festivals and fairs all over India. Today, theyyam is a theatre performance in the West and there are several foreign students learning Theyyam.

Conclusion

While the Theyyam continues to be performed in northern Kerala, today it is the foremost of the ritual folklore art forms of the state. This art combines the significance of social unity, harmony and mutual respect with the highlights of cultural heritage and aesthetics.[20]

Theyyam performances have gone out of the state as a medium of entertainment.[21] Photographs of the theyyam were illustrated on the cover of a *Folk Arts Directory* published by Kerala Sangeet Natak Akademi in 1978, as well as the inside cover and first page of an official Public Relations Department publication about *Dances of Kerala* issued in 1980. [22]

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[17] M. P. Damodaran, 'Teyyam is the Best Tool for Reconstructing the History of North Malabar', *Anthropologist,* 10 (4), 2008, p. 284.

[18] Wayne Ashley & Regina Holloman, 'Teyyam' in Richmond, F.R. et al (ed), *Indian Theatre Traditions of Performance,* Hawaii, 1990, pp. 131-165.

[19] Theyyam could not achieve the status of a classical theatre as its growth was arrested due to various factors of social, political and economic system of the region. Further, as the artists belonged to the depressed communities the status of the art form was belittled by a caste-ridden society. The social system which patronised this art form, kept the artist bonded and submissive. The rigid social system of a caste-oriented society did not encourage the all-round growth of personality of the artist.

[20] K. K. Gopalalakrishnan, *The Hindu*, 6 March 1994.

[21] Richard Schechner, From Ritual to Theatre and Back, in Essays on Performance Theory 1970-1976, Drama Book, New York, 1977.

[22] Tarabout, *op.cit.*

While there is a debate on the ‘spectacle’ status acquired by theyyam from scholars and practitioners who consider it as a serious ritualistic affair, the cultural respectability and recognition acquired by theyyam has not ceased since.

RELATIONSHIP BETWEEN SOCIAL MEDIA USE, PERCEIVED SOCIAL ISOLATION AND PSYCHOLOGICAL WELL-BEING AMONG YOUNG ADULTS

Ms. Shreya Mehta, Asst. Professor, Psychology
Smt. Maniben M.P Shah Women's College of Arts & Commerce
Ms. Mugdha Desai, Asst. Professor, Psychology
K.E.T.'s V. G. Vaze College

Abstract

With the advent of technology, geographical boundaries have been transcended and there are more opportunities for establishing connections across the globe. Usage of various social media platforms such as Facebook, Twitter, Snapchat, Instagram etc. has increased manifold times over the past few years. Ironically, the past few years has also seen an increased in the rates of loneliness and depression. The current study aimed at exploring the relationship between Social Media Use, Perceived Social Isolation and Psychological Well-Being. 40 young adults were assessed on their frequency and duration of social media use. Social Isolation and Psychological Well-Being were assessed using the Friendship Scale and Psychological Well-Being Scale respectively. Significant negative relationship was found between Social Media Use and Psychological Well-Being ($r = -0.42$ $p<0.01$) whereas a significant positive relationship was found between Social Media Use and Perceived Social Isolation ($r=0.33$, $p< 0.05$). Future Recommendations and Limitations have also been discussed.

Key Words: *Social Media Use, Perceived Social Isolation, Loneliness, Psychological Well being*

INTRODUCTION

The world has indeed become a smaller place to habitat in. Writing letters and awaiting reply, traveling afar and standing in long queues to make long distance calls, waiting for years to see one's grandchildren seems all distant memories now. With the help of technology, various social media platforms have enabled one to stay connected to each other across the globe

instantaneously. According to the Global Digital Report (2019), social media usage witnesses a growth of 9% on a year-on-year basis, with the current number of social media users worldwide standing at 3.484 billion (nearly 45% of the world's population). In India, about 52.3% of social media use comes from the millennials. Despite this strong technology enabled connectivity, psychological concerns such as loneliness, social isolation, depression are still prevalent at a higher rate. Thus, it can be speculated that being connected with one another via social media is different from the subjective experience of feeling connected with one another.

The current study seeks to understand the relationship between Social Media Use, Perceived Social Isolation and Psychological Well-Being among young adults.

Important Concepts:

- Social Media: According to Lai & Turban (2008), Social Media refers to "The online platforms that people use to share opinions and experiences including photos, videos, music, insights and perceptions with each other."
- Perceived Social Isolation: Holt-Lunstad et al (2015) have distinguished between objective social isolation i.e. the actual lack of social ties and subjective social isolation i.e. the feeling of a lack of engagement with others or perceived lack of social support. The current study focused on subjective experience of social isolation i.e. perceived social isolation.
- Psychological Well-Being: Psychological Well-Being can be conceptualized as comprising of six factors- self-acceptance, positive relations with others, autonomy, environmental mastery, purpose in life and personal growth (Ryff, 1989).

LITERATURE REVIEW

Relationship between Social Media Use and Perceived Social Isolation

The relationship between Social Media Use and Perceived Social Isolation is indeed mystical and not completely understood. Some research studies have reported a negative relationship between Social Media Use and Perceived Isolation or loneliness among older adults. For example, in his review of studies assessing impact Social Media Use among the older adults, Leist (2013) found that Social Media Use helped in overcoming loneliness, releasing stress and increasing feelings of self-efficacy.

Contrary relationships are also found. For instance, a recent study by Primack (2017), revealed that participants with high social media usage time were twice as likely to experience perceived social isolation, as compared to the group with low social media usage. It thus seems that, by confining oneself to online interactions and abandoning real social interactions, one is at a higher risk of creating experiences of increased loneliness for themselves.

Relationship between Social Media Use and Psychological Well-Being:

Research has demonstrated a negative association between Social Media Use and Psychological Well-Being. A unique qualitative study by O'Reilly et.al. (2018) explored perception of 54 adolescents regarding media usage and its impact on their well-being over a span of 3 months. Results revealed the participants themselves considered use of social media as a threat to their psychological well-being. The identified themes of the study included social media being perceived as cause of mood and anxiety disorder, social media leading to cyber bullying as well as social media decreasing psychological well-being by creating an addiction to media usage.

In a study by Woods, H.C. et al. (2016), the researchers assessed the impact of overall and night time social media use among 467 adolescents. Results revealed that both overall and night time social media use was associated with decreased sleep quality, low self-esteem and higher levels of anxiety and depression.

One of the most popular social media tool is Facebook. A recent meta-analysis to understand the effect of Facebook use among adolescents and adults was conducted by Marino et al (2018) Results revealed that problematic Facebook use was positively correlated(r=.34) with psychological distress and negative correlation (r-.22) was found with variables of well-being such as life satisfaction and positive mental health. These associations could well be explained by the findings of Rae, J. et al (2015) which suggest that the use of Facebook for forming new bonds acts as stronger mediating factor in the negative association between Facebook use and Psychological well-being as opposed to Facebook use for maintain existing relations.

Thus, past studies have revealed mixed outcomes regarding Social Media Use and Perceived Social Isolation. Also, most studies have employed adolescents and older adults to understand impact of Social Media on psychological variables such as Perceived Social Isolation, Psychological Well-Being etc. Youth being one of the largest consumers of social media as well

as one of the expanding segments of Indian Population (National Statistical Commission, 2017), the current study focuses on Social Media Use and its relationship with Perceived Social Isolation and Psychological Well-Being among young adults.

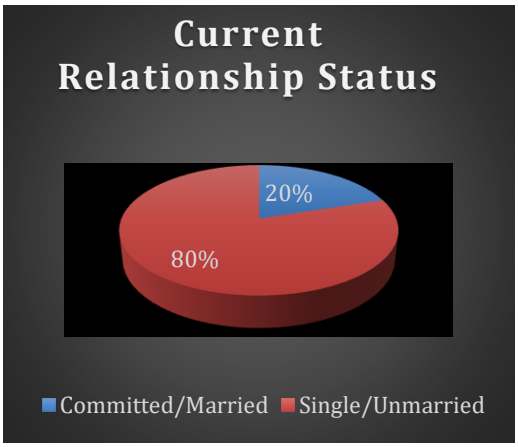
METHOD

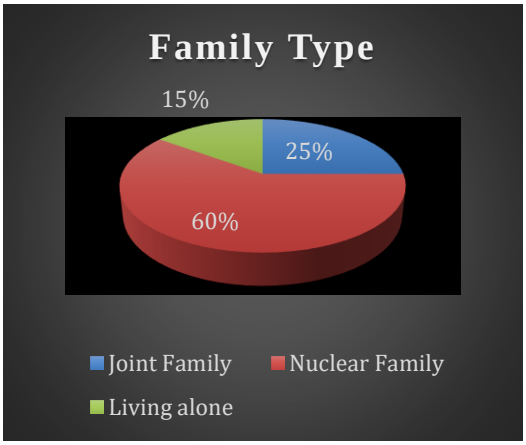
Hypotheses:

1) There is a positive relationship between Social Media Use and Perceived Social Isolation.
2) There is a negative relationship between Social Media Use and Psychological Well-Being.

Sample Description

The sample consisted of 40 young adults, 27 females and 12 males. The mean ages for both male and female participants was found to be 22.45 each. All participants had minimum educational qualification of 12th Std. Summary of other demographic details have been provided below.





Research Design

A Correlational research design was employed to understand the relationship between Social Media Use and Perceived Social Isolation as well as the relationship between Social Media Use and Psychological Well-being. Pearson Product Moment Correlation was used to find out the relationship among the variables.

Variables

1. Social Media Use

2. Perceived Social Isolation
3. Psychological Well-being

Tools

- Social Media Use: Social Media Use of participants was assessed in two complementary ways, gaging the duration and frequency of social media use using a Likert Scale (1= Never, 5= Almost Always). Participants were explicitly instructed not count any time spent on social media for work. To ensure robustness of results, all analyses were conducted by considering the variable as continuous.
- Perceived Social Isolation: The Friendship Scale (FS) developed by Hawthorne and Griffith (2000) is a 5 item scale which assesses perceived social isolation. The items are adapted from the Social Isolation Scale, Notthingham Health Profile (Martini and Hunt 1987) to a 5-point Guttman-type response format (Almost always, Most of the time, About half the time, Occasionally, Not at all). In order to ensure friendliness, the instrument was named the 'Friendship Scale' (FS) rather than include any reference to social isolation. The scores range from 0-20, where the higher the score the greater the extent of social isolation. The scale is demonstrated to be valid, reliable and sensitive instrument.
- Psychological well-being scale (PWB): Developed by Ryff et. al (1995), the 18 item scale measures psychological well-being by focusing on 6 factors: autonomy, environmental mastery, personal growth, positive relations with others, purpose in life, and self-acceptance. Participants respond to each item on a 7-point Likert scale, where 1 indicates strongly disagree and 7 indicates strongly agree. Higher scores indicate higher psychological well-being. The coefficient alpha are low to modest ranging from 0.33 to 0.56.

Procedure

Convenient sampling method was used to obtain the data for this study. After obtaining informed consent and basic demographic details, the participants were administered the 3 instruments and their scores were obtained and analyzed. The participants were thoroughly debriefed about the purpose of the study. Any doubts that the participants had were addressed. Ethical considerations were strictly adhered to.

RESULTS AND DISCUSSION

In order to assess the relationship between Social Media Use and Perceived Social Isolation, Pearson Product-moment correlation was computed. It was hypothesized that there is a significant positive relationship between Social Media Use and Perceived Social Isolation.

Table 1 shows the Pearson's Correlation, Mean and SD for the scores on social media use and perceived social isolation. The r value was found to be 0.33 which was significant at 0.05 level of significance. Thus, as hypothesized, higher levels of Social Media Use was found to be associated with higher levels of Perceived Social Isolation.

Table1: Pearson's Correlation, Mean and SD for Social Media Use and Friendship Scale

Measures	**SMU**	**FS**
SMU	1	
FS	0.33**	1
Mean **SD**	11.16 2.94	8.68 3.03
p<0.05** Note: SMU: Social Media Use; FS: Friendship Scale		

The results are consistent with previous line of research by Kraut, K. (1998) which revealed that increased internet use for communication was highly associated with decreased communication with family members and declining social circles. Thus, this contradictory experience of isolation prevails since face to face interactions which provide higher degree of closeness, self-disclosure and overall satisfaction than online interactions does get compromised along with high Social Media Use (Mallen, M., et al., 2003). Ancillary questions did reveal that face-to-face interactions are perceived as more meaningful and satisfying than online interactions.

Hypothesis 2 stated that there is a significant negative relationship between Social Media use and Psychological Well-Being. Table 2 shows the Pearson's Correlation, Mean and SD for the scores on Social Media Use and Psychological Well-Being. The r value was found to be -

0.42 which was significant at 0.01 level of significance .Thus, as hypothesized, a significant negative relationship exists between Social Media Use and Psychological Well-Being.

Table 2: Pearson's Correlation, Mean and SD for Social Media Use and Psychological Well-Being

Measures	**SMU**	**PWB**
SMU	1	
PWB	**-0.42****	1
Mean **SD**	11.16 2.94	93.07 9.70
Note: p<0.01** SMU: Social Media Use; PWB: Psychological Well-Being Scale		

These results are in line with a recent study by Tweng, J. et al. (2019) which revealed that low use of media (< I hour/day) was associated with higher psychological well-being than high media use (5 + hours/day). The study also found that high media users were more likely to have suicidal ideation than low users. Similar findings have also been reported in other studies where high use of social media is associated with greater symptoms of dispositional anxiety (Vannuccia, A. et al., 2017) and depression (Pantic, I., et al, 2012).

IMPLICATIONS

Social Media though becoming a pervasive part of everyone's life, cannot substitute face-to-face interaction. Adequate awareness about the same needs to be prevalent amongst individuals using social media platforms. Monitoring the frequency and setting limits on the amount of time spent on Social Media platforms can help regulate social media use better. Also, Social Skills Training can be provided to those who lack confidence in their social skills so that with adequate training, these individuals can learn to complement their social media platform enabled interactions with face- to- face interactions.

STUDY LIMITATIONS AND FUTURE DIRECTION

Exclusive reliance on self- report method and small sample size are some of the limitations of the study. In future, in addition to existing self- report measures, using a case study method and identifying triggers for excessive social media use can help understand the reason for the excessive reliance on social media as a platform for expanding one's support systems. One could also employ objective measures such as academic/work performance grades, physiological measures of anxiety, disturbances of sleep-wake cycle etc in relation to social media use. Comparative studies of quality of relationships developed via face-to-face interactions and social media platforms could also be employed.

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Security In Cloud Computing

Sunanda Pandita
Department of BMS, KET's V.G. Vaze College of Arts, science and Commerce.
Mulund East, Mumbai.
Email: sunanda7723@gmail.com

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Sunanda Pandita
Department of BMS, KET's V.G. Vaze College of Arts, science and Commerce.
Email: sunanda7723@gmail.com

ABSTRACT
Cloud Computing refers to the ability to access and manipulate information stored on remote servers, using any Internet-enabled platform. But data in the cloud is easier to manipulate, and also easier to lose control of, which brings up issues of traditional security, trust and privacy mechanisms. Privacy refers to the right to self-determination, that is, the right of individuals to 'know what is known about them', be aware of stored information about them, control how that information is communicated and prevent its abuse. In other words, it refers to more than just confidentiality of information. Protection of personal information (or data protection) derives from the right to privacy via the associated right to self-determination.

1. Introduction

Every individual has the right to control his or her own data, whether private, public or professional. Without knowledge of the physical location of the server or of how the processing of personal data is configured, end-users consume cloud services without any information about the processes involved, storing personal data on a server somewhere in cyberspace could pose a major threat to individual. "Cloud computing" is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. The five key characteristics of cloud computing are on-demand self service, ubiquitous network access, location-independent resource pooling, rapid elasticity and measured service, all of which are geared towards seamless and transparent cloud use. Rapid elasticity enables the scaling up (or down) of resources.

1.1 Service Delivery Models

The three cloud service delivery models are: Application/Software as a Service (SaaS),Platform as a Service (PaaS) and Infrastructure as a Service (IaaS). These three classic cloud service models have different divisions of responsibility with respect to personal data protection. The risks and benefits associated with each model will also differ.

1.1.1 SaaS enables the consumer to use the provider's applications running on a cloud infrastructure. The applications are accessible from various client devices through a client interface such as a web browser (e.g.web-based email such as Gmail or CRM from Salesforce). With the SaaS model, the consumer has little or no influence how input data is processed, but should be able to have confidence in the cloud provider's responsibility and compliance or can control which input he gives to a SaaS. First of all he can avoid to give sensible data to a SaaS. Secondly he might be able to "secure" the sensible data before he inputs them into the SaaS (e.g. their exists plugins for browsers supporting encryption of input form fields. This could be used to send only encrypted mails using Gmail).

1.1.2 PaaS provides tools, supported by a cloud provider, that enable developers to deploy applications (e.g.Salesforce's Force.com, Google App Engine, Mozilla Bespin, Zoho Creator). On the one hand, a big responsibility lies with the developer to use best practices and privacy-friendly tools and the developer has to rely on the trustworthiness of the underlying PaaS (and related infrastructure).

1.1.3 IaaS provider will typically take responsibility for securing the data centres, network and Systems, and will take steps to ensure that its employees and operational procedures comply with applicable laws and regulations. However, since an IaaS provider may have little application-level knowledge,it will be difficult for that provider to ensure data-level compliance, such as geographic restriction of data
transfers. In this case, the responsibility lies with the cloud user to maintain compliance controls. IaaS is the model that guarantees more direct control but also leaves the customer responsible for the implementation of technical and procedural security and resilience measures should be some way for the consumer in an IaaS cloud environment to express his privacy/security related requirements. For example, if the IaaS is based on virtualization, the consumer might want to express that the IaaS provider is not allowed to migrate the virtual machines from EU based data centers to US based ones due to data protection laws and regulations.

1.2 Privacy Enhancing Technologies (PET)

There is no commonly accepted definition for the term Privacy Enhancing Technologies (PETs). In general PETs are viewed as technologies that:
a) Reduce the risk of contravening privacy principles and legislation.
b) Minimize the amount of data held about individuals.
c) Allow individuals to retain control of information about themselves at all times.

1.3 Cloud security controls

Cloud security architecture is effective only if the correct defensive implementations are in place. An efficient cloud security architecture should recognize the issues that will arise with security management. The security management addresses these issues with security controls. These controls are put in place to safeguard any weaknesses in the system and reduce the effect of an attack. While there are many types of controls behind a cloud security architecture, they can usually be found in one of the following categories:

1.3.1 Deterrent controls

These controls are intended to reduce attacks on a cloud system. Much like a warning sign on a fence or a property, deterrent controls typically reduce the threat level by informing potential attackers that there will be adverse consequences for them if they proceed. [Some consider them a subset of preventive controls.]

1.3.2 Preventive controls

Preventive controls strengthen the system against incidents, generally by reducing if not actually eliminating vulnerabilities. Strong authentication of cloud users, for instance, makes it less likely that unauthorized users can access cloud systems, and more likely that cloud users are positively identified.

1.3.3 Detective controls

Detective controls are intended to detect and react appropriately to any incidents that occur. In the event of an attack, a detective control will signal the preventative or corrective controls to address the issues System and network security monitoring, including intrusion detection and prevention arrangements, are typically employed to detect attacks on cloud systems and the supporting communications infrastructure.

1.3.4 Corrective controls

Corrective controls reduce the consequences of an incident, normally by limiting the damage. They come into effect during or after an incident. Restoring system backups in order to rebuild a compromised system is an example of a corrective control.

1.4 Data security technologies-:

1.4.1 Disk Encryption-:

Disk encryption refers to encryption technology that encrypts data on a hard disk drive. Disk encryption typically takes form in either software or hardware. Disk encryption is often referred to as on-the-fly encryption (OTFE) or transparent encryption.

1.4.2 Hardware-Based Mechanisms for Protecting Data-:

Software-based security solutions encrypt the data to prevent it from theft. However, a malicious program or a hacker could corrupt the data in order to make it unrecoverable, making the system unusable. Hardware-based security solutions can prevent read and write access to data and hence offer very strong protection against tampering and unauthorized access.

Hardware-based or assisted computer security offers an alternative to software-only computer security. Security tokens such as those using may be more secure due to the physical access required in order to be compromised. Access is enabled only when the token is connected and correct PIN is entered. However, dongles can be used by anyone who can gain physical access to it. Newer technologies in /hardware-based security solves this problem offering fool proof security for data.

Every enterprise will have its own identity management system to control access to information and computing resources. Cloud providers either integrate the customer's identity management system into their own infrastructure, using federation or SSO technology, or provide an identity management solution of their own.

1.4.2.1 Physical security **:**

Cloud service providers physically secure the IT hardware (servers, routers, cables etc.) against unauthorized access, interference, theft, fires, floods etc. and ensure that essential supplies (such as electricity) are sufficiently robust to minimize the possibility of disruption. This is normally achieved by serving cloud applications from 'world-class' (i.e. professionally specified, designed, constructed, managed, monitored and maintained) data centers.

1.4.2.2 Personnel security **:**

Various information security concerns relating to the IT and other professionals associated with cloud services are typically handled through pre-, para- and post-employment activities such as security screening potential recruits, security awareness and training programs, proactive security monitoring and supervision, disciplinary procedures and contractual obligations embedded in employment contracts, service level agreements, codes of conduct, policies etc.

1.4.2.3 Availability **:**

Cloud providers help ensure that customers can rely on access to their data and applications, at least in part (failures at any point - not just within the cloud service providers' domains - may disrupt the communications chains between users and applications).

1.4.2.4 Application security **:**

Cloud providers ensure that applications available as a service via the cloud (SaaS) are secure by specifying, designing, implementing, testing and maintaining appropriate application security measures in the production environment. Note that - as with any commercial software - the controls they implement may not necessarily

fully mitigate all the risks they have identified, and that they may not necessarily have identified all the risks that are of concern to customers. Consequently, customers may also need to assure themselves that cloud applications are adequately secured for their specific purposes, including their compliance obligations.

1.4.2.5 Privacy :

Providers ensure that all critical data (credit card numbers, for example) are masked or encrypted (even better) and that only authorized users have access to data in its entirety. Moreover, digital identities and

credentials must be protected as should any data that the provider collects or produces about customer activity in the cloud.

1.4.3 Backups-:

Backups are used to ensure data which is lost can be recovered and nowadays it's very important to keep a backup of any data.

1.4.4 Data masking-:

Data Masking of structured data is the process of obscuring (masking) specific data within a database table or cell to ensure that data security is maintained and sensitive information is not exposed to unauthorized personnel. This may include masking the data from users (for example so banking customer representatives can only see the last 4 digits of a customers national identity number), developers (who need real production data to test new software releases but should not be able to see sensitive financial data), outsourcing vendors, etc.

1.4.5 Data Erasure:

Data erasure is a method of software-based overwriting that completely destroys all electronic data residing on a hard drive or other digital media to ensure that no sensitive data is leaked when an asset is retired or reused.

1.5 Working Of Hardware-Based Security:

A hardware device allows a user to log in, log out and set different privilege levels by doing manual actions. The device uses biometric technology to prevent malicious users from logging in, logging out, and changing privilege levels. The current state of a user of the device is read by controllers in peripheral devices such as hard disks. Illegal access by a malicious user or a malicious program is interrupted based on the current state of a user by hard disk and DVD controllers making illegal access to data impossible. Hardware-based access control is more secure than protection provided by the operating systems as operating systems are vulnerable to malicious attacks by viruses and hackers. The data on hard disks

can be corrupted after a malicious access is obtained. With hardware-based protection, software cannot manipulate the user privilege levels. It is impossible for a hacker or a malicious program to gain access to secure data protected by hardware or performs unauthorized privileged operations. This assumption is broken only if the hardware itself is malicious or contains a backdoor.The hardware protects the operating system image and file system privileges from being tampered. Therefore, a completely secure system can be created using a combination of hardware-based security and secure system administration policies.

1.5 Identity management

(IdM) describes the management of individual principals, their authentication, authorization, and privileges within or across system and enterprise boundaries with the goal of increasing security and productivity while decreasing cost, downtime and repetitive tasks.

The terms "Identity Management" and "Identity and Access Management" (or IAM) are used interchangeably in the area of Identity access management, while identity management itself falls under the umbrella of IT Security.

Identity-management systems, products, applications and platforms manage identifying and ancillary data about entities that include individuals, computer-related hardware and applications.

Technologies, services and terms related to identity management include Directory services, Service Providers, Identity Providers, Web Services, Access control, Digital Identities, Password Managers, Single Sign-on, Security Tokens, Security Token Services (STS), Workflows, OpenID, WS-Security, WS-Trust, SAML 2.0, OAuth and RBAC.

IdM covers issues such as how users gain an identity, the protection of that identity and the technologies supporting that protection (e.g., network protocols, digital certificates, passwords, etc.).

Identity management (IdM) is the task of controlling information about users on computers. Such information includes information that authenticates the identity of a user, and information that describes information and actions they are authorized to access and/or perform. It also includes the management of descriptive information about the user and how and by whom that information can be accessed and modified. Managed entities typically include users, hardware and network resources and even applications.

Digital identity is an entity's online presence, encompassing personal identifying information (PII) and ancillary information.

1.6 Identity management

1.6.1 Identity Management Function

In the real-world context of engineering online systems, identity management can involve three basic functions:

1. The pure identity function: Creation, management and deletion of identities without regard to access or entitlements;

   The user access (log-on) function: For example: a smart card and its associated data used by a customer to log on to a service or services (a traditional view);

2. The service function: A system that delivers personalized, role-based, online, on-demand, multimedia (content), presence-based services to users and their devices.

1.6.2 Pure identity

A general model of identity can be constructed from a small set of axioms, for example that all identities in a given namespace are unique, or that such identities bear a specific relationship to corresponding entities in the real world. Such an axiomatic model expresses "pure identity" in the sense that the model is not constrained by a specific application context. In general, an entity (real or virtual) can have multiple identities and each identity can encompass multiple attributes, some of which are unique within a given name space. In most theoretical and all practical models of digital identity, a given identity object consists of a finite set of properties (attribute values). These properties record information about the object, either for purposes external to the model or to operate the model, for example in classification and retrieval. A "pure identity" model is strictly not concerned with the external semantics of these properties.

The most common departure from "pure identity" in practice occurs with properties intended to assure some aspect of identity, for example a digital signature or software token which the model may use internally to verify some aspect of the identity in satisfaction of an external purpose. To the extent that the model expresses such semantics internally, it is not a pure model.

Contrast this situation with properties that might be externally used for purposes of information security such as managing access or entitlement, but which are simply stored, maintained and retrieved, without special treatment by the model. The absence of external semantics within the model qualifies it as a "pure identity" model.

Identity management, then, can be defined as a set of operations on a given identity model, or more generally as a set of capabilities with reference to it. In practice, identity management often expands to express how model contents is to be provisioned and reconciled among multiple identity models.

1.7 Conclusion

Social web and online social networking services make heavy use of identity management. Helping users decide how to manage access to their personal information has become an issue of broad concern.In addition to creation, deletion, modification of user identity data either assisted or self-service, Identity Management is tasked with controlling ancillary entity data for use by Authentication: Verification that an entity is who/what it claims to be using a password, biometrics such as a fingerprint, or distinctive behavior such as a gesture pattern on a touch screen,Authorization : Managing authorization information that defines what operations an entity can perform in the context of a specific application. For example, one user might be authorized to enter a sales order, while a different user is authorized to approve the credit request for that order.Roles : Roles are groups of operations and/or other roles. Users are granted roles often related to a particular job or job function. For example, a user administrator role might be authorized to reset a user's password, while a system administrator role might have the ability to assign a user to a specific server.Delegation : Delegation allows local administrators or supervisors to perform system modifications without a global administrator or for one user to allow another to perform actions on their behalf. For example, a user could delegate the right to manage office-related information.Interchange : The SAML protocol is a prominent means used to exchange identity information between two identity domains.

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Screening of various extracts of *Garcinia indica* viz., leaf, seed, stem, root and fruit for UV protective activity and incorporation of extracts in sun protective formulations

Authors
M. Dike, R. Thergoankar, M. Deodhar

Abstract

Exposure to UV radiation from the sun is a major cause of sunburns, pigmentation as well as skin cancer; hence sun protecting compounds are essential commodities of life. The inorganic sun blockers viz., ZnO and TiO_2 give broad spectrum UV protection but, have the drawback of skin whitening. Organic compounds having UV protective ability both in UV A and UV B region include benzophenones. *Garcinia* species are known to produce different types of benzophenone like garcinol, isogarcinol, xanthochymol, isoxanthochymol, etc. In previous studies, natural benzophenones present in *Garcinia indica* were screened for UV protective activity. Out of various extracts of fruit rinds of *G. indica*, viz., aqueous, ethanolic, methanolic, water, n-butanolic, hexane and ethyl acetate were screened for UV protective activity. Initially the selected extracts were screened by spectrophotometric method. The maximum sun protective activity was found in ethyl acetate and n-butanolic extract in both UV A and UV B region. The ethyl acetate extract when incorporated in sun protective cream formulation gave SPF 3.43 and boot star rating five which indicates strong UV protective activity in the UV A region. In the present study, natural benzophenone in various parts of plant of *G. indica* like leaves, seeds, roots and bark were screened for UV protective activity. The extracts were also incorporated in sunscreen formulations and SPF was determined by SPF analyzer. The cumulative effect of *G. indica* extracts along with commercial UV protective compounds like TiO_2, benzophenone 3 and uvinul A plus was also studied.

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The Well-being of Slum Dwellers

Mrs. Vaishali Sambodhan Dhammapathee
Head, Assistant Professor
Department of Economics
KET's V.G. Vaze College of arts, science and commerce, Mulund east, Mumbai
Cell no: 9773100887
Email: dethevaishali2@gmail.com

Abstract

Labour market outcomes cannot explain and determine urban poverty as it goes far beyond it. Urban poverty cannot be captured only in terms of the headcount ratio of poverty. Multiple dimensions of deprivation have been discussed in the past (Sen, 1981; 1985; Haq, 1995). These dimensions include education, health, shelter, drinking water and sanitation, freedom, security, opportunity, asset, and vulnerability, among others. Migration may lead to some improvement in these dimensions in the lives of migrants. Therefore, studying the impact of migration on the well-being of the migrants needs to be paid serious attention, and this paper precisely attempts this.

Key Words: Migration, slum, well-being

Introduction

The most crucial issue of political debate worldwide nowadays is a process of continuous migration. Migration has shown an upward trend in various ways, voluntary or involuntary. Managing migration has become one of the critical challenges of many countries and their governments, whether it is a developed economy or a developing economy. The problem of migration is mainly a big issue in cities where migrants get attracted to a better life.

The world holds an estimated 244 million international migrants (UN DESA, 2016) and 763 million internal migrants.

The above numbers indicate that one-seventh of the world's population is migrant. Many developed countries exhibiting population diversity is because of international migration, but in underdeveloped countries, internal migration contributes to population diversity.

The data of the 2001 census shows that the total number of internal migrants in India was 309 million. The migration status considered is based on the place of the last residence who

constituted nearly 30 percent of the total population. Although the number of internal migrants has doubled since 1971 (from 159 million in 1971 to 309 million in 2001), the proportion continued to be around 30 percent since 1971 except the 1991 census when it has declined to 27 percent to the total population. It is generally accepted that migration has slowed down during the decade 1981-91 as a result of increased unemployment and sluggish growth in the Indian economy.

Maharashtra received the most extensive number of migrants (7.9 million) by place of birth from other states and other countries. Based on net migration for 1991-2001 decade, the difference between in-migration and out-migration in each state, it is observed that Maharashtra stands at the top of the list with 2.3 million net migrants. Maharashtra witnessed the most massive in-migration of the population during 1991-2001 from different states. The total number of in-migrants was 3.2 million and 0.89 million out-migrants from the state during the decade.

For a long time, migration is perceived by policy planners as a flow of rural poor and destitute in search of employment. Urban poverty considered as merely a "spill-over" effect of rural poverty as poor migrants from the rural area get employed in informal sector jobs with low productivity. (Dandekar and Rath, 1971). Even in the theoretical literature, the relationship between urban and rural poverty is perceived to be dominant. For example, Bhagwati and Srinivasan (1974) argue that the agriculture sector should be provided with the production subsidy. Other studies suggest that the absorption of labour in the informal sector in cities, i.e., native as well as a migrant is due to sluggish employment growth in the (formal) industrial sector. As the industrial sector is having limited spread and has adopted capital intensive technology, it is leaving no room for those laborers. From this point of view, there seem to be overlaps among informal sector employment, slum dwelling, and poverty (Mitra, 1994).

Labour market outcomes cannot explain and determine urban poverty as it goes far beyond it. Urban poverty cannot be captured only in terms of the headcount ratio of poverty. Multiple dimensions of deprivation have been discussed in the past (Sen, 1981; 1985; Haq, 1995). These dimensions include education, health, shelter, drinking water and sanitation, freedom, security, opportunity, asset, and vulnerability, among others. Migration may lead to some improvement in these dimensions in the lives of migrants. Therefore, studying the impact of migration on the well-being of the migrants needs to be paid serious attention, and this paper precisely attempts this.

Concept of well-being

In recent years well-being is getting considerable attention by policymakers and social scientists. The broad conceptual approaches which dominate well-being research are two. The first is the objective approach that examines the physical components of a good life, whereas the second, subjective approach examines people's subjective evaluations of their lives by them.

Well-being is a definite idea that is meaningful for people and society in many ways. The subjective well-being of people is nothing but a perception of people that their lives are going well. This perception of well-being includes many positive things, such as feeling happy, socially connected, and purposeful.

The origin of the objective approach to well-being can be found in Amartya Sen's work in welfare economics where he talks about how to measure poverty and inequality, and its extension has drawn to the capabilities of individuals.

Social scientists' and policymakers' interest in the nature and determinants of well-being has grown after the work of Kahneman, Diener, and Schwartz's work in well-being research.

The objective approach helps in building national and international statistical indicators like the United Nations Development Programs, Human Development Index; the French government's Commission on the Measurement of Economic Performance and Social Progress and the OECD formulated- a better life initiative.

Research Design

The present research is an empirical study based on primary data collected by the trained enumerator personally approaching the respondents. In this study, the respondent is the household head henceforth referred as HHH.

A) Methods of data collection

1) Primary data: Primary data have been collected from 213 households from Matunga Labour Camp slum, located in Mumbai. Information on diverse characteristics of slum dwellers was collected through a structured questionnaire based on the objectives of the study.

2) Secondary data: Secondary data has been gathered from government websites, University websites, and other sources.

B) Sample Description

Matunga Labour Camp (henceforth called as MLC) is one of the oldest slum settlements in Mumbai. Matunga labour camp is the ward no. 180, G/N of Mumbai. The population of this ward is 582007, out of which 324886, i.e., 55.82% is slum population. (Mumbai)
As per the records in primary health centre present here, there are total 4211 slum households with a population size of 19100. Out of the 4211 total households' 5 percent are randomly selected as sample.

C) Statistical Tools and techniques of Data analysis: The collected primary data has been classified, tabulated, and analysed using different statistical techniques and SPSS (21.0 version). Excel software is also used.

D) Objectives of the Study:

i. To develop a well-being index based on some of the relative and diverse characteristics of households.
ii. To study the difference between well-being index of the households who own zopdi (housing unit) and households who have rented in zopdi in the MLC slum
iii. To study the relationship between well-being index and duration of migration of households in MLC slum
iv. To study correlation between the total family income and educational level of HHH of household in MLC slum
v. To study the correlation between well-being index and educational level of HHH in household in MLC slum

Results and Analysis:

This part of the paper provides the brief procedure of wellbeing index construction. Further the correlation of the wellbeing index with certain household characteristics is analysed and discussed.

Well-being Index :

Well-being index is constructed by considering ten relative and diverse characteristics of households. The considered variables are household size (HHSZ), per capita total expenditure which includes food and all categories of non-food expenditure excluding health expenditure(PCE), proportion of persons in the household who reported illness one year preceding the date of survey(ILL), percentage of household members who acquired at least primary education(PRIM), percentage of members in the age group 15 to 59 - proxy for adult potential earners (PER 15 to 59), percentage of working members in the household (WM),

age of the household – proxy for experience in the job market (AG), health expenditure per capita (HPCE), per capita household income (HHPCI) and child women ratio (CWR).
As per the previous studies on the subject (Yuko), variables like household size, child-woman ratio, and percentage of ill members in the household, is likely to reduce the well-being of the household. On the other hand, health expenditure per capita on a priori basis may reduce or raise the well-being of the household. Other variables would be expected to enhance well-being. Since these variables are heterogeneous, it is challenging to combine them to indicate an overall living standard of households. Hence, factor analysis in SPSS was conducted, and using factor loadings as weights, variables were combined to generate a composite index of well-being.

Table 1. Descriptive statistics

Variable	Mean
HHSZ	5.33
per capita total expenditure	1865.00
IIL	8.03
PRIM	61.47
PER 15 to 59	61.09
WM	28.04
AG	38.64
HPCE	245.12
HHPCI	2440.99
CWR	1.355

From Table 1, it can be observed that the average per capita total expenditure of slum households is 1865 Rs. per month, with health expenditure per capita of Rs 245.12 per month. The average total monthly per capita income is 2440.99 Rs. per month. The average household size in the MLC slum is 5.33 members in the family .
To test the suitability of the data for doing factor analysis two tests were performed with the help of SPSS software. The results are as follows:

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.645
Bartlett's Test of Sphericity	Approx. Chi-Square	903.390
	Df	45
	Sig.	.000

This table shows two tests that point out the suitability of the data for structure detection. The **Kaiser-Meyer-Olkin Measure of Sampling Adequacy** is a statistic that show the proportion of variance in the variables that might be caused by underlying factors. High values (close to 1.0) point out that a factor analysis will be convenient with the data. If the value is less than 0.50, the results of the factor analysis probably won't be fruitful. The value for our data is 0.645 .

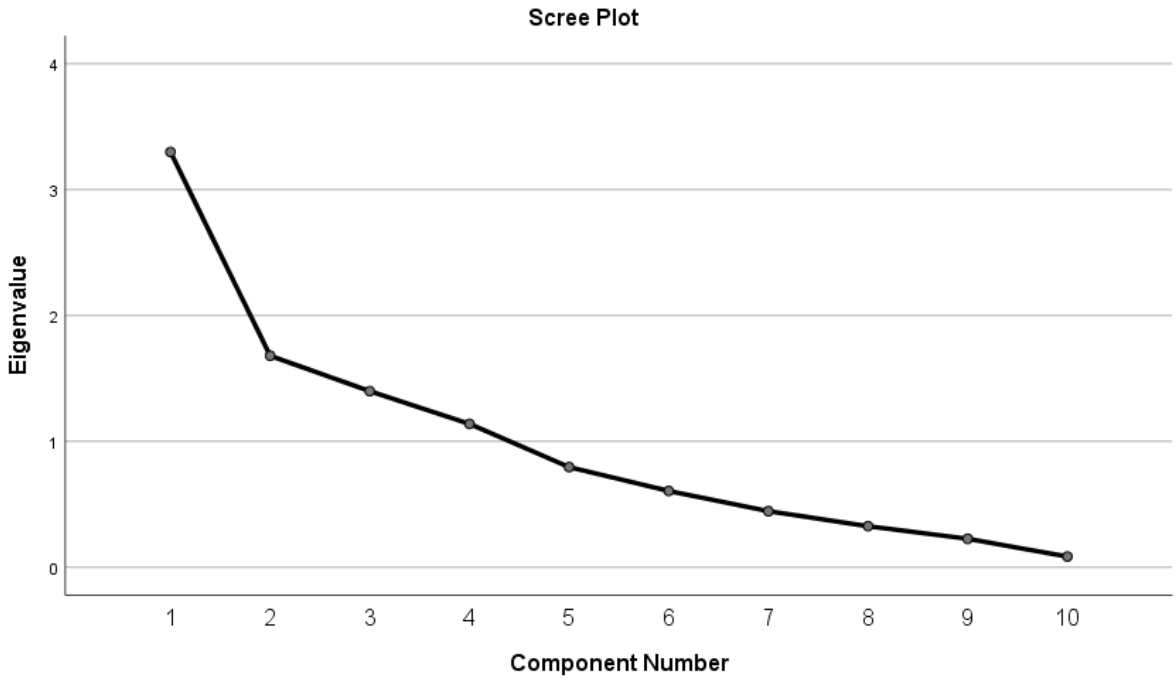
Bartlett's test of sphericity tests the hypothesis that correlation matrix for the variable considered is an identity matrix, which would indicate that the selected variables are not related and hence not suitable for structure detection. Small values (less than 0.05) of the significance level shows that a factor analysis may be useful for the given data. The value in our case is 0.000 making it perfectly suitable to run the factor analysis. (IBM)

After running the principle component analysis, 4 Factors or component were obtained. First factor included variables PCE, HPCE, HHPCI and PRIM. Second factor included variables WM and HHSZ. Third factor included variables PER 15 to 59 and CWR. Fourth factor included variables ILL and AG.

The scree plot obtained for the PCA is represented below in the figure 1

In the given scree plot the number of factors on the x-axis and eigen values are represented on the y-axis. The point from which the slope of the curve clearly levels off (the elbow) indicates the number of factors that can be generated from the analysis. In the above figure 1, a cut-off of an eigenvalue ≥1, gives four factors. Therefore, four factors are considered.

Figure 1: Scree plot of factor analysis for MLC



Wellbeing Index Computation

As a first step in the computation of a single index, factor score coefficients, also called component scores were estimated using regression method with the help of SPSS software.. Factor scores are the scores of each case , on each factor. To compute the factor scores for a given case for a given factor, the case's standardized score on each variable is multiplied by the corresponding factor loading of the variable for the given factor, and summed these products. This calculation was carried out using SPSS procedure and factor scores were saved as variables in subsequent calculations involving factor scores.

The four factors explained 75.161 per cent of the total variation, with the first, second, third, fourth explaining 32.983 per cent, 16.802 per cent, 13.985 per cent, 11.391 per cent, respectively. Therefore, the importance of the factors in measuring overall wellbeing is not the same. Using the proportion of the these as weights on the factor score coefficients, a Non-standardized Index (NSI) was computed using the following formula:

NSI = 3.983(Factor 1 score) + 1.6802 (Factor 2 score) + 1.3985 (Factor 3score) + 1.1391 (Factor 4 score) /7.516

The value of the NSI for some households was positive and for other negative, making it difficult to interpret. Therefore, a Standardized Index (SI) was developed, the value of which can range from 0 to 100, using the formula:

SI= (NSI of household – Minimum NSI / Maximum NSI – Minimum NSI) * 100

In MLC slum, the sum of (SI) well-being index obtained is 8267.127, and the sample size from MLC slum is 213 households. Therefore, the average well-being of MLC slum can be computed as follows:

$$Average\ Wellbeing\ Index = \frac{\text{Summation of Standarized WI}}{n}$$

$$= 8267.127/213$$

$$= 38.81$$

Table 2 Household specific Wellbeing index and Duration of migration:

Duration of migration (years)	**Number of Household**	**Average Wellbeing Index**
Less than 5 years	6	36.18
Between 5 to 10 years	11	38.54
Between 11 to 15 years	9	35.28
Between 16 to 20 years	12	36.03
More than 20 years	22	39.32
Whole life	153	40.02

from the above table it could be found that average wellbeing index of slum households who are in the city for whole life is slightly greater than the households being first generation migrants in the city. To understand the relationship between the duration of migration and wellbeing index correlation was measured in excel.

The difference between well-being index of the households who own zopdi(housing unit) and households who have rented in zopdi in the MLC slum

The average wellbeing index of the people who owned house in slum and those who live on rent was also found out. People who own house in MLC slum, their well-being index is 39.07. 55 households out of 213 households live on rent. Their well-being index is 40.14.

Type of house	No. of households	Average Wellbeing Index
Owned	158	39.07
Rented	55	40.14

There is a slight difference in the average wellbeing index of the slum households who own the house and those who live in rented house in MLC slum.

Correlation results:

1. **The well-being index and duration of migration in MLC slum:** The relationship between well-being index and duration of migration of the slum households in the city is of 0.04. The obtained value 0.04 is insignificant. Therefore, it is concluded that there is no relationship between wellbeing index and duration of stay in the city for slum dwellers.
2. **Correlation between the total family income and educational level of HHH of household :** The relationship between total family income of the household and educational level of HHH of household is 0.27. The obtained value 0.27 is showing weak positive relationship between the variables.
3. **The correlation between well-being index and educational level of HHH in household**

   The relationship between wellbeing index and educational level of HHH of household is 0.057 . The obtained value 0.057 is insignificant. Therefore, it is concluded that there is no significant relationship between well-being index and educational level of HHH in household .

Conclusion

The relation between well-being index and the duration of stay/ migration in MLC slum is very low positive making it insignificant. This finding indicates that the benefits of migration to slum is going to improve the wellbeing of a relatively new entrant at par with that of the old migrants. This finding explains the continual rural - urban migration flow in cities like Mumbai. Also, the ever-rising slum formation can be better understood with this correlation. There is a slight difference in the average wellbeing index of the slum households who own the house and those who live in rented house in MLC slum. For migrants staying in city is more important to earn living than owning the jhuggi/zopdi(which eventually they can own) Also the underlying cause of dearness of zopdi cannot be overlooked.

The week positive relationship between the HHH's education level and total family income in the household is the indicator of the stigmatization of the slum dwellers in the job market where they usually settle with the low paying jobs despite having qualification to get better paying jobs. Also the insignificant relation between educational level of HHH and the wellbeing index of the household suggest that the educational level of HHH is not allowing

him to improve the variables positively contributing to wellbeing index value or lower down the negative impact of the variables who contribute negatively to wellbeing index value. Slums are the pockets of low standard of living, unhygienic environment, overcrowded and shabby places of poor people. However, they are the places where people struggle generation together to achieve betterment in their lives. As seen in the analysis section many households have strived and achieved better wellbeing levels than their counterparts. It is important to find out factors which contribute to their wellbeing and further enhance it. Policymakers must take cognizance of those factors and try to foster them through various programs and schemes.

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Slowbalization of Indian Economy and It's way out

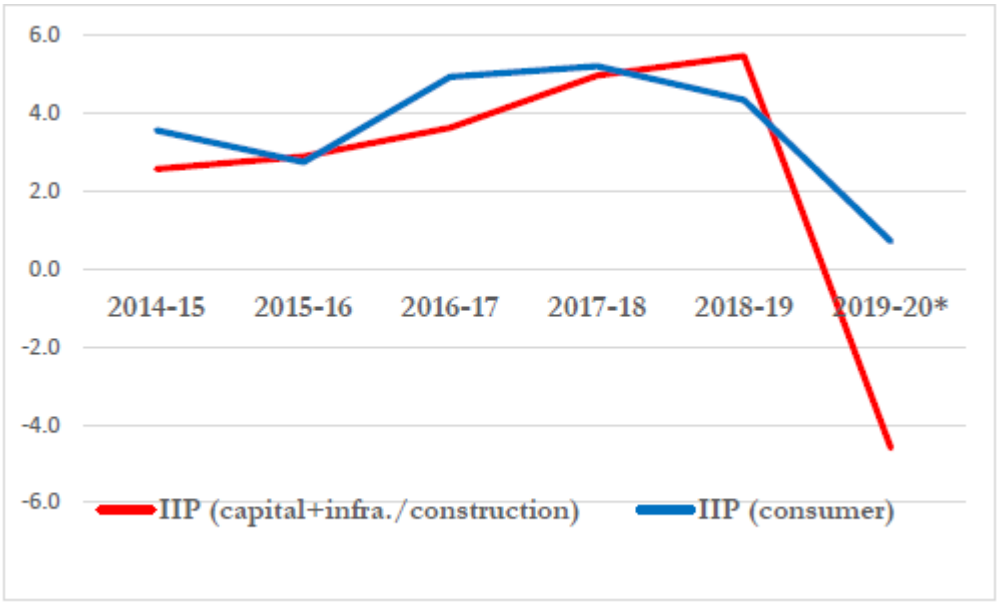
Ms. Neha K. Satoliya
Assistant Professor
Department of Business Economics
KET'S V.G. Vaze Kelkar College of Arts, Science and Commerce
Email id: nehaasatoliya@gmail.com Mobile Number: 8452825180

Abstract
This paper concentrates on cyclical and structural factors, including finance being peculiar element. Immediately after Global Financial crisis (GFC), investment and export growth, two root operator of economic growth reduced sharply. In the mid-2000s, investment boom of India was affected due to Twin Balance Sheet crisis, including infrastructure companies and banks. Despite, inopportune demonetization and GST distress Indian economy kept growing. It enjoyed income gain by non- bank financial companies, government spending including and reduction in international oil prices- resulting in explosion of credit. With the explosion of credit unfeasible real estate was financed. In 2019, this swollen bubble burst and cause in fall in consumption causing destruction of economic growth. Due to this, a Four Balance sheet challenge- real estate companies and NBFCs, infrastructure companies and the original two sectors is stuck in a contrary interest growth dynamic. Growth is depressed due to aversion of risk, which lead to hike in interest rate and generates more risk aversion. Today, high priority is improving economic productivity in agricultural sector. Formerly, Data Big bank is required to regain faith and implement suitable policy designs.

1. Slowbalization:

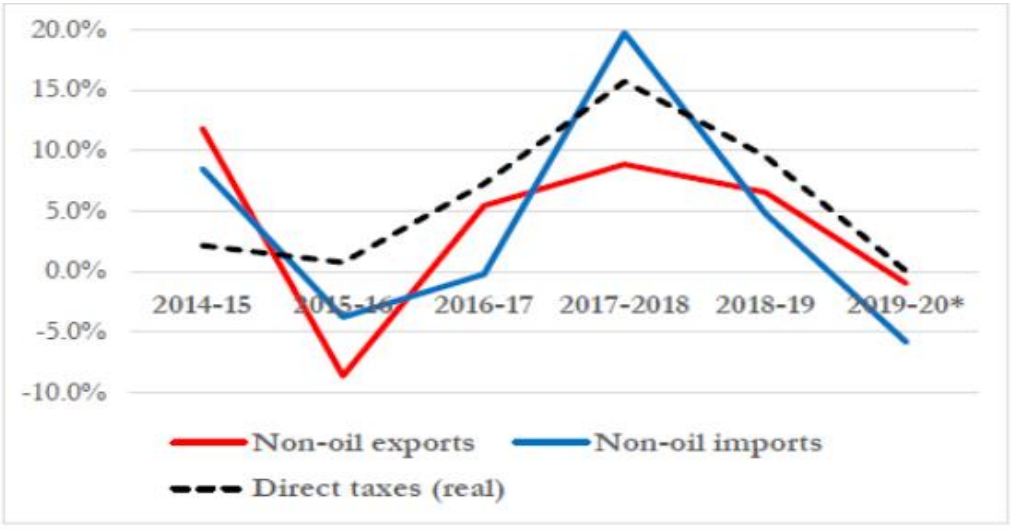
Indian economy is slowing down. The official figures are alarming with merely growth rate of 4.5 percent in the second quarter of fiscal year 2019. The dis-aggregated data is highly painful. Contraction in Investment good's and consumer good's production is the indicator of reduction (Figure 1.1) in export, import government revenues, which are approaching negative (Figure 1.2 also see Sandefur and Duggan, 2019).

Figure 1.1 Indicator of Investment and consumption



Source: MOSPI.

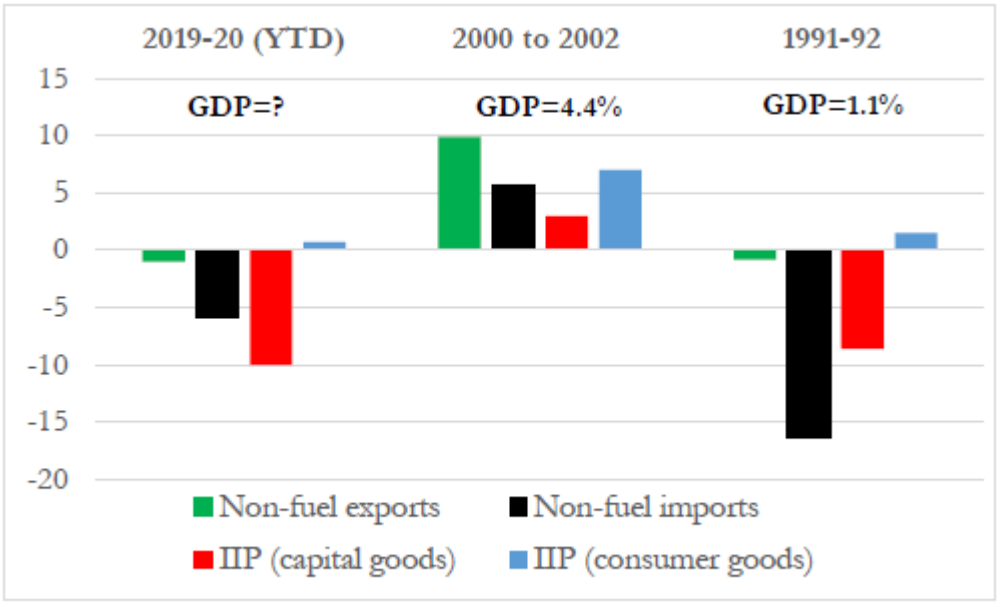
Figure 1.2 Taxes and Trade (growth in percentage,taxes in real Rupee, trade in Dollar $)



Sources: RBI for exports, Ministry of Commerce for imports, and Ministry of Finance for taxes.

The given indicators indicate that the economy's sickness is critical. Figure 2.1 resembles that the ongoing economic slowdown is similar to the slowdown seen in 1991 than the 2000-2002.

Figure 2.1: Slowdowns- Present and Previous



Sources: WDI and MOSPI

Till recent time as per official figures Indian economy was not only in excellent health with growth rate of around 7 percent. But also not facing with the 3F problem said by Harish Damodar. Which is Food harvest haven't fail. World fuel price haven't risen. The fisc has not spiraled out of control. Then, what is the reason of sudden fall of an economy? Hence, Indian economy's situation is Puzzling.

The government and RBI is working vibrantly to revive the economy's health. They are continuously introducing new policies which also includes huge tax cut to boost investment, privatizing four major Public Sector Undertakings (PSUs). In 2019, with an objective of strengthening lending, the RBI cut the interest rate by 135 basic points. Despite this step investment is trapped. Therefore, Indian economy's condition is frustrating as well. Thought various remedies provided, they are not effective. However, Such an economic situation is not acceptable as well. This paper endeavors to contribute for the solution.

India is facing a the Twin Balance sheet crisis, this crisis is arrived in two waves. The first wave is waves consist of infrastructure companies and banks, arose later Global Financial crisis (GFC). When the economy of the world was decelerating, in mid 2000s, the infrastructure projects which had began during the boom of investment in India turned dry. Failure to identify these problems competently, has put exports and investment, the two driving force of the economy at a stack. Despite that economy was growing at a decent rate, behind the series of provisional expedients. In the beginning a large windfall from the sudden decrease in international oil prices and later credit boom of NBFC with vast but hidden boost. The end of the credit boom began in 2018 has led to the Ongoing Deadlock. Then all the dominant engine of growth including consumption, reduced causing economic growth to decelerate. The weakening of growth has led to a Four Balance Sheet Challenge. In such circumstances uniform solution to the problems are not present. Due to the breakage of the transmission mechanism monetary policy cannot be regained. Since financial system have distress in a absorbing the huge bond issues. Therefore, fiscal policy cannot be adopted. To overcome present vicious cycle and the deceleration of the economy, there is a need to identify the present Four balance sheet problem. Without identifying Four Balance sheet

problem Indian Economy will not grow at a sustain rate. Though this argument as made in the economic survey 2017, it seems to by more appropriate for today's economic situation.

II. Which slowdown is it: Cyclical or Structural ?

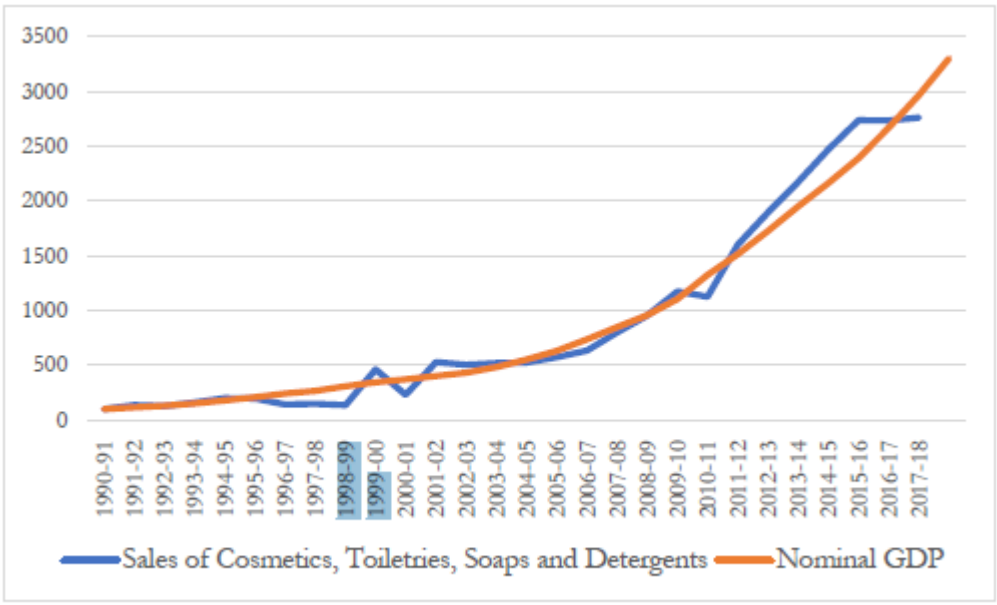
Here, the reason for other explanations being disquieting is explained. On one side are the structuralists who attribute the problem to structural constraints such as labor and land restrictions and governance (Rajan, 2019; Sharma, 2019) or income inequality (Roy, 2019; Mukherjee 2019). Then there are the cyclicalists, who focus on more recent developments, attributing the slowdown to a slump in aggregate demand, explained by problems in agriculture (Kotwal and Sen, 2019; Damodaran, 2019; Ghosh 2019; Dev and Goyal, 2019); demonetization and GST (Banerjee, 2019; S.Subramaniam, 2019); monetary tightness (Balakrishnan, 2019); or policy and political uncertainty (Singh 2019; Basu 2019).

Beginning with Structuralist approach. The given interpretation concentrates on the long-standing structure of the Indian economy, on the characteristics like labour laws. It has been same in the last few decades. Hence, this theory is not only insufficient in explaining the reason for the deterioration of the Indian economy but also unable to provide the reason for the Indian economy's boom in the mid - 2000s. This explanation indicates that the constraints which were not binding before, has abruptly been binding.

Roy's (2019) income inequality hypothesis is that ever since 1991 the economy has been carried along by a consumption boom, as the beneficiaries of reform have spent their new-found earnings on accumulating goods and obtaining services.Since the beneficiaries have been small group, this growth mechanism has perpetually unavoidable

In post- 1991 era, income inequalities has increased, is highlighted from this theory. However this theory counter the witnesses. To initiate, exports and investment has been the moderate driving force of the Indian economy since 1991. Liberalisation has contributed significantly to improve the minimal level of the population by enlarging the consumer's reach to avail various types of marketed products like cosmetics and toiletries leading to sharp and continuous boom in the sale of fast - moving consumption good (Figure 3.1).

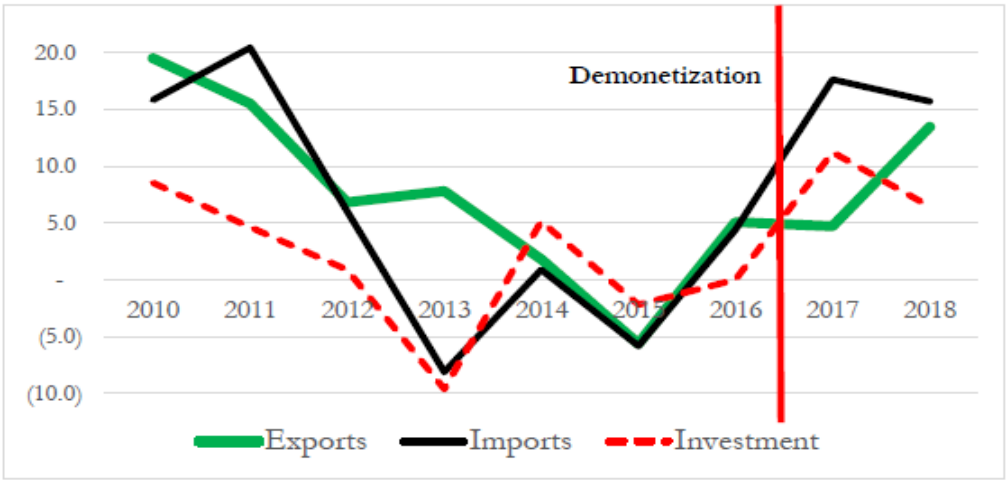
Figure 3.1: FMCG sales and Nominal GDP (Index, 1990-91=100)



Sources: CSO and CMIE.

Declaring "demand" as the root cause for the sluggish performance of the economy doesn't solve the puzzle. Aggregate demand has declined due to fall deceleration of the production. Figure 3.2 indicates that after implementation of the GST and Demonetization also the economic growth is continuing. Growth rate of 2017-18 indicates that something else has triggered the deterioration of rural, informal agricultural sector including of the whole economy. Few have argued that decline in the budget deficit of the centre is the cause of falling demand. But the realism is contradictory which is government deficit has shoot up.

Figure 3.2: Cyclical Indicators (growth rates)



Source: CSO, National Income Accounts

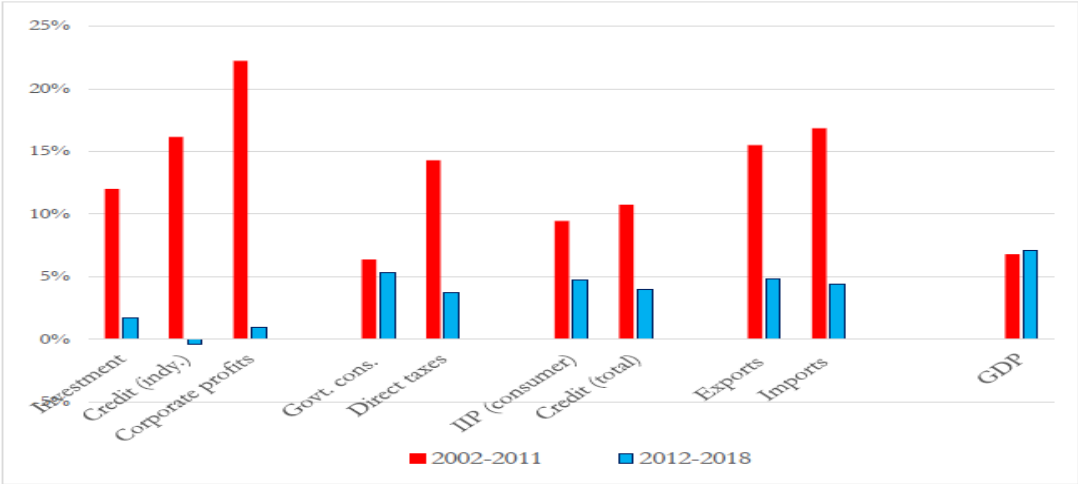
Merely concentration on the current development is the major issue associated with the cyclicalists. Consequently, they lose the larger picture especially the root element of the demand has been impairing for around decennary.

III. Growth Engines and emergence of the structural problems

Figure 4 demonstrates the prominent demand indicators in the pre- and post crisis periods. It is depicted that India has not redeemed from the Global Financial Crisis. Exports and investment has been the driving force of growth during 2002-11 resulting in stimulation of consumption and imports. However, after 2011, this decline is almost by double digits with the weakening of investment's average growth and real exports and imports by 12% and more.

Earlier global, cyclical and structural factors drift the economy. But now these factors are pulling the economy down.

Figure 4: Collapse in the Engines of Growth, post-GFC



Source: Subramanian, 2019

In the beginning of 2000s:

Economy of India commenced to ado, followed by recession due to:

- Due to expansion of the world economy at a fast pace in the last 40 years, upswing was evident.

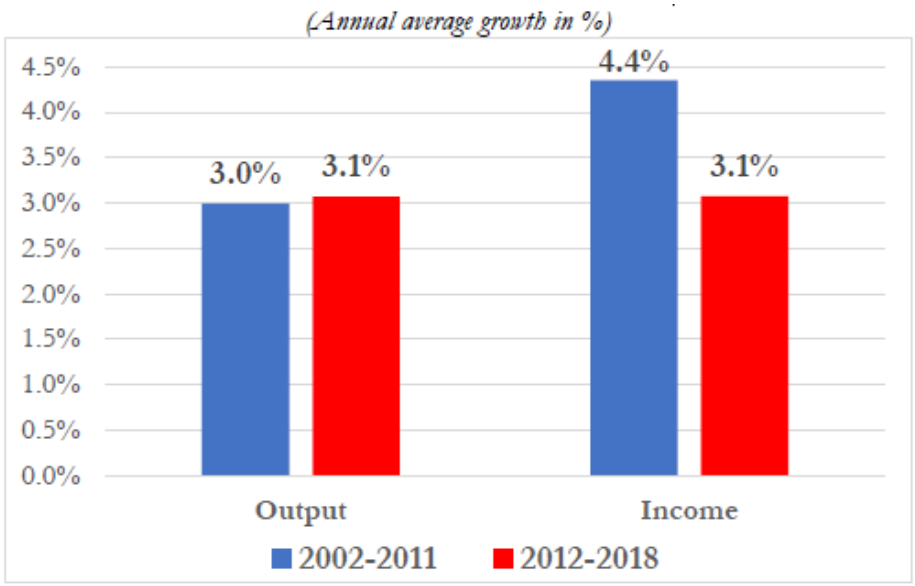
Occurrence of this convinced firms and consumers, time to receive rewards from the post-1991 payoff had appear. Now India can be the next China with the 10 percent growth rate per annum for coming decades.

Since independence India began to grow at fastest rate with boom of export, global demand mounted. This coalescence proved to be fruitful. With the rise in the confidence within 4 years investment in infrastructure escalated by 11 percentage points. This led to phenomenon amplification of the credit, alone in 2007-08 capital inflows outshine by 9 percentage of GDP. With the underpinning of global and structural factors, after few years boom collapsed

- The Indian export a rate which was 15 percentage tremble down to 5 percentage after Global Financial Crisis, 2008. Subverting

- Prices of global commodity also collapsed subverting incomes of farm. Figure 4.1 demonstrates that during 2012-2018 real agricultural income growth decreased by 1.3 percentage points.

Figure 4.1. Real Agricultural Output and Income



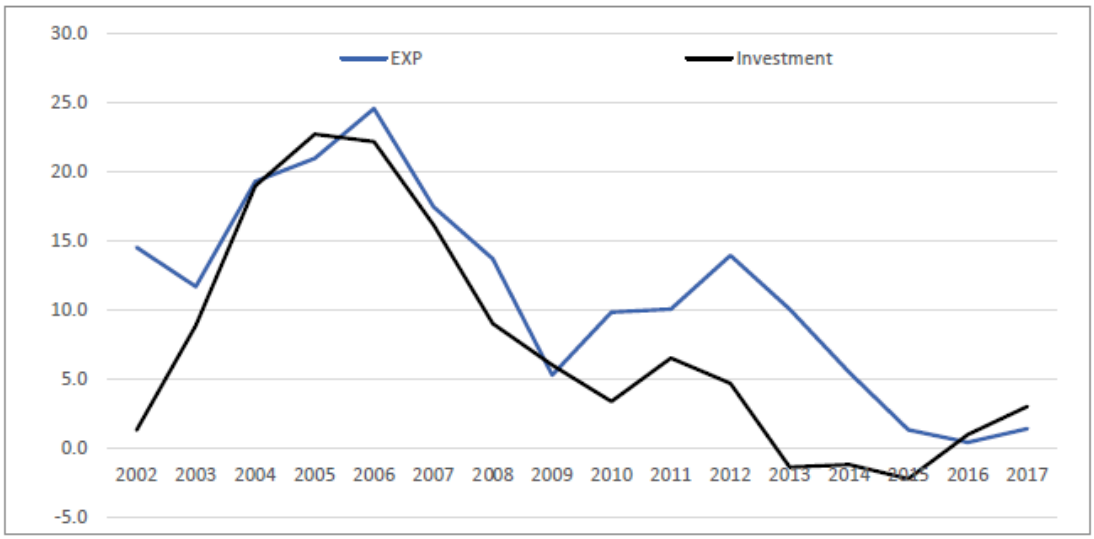
Source: WDI. Income is measured as nominal agricultural value-added deflated by the consumer price index for agricultural labor.

Out of the total debt 40 percentage was corporate debt. With the increase in corporate debt, nonperforming asset in the banking sector skyrocketed. This led to an emergence of a Twin Balance Sheet (TBS). Then many corporates were unable to endeavour new investments, those who were capable found it exacting to receive loans from banks.

The figure 4.2 depicts that in the beginning of 2010 investment growth retarded sharply post 2008 slow recovery can be observed again export continue to decelerate from 2012. This led to the structural and global problems.

With the deterioration of the real export and investment, real imports of goods and services collapsed leading to deceleration of growth rate of 13 percentage points.

Figure 4.2 Growth of Real Exports and Investment (percentage)



Source: WDI

To sum up, Indian economy has drastically depleted from GFC due structural and global factors. However, this elaboration only boosts more questions . Because, recapitalizing the banks and introducing the Insolvency and Bankruptcy Code (IBC) the TBS problem has already been identified.

IV. Unsolved TBS Stress: As the soul reason of the great Slowdown

To solve TBS problem in last few decade some improvement has been made. Beginning from the problem of the bank side. In the public sector banks huge amount of the capital has been impregnated. It facilitated the banks to write off Rs. 7.2 crore of their nonperforming assets - for the current fiscal 2.8 lakh crores budgeted. (Source: Credit Suisse).

V. Reasons of the survival of the economy.

Few domestic developments like Demonetization and GST has pulled the economic growth down. With the inducement of the various sources this negative shocks has been neutralized. From 2017-18, three cyclical factors: hidden fiscal stimulus, unexpected credit stimulus and exports strengthened the economy.

.VI. Bursting of Housing "Bubble" and causes of the current slowdown.

The collapse of ILFS in September 2018 generated the slowdown. This collapse was completely unpredictable, inspiring the market to mount and retrace the whole NBFC sector.

VII. Solution

To provide the measure to tackle the problems identification of the problem is important.

1. Identification

Regular lame solutions will not help the economy to move out of the slow pace. Identification of the problem is important. Collapse of the transmission mechanism is the main issue. If cut in repo rate is not transmitted into reducing the lending rate, the policy easing will fail to control inflation as well as to provide support to the economy.

2. Five R's

The primary action can be a Data Big bank, it not only impregnate confidence but also generates a sound foundation of policy making.

Policies required to be enacted on the 5 Rs:

- Recognition: To cover NBFCs and banks a new Asset Quality Review to be conducted
- Recapitalization: Linking recapitalization for resolution
- Resolution: To assure that the participants have incitement to solve problems
- Regulation: Enhancing oversight, eminently NBFC's
- Reform : Of shirked public sector banking

VIII. Conclusions:

Two driving force of the economic growth- export and investment has sputtered after 2008, which resulted the collapse of the economy since then. At present, consumption another agent of economic growth is also halted. After identifying the problem implementing the solution in the form of 5Rs will help the economy to regain the speed in growth rate.

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BOOK: RECENT TRENDS IN HUMANITIES AND SOCIAL SCIENCES

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The East – West Technological Synergies During The World Wars with Special Reference to Modern Transport in British India

Dr. Satwant Balse,

Assistant Professor,

Department of History,

KET's V. G. Vaze College of Arts, Science and Commerce,

Mulund -E, Mumbai, 400081.

ABSTRACT

The technological inventions and innovations of the first and second world wars continue to have its impact in the contemporary world. As the world wars created severe restrictions in trade huge synergetic efforts of western technology with resources of the European colonies was evolved to meet the war requirements. My paper attempts to explore innovative technologies that evolved in India to meet the shortage of machinery and products used in its manufacturing and assembly units to fulfil war time requirements. It will also bring into focus the ways transport logistics were modified in Indian workshops to be exported to support the British and its allies in their war efforts. To highlight areas which further needs to be re-visited, to understand ways in which the inventions and innovations of the two world wars long-term effects on humanity had will also be one of the goals of this paper. The paper will be a critique on the mixed impact of world wars on technological transfer from west to east with special reference to India.

The sources used for data collection will be relevant government reports available in Maharashtra State Archives, Mumbai; primary and secondary sources from libraries of Asiatic Society and University of Mumbai, Times of India Archives and internet resources.

Keywords: Impact of World Wars, Technological innovations during World Wars, Role of India in World Wars

Introduction

The two world wars are testimony of brutal exploitation of the material and human resources of the colonies by their imperial masters. The modern transport system aided the western imperialism and served their war efforts. Prior to the World Wars the workshops of Indian Railways and troops were utilized for British expedition in Asia and Africa.[1] With vast resources of India, large network of railways under their command and highly reliable Indian troops, the British made India a participant in both the wars. The immediate impact of war was cessation of trade with hostile powers and gigantic demands of the war. It created shortages hampering industry and trade. Industrialization in India was encouraged to fulfil these shortages.

First World War (1914 – 1918)

The first World War promoted a new era of industrialized warfare. Territories of Ottoman Empire, a German ally, formed the eastern theatre of the war making India the main operational base for the British in the east. The exhausting demand for personnel and materials made India a major supplier at both eastern and western front.[2] Indian Railways supplied locomotives, rolling stock, rail-lines and other goods. Railway coaches were converted for military movements, food grains and ancillary supplies. They were customized for use in desert regions. Portable buildings, pontoon bridge work, hospital furniture was made in Jhansi. Special kind of engines were used to draw the goods trains into the workshops at Matunga, Mumbai (then, Bombay) from Kolkata (then, Calcutta).[3] The North Western Railways (NWR) converted 11 bogie carriages into an entirely new hospital train with separate ward cars for officers, medical staff, dispensary, kitchen and store. The Railways organized training camps of volunteers and army personnel to form railway maintenance gangs in Mesopotamia. A training school was opened for railway telegraph signallers and assistant station masters to be sent overseas or replace the senior railway staff who joined the military railways. The workshops used scrap iron and tyres to make new machinery. The spring steel rolls and lathes manufactured in Great Indian Peninsular Railways (GIPR) workshops inspired the other railways. Painting, grinding and the field cutting machines were constructed. The red and white lead used for painting the rolling stock used to be imported from Europe. As their imports stopped local slates and clays were used to manufacture paints giving modified hues to vans and coaches. The innovations of the workshop proved very successful. The military traffic created extra burden on the railways. A Controller of Traffic was appointed for efficient management of military and civilian railway traffic. The passenger services were heavily cut down to make way for military traffic.[4]

Motorised transport also formed a major source of logistic support. Through India War Fund 56 ambulances from United Provinces were gifted to the British Naval Transport Medical service.[5] The Railway Companies of India provided extensive motor transport service during the war in Mesopotamia, East Africa and other theatres of the War. The chassis of the ford cars arrived at Kolkata. They were transported to Matunga railway workshop, customized for war requirements and shipped out. Motor transport facilitated speedy delivery of mails to different parts of the country. The mechanism for motor vehicles were simplified to suit India's hot climate. The workshop manufactured first cell charging van in 1918 and by 1920 it was modified to manufacture wagons.[6] The Tata Iron & Steel Company (TISCO) was given contract to supply rail lines for Mesopotamia where 1500 miles of railway lines were

constructed by the British. The transport services provided from India became one of the main causes of the success in the Mesopotamian Campaign.[7]

The newly constructed Alexandra Docks in Mumbai became the main outlet for transport of army personnel and materials. From 21st August 1918 onwards convoys carrying men and supplies sailed out to various destinations. The largest one being of about 80 vessels from Mumbai and Karachi. For anchoring of these ships new mark buoys were laid out occupying the major coastal waters of Mumbai.[8] Bombay Port Trust Railway was opened on 1st January 1915 to meet the military traffic requirements.[9]

Second World War (1939 – 1945)

Once again, India became a crucial defence base and supplied troops, food and various goods to different war theatres, due to her location at the centre of communication lines between United Kingdom and her colonies/dominions. About 40,000 tons per month of grains, 3/4ths of cement and steel produce, 1/10th of India's railway carriages, almost entire production of woollen textiles, timber, leather goods, was the estimated requirement from India. Different parts of India were transformed into factories producing military uniforms, parachutes, boots, ammunitions, machine parts, binoculars. Matunga workshop built motor trolleys and ambulance trains for the defence department. The goods and services provided by India valued more than £ 2 billion, making India's contribution largest next to Britain.[10]

The War created two automobile giants of India – the Tatas and Mahindra &Mahindra. The Tata Company and East Indian Railways jointly manufactured the first mass produced armoured vehicle of India -the ACV Indian Pattern. Modelled after the Ford Chassis, Canada it was popularly known as the 'Tatanagars'.[11] J.C. Mahindra, the commercial head of TISCO was appointed as the Iron and steel controller of India during the War. In 1945 along with his brother K.C. Mahindra and friend Malik Ghulam Mohammed he founded the Mahindra & Mohammed a steel trading company in Ludhiana. After Ghulam Mohammed migrated to Pakistan the company was renamed as Mahindra & Mahindra and got into manufacturing jeeps and military vehicles.[12] *

The Second World War brought the air-battle to larger prominence. Indian fighter pilots participated in the Battle of Britain. Indian air space became a convenient aerial route for Americans to supply materials to China against Japan, bypassing the Japanese occupied Burma. Kolkata's proximity to China made it crucial military base of the allied powers.[13]

Effects

The demands of the wars put severe strain on the railway administration and road transport services which was already coping with difficulties of managing traffic in normal times. Traffic congestions disrupted the life of the people in multiple ways. Less used railway tracks were dismantled to meet war demands. During the year 1917-18, 423 miles of open rails were dismantled and despatched abroad to build military railways.[14] As the sea route from Kolkata was closed, the coals shipments were diverted through railways severely adding to the congestion. Restriction of development funds and shortage of rolling stock and other machinery deteriorated the standard of rolling stock, railways, roads and bridges.[15] Restrictions were placed on use of Class I coal for steam locomotives. Experiments were conducted in use of pulverised coal. The NWR introduced locomotives using oil-fuels. The supply of steel and pig iron for war created problems in replacing the railway wooden sleepers of durable timber. As timber was in short supply the option of using treated softer wood was adopted. The NWR installed creosoting plant to treat 300,000 tonnes per year of softer wood by 1919-20. Till then the Government of Nepal supplied 200,000 sal sleepers procured from Nepal's Sarda forest. Other railways began experimenting with concrete sleepers.[16]

The World Wars disrupted the industrial units in Britain and Europe paving way for industrial growth of India – specifically the textile industries. Indian manufactured products re-entered the domestic markets. By 1945 Indian textiles formed 75% of the Indian market. When situation normalized the British continued the practice of suppressing Indian competition. V.O. Chidambaram Pillai was permitted to open a Shipping Company in Chennai (then Madras) during the First World War. His success alarmed the British so much that when regulations did not discourage his enterprise, he was arrested for his nationalistic activities which destroyed his industry.[17]

Cessation of hostilities in 1918 did not help to bring relief to the people from shortages of food and materials, inflation and chaotic traffic conditions. During the Civil Disobedience movement public anger often targeted the railways which was looked as the symbol of British imperialism. Railway issues were repeatedly raised in the Legislative Assembly. In 1920 the Acworth Committee was formed and following its recommendations the Railway Board was created. Railway finance was separated from the general budget. It helped in improving maintenance works. The whole railway system was overhauled. India's first electrified train was inaugurated in Mumbai in 1925. Gradually railways recovered from the wartime loses. This progress was not sustained as the Great Depression of 1929 led to heavy

cut-down on maintenance and new works. By the time the Second World War broke out the railways were even less prepared than in 1918.[18]

India's forced participation exposed her to Britain's enemies. On 22nd September 1914, Chennai port was bombarded by German light cruiser SMS Emden. During Second World War after Japanese occupation of Burma about 700 Tamil refugees fled and reached Chennai via Kolkata. The Japanese air force bombarded Vishakhapatnam and Chennai creating panic. About 50,000 people left Chennai everyday creating immense overcrowding in the trains.[19] The Japanese air-force bombarded Kolkata on 20th December 1942 destroying the city's infrastructure. The aerial attacks continued right up to 1944 till the Japanese diverted their attention to other targets. Japanese bombardment cost hundreds of lives and destruction of properties.[20] Throughout the war period the threat of air and naval attacks loomed over Mumbai. Air Raid Precaution (ARP) Schemes were introduced. Police personnel were given training in ARP regularly.[21] The worst impact of the War was the Bengal famine killing 3 ½ million people. The scorch earth policy followed due to fear of Japanese invasion created severe food shortage. The disinclination of the British War Cabinet to divert food supplies to India escalated the death toll.[22]

The 1942 'Quit India' movement saw even bigger participation of people often directing their anger towards railways, tramways, communication installations and Government offices.[23] The Naval Mutiny of 1945 at Mumbai's dock ultimately sent a strong message that Indian forces were no longer the strong pillar of the British empire.

Conclusion

The First World War with new methods and war machinery had no precedence. As seen above technological innovations and challenges of heavy traffic for military and civilian needs created whole new exercise in traffic, materials, operations, human resource and crisis management. It required meticulous synergizing of the strengths and opportunities available. Without this synergy of western power and eastern resources the wars could not have been carried out over the years or taken to its desired conclusion. Second World War had several theatres of war with more sophisticated transport, communication systems and weaponry demanding higher specialized skills. The two world wars continue to impact even now, and a deeper study, from both transnational and regional perspective, is required to understand the evolution of the events and systems of current times. The casualties of wars usually focus on areas of open conflicts. To these deaths caused due to overall impact of wars in different facets of lives of people involved in various capacities in a war should be calculated to know its actual cost on human lives.

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TWO- DAY INTERDISCIPLINARY NATIONAL SEMINAR

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SUBALTERN MOVEMENTS IN INDIA:

ISSUES AND CHALLENGES

DR. SATWANT BALSE

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MUSIC AND LITERATURE: SUBALTERN VOICES FROM PUNJAB

Dr. Satwant Balse
Assistant Professor of History
V.G. Vaze College of Arts, Science, and Commerce,
Mulund-East, Mumbai.
Email: satwantbalse@gmail.com

Keywords: Subaltern Studies, Punjabi Dalit Literature, Punjabi literature and resistance, Feminist writers, Punjabi Music, and Assertion.

Abstract

Punjab has a long history of people's resistance. Music and literature have served as channels of identity assertion, trauma, resistance, preserving memories, hope and spiritual/religious life of common people. Sufism and Bhakti Movement of medieval India have been credited to provide the base for voicing and mobilizing popular movements of undivided Punjab and the post-independent Indian Punjab. The emergence of Dalit identity assertions has been a significant factor in the growth of prose, poetry and musical traditions of Punjab. The paper attempts to study the growth of subaltern assertions through Punjab's musical and literary traditions. It examines various influences through the ages – Sufism, Bhakti Movement, role of Sikh Gurus and Sant Ravidas, conditions provided during British rule, Dr. B.R. Ambedkar to form varied shades of assertions of the subalterns in Punjab. The languages that form literature of Punjab are – Punjabi, Urdu, regional languages of north India and Deccan. I have also read historiographies on Punjab's literature in English.

Introduction

The growth of regional literature of Punjab is attributed to – the evolution of universal spiritualism, syncretism and egalitarianism promoted by the Saint tradition, Sufism, Islam and Sikhism; and formation of two scripts: Shahmukhi and Gurmukhi. Shahmukhi evolved

from the Perso-Arabic script used by Sufi saints to write in Punjabi. The Gurmukhi script evolved from the Brahmi system to compile verses of Sikh Gurus, Sants, and Pirs. It was modified in its present form by the second Sikh Guru Angad Dev. The spiritual/religious literature: Sufi, *Gurmat* (Sikh scriptures), and *Sant Sahit* propagated respect for human beings, deep devotion, righteous living, company of holy people and perpetual guidance of a teacher (Guru/murshid). The Punjabi secular literature largely in form of *Qisse* (storytelling) covered a whole range of human emotions, ethics and common man's voice against oppression. They added depth and richness to the Punjabi folk music and poetry. It's with this foundation one can examine the tradition of assertion and resistance in Punjab.[24]

Medieval Punjab

Sufi poets like Shah Hussain and Bulleh Shah fearlessly condemned the oppressive actions of the Mughal forces. The execution of Dulla Bhatti- the legendary bandit leader on orders of Emperor Akbar was publicly lamented by Shah Hussein. Earlier writers described Dulla as a leader of marauders, the current writers like Gaur hail him as "The Robin Hood of Punjab" for distributing his stolen wealth among the poor and rescuing the abducted women. His banditry has been justified as a class struggle against the central revenue system and standing up for the downtrodden. He is fondly remembered each year on Lohri festival through his composition – *Sundar mundariye, Hoye; tera kaun vichara, hoye*. Gaur states that Dulla deserves much more attention for leading a peasant rebellion than being placed at the fringe of the medieval Punjab's historiography.[25]

Bulleh Shah and Waris Shah were contemporaries of Emperor Aurangzeb. Bulleh Shah in defiance to Emperor's ban against music and dance traveled through villages singing and dancing to his own compositions.[26] His humanist style has made him the most influential poet across various cultural boundaries. Waris Shah's *Heer* challenges political and religious institutional control over human life. It gives a detailed realistic and captivating description of Punjabi folklife of the eighteenth century. Sufi Ali Haider's poetry is a first-person account of Nadir Shah's invasion of India. He slams the failure of the Indian ruling class to protect its people and their ill-treatment of the working class.[27]

The egalitarian spiritualism of Sikhism is composed in the *Guru Granth Sahib* over 1,450 pages with 5,894 verses set to thirty-one ragas. The verses and life- stories of the Sikh Gurus aimed at empowering people to follow their spiritual path, challenge orthodoxy, and oppression. Guru Nanak, criticizing caste discrimination proclaimed:

Lowliest among lowliest, the lowliest of all
Nanak is with them and doesn't envy the big.

Guru Gobind Singh's energizing hymns and *Khalsa* formation became the ultimate weapon of empowerment. It integrated and mobilized people from all sections of society with Dalits forming the backbone of a long and intensive struggle for liberation.[28]

The literary works were set to classical, semi-classical and folk traditions. The sixth Guru Hargobindji commissioned the rural bards – *Dhaddis* who use Dhadd and sarangi to sing ballads. He trained them to sing Gurbanis and events associated with Sikhism. *Dhaddis*, with their wide outreach among common people, made a significant contribution in spreading Sikhism and instilling a desire for justice and liberation. Later, the scope of Dhaddi widened to include ballads of Dulla Bhatti, Bhagat Singh, Udham Singh and addressing various social issues. Currently, the participation of women as dhaddis has gained huge popularity.[29]

Dalit Poets

The spiritual inclusiveness encouraged education and vibrant literary activity among all castes and communities. It began with deep intellectual and spiritual contemplation gradually leading to strong identity construction. Within the Sikh fold, four Dalit poets emerged between 17th to early 20th centuries – Bhai Jaitaji, Sant Wazir Singh, Giani Ditt Singh, and Sadhu Daya Singh. Bhai Jaitaji closely associated with Guru Gobind Singh's household became the first Punjabi Dalit poet. He composed *Sri Gur Katha* a detailed biographical work on Guru Gobind Singh. It is highly acclaimed for the usage of a high standard of literary techniques. Sant Wazir Singh (1790 – 1859) won the title of *Mahakavi* due to his voluminous poetic works in Punjabi and Braj. Mid - 19th century saw the reversal of caste-based discriminatory praxis in Punjab. Wazir Singh boldly lashed out at Brahmanical order, deviation of Sikhs from ideals prescribed by the Gurus, denounced the upper caste ill-treatment of women, female infanticide and gave graphic details of opposition against him from the vested interests. He traveled widely and wrote ethnographical accounts of the societies in Punjab and other regions. Among his large followers was Narang Devi, the first woman Punjabi Poet. Her poetries severely criticized social hypocrisies with detailed clarity.[30]

British Period

Giani Ditt Singh (1850-1901), a contemporary of Swami Dayanand Saraswati, was Professor of Punjabi at the Oriental College, Lahore and became the main pillar of the Singh Sabha Movement. From 1887 – 1901 he was the editor of the Lahore Singh Sabha's *Khalsa Akhbar* and was a major force in the establishment of Khalsa College, Amritsar. He voiced against regressive tendencies creeping among the Sikhs and published a write up of his polemic with Swami Dayanand Saraswati.[31] Giani Ditt's *Abla Nind* is a critique of Sadhu Gulabdas's

asylum to Piro Preman who had escaped oppressive confinement. Acclaimed as the first revolutionary female Punjabi poetess, Piro composed 160 *Kafis* which reflect her courageous fight against patriarchy and its evils.[32]

Daya Singh mastered the Sikh scriptures, Punjabi Qisse, Sanskrit, Arabic, and Persian. His poetic work, *Fanaa da Makan* expresses deep contempt towards growing communal tensions, Brahmanical ritualism, and idolatry. His lyrical poetry *Zindagi Bilas*(1916) made him a household name. It defines each year of human life, promotes the practice of good deeds and high moral standards by emphasizing the mortality of human life.[33]

The exceptional literary achievements of the Dalits and their service towards Sikhism were published widely due to the advent of the print media. Yet their contributions do not find a significant place in standard works of Historiography of Punjabi Literature. They remained ignored or at the best received passing reference reflecting caste discrimination that had crept in from the post- Ranjit Singh era.[34]

Power of Jugni & *Pagdi Sambhal Jatta*

Folk music became a powerful vehicle to inspire anti-colonial movement. In the Punjabi folk narrative, *Jugni* is a medium to express events or/and conditions of people. She is the omnipresent imaginary woman hovering over the sky keenly observing situations in villages and towns. In 1897 the circulation of Jubilee torch throughout the British empire to mark Queen Victoria's Diamond Jubilee year met with people's resistance in Punjab. They were still reeling under the impact of the Anglo –Sikh wars, famine of 1869, the Land Alienation Act 1900 and the growing landlessness and indebtedness among the farmers. Two local bards Manda and Bishana revived *Jugni* in Dhaddi style to counter the jubilee celebrations with dissident narratives of the British excesses. The masses identified with *Jugni* songs and gave support to Bishna - Manda to set up their tents opposite the venues of Jubilee celebrations. Every verse of the *Jugni* narrative commenced with the name of the place she visited and summarizes the condition of its people. For example,

Jugni stumbles in Majitha
No woman grinds the hand-mill
For their young sons have been killed
Tears stream down their eyes
But their lips are sewn
Oh my Peer, Jugni comes and wonders
What torches have they lit, she ponders?[35]

The *Jugni* of Bishana – Manda resulted in popular protests at the celebration venues. In 1906, they were arrested in Gujranwala and killed in custody. However, the spirit of resistance coninued. In 1906 the passing of Colonisation Bill erupted into a powerful peasant movement. Bankeylal's poem "*Pagadi Sambhal Jatta*" became the slogan of this movement. Peasant riots broke throughout Punjab spilling into the army ranks. The agitation ended with mass arrests and deportation of the leaders like Lala Lajpat Rai and Sardar Ajit Singh.[36]

The New Wave

During the 1920s the spread of western education, growth of socialism and exposure to the western world created a new wave of literary activities. Still a focussed attention on the problems of Dalits was lacking. It was Bhagat Singh, who in his article – "Achhut De Sawal" published in a Punjabi weekly *Kirti* (1928) called upon the Dalits to unite for their rights. The *Ad Dharm Movement* by Mangooram Mugowalia aimed at empowering the Dalits through 'cultural transformation, spiritual regeneration, and political assertion'. During the census of 1931, about 418,789 Dalits registered themselves as *Ad Dharmis* expressing clear dissention from the major religions. The Chamar caste expressed their assertion by forming the Ravidasia Sect. These developments had a profound influence on the growth of Dalit literature in the Post-independent phase.[37]

In 1935, inspired by The International Conference of Writers in Paris, a Conference of the Indian Progressives in Lucknow presided by Premchand created awareness about a writer's responsibility towards the readers. This led to the rise of short stories centered around common people. Saadat Hussain Manto's short stories (*Tamasha, Toba Tek Singh, 1919 Ki Ek Baat)* set against anti-Rowlatt Agitation, Jallianwala Bagh Massacre and partition riots cover characters who get overshadowed by narratives of more visible sections. Amrita Pritam's *Pinjar* and Rajendra Singh Bedi's *Lajwanti* narrated victimization of women and their social isolation.[38]

Growth of Dalit identity consciousness and feminist writers

In the post-independence period the Dalits began examining social discrimination from socialist or Dr. Ambedkar's perspectives which had laid dormant under religious affiliation. Gurdial Singh's novels highlighted the plight of Dalits under the State's economic policies favoring the upper classes. His *Madi da Diva* became the first Punjabi novel to have a Dalit as the lead character. It was published at the time when the green revolution had uprooted the Dalits from villages into the urban areas for their survival. His novels shaped the political visions of the Dalits in Punjab in the post-1960s.[39]

Gurdas Ram Alam, inspired by his own experience as the construction child-labor is considered the first Dalit poet representing Dalit consciousness. His poetries had mass appeal due to its simple language. His famous works are *'Inquilabi Aggu'* and *'Patni da Gilla'*. Known as Lok-Kavi and an Ambedkar Missionary poet, an award for his genre has been instituted in his name.[40]

During the 1960s rise of Naxalism in Punjab influenced two Dalit poets- Sant Ram Udasi and Lal Singh Dil. Sant Ram Udasi is well known for his radical poetries like *Lahu Bhije Phool*. Dil's works express social attrocities with such realism that he is acclaimed as the 'bard' of Punjab's Naxalite Movement. His works *Satluj di Hava* (1971), *Bahut Saare Suraj* (1982), and *Sathar* (1997) have an illustrious space in Punjabi literature.[41]

Growth of Punjabi short stories strengthened the formation of Dalit identity. Attarjit's *Bithalu Chamiar* is a pioneer work in this genre. Bhagwant Rasulpuri, Gulzar Mohammed Goria, Mohan Philoria, Gurmit Kadialavi profoundlu enthused with Ambedkarite ideology were the Dalit writers of the 1980s-90s.[42]

The Punjabi literature of feminist writers is autobiographical. Amrita Pritam, the first woman recipient of the Sahitya Akademy Award, in her *Raseedi Ticket* presents chronologically significant events of her life. Defying the traditions, she narrates honestly about her dreams and relationships. Ajeet Cour known as a crusader of women's issues has brilliantly analyzed the unequal position women have to men in *Khanabadosh and Koorha Kabaarha.* While *Novembara Chaurasi* (November 1984) narrates graphic details of the Sikh genocide in Delhi following Mrs. Gandhi's assassination. Bachint Kaur's *Pagdandian* describes the preference of the male child, life with an indifferent husband and her struggles culminating in her rise as a successful writer.[43]

Autobiographies are also prominent among the Punjabi Dalit writers. Lal Singh Dil's *Dastan* shares his experiences on untouchability praxis in Punjab. Prem Gorky's *Gair Hazir Admi* (1994) depicts his frustration due to landlessness. Balbir Madhopuri's *Changia Rukh* narrates isolated locale of the untouchables in villages. Absence of women Dalit writers and Jatts as immediate oppressors are other features of Dalit Punjabi literature. Attarjit's autobiography narrates Dalits challenging Jatts on issues of self-respect.[44] The Dalits of Punjab constitute 31.9% of Punjab's total population. Their share in the ownership of land is the lowest, 3.20% of the total land holdings in the State. This explains the reason for economic disparity related to land ownership being a prominent part of Dalit assertion.[45]

The current Punjabi music world has the towering presence of Dalit women artists like Neelam Thakarwal, Rajni Thakarwal, and Ginni Mahi. Their music albums dedicated to Guru

Ravidas, Kanshi Ram, Babasaheb Ambedkar, and Mayawati have made them the symbol of Dalit assertion. Gini Mahi's 'Danger Chamar' made her an overnight international star and her 'Fan ha Baba Saheb Di' established her as the Dalit Youth Icon.[46] It presents pride in identity and determination to move forward in their terms.

Conclusion

Literature and music are cultural evidence of a region. The role of Punjab's musical and literary tradition in the formation of assertion and resistance through the ages has been discussed. Punjab has witnessed remarkable synergy between diverse groups during medieval times. Despite the revival of discriminatory practices, the spirit of assertion and resistance never fizzled out. It has found new grounds. Recently women and Dalits have demanded participation in Gurdwara management committees. The Punjabi literature does not receive much attention in the historiography of subaltern studies. A lot has to do with a lack of translation of key works in English and other languages. The Indian diaspora has contributed to subaltern studies but just about touch the surface of the current ground realities. Special efforts within Punjab are required to encourage women writers and to translate Punjab's rich literature which has high potential to perhaps re-write the subaltern history.

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Presentation on Myths in Floor Patterns: Deconstructing the Rangoli

Dr. Preeta Nilesh

Professor & Head, Dept. of History,

Vaze College (Autonomous)

(Abstract for the International Conference on 'Mythology in Indian Culture, Literature and Art, January 30 & 31, 2020 organised by the Depts. of English & History, Sophia College (Autonomous)

Abstract:

While Rangolis are created for their decorative value, they are drawn most often at door entrances as a talisman for good luck and to ward away evil forces attempting to enter homes. This folk art that is known by various names has attached myths, legends and a cultural significance.

This paper attempts to study various rangoli patterns drawn in India, know the nomenclature and understand the logic and significance behind the colours, designs, materials used and associated stories with a view to analysing and critiquing the traditions, mythologies and folklore associated with them.

The paper is constructed using oral history in addition to secondary sources and internet resources.

Introduction:

Rangoli is a sanskrit word which means a creative expression of art through the use of color or a row of colours. It is a Hindu folk art, in which patterns are created on the floor in living rooms or courtyards using materials such as colored rice, dry flour, colored sand or flower petals on special festive occasions. It is usually drawn by Indian women in front of their doors or gates to provide a warm and colorful welcome to visitors. It is looked upon as a talisman, bringing in good luck into the household.

While the most important place for the floor design is the front of the main entrance, on festive days it is also made in the verandah, the forecourt and the floors inside the house, especially in the kitchen and in front of the altar. This floor art is practised in various parts of India and its significance is much wider than the aesthetic and decorative; it is a ritual rooted in emotion and myth.

Known by various names, this art is attached to folklore and legends and has a cultural significance. The symbolic interpretations of Rangolis have only added colour to our socio-cultural history.

This paper attempts to study various rangoli patterns drawn in India, know the nomenclature and understand the logic and significance behind the colours, designs, materials used and associated stories with a view to analysing and critiquing the traditions, mythologies and folklore associated with them.

The paper is constructed using oral history in addition to secondary sources and internet resources. Interviews, Case studies of temple priests, householders-men and women,

Historical Background:

The origin of rangoli goes back to the past and scholars of Indian arts have tried to show its link with ancient magic rites and rituals. Parallels can be drawn with early rock paintings of India and drawings found on seals and amulets of the Indus valley where motifs like the Swastika, spirals, knots, the mother goddess and snakes are found, [47] motifs commonly used in the rangoli art even today. There is every possibility of the absorption of this practice by the Aryans who gave it a new form; that of decorating the Vedic altars with the various shapes like lines, triangles, circles, semi-circles, squares, lotuses etc. drawn with the help of grains, flour, turmeric, vermillion, flowers and leaves. Almost all the Puranas enjoin drawing of diagrams on the floor in some form or the other, related to various occasions and rituals like *vratas*.[48] Allusion to this art is found in the Ramayana and Mahabharata too. There are references to rangoli at Sita's wedding pavilion where rangoli designs adorned the floors. Also, Sita was protected by the enchanted circle drawn round her hut by Lakshamana and she was asked not to cross the latter during her protector's absence. As per oral traditions, this enchanted circle was rangoli.

Stories in the Puranas and other religious writings highlight the importance of drawing rangolis and the benefits gained thereby. Stories have been woven around rituals so as to encourage people to follow the practice of writing rangolis ritually and religiously, so as to avail of physical and spiritual benefits.

Floor Art Outside India:

Interestingly, floor paintings are a ritualistic part of many other ancient cultures too. In America the Native tribal medicine men drew patterns on floors to invite friendly spirits and

cure patients. The Australian aborigines too created dot paintings to depict their dreamtime stories. These dot paintings drawn by the elders in the clan, were used to cover secret-sacred ceremonies, the details of which were not revealed to anyone outside the clan.. African aborigines also drew magic diagrams on the floor with respect to rites of fertility and creation.[49] Vever designs in the island of Haiti, the Tibetan sand paintings, Japanese tray pictures as also the table decking at the European courts are other examples of similar art that are being studied today to understand the symbolisms, myth and magic associated with them.

Though floor painting was practised in many cultures throughout the world, as a day to day practice, it has survived primarily in India.

Rangoli in the Modern Period/ Nomenclature:

It is believed that the tradition of Rangoli originated in Maharastra and slowly disseminated to other parts of India. Rangoli or Floor art is known as Chowk purna in Chhattisgarh, Mandana in Rajasthan, Aripan in Bihar, Alpana in Bengal, Rangoli in Maharashtra, Rangavalli in Karnataka, Kolam in Tamil Nadu, Muggulu or Muggu in Andhra Pradhesh, Alikhthap in Kumaon, Poovidal in Kerala, Osa or Jhunti in Orissa,and Saathiya in Gujarat. While the nomenclature of rangoli and style may vary, there exists a substantial similarity in spirit and culture and this feature gives it its diversity and uniqueness.[50] Rangolis can be vivid, a three-dimensional art complete with shadings or they can be the traditional plain, yet as beautiful as, two-dimensional designs.

The colored powder is usually applied freehand by letting it run from the gap formed by pinching the thumb and the forefinger. Typically a Rangoli begins with a grid of dots being made. The more the dots, the more elaborate the patterns. There are modern and traditional rangoli designs. The designs are usually inspired by nature, but they may also be in the form of abstract art. They are simple geometric shapes or shapes of gods and goddesses.

While in Maharashtra, rangolis are drawn on the doors of homes, Alpana designs in Bengal are often associated with designs on utensils. Aipan, the rangoli of Kumaon, in the state of Uttarakhand is also used to decorate walls at the places of worship,[51] and the Pookolum or flower rangoli of Kerala is associated with the welcome given to Lord Mahabali for Onam, the harvest festival of the state.

Muslims draw Alpanas at their weddings and they use turmeric paste for the Alpanas. These diagrams also form an important part of the spiritual and mystical practices of the Buddhist and Jain traditions too. The practice of decorating the threshold is also seen in Parsi households. Since time immemorial,

the floor art forms an important aspect of tribal tradition too. Though not practised everyday, it forms one of the important components of any ritual.[52]

The purpose of rangoli is decoration[53], and it is thought to bring good luck. Design depictions vary from state to state as they reflect traditions, folklore and practices that are unique to each area.

Among the Warlis, at the time of marriage, a circular rangoli, which they call bhovara is drawn and the groom and the bride stand on it. According to tradition, they should not cross over the boundary line of the bhovara, because belief is that if one crosses it, the other partner flees away. Such patterns are also at the time of funeral rites and the body of the deceased is kept on it. It is believed that the tree grows in these circles.

Also, on the morning of the wedding day, a chowk (square diagram) is drawn around the umbar tree and the tiger God (Waghdev) implying that before the actual wedding of the couple, these two have to be united Yashodhara Dalmia, *The Painted World of Warlis*, Lalit Kala Academy, New Delhi, 1988, p.109.

Myths about Rangolis: Rangolis have attached myths that deal with decoration, auspiciousness, performance of duties and other attributes.

ALANKARA

As per traditional Indian culture, only things or places covered with ornaments or decorations are beautiful. Just as alankara, the metaphors, alliterations etc. adorn poetry and music, decorations adorn the house of god and men. Ornamentation on the house of God and also on the houses of men is believed to be auspicious and to promote prosperity, well-being etc. and to avert bad luck, poverty, calamities and evil spirits. It is believed that the ornamentation facilitates the process of conjuring or inviting the divinity into a statue, place or residence.

AUSPICIOUS

South Indian Rangoli, on a circular grid is usually based on geometric shapes, while in the north; rangolis are made on a square grid.

Deity impressions, flower and petal shapes, peacock motifs or auspicious symbols are the commonly used rangoli patterns. Many of these motifs are traditional and are handed down by the previous generations.

According to Mulk Raj Anand, ‘the sources of the folk painting lie in the protection sought by Homo

sapiens in the magical drawing, which may prevent the auras of bad spirits from coming into the house.' [54]

Apart from being a symbol of auspiciousness, the art of rangoli is in fact drawing of magic diagrams for rituals, a means to ward off evil, to invoke the deity, for meditative purposes and to create a sacred space within the confines of home.[55]

Rangoli patterns, used in India as a form of worshipping Hindu gods, are almost always cyclic, thereby signifying a stable state, harmony, and peace. [56]

PERFORMANCE OF RELIGIOUS DUTIES

Rangoli serves the social needs for a traditional Hindu family. It is generally believed that the rangoli drawn in front of the house is a reflection of the good culture prevailing in the house. A house whose front door has fresh rangoli each morning and is swept clean each evening is a home where religious duties are being properly enacted, evidencing internal orderliness and self-respect. A home without attention to religious ritual would be seen as a home where religion is disregarded, or where disorder was interfering with appropriate actions, or a home occupied by members of another religion or ethnic group.

MAGIC , SUPERSITION , HAPPINESS, HOPE, IDENTITY, WEALTH, PURIFICATION

Thus rangoli serves as one of the significant mediums of ensuring religious, psychological, physical, social and cultural welfare of a traditional Indian family in general and the women of the family in particular. Rangoli is also looked upon as a form of Tantric design; the designs symbolic of secret, philosophical and religious meanings.[57]

According to a legend recorded in *Chitra Lakshana*, the earliest treatise on Indian painting, a king and his kingdom were steeped in sorrow at the death of the high priest's son. Everybody prayed to Lord Brahma, who moved by the prayers, asked the king to paint a portrait of the boy on the floor so that he could breathe life into it. The young prince came to life and with that the art of floor painting came to life. And that is how rice, flour and flowers were transformed into picturesque offerings to God in the form of floor painting.[58]

During the festival of Onam in Kerala, flowers are laid down for each of the ten days of the celebration. As the myth goes, Lord Mahabali visits his subjects every year on Onam day.

In Tamil Nadu there is a prevalent myth, that Andaal[59] worshipped Lord Thirumaal and was married to him in the month of Margazhi. So during this month, unmarried girls get up before dawn and draw

a Rangoli to welcome Lord Thirumaal in the hope that they would also be fortunate to be married to a man like Lord Thirumaal. In Tamilnadu, the house without a rangoli is called *muli*, which means a woman devoid of ornaments and who if married, is not adorned with kumkum on her forehead.

Another myth that prevails is that if uniform rangoli patterns are drawn in the entire village, it would ensure prosperity for the entire village. During festivals, therefore, women set their individual creativity aside and aligned to the demands of culture or tradition. Village rules became household rules and all draw same rangoli patterns. myths can be used as a trope to secure a certain sense of individual and collective identity.

Although rangoli is made on many occasions in India, the Diwali festival witnesses the greatest use of rangoli. People make rangoli on the entrance doors of their homes on the auspicious day of Lakshmi Poojan to welcome the Goddess of wealth and fortune.

Rangolis's are drawn at sunrise, a salutation to the energizer of the universe. The Rangoli is also looked upon as a form of *surya namaskar*, an ode to the Sun God and as a symbol of purification. [60]

Myths, Physical Space and Rangoli

The threshold of the front entrance constitutes a sacred space that is identified with change in the cosmic cycle. Threshold ceremonies are performed to initiate individuals and help them to overcome and adopt new roles, including that of a householder

The threshold is symbolic of the passage from the mundane to the sacred. Rangoli being one of the mediums to attract the auspicious is made on the threshold everyday.

On festivals and occasions, elaborate rangolis are drawn. Rangolis are also drawn on the threshold as an expression of hospitality.[61]

It is also customary to see rangolis around the meal plate or the banana leaf on festive occasions, especially around the plates of the bride and bridegroom during a marriage.

This rangoli is drawn clockwise around the food offering plate arranged for the deity (which is later consumed by the priest) and in the reverse direction around the plate arranged for the ancestors' soul (which is supposed to be consumed by the crow)

Death rituals too demand the drawing of rangoli; only this time it is drawn with ash alongside the chanting or mantras around the meal plate of the priest.[62]

Rangolis are also drawn on the altar of temples in homes. This is done as a ritual in many Hindu homes.

Myths, Gender and Rangoli

Rangolis are traditionally drawn by women. Women elaborate their vision in forms by which the floor is covered with the magic potency in patterns. No brush or tool of any kind intervenes between the hand of the artist and the ground. This direct contact of the finger, powder or paste and ground allows the direct translation from her inner vision and experience into visible form. The act of drawing with the thumb and the index finger forms a type of Hasta Mudra called Gyan Mudra. As per yogic practices, this mudra is effective in cases of mental ailment, imparts happiness, develops intellect and sharpens memory. Rangoli diagrams drawn with full concentration also helps the artists achieve meditative state of mind with focused attention, thus further enhancing her well-being.

Why would a women rise early in the morning before the other members of the family and create patterns if there was no significant gain from this? While creating something that is beautiful and orderly for pleasure is one thing, it also involves the healthy physical activity of bending and stretching, and constructing something that has a beautifying impact on the environment. These are certainly good reasons for the women making rangoli.[63] It was believed that the lady of the household [64] was the grand priestess who harnessed cosmic energy and brought it into the household. The rangoli symbolized the importance of her existence despite the relegation of the Hindu woman into enclosed domestic spaces.[65]

Rangoli can be viewed as crucial to a woman's bonding to her home and relationships that enhance her identity, self-esteem and sense of capability, promoting mental, emotional and physical well- being. It is believed that the woman who creates the rangoli and maintains sacred spaces is sensitive to the stresses and needs of the family and it is her way of asserting her identity within her family and neighbourhood, establishing her role as caretaker of orderliness and appropriate relationships between her family and the divine.

There is also a belief that the painstaking drawing of the rangoli teaches women patience that they need throughout their life.[66]

She secured divine grace into her home demonstrating her personal relationship with the household deities, and establishing her relationship with the society outside the house.

Who was the woman who could write the Rangoli?

The lady was essentially a married woman with children.
Widows were not allowed to do this and
virgins could only support their mothers.
During the days of menstruation too, women were disallowed from drawing rangolis.
Rangoli was a medium used by older women to instruct and socialize younger women into tradition, ensuring continuity of culture within space.

Men traditionally do not create rangoli. Male priests were allowed to create rangolis as part of ritual but those were different from the ones created by women.[67]

Other facets of Rangoli

Rangoli making all over India, is always referred to as 'writing' and not 'drawing'. Thus in Maharashtra it is 'rangoli lihine', in the North 'chowk likhna', 'kolam ezhuthu' in Kerala and so on. This is an indication of its hieroglyphic nature, the origin of many languages in the world. Rangoli must have been a sort of picture-writing and must have preceded the development of actual writing script. [68] Rangolis have also been used to pass on messages of sorts. There exist references to simple motifs drawn on the threshold, which indicated that a member of the family was suffering from a disease like small-pox. Looking at the rangoli, people avoided entering the house.[69]

Rangoli colours, medium and associated myths:

Colour

The use of colours is a significant aspect of rangoli art. The earliest colours used included white, black, red, yellow and green. The main design was always made in white and the other colours were used for the filling. White and black, associated with concepts like good and evil, day and night had a visual appeal. White, a symbol of purity, seen in the expression 'white wash' or 'lipai' or 'lipana' has evolved into the names of rangoli in various regions like- alpana, aipan, aripan. The colour red when combined with white and yellow has a special significance in rituals. In south India, it is believed that the 'sudde mannu' or purified earth dust that is white in colour and 'kalli mannu' or red soil are husband and wife. Red clay or 'geru' is also used as a base coating for rangoli. On auspicious occasions, temples and homes are even painted in white and red. White pattern on the dark reddish packed clay floor

besides enhancing the overall effect of the patterns also act as symbols of fertilization and procreation; the white dot signifying the male and the red, the female.

The colour yellow is the colour representative of fullness and prosperity and used in weddings. It is also believed to drive away evil. Green symbolizes a new beginning, harvest, and happiness and is hence used in the rangoli. Black is considered an inauspicious colour, never to be used on auspicious occasions. But black is used to ward off the evil eye.[70]

Medium

Folk traditions believe that all material available in day to day life are worthy of serving as a medium of expression. It is also true that some scientific and spiritual aspects and religious beliefs are also attached to its usage.

Hence, in South India, Bengal and in the Konkan, where rice is abundant, rangolis are made of rice flour or rice paste. Water left behind from boiling rice or powder made by burning rice husk is also used. In other regions like Rajasthan, Gujarat, Madhya Pradesh, Uttar Pradesh, lime powder (chunna) and sometimes flour of wheat or jowar are used. Rice flour rangoli is considered as ‘bhuta yajna’ or offering of rice flour to creatures like ants and other insects, thus a good deed. Attached is also a rational explanation that the rice flour feeds ants and ensures that they do not enter the home. Rice powder is also supposed to scare away evil spirits and the designs made with rice powder are presumed to have magical power.[71] Also the belief in Hindu mythology that Hindus have a karmic obligation to feed a thousand souls or offer food to those that live among us. By providing a meal of rice flour to bugs, ants, birds and insects, the Hindu home begins the day with a ritual of generosity with a dual offering to divinity and nature.

Lime powder used for rangoli has a purificatory significance. It serves a as a disinfectant and it also has a scientific puropse in addition to a decorative one. White lime is supposed to prevent ghosts from killing family members and thus guarding the doorway.

Rangoli Designs & Myths

Mackenzie is of the view that all ancient art practices were rooted in religious and magico-religious beliefs; this goes for the role and origin of pictorial symbols as well.[72] The geometrical forms drawn in rangoli represent various gods and goddesses and natural spirits.

A downward pointing triangle represents a woman, an upward pointing triangle represented a man. A circle represented nature while a square represented culture. A lotus represented the womb. A pentagram represented Venus and the five elements.(fire, earth, wind, water & space). The loop or knot pattern in rangoli is symbolic of protection; a design representing an endless knot is also found on some Indus Valley seals.[73]

It is also believed that the rangoli patterns reflected the mood of the household. Similar patterns on a daily basis indicated discipline while beautiful patterns indicated joy and festivity. The drawing of elaborate patterns was supposed to indicate focus and dedication while shoddy patterns indicated negativity- a bad mood, a quarrel or a conflict. The absence of a rangoli in the threshold indicated that something was inappropriate in the home.

Commercializing rangoli: The modern rangoli

The rangoli continues to exist today. The materials have changed, the rangolis have become more colourful and rangoli patterns are used for alternate decorations too. This has happened perhaps as a result of migration and assimilation. There are experimental rangolis, including the floating ones, rangoli stickers, flower and grain rangolis etc. Rangoli designs on coasters, souvenirs, vases, greeting cards, jewelry boxes, key rings, bookmarks, and wall tiles and as decoration on terracotta products are commonly seen. These attractive patterns and motifs are also found in textile products like shawls, tablecloths, and bed sheets.

Thus rangolis continue to be drawn and myths continue to exist.

Conclusion:

Reflecting regional beliefs and aesthetics based on a common spiritual plane the art of floor painting is one which has survived all influences and retained and transmitted the spirit of Indian life.

Walked on by family and friends, the drawings become blurred and disappear only to be renewed the next morning. Its value lies solely in its creation and it is not meant to last. The ephemeral nature of rangoli symbolizes the frailty and the ephemeral aspect of everything in this world.

The Rangoli is never permanent. It is wiped off each morning, reminding all that things change. Yesterday's bad mood can be become tomorrow's good mood. Bad patterns can give way to good patterns. The household changes and so do its patterns. People learn and grow and with that patterns become more confident and more joyful.

Pride and Prejudice Revisited

Dr. Nilakshi Roy

Even as this is being written, someone in the world may be either reading *Pride and Prejudice* or writing another story about a Darcy and Elizabeth Bennet. Reading Jane Austen's classic novel is like a ritual participation in a legacy. It enlightens readers about what marriage is, what to expect from it and what it does to us and our lives. Over the ages, reenactments of the story have appeared, subtly, like a *Bridget Jones' Diary*, and not so subtly, like in *Jane Austen Stole my Boyfriend*, or *Pride and Prejudice and the Zombies*, and Sharon Lathon's Pemberley series that continue Elizabeth and Darcy's love.

Two film versions, by Simon Langton and Joe Wright, have remained true to the original milieu whereas *Bride and Prejudice* by Gurinder Chadha takes it totally out of context into India and America, like the popular Indian teleseries *Trishna* set in India.

The question arises: while critiquing their own social milieu adopting the trenchant satire of Austen's pen, do they offer anything to surprise, interrupt, and interpret our engagement with the experience of the original reading of the classic? The paper attempts to answer these questions in the light of the New Historicist notion of cultural exchange.

Pride and Prejudice Revisited

Adaptations are now being analysed as products of artistic creativity caught up in the ongoing whirl of intertextual transformation, to convey new meanings. In this process, for an adaptation to remain a work of art, it needs to be an independent, coherent and convincing creation with its own subtleties of meanings. Our favourite books, like Jane Austen's *Pride and Prejudice* written and revised between 1796-1811, published in 1813, possess the ability to plunge us into a magic realm, into an atmosphere that embraces all our senses. Films and other media, images, sounds, the spoken word, music, and the performing artist's mediation guide us to a new aesthetic experience, bearing intertextual echoes with the original text. Ranging from narratological to historical, the approaches by critics such as Linda Hutcheon, Thomas Leitch, Brian McFarlane, Dianne Sadoff, and Julie Sanders, have expanded the field of adaptation study beyond issues of

fidelity. The result is that, as Deborah Cartmell observes, the "most recent adaptations of *Pride and Prejudice* are ... as much dependent on previous film and television adaptations as they are on Austen's novel". (126)

Ever since the novel was adapted into a movie in 1940 by Robert Leonard, *Pride and Prejudice* in its 80 years of visual media history has engaged and intrigued the changing generation of viewers. The legacy continues even in the 21st century. Apart from the staggering number of television series and movies, *Pride and Prejudice* in its visual manifestation reveals the New Historicist notion of cultural exchange--a process by which cultural practices and images are negotiated and exchanged between two generations or historical eras. Alistair Duckworth "suggests that Austen tends to be all things to all people: conservative, feminist, Romantic, Augustan, etc." (cited in Stasio and Duncan, 144) Linda Hutcheon maintains that, in experiencing a work as an adaptation, the reader/ viewer "oscillates" between the adaptation and its source (xv). Andrew Wright asserts in a detailed evaluation of early 20th century adaptations of the novel, that even the first world versions across genres are "at least as open to challenge as the third-world versions". (424) According to New Historicists just as the author is "historically bound and cannot escape the power of her culture and ideology", the text is also used to understand the "social energy in order to decipher the ideology of a given culture." (Dogan 92)

The once much appreciated dramatization of *Pride and Prejudice* by Helen Jerome had been performed in both New York and London, in the mid 1930s. Aldous Huxley and Jane Murfin (1940), wrote a script for a film produced by Metro-Goldwyn-Mayer. Even a musical *First Impressions*, which was performed in New York in 1959, was inspired by Helen Jerome's play. There are some distinct differences in these versions, especially in the play: there are three daughters instead of five, for instance. Moreover, the type of production house of the film version and the plays determined their length and their run-time in the theatres.

Some conclusions can be drawn from the adaptation by Helen Jerome and the film and musicals: regional and historic origins of the adaptations impacted upon them, adaptations were controlled by the market and commerce by way of transmission and dissemination, and proximity to the original language was indeed important, because as Wright says, "no one writes Jane Austen so well as Jane Austen". (423)

Due to the very fact that films depend on screenplays, and therefore on literary source material as well, they are essentially doubly performative. On screen, the performers must adapt from a

written script adapted from a novel, as Leitch says, “the script is a performance text - a text that requires interpretation first by its performers and then by its audience for completion - whereas a literary text requires only interpretation by its readers.” (150 cited in Wilson, 323).

As Thomas Leitch points out, direct communication from writer to reader, which we often take for granted, is actually a two-layered adaptation between the audience and the original source.

In the film *Bride and Prejudice* scripted by Paul Mayeda Berges and directed by Gurinder Chadha, there is a unique multi-layered interface between film maker and audience**.** Cheryl L.Wilson comments that “*Bride and Prejudice* is and is not Jane Austen, is and is not Bollywood, and is and is not Hollywood, it can reach the "multi-national" audience Chadha identifies as her target by providing each viewer with something that is familiar and something that is not.” (324)

Since both the texts, the film and the novel, critique women's status, and the performance of femininity required to achieve and maintain it, with some humour, they achieve the same ends. Chadha’s position as an African-Asian immigrant originally from Punjab, is unique. Moreover she is a British film maker tying up with Hollywood, shooting in India and using conventions of Bollywood. She is both inside and outside of the West, and the East, really, as well as Hollywood, and Bollywood, introduces multi- layered nuances, regarding race, gender, family and nationality. In the words of Cheryl A Wilson, “such complication prompts a reflexive re-reading of the novel's conclusion”. (324) As a result of this mix-up, a Westernised feminist and social perspective, an extended Indian perspective of identity embedded in Bollywood, a genre she effectively uses, Chadha is able to convey the incongruities at the heart of globalised encounters, though modern, yet something akin to Jane Austen’s own perspective.

In two of the key areas, one finds that the tweaking of the plot/story; the additional layering of three different social conventions, Indian, American and British; and the use of filmic grammar, both challenge and enrich the existing fictional framework that *Pride and Prejudice* offers.

Firstly, Lalita, Chadha’s Darcy, an American, doesn’t need to rescue Lalita or even stage manage Lakhi’s wedding as Lalita herself joins him in her search for her wayward sister. Laita has more agency than Elizabeth in the original. She and Darcy also manage to fall in love and marry despite their two mothers, one who searches online on Indian matrimonial sites for a husband for her daughter, and the other who openly matchmakes for her son at a party, right in front of Lalita, his beloved.

Secondly, Darcy, by convincing his mother not to expand her hotel chain empire in India rejects the power structure his class and position offer him. However, will the mixed race couple not always have to negotiate the class and cultural difference imposed by the presence of the controlling mother-in-law in Lalita's life? Is their marriage not already fraught with the contradictions of American metropolitan/ultramodern society versus Indian rural/traditional? The adaptation thus succeeds in "ultimately tempering the celebratory ending of the film", as Wilson comments. (329)

Thirdly, Chadha had made her intentions clear about how she would make "a Bollywood-style Hindi movie that somehow interacted wholeheartedly with another cultural tradition," in this case the "English literary tradition". (Chadha and Burges cited in Wilson 331) Since both the Austenian novelistic milieu and the Bollywood format make integral use of song and dance to suggest sexual tensions and attraction, Chadha uses song and dance full tilt in her adaptation, successfully integrating the two traditions of comedy and song and dance effectively closing the gap "from Amritsar to UK."(331)

The term fanfiction**,** called fanfic for short, refers to stories produced by fans based on plot lines and characters from either a single source text or else a whole group of books. They express the passionate rendition of fans and their admiration and aspirations for their favourite characters or era, or an ethos the characters inhabiting that world, represent. These fan-created narratives often take the pre-existing storyworld in a new, sometimes bizarre, direction. While the activities of fans may take many forms, writing stories deriving from one or more source text has long been the most popular way of concretizing and disseminating their passion for a particular fictional universe. Pugh (2005) hints at the democratic quality of the genre, whereas Stasi (2006) claims that fanfic is "canny, sophisticated and resonant with postmodern textuality" (129). While some critics place fanfic alongside conventions of the literary world, critics from the media studies world consciously avoid evaluating fanfiction based on the any kind of serious evaluative criteria. Due to their tendency towards making academic value judgements, they are often called "Aca-Fans" (Thomas 3), like Jonathan Gray, Cornel Sandvoss, and S. Lee Herrington. Alan McKee (2004) accuses first-wave theorists of ignoring the discourse of fanfiction as something powerless compared to the pre-existing powerful text. Later theorists look at fanfiction as a more participatory culture: fans create communities, they are like a process, these works are like work in progress, they are additive, they want more and more of a never-ending story, they participate

in social networking, uphold standards of privacy, loyalty and belongingness. They create merchandise and tell stories about an Alternate Universe, they create new models for new theories to emerge. For example a whole new occupation or home industry has emerged, of making memorabilia and “merch” or merchandise of these fictional characters. In the case of Pride and Prejudice, through puppet-making of actors like Colin Firth and Jennifer Ehle, the larger than fiction aspect of these characters emerges: to so many fans these actors ARE Darcy and Elizabeth in their collective imagination. Bronwen Thomas shows how fanfic has evolved new terms like PWP (Plot what Plot); AU or Alternative Universe, Merchandising and OOC (Out of Character), (9) Fanon (10), in place of “canon”.

Jonathan Gray (2003) proposes new values for appreciating fan fiction, especially those related to challenge and change, and even according to genre or medium. Bronwen Thomas suggests that “we may need to explore a new understanding of aesthetic value that reflects the decentralization of contemporary culture” (13)

Sarah Cardwell justifies the use of comparative studies for "comparison of texts in different media" to gain "a fuller and more complex understanding of the specificity of the media themselves" ("Adaptation Studies" 56), while George Raitt suggests that “one must approach an adaptation as an intertext” (128), going beyond binaries and good or bad choices.

Raitt further proposes that screen adaptation, and in particular reading/viewing a screen work informed by differences, enables us to study how new and different stories actually emerge. For example, what if the heroine was not intelligent or pretty? Aragay and López Apegaon write about the post-feminist world, in the late-twentieth-century cultural context, in which women like Bridget Jones of the famous intertext *Bridget Jones’ Diary* are free to choose their lifestyle; but they are therefore free to choose even traditional roles and feel anxious in fulfilling them. Bridget is a free modern woman who is still trapped to find a socially acceptable date, first, and then a husband, in a socially acceptable dress to cover a socially unacceptable figure. Seeing her plight one feels that Elizabeth or Lydia were far better off in their times. Thus a modern adapatation actually challenges the precepts of the *Ur* text.

New teleseries are the latest to join the intertextual parapharnelia of Pride and Prejudice remakes. These texts often show how the younger generation is quite jaded in their view of the adult world, like Amanda Price in the teleseries *Lost in Austen,* whose relations with parents, her feelings of rejection and loss, colour her perceptions of love and romance as well. Through the

device of time travel, Amanda becomes an "Elizabeth Bennet figure."(Raitt 132) and starts judging the new fantasy world she inhabits with the eye of a disillusioned adolescent critical of hypocritical parents.

Amanda Price switches between the two worlds, the world of Austen in which Lizzie has left the village to stay in London, and whom she replaces at her home as if she were a secret friend. Amanda meets with the most awful of scrapes, as a result of being from the modern Amercian world thrust onto Regency England. She is unaware that her disclosure to Darcy that she is not a virgin could make a difference, and is distraught when he says he consequently cannot marry her. Darcy does not rescue the Bennet family from ruin, and it is he who articulates the world view attributed to Austen's Elizabeth when he tells Amanda he cannot marry Caroline Bingley because he does not love her. Elizabeth is in London and is not interested in marrying at all! Caroline Bingley discloses to Amanda that she is a lesbian, but is determined to marry Darcy, and will endure physical love with a man because endurance is the specialty of the female sex. After a twist in which Jane marries Mr. Collins before she realizes that Bingley loves her, Mrs. Bennet tells Amanda "there is nothing to be done for it - the world is full of miserable, loveless marriages - she will find a way to endure it - women do." Amanda using her best her post-feminist voice replies "we are not condemned to endure our lives, we can change them." But she really doesn't have the power to change anything at all.

Thus, at first glance, *Lost in Austen* portrays a post-feminist heroine making a choice to change the direction of her life, to voluntarily enter a fantasy world that limits her role as a woman. But, when the novel and television series are read /viewed together with other works like *Bridget Jones' Diary*, in an intertextual cluster, resulting differences and new interpretations tend to undermine a reading of the post-feminist view of the world in the respective literary and screen works.

Similarly, in *Jane Austen Stole My Boyfriend* by Cora HarrisonJane Austen and Jenny are friends who while away their time in Bath: dancing, shopping, watching men, fantasising over them and finally falling in love, but alongside that there's the life at Bath which complicates the innocent friendship and Jane becomes the talk of the town as a girl who steals boyfriends. This Jane is also the repository of an extraordinary imagination, fantasy, irony and capability of high flirtation, and is yet is full of vulnerable charm. The Austenesque persona is exploited by the author to carry fanfiction to the level of mock autobiographical fiction.

In Seth Grahame-Smith's *Pride and Prejudice and Zombies,* in an original twist, Austen allegedly co-authored her last novel with the American author, Seth Grahame-Smith, in April 2009, with elements of modern zombie fiction. Specifically, Grahame-Smith has meticulously preserved the original effects of dry-humour, emotions and even syntactic constructions of the original text. Also, by publicly crediting Austen co-authorship, Grahame-Smith has surpassed the boundaries of a regular adaptation, and steered a creative practice of remixing to negotiate between two eras and generations. While transforming Austen's intended social depiction from subtle metaphors to literal monsters, Seth Grahame-Smith has blended into a classical text the paradigms and conventions of horror and popular fiction.

> "It is a truth universally acknowledged that a zombie in possession of brains must be in want of more brains. Never was this truth more plain than during the recent attacks at Netherfield Park, in which a household of eighteen was slaughtered and consumed by a horde of the living dead." (Grahame-Smith 1)

So begins *Pride and Prejudice and Zombies,* the undead reformulation of the canon. Smith declares in an interview that, "The point wasn't to rewrite or modernize the original. Rather, it was to preserve as much of it as I could while surgically weaving in (as seamlessly as possible) new words, lines, paragraphs, and occasionally – pages of new battle sequences." (2009)

Therefore, the purpose of this literary-remixing is a more metaphorical reinterpretation of certain aesthetics in cultural history, under the humorous and sarcastic veils of horrification and 'zombification'. The Zombies are roaming the English country-sides and yet everyone is as excited to dress up and go for a ball to meet their probable match. As Smith further comments: "Many of Austen's characters are rather like zombies...They carry on single-mindedly in their bubbles of immense wealth and privilege, no matter what's going on around them.." (Dennis 2009), very much like Mrs Bennet during the Napoleonic wars.

Jane Austen's Elizabeth who is a strong willed, intelligent, lively, attractive girl here becomes a far more ferocious person, whose reaction to Darcy's opinion about her in the ball brings out killer instincts.

> "As Mr. Darcy walked off, Elizabeth felt her blood turn cold. She had never in her life been so insulted. The warrior code demanded she avenge her honour. Elizabeth reached down to her ankle, taking care not to draw attention. There, her hand met the dagger concealed beneath her dress. She meant to follow this proud

Mr. Darcy outside and open his throat."(Smith 15)

The Bennet sisters are trained warriors, Mr. Bennet trains them in martial arts and weapons training, moulding them into a fearsome zombie-fighting army, Elizabeth being the best among them. She can singlehandedly fight and defeat a hoard of the living dead. Even Lady Catherine is described as the greatest warrior in whole of England. This fictional, almost radical feminist, description of the Victorian women as warriors and saviours of England from the 'unmentionables' empowers the live female characters created by Austen and at the same time renders a sarcastic comment on their political nature hidden under the masks of sophistication.

Austen presents the callous argument between Lady Catherine and Elizabeth as follows:

'And will you promise me never to enter into such an engagement?' (Austen 193) Smith, however, alters the scene with a more literal expression of the characters' animosity:

"I would sooner die than see my honour so defiled." "Then Miss Bennet," said Lady Catherine, setting down her parasol and removing her coat, "die you shall." Upon this, she set her feet for combat. (Smith 193)

Seth says in an interview to Den of Geeks that "many of Austen's characters .... simply carry on with their gossip and romances and manners and balls, despite the fact that people are being gored and eaten alive." Thus, Seth Grahame Smith's creative exemplar *Pride and Prejudice and Zombies* has paid its own unique homage to this canonical text by Jane Austen in more than one way, interrupting it with references to Zombie fiction, nuancing it with radical feminist undertones, which surprise the readers and interpret the original text in a challenging way.

A YouTube video adaptation of *Pride and Prejudice* called *The Lizzie Bennet Diaries,* produced specifically for the Internet platform YouTube, transfers the story of Bennet family to the year 2012. Lizzie, an American graduate student, the protagonist and primary first-person narrator telling her story format typical of YouTube: the vlog. Biweekly, a video was posted Lizzie Bennet's YouTube channel, resulting in an adaptation that spread over the course of almost an entire year, ultimately reaching one hundred episodes on the main channel and adding up to seven to ten hours' worth video material. *The Lizzie Bennet Diaries* creators also chose to embrace a transmedial approach to the adaptation process, adding other Internet-based media like Twitter, Tumblr, Lookbook, Pinterest or Facebook to entertain fans. Followers could explore the characters', as well as the cast and crew's social media profiles. Additionally, *The Secret Diaries of Lizzie Bennet,* a fictitious diary in print, complementing the YouTube series was

published in 2014 and a novelization from Lydia Bennet's perspective is due to be released subsequently.

Vlogs, like new series, fanfiction and film or television series have thus the ability to give viewers a sense of intertextuality, narrative fiction, experimentation, transmedia storytelling and the unique possibility of interactivity. Even if it remains fragmentary, an adaptation is worthwhile because it embeds the text in a network of creative activities and interpersonal communication. They can no longer be dismissed as adolescent forays into fictive adventures; rather, they do surprise, interrupt, challenge and interpret our engagement with the experience of the original reading of the classic. And all through this, Jane Austen's *Pride and Prejudice* lives on.

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"Sacred Games" - A Modern Indian Dystopia"

Dr Nilakshi Roy

Some of the primary characteristics of a dystopia are a pessimistic outlook and destructive way of living. *The Sacred Games*, a series by Anurag Kashyap and Vikramaditya Motwane portrays Mumbai in the grip of gangster raj: a disturbed universe of high treason, violence and destruction. A boy bludgeons his mother and her lover with a stone while his father goes silently to jail. The series portrays the thriving underbelly of Mumbai life, especially the kingdom of Urban Waste. The role played by the authorities in pursuing clues to the "Game" played by the hidden "messenger" overlord, is what adds grit and suspense to the plot, as disaster threatens all.

Does this kind of dystopia continue the tradition of western dystopias or are there enough Indian models? Perhaps more than the writer, Vikram Chandra, the filmmakers have found correspondences that are more potent to unleash the evil, in a story that mockingly points to its Other, the "Sacred", its obverse, in not something rational and profound, but quite arbitrary and casual, a mere "Game". These are some of the questions this paper asks , while interrogating the relevance of the genre in literature and film today.

"Sacred Games" - A Modern Indian Dystopia"

Dr Nilakshi Roy

"To win is to lose everything, and the game always wins." (Chandra, *Sacred Games* 42) Some of the primary characteristics of a dystopia are a pessimistic outlook and destructive way of living. *The Sacred Games*, (2018) a series by Anurag Kashyap and Vikramaditya Motwane portrays Mumbai in the grip of gangster raj: a disturbed universe of high treason, violence and destruction. A boy, possibly, bludgeons his mother and her lover with a stone while his father goes silently to jail. The series portrays the thriving underbelly of Mumbai life, especially the kingdom of Urban Waste. The role played by the authorities in pursuing clues to the "Game" played by the hidden "messenger" overlord, is what adds grit and suspense to the plot, as disaster threatens all.

The 901 page ur-text *Sacred Games* (2007) by the author Vikram Chandra trajectories the fortunes of Sartaj Singh, the man whom readers of *Love and Longing in Bombay*(1997) recollect instantly as the romantic, handsome, male lead of a stormy, extended, sex scene in the short story "Kama." Sartaj, as

we see him in *Sacred Games*, is a tough detective, but one who is used to impress old people, and women criminals and sources to wheedle out information or seek confessions. It is because of his past , his father having been the most honest policeman, and also because he is something of an "Other" because of his genteel manners, and dressing sense. Maybe it is also because of his religion, he is a turbaned Sikh, or perhaps not as given to bribery and corruption as his guru, his senior, Parulkar, who himself had been tutored by Sartaj's father, who was a legend on the Bombay police force. Mumbai, as such, was becoming quite a favourite as a location for such novels, what with Suketu Mehta's *Maximum City* (2004) and *Shantaram* (2003) a novel by Gregory David Roberts.

Why did Chandra select him as the hero of not a sequel but a tome of a modern-day detective novel set in the criminal underworld of Mumbai? The reviewer in *Publishers Weekly* describes him as follows:

> Sartaj, still handsome and impeccably turned out, is now divorced, weary and resigned to his post, complicit in the bribes and police brutality that oil the workings of his city. (30).

In *Kirkus Reviews*, an Autumn and Winter preview by his publishers, Chandra was quoted to explain the selection. "He forced himself into the book, right from the start," says Chandra, and "He's an interesting guy--tough, a bit wistful, something of a cynical romantic, if you can imagine such a thing." (Kirkus reviews) He also suggests that there will be no Sartaj sequel, as he had had ten years with him and "that's a lot of time". (Kirkus reviews) Pitted against the semi-tragic Mafia Don Ganesh Gaitonde, Sartaj is a loner, in search for fulfilment though the company he keeps daily, cops and criminals, are very similar to Gaitonde himself.

The crime thriller novel genre itself has this essential loneliness about it: the detective being the *döppelganger* of the reader in quest for fulfilment of some kind. Here Sartaj seems to have met the most unequal match who he finds at the last hour of his life, and thus starts the problem of the novel: it brings together the sacred and the profane, crime and mythology, murder and exaltation to weave a long story of what must have happened, told in the voice of the dead Ganesh Gaitonde. Sartaj is not the first person narrator, never: it is Ganesh who tells the story as if he were alive. What better beginning of a dystopian tale than a dead narrator speaking to a lost listener?

The detective as hero

According to Shoshana Felman, the detective " works to exhort the *secret* of the text", (176) and in this case it must be said that the reader finds an analogue of himself/herself in the detective, the good-

looking, well-dressed, middle-class, somewhat urbane, and English-speaking youngish man, whom it is easy to identify with. However, it is Sartaj who sets the tone for the dystopic tone of the novel and the series. Apart from his personal anguish and loneliness, there is no way he is ever to be rewarded, he knows that the success of his boss is going to be his undoing, and that he himself will never be rewarded for finding Gaitonde in the first place! It seems that his pessimistic outlook has become so ingrained in him that it seems to be his only reality. This forms the dystopic basis for both the novel and the series. The long shots, the close-ups and the fade outs show how the taciturn Sartaj is resigned to his fate right from the beginning but like clockwork springs onto action when summoned. Is he the robotic species of the New Age? The series and the novel show him to have the spark of humanity still, and core values. But does that affect the general sense of bleakness at the heart of the story, or rather , its narration?

Tzvetan Todorovpostulates that there are two stories in the detective fiction: the story of the crime and the tale of its detection (44, cited in Martin 166). Between the story of the crime and the overlaid narrative of its detection lies a long wait during which the reader lives his readerly existence: an existence full of waiting. The thrill of reading a classic detective novel is largely the thrill of a foreseeable future, as much as the unravelling of a past, which is usually the longest, of future expectation, a constant looking forward to an almost perfect, "a Utopian moment of absolute knowledge"(44, cited in Martin 176) , a reconciliation of good and evil. This promise is not lived up to in the novel under study, nor the series, which is why the dystopic elements predominate. The long nine hundred page wait, and the eight part series defy the audience expectation is what this paper asserts. There is still talk of a sequel therefore. Both of the texts assert the ways in which the new kind of detective novel focuses on the breakdown of expectation by putting together new binaries: high and popular culture, expectation and its failure, fulfilment versus unsatisfied hunger for a solution.

The highly teleological western genre of detective fiction comes across the boulder of spirituality, religion and its manifestations in the non-west , in this novel, and series. Thus it seems to crumble at the possibility of failure to reach the suitably climactic end. Despite the averting of a nuclear threat, the unearthing of the conspiracy and the criminals being apprehended, the end is a deferral: Sartaj waits. It seems to start the beginning of another story. This is possibly the influence of the open-ended Indian mythical narratives, in the case of the

series, taken from the Mahabharata, and the references to Hindu mythology, and the cyclical tales of crime and passion lacing the Bollywood charts from the 1970s, if not earlier.

At the heart the novel/ series is the story of Ganesh Gaitonde, a very attractive personality as his friends and lovers aver, whose first-person narration distracts the reader who is used to the first-person voice of the detective. As opposed to Sartaj, the gangster appears to be more sympathetic, intuitive, and a very hard worker who has risen from the ranks. One cannot but admire his phenomenal unsupported rise to power over city, district, country and the international crime scene. The sheer trajectory of his rise compares much more favourably as opposed to the unassuming Sartaj and his even more low-key father, a retired policeman, now expired. The way he patronises, creates and falls in love with Zoya Mistry, the movie star; and through her and her supplier Jojo, how he infiltrates Bollywood is really admirable. He learns English by himself; later works for Indian intelligence; survives the constant threats from his Muslim rival, Suleiman Isa; and finally seeks, from the jail and after, religious guidance through life from Guru Shridhar Shukla. This speaks of a far higher intelligence than any of the other characters, except perhaps Anjali Mathur, whom he does not meet. Sartaj's search for Gaitonde's movements and motivations are never fulfilled, till he reaches out to the higher authorities who observe irregularities in Gaitonde's case. Till then, Sartaj is able to only understand and guide the reader through partial truths. This constant running after evidence and the dense narrative bolstering the historicity of the criminal world, is something the reader expects to happen in a more logical and causative manner. Through the piles of murder, blackmail, gang rivalry and neighbourhood quarrels, Sartaj and the readers with him, are tired and defeated. Anjali Mathur saves the scenario in both the texts, though even what she offers does not reach the public, and there is never any clear disclosure about where the Guruji disappeared. A large part of the text is rumination: like most postmodern novels, memory supplies the missing action right up to the end, and memory is how the action even begins. Even at the point of death, the gangster-police duo ruminate on the meaning of life and death, like the best of friends. The police-officer/detective is no longer shown as the one with agency, in his limited aspiration, he is the one searching till the end , and failing each time. So much of the story is revealed to the reader, unbeknownst to him!

The tale of the mysterious deaths of the two characters is laid aside for deeper mysteries: money crossing borders, false terrorist organisations, a guru, new handlers , new location and a deeper,

labyrinthine past which creates far greater dangers to the nation. These weigh far more than what a very average, almost puny detective officer, with whom the reader actually identifies with, started off solving. This deferral of interest, this throwing the detective officer aside for a smarter, more tech savvy, female, officer of the RAW is the new aspect of dystopic fiction that one needs to look out for. It tells us that crime is no longer the linear , psychosocial case-focused matter anymore: it encompasses contemporary geopolitics through cartels motivated by religious fundamentalism, traverses international locations as easily as Bollywood, and overrules one's expectations of causality. There is practically no logical explanation for Guruji's plan of creating a nuclear arsenal and blowing up Mumbai. And, the fact that Sartaj never really knows why Gaitonde died along with his favourite "friend" Jojo, is like a debasement of the detective hero in this genre. Things are by far more complicated to know: Sartaj the detective, is too ahistorical to be attuned to more than the immediate present in offering a satisfactory solution to the murder mystery than all the rest taken together.

Slick New Style

Each of the serialised episodes take names familiar from the world of Hindu mythology. The first episode is titled "Aswatthama", a character whose story is intimately linked with betrayal. from the Sanskrit epic Mahabharata. "Halahala", another episode, is synonymous with a deadly poison. "Atapi-Vatapi" were a pair of tricksters among demons. "Brahmahatya" means killing of a Brahmin, one of the highest crimes according to the Hindu shastras. The episode "Yayati" was named after a king cursed with premature old age. Somehow the nomenclature, the sexual fantasies played out by mythological dressing of one of the molls, point out to deeper, darker, self-reflexive critique of the dominant ideology in India today.

While reading the novel, the chapters after the opening double death, lead us on to the journeys of many lives, many histories and many "slices of life". Poised on the brink of nuclear escalation, and an actual bomb being assembled, details of which are not discussed and revealed till the penultimate chapter, the novel rambles on through history and religion, government policies and rise of political parties, subcontinental arms-drug mafia and a wealth of other details. Many questions arise in the mind: Are we poised for good days to come or are we only witness to a darker, bleaker, gloomier countdown to an Apocalyptical future? What is the State's

role in the playing out of the secretiveness of the theme? Whose deep dark secrets are being so carefully hidden by the powers that be? Disappointment inheres in the very structure of the solution, the inevitable. According to Martin, postponement of the end disappoints the reader and the wait becomes an endless one with deferrals, historical fact-checkings and endless mysteries seemingly unrelated to the first death. The most interesting part of the novel is probably the use of *Bambaiya* Hindi "the anglophone writer's new engagement with the street life of Bombay." (Beliappa 350) This is one feature that becomes irrelevant in the series which is in fact in Hindi, largely *Bambaiya*.

The series however, much more cohesive and determined to unravel an essentially dystopic plot, explores mainly the subplot entitled in the chapter "The Game", a psychological exploration of Anjali Mathur's careful unravelling of the facts. In the novel it comes towards the middle, when she tries to unravel K.D. Yadav's memory, he who was the initial handler of Ganesh Gaitonde, to extract further information from him. Anjali Mathur brilliantly explores this trail of linkages between counterfeit money and the international nuclear terrorism racket sponsored by the religio-political ideology and funding of the Guru-ji, who does not become such a powerful figure in the series. The character of Anjali Mathur, quite well-delineated in both, is eliminated half-way through, by the film maker in the series.

Writing and adapting, : possible lineages

It seems that while working on the book, Chandra met with many of the Mumbai Mafia bosses. "The bosses of the bigger 'companies'--as the gangs are called in Mumbai--actually do function like corporate executives, in that they are keenly aware of their public profiles, and are as eager to spin you as you are to interview them," says Chandra. "Usually the dons tried to come off as misjudged realists, people who were trying to make their way in a harsh world as best as they could, and help the poor and suffering along the way."(Kirkus Reviews)

It is not surprising the book has several intertextual echoes and multiple references to the world of Bollywood, its music, its actors, its films, its working, and its linkages with the mafia. The series also exploits the same by virtue of the lineages of the director and producer who are known for their gangster and mafia-related oeuvre.

Gaitonde, forever the ambitious and power hungry, ruthless criminal, is modelled on so many before him, but he is a Hindu gangster , exploited for his being a Hindu by the corrupt ideologue, Guruji, though he himself was initaily unbiased and secular. The typical lineage of Mumbai films like *Deewaar* and *Parinda* on the psyche of the Mumbai gangster is even mentioned in the novel. Gaitonde is also the gangster with the Robin Hood heart, looking after people who have sought his protection, and his boys and their families, another Bollywood and gangster stereotype. Both the novel and the series open with a face-off between Sartaj, the good policeman, with whom the reader identifies, and the evil gangster , Gaitonde, who continues to talk to Sartaj from his self-created bunker. "Chandra connects them as he connects all the big themes of the subcontinent: the animosity of caste and religion, the poverty, the prostitution and mainly, the criminal elite, who organize themselves on the model of corporations and control their fiefdoms from outside the country." (Ermelino)

Neither easy to read nor to forget, Chandra's blockbuster resembles--and was perhaps influenced by--Mark Smith's NBA-nominated The Death of the Detective (1974). Both books have a curious blend of the world of the rich and famous implicated with a thriving underworld and a detective in search of a criminal mastermind. Moreover, both novels "remind us again that we're all connected, all both innocent and guilty, all both authors of our own stories and characters enmeshed in their convoluted, compelling, echoing patterns." (Allen)

"There is a curious symbiosis between the underworld and the movies. . . . Hindi film- makers are fascinated by the lives of the gangsters and draw upon them for material. The gangsters, from the shooters on the ground to the don-in-exile at the top, watch Hindi movies keenly and model themselves, their dialogue, the way they carry themselves, on their screen equivalents." (Mehta954)

The endings

The novel ends therefore on a traffic jam, and with possibilities of "another day", just as it had continued with Gaitonde's narration about "what happened next and what happened next" (Chandra *Sacred Games* 49). It does not end as a detective story merely, and Chnadra takes us beyond the tale to the city. "Solving the crime is important, but he also hands us the keys to the city and reveals its sordid mysteries." (Bromley, 28)

As this paper is going to print, thetelevision series is now revived. *TheSacred Games,* Series Two, will probably satisfy many viewers, as the first series had left out a wealth of details from both the lives, of Sartaj and Gaitonde. The presence of Guruji definitely complicates matters. So , now it weaves a more

compact though dystopic tale of intrigue, criminality, sexual fantasy and loneliness at the heart of the city, both in its citizens and their protectors' lives.

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Important Role of Distributors and Sub-distributors in distribution of Dairy Products in Thane City

Mrs. Shilpa Palande
Assistant Professor
KET's V. G. Vaze College of Arts,
Science and Commerce

ABSTRACT

Milk is an important healthy food in our day to day life. But the milk is perishable item. The production and processing of milk is carried out at one place and the distribution is all around. So the milk and milk products producing firms are not in a position to distribute it to the ultimate consumers. But with the help of distributors and sub-distributors it is possible to make proper distribution of milk and milk products in good condition and on time. Without supply chain management it is not possible to ensure smooth distribution to the consumers.

Key words : Distributor, Sub-distributor and Dairy Products.

INTRODUCTION

As human beings our basic needs are food, clothing and shelter. Our primary need is food to survive in our day to day life. Food plays an important role simultaneously milk is also important as a healthy food from childhood to adult. Milk as well as milk products which are made from milk are consumed by children and adults. Due to rising population and environmental changes and pollution, immunity power of the people are get reduced which results in different health issues to them. So to reduce the disease and increase the immunity power mostly people consume milk. Therefore, milk is an important and healthy food. Now a days, with the help of milk different by products are also produced. There are number of dairy firms producing different products like curd, yougurt, shreekhand, basundi, buttermilk etc.

Dairy firms are collecting the raw milk from farmers and doing certain procedures to keep the milk in good condition because milk is a perishable item. After completing the certain procedure the milk is packaged in bags and distributed to the consumers. Due to day by day increase in population, there is an increase in consumption of milk. Dairy firm producers are not able to make the proper distribution of milk to the final consumers. The production of milk is at one place but the distribution of milk is all around the Mumbai and Thane City. To cater to the needs of each and every consumer, the dairy firms are taking the help of distributors to do the distribution work at different places and on time. The distributor will collect the milk and

milk products from the dairy firms and distribute it to the sub-distributors at different points. The distributors have to collect the milk in large quantities and distribute in small quantities. Then it is the final duty of the sub-distributors to distribute it to the final consumers in small quantity or sale the milk at their point or distribute it to the different retail shops and hotels as per their requirements.

REVIEW OF LITERATURE

The authors talked about the importance of supply chain management in distribution of different products. The main aim of the study was to provide an up to date and brief review of the supply chain management literature that was found on broad green of the supply chain management concept. The researcher has been interpreted the different definitions of supply chain management developed by the various researchers in their papers. As per authors, previously manufacturer were drivers of the supply chain management at the place at which the products were manufactured and distributed. But today, customers are calling the shots and manufacturers are scrambling to meet customers demand for different options, style, fast delivery etc. In this paper, the attempt has been made to review the literature on supply chain management. They used the discussion method in analysis of their papers and had no attempt to make any quantitative analysis.[ciii]

This paper examines the relationship between supply chain management process maturity and performance and provides a supply chain management process maturity model for enhanced supply chain performance. The purpose of this paper was to discuss about today's organizations are faced with increasing levels of global competition, demanding customers and employees, shrinking product life cycles and decreasing acceptable response times. Thus organizations need to develop strategically aligned capabilities not only within the company itself but also among the organization that are part of its value adding network. The study concluded that the relationship of supply chain management efforts by indicating which maturity measurement are deficient therefore, focusing on continual improvement efforts.[civ]

OBJECTIVES :

1. To understand the working pattern of dairy firms.
2. To understand the importance of distributors and sub-distributors of dairy firms.

LIMITATIONS OF THE STUDY :

Due to time limit the researcher has collected the data within the boundaries of Thane City and taking into consideration of only one milk brand i.e. Mahananda.

DATE COLLECTED :

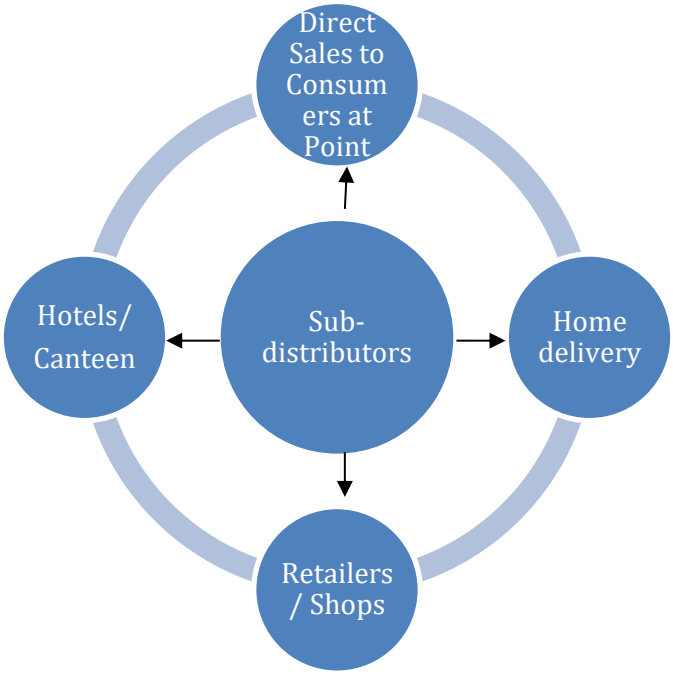
The researcher has collected all the information of dairy firms, distributors and sub-distributors with the help of primary data. The details of distributors and sub-distributors are collected through questionnaire by taking personal interview.

In Thane city there are 4 distributors of Mahananda dairy. The following table shows the total number of distributors and sub-distributors in Thane City.

Distributors	Sub- distributors
Distributor No. 1	22
Distributor No. 2	28
Distributor No. 3	24
Distributor No. 4	18
Total	92

From the above chart, it is clear that each distributor are having certain number of sub-distributors. The researcher has collected the data from 92 sub-distributors, to know about the types of customers. It means whatever milk and milk products collected by the distributors are distributed in small quantities to the sub-distributors.

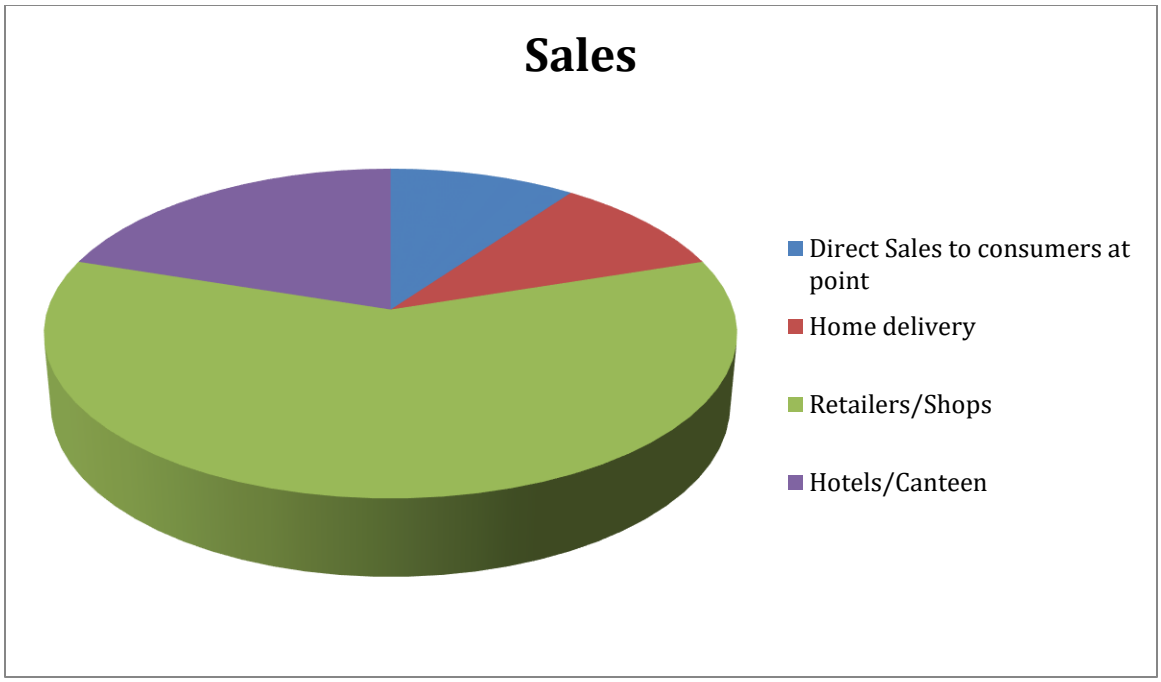
The milk and milk products delivered by the distributors to the sub-distributors are divided into different types of customers, like



On an average the milk is distributed to different categories as under :

Milk distributed by sub-distributors	%
Direct sales to consumers at point	10%
Home delivery	10%
Retailers/ Shops	60%
Hotels/ Canteen	20%
Total	100%

Milk distributed by the Sub-distributors to the consumers either at their point or through delivery boys to the consumers at home. More than 50% of milk and milk products are distributed to the retailers and the final consumers purchase it as per their convenience.



From the above chart, it is clear that maximum quantity of milk and milk products distributed to the retailers/ shops.

FINDINGS

1. 80% of the milk is directly or indirectly consumed by the final consumer.
2. Final consumers are purchase it either through directly collecting from sub-distributors at point or take home delivery or purchase from retailers/shops.
3. Only 20% of the milk distributed in hotels and canteen for their preparation.
4. Due to the supply chain management between dairy firms, distributors and sub-distributors, the consumers are getting benefits of different brands of milk and milk products at their own place.

CONCLUSION :

The study concluded that with the help of distributors and sub-distributors, the dairy firm producers are able to give more concentration on production of different products from milk and of different brands. Distributors and sub-distributors are worked at night as well as early

in the morning to do their duties on time. Due to their efforts and hard working, customers are able to take milk and milk products as per their own demand and at own place. Time is being considered as an important factor to make the delivery of milk and milk products on time because milk is a perishable goods. With the help of supply chain management, consumers are in a position to get the milk at early morning at their door step. Distributors and sub-distributors are plays an important role in supply chain management, without their help it's not possible for the dairy firm to make the delivery of milk and milk products to the different consumers all around.

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Research Article
Evaluation of CO_2 Removal Efficiency of *Pseudanabaena limnetica* (Lemm.) *Komárek* Grown in Na_2CO_3 Enriched Seawater Medium in 60 L Airlift Flat Panel Photobioreactor

[1]Chaitanya Magar, [1]Sagar Rambhiya and [2]Manjushri Deodhar

[1]Department of Biotechnology, KET's Vinayak Ganesh Vaze College of Arts, Science and Commerce, Mithagar Road, Mulund East, 400081 Mumbai, Maharashtra, India
[2]Botany Research Laboratory, Department of Botany, KET's Vinayak Ganesh Vaze College of Arts, Science and Commerce, Mithagar Road, Mulund East, 400081 Mumbai, Maharashtra, India

Abstract

Background and Objective: Oceans are major sinks for the anthropogenic CO_2 and microalgae play a characteristic role in mitigating it. Due to the heavily released anthropogenic CO_2 into the environment, the natural phenomena those control the CO_2 concentration in atmosphere are now not sufficient enough to normalise it. This has imparted on a need of novel environmental friendly option of CO_2 sequestration. Cultivating microalgae for biofuel can directly consume the industrially released CO_2 and help to reduce the release of anthropogenic CO_2, but making this CO_2 available into the liquid medium by artificial mean is the challenge. Buffering ability of seawater accelerates the mass transfer of CO_2 in an aqueous phase and can hasten up the removal of anthropogenic CO_2. **Materials and Methods:** In present communication salt tolerating strain *Pseudanabaena limnetica* (Lemm.) *Komárek* was grown in the operationally optimized 60L flat panel photobioreactor containing Na_2CO_3 rich Modified Seawater BG11 medium (MSWBG11). Initially, CO_2 dissolution capacity of only seawater and MSWBG11 medium was determined. Then the effect of 2 different CO_2 flow rates viz. $\leq$0.001LPM (set I) and $\leq$0.005LPM (set II) on CO_2 dissolution (DCO_2), associated pH change and its effect on biomass production in MSWBG11 were studied. **Results:** In the control experiment the DCO_2 was reduced from 2.08-1.19 mg L^{-1} and the amount of dry biomass produced was 1.15 g L^{-1}. In set I the DCO_2 concentration was maintained in the range of 8-15 mg L^{-1} and the biomass produced was 1 g L^{-1}. In set II the DCO_2 remained in the range of 3.59-4.00 mg L^{-1} and the biomass produced was 1.20 g L^{-1}. **Conclusion:** Thus, feeding of CO_2 at a lower flow rate was found to be favorable for algal growth. Though the mass transfer coefficient (KLa min^{-1}) increased at the higher CO_2 flow rate, the actual percentage of CO_2 removal was not increased.

Key words: CO_2, seawater, salt tolerating, flat panel photobioreactor, mass transfer coefficient (KLa min^{-1}), percentage CO_2 removal

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Corresponding Author: Manjushri Deodhar, Botany Research Laboratory, Department of Botany, KET's Vinayak Ganesh Vaze College of Arts, Science and Commerce, Mithagar Road, Mulund East, 400081 Mumbai, Maharashtra, India

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

It is well known that algae fix CO_2 and must be doing so by extracting it from the aqueous medium in which it is dissolved. Typically this CO_2 is transferred from the atmospheric CO_2 concentration of 0.04%. Microalgae produce approximately 50% of the atmospheric oxygen on the earth while consuming vast amounts of Carbon dioxide[1]. The 1 kg of dry algal biomass utilizes about 1.83 kg CO_2. Therefore, in order to take advantage of high CO_2 content (~20%) in exhaust flue gases, it is conventional wisdom that the chosen strain of microalgae must be found that tolerates the high concentration of dissolved CO_2.

Higher CO_2 concentration generally favors the algal growth but the barrier is a stability of the dissolved CO_2 in aqueous solution. There has been a focus on improving the rates of CO_2 mass transfer within a microalgal growth medium. The most common method is to sparge culture with bubbles of flue gases containing CO_2. In order to achieve better CO_2 mass transfer the unique design of fluid oscillator had also been proposed by some scientists to significantly reduce the bubble size[2]. Alternatively, CO_2 from fossil fuel stations shall be absorbed into solvents containing inorganic salts such as potassium carbonate and CO_2 loaded solvent which is then pumped directly into raceway ponds or photobioreactors (PBR)[3].

It has been reported that the microalgal cultures in PBRs are usually sparged with CO_2-enriched air (generally 5%)[4], but this practice is not fruitful as most of the free CO_2 escapes out into the atmosphere and sparging excess of CO_2 doesn't mean that it will not cause CO_2 limitation. To resolve this issue, maintaining dissolved CO_2 concentration above the critical level would be mandatory. The critical CO_2 level is the level of dissolved CO_2 just enough for the growth of particular algal strain, which is determined by experimenting the different concentration of dissolved CO_2 in the growth medium and checking their effects on algal growth. When large scale cultivation is the target, the CO_2 demand would be higher with the conventional ways of CO_2 feeding which will not be economical. Hence maintaining CO_2 concentration at a critical level would reduce the cost of CO_2 feeding significantly by curtailing down it to the actual requirement of CO_2 for algae culturing[5].

CO_2 has some significant limitations in mass transfer. When it is passed into aqueous phase it reduces pH due to the formation of H^+ and HCO_3^- ions. Basically, microalgal cells preferentially uptake HCO_3^- over CO_2 despite the fact that HCO_3^- is a poor source of carbon than the CO_2[6]. And therefore this hastens up the escape of unreacted, free CO_2 into the atmosphere resulting in a significant CO_2 loss. pH is the major determinant of maintaining relative CO_2 concentration in the aqueous system. This can be done by dissolving carbonate or bicarbonate salt in seawater, making it a best buffering system. This system does not allow a sudden drop in a pH of seawater medium with CO_2 feeding and therefore, accelerates the uptake of anthropogenic CO_2. For scavenging maximum CO_2 using microalgae, process parameters such as sodium bicarbonate concentration, pH, aeration and agitation rates and rate of CO_2 sparging along with bubble size are need to be optimized.

The salt tolerant algal strain *Pseudanabaena limnetica* (Lemm.) *Komárek* isolated from salt pans of the eastern suburban region of Mumbai, India is capable of tolerating Na_2CO_3 rich alkaline seawater medium (pH reaches up to 9)[7]. The strain is also withstand to natural conditions of high light intensity up to 1,296 μmol m^{-2} sec^{-1} and temperature up to 38°C. The operationally standardized 60L flat panel PBR system for cultivation of *P. limnetica* was used here in CO_2 sequestration experiments[8].

In the present communication, using pneumatically agitated 60 L flat panel culture system CO_2 was sparged at different flow rates in Na_2CO_3 rich modified seawater BG11 medium. The amount of CO_2 dissolved in the medium was measured by the CO_2 sensor. Through this, an optimum suitable concentration of CO_2 feeding which favors the algal growth has been determined.

MATERIALS AND METHODS

Strain selected: Microalgal strain selected was *Pseudanabaena limnetica* (Lemm.) *Komárek*, which is an indigenous halophilic strain isolated from salt pans of Mumbai suburban region[7].

Culture medium: Modified Seawater BG11 medium (MSWBG11) was formulated from the BG11 medium as tabulated[9] in Table 1. The chemicals used were obtained from Loba Chemie Pvt. Ltd.

Photobioreactor design and culture conditions: To conduct the experiments for CO_2 sequestration, the culture was scaled up from 8-60 L photobioreactor in above-mentioned culture medium and then maintained in the 60 L photobioreactor. The photobioreactor was made up of glass and dimensions were 20 cm (breadth) × 50 cm (length) ×70 cm (height)[8]. The initial culture density of *P. limnetica* was maintained at 0.25± 0.05 g L^{-1} in the MSWBG11 medium.

Table 1: Composition of the modified seawater BG11 medium (MSWBG11)

Compounds	(g L^{-1})
$NaNO_3$	0.7
$K_2HPO_4.3H_2O$	0.04
$MgSO_4.7H_2O$	0.075
$CaCl_2.2H_2O$	0.036
Citric Acid	0.006
Ferric Ammonium Citrate	0.006
$Na_2EDTA.2H_2O$	0.001
Na_2CO_3	0.2
H_3BO_3	0.00286
$MnCl_2.4H_2O$	0.00181
$ZnSO_4.7H_2O$	0.000222
$Na_2MoO_4.2H_2O$	0.000390
$CuSO_4.5H_2O$	0.000079
$Co(NO_3)_2.6H_2O$	0.0000494

The culture was exposed to the white fluorescent light of 185-222 μmol m^{-2} sec^{-1} intensity for 12 h every day. The agitation was achieved through spargers situated as horizontal tubes at the base of the photobioreactor. The compressed air supplied at 4LPM of air flow rate which was controlled with the help of acrylic flow meters i.e., rotameters (Napro Scientific, Pune).

CO_2 feeding: The CO_2 supply was obtained from the CO_2 cylinders commercially prepared by Super Industrial Gases, Thane. The cylinder contains 100% pure compressed CO_2. The flow rate of CO_2 was controlled with the help of pressure regulator. Further, for accurate flow rate, rotameter of 0.001LPM to 0.05LPM air flow rate measurement capacity was used. The gaseous CO_2 was fed into the medium at a flow rate of 0.01LPM through the sintered glass sparger made up of borosilicate glass material (Deepali enterprises, Mumbai). For experiment purpose, two different flow rates were achieved viz. $\leq$0.005LPM and $\leq$0.001LPM using same rotameter and sparger system.

pH, temperature, dissolved oxygen (DO_2) and dissolved carbon dioxide (DCO_2)

Detection and biomass estimation: The detection and monitoring of pH, Temperature, DO_2 and DCO_2 were carried out using electronic sensors, which were immersed in the working liquid system of the photobioreactor. All the individual sensors i.e. pH, DO_2 and DCO_2 along with inbuilt temperature sensor in each of them were obtained from Mettler-Toledo India Pvt. Ltd. The readings from pH, Temperature and DO_2 sensors were noted at every minute throughout the experiment. For proper representation purpose, the three (n = 3) continuous readings of respective three consecutive min were considered. These readings were purposefully derived from the same time period every day. In case of DCO_2 sensor the readings of each and every second was recorded by the data logging system but as explained for other sensors, same was followed for obtaining three consecutive readings (n = 3) for dissolved CO_2 concentration also. The dry weight of the biomass (DWB) was estimated by gravimetric analysis. Gravimetric analysis was performed by withdrawing three culture samples (n = 3) from the photobioreactor on every 3rd day after inoculation till the end of the experiment. Each type of experiment was performed in triplicates and selective readings were noted as mentioned before. Further, f or these shortlisted readings, statistical mean value was calculated along with their respective standard deviation (SD). The final cumulative data obtained containing Mean±SD was tabulated in Table 2, 3 and 4 into the respective category of the experiments.

Comparison of CO_2 dissolution ability of tap water, seawater and MSWBG11 medium: To study CO_2 dissolution ability three different aqueous samples were selected viz. normal tap water, normal seawater and seawater-based modified BG11 medium (MSWBG11). The experiments were carried out in a 60L PBR system. During experiments, these aqueous samples were pneumatically agitated at 4LPM. CO_2 was sparged through sintered glass sparger at 0.01LPM. The rate of dissolved was noted for each water source until the pH drops down from alkaline to neutral or slightly acidic. Dissolved O_2 and associated pH change were noted with the help of dissolved O_2 sensing sensor and pH sensor, respectively. The

Table 2: CO_2 dissolution rate with pneumatic agitation in tap water, seawater and modified seawater BG11 (MSWBG11) medium and its effect on DCO_2 value and pH

	Tap water		Seawater		MSWBG11 Medium	
Time (h)	pH (Mean±SD)	DCO_2 (Mean±SD) mg L^{-1}	pH (Mean±SD)	DCO_2 (Mean±SD) mg L^{-1}	pH (Mean±SD)	DCO_2 (Mean±SD) mg L^{-1}
0	7.33±0.12	2.00±0.23	7.95±0.07	2.17±0.35	8.36±0.16	3.04±0.56
1	6.92±0.09	3.03±0.11	7.46±0.30	5.60±0.15	8.04±0.12	3.77±0.92
2	6.47±0.09	5.10±0.16	7.22±0.06	9.58±0.71	7.63±0.10	7.66±0.40
3	7.13±0.18	3.46±0.08	7.35±0.23	12.05±0.98	7.38±0.10	18.30±1.17
4	7.60±0.16	2.52±0.26	7.58±0.31	4.36±0.39	7.51±0.18	12.18±0.72
5	7.77±0.07	1.89±0.10	7.87±0.15	3.02±0.27	7.59±0.11	7.37±0.60
6	-	-	7.82±0.22	2.59±0.46	8.02±0.14	4.70±0.28
7	-	-	-	-	8.29±0.18	3.34±0.37

Table 3: Effect of growth of *P. limnetica* on DCO_2, DO_2 level and pH of the MSWBG11 medium along with the percentage of CO_2 consumption/day

Days	pH (Mean±SD)	Temperature (Mean±SD)°C	DCO_2 (Mean±SD) mg L^{-1}	DO_2 (Mean±SD) mg L^{-1}	CO_2 consumption (%)	Biomass produced (Mean±SD) g L^{-1}
1	08.73±0.14	30.70±0.45	1.97±0.07	09.66±0.28	4.37	0.33±0.025
2	08.84±0.12	30.30±0.24	1.91±0.07	09.71±0.32	5.73	-
3	08.94±0.13	30.10±0.21	1.83±0.01	09.81±0.30	7.07	0.37±0.016
4	09.05±0.09	30.33±0.74	1.70±0.03	10.03±0.27	2.91	-
5	09.28±0.25	30.30±0.49	1.70±0.02	10.43±0.40	7.02	-
6	09.44±0.40	29.93±0.58	1.60±0.02	10.42±0.35	5.56	0.39±0.008
7	09.66±0.45	30.80±1.18	1.52±0.02	10.42±0.29	4.58	-
8	10.02±0.68	30.56±0.55	1.45±0.02	10.46±0.22	4.03	-
9	10.22±0.80	29.76±0.90	1.44±0.03	10.73±0.40	4.83	0.75±0.008
10	10.09±0.14	29.86±0.86	1.39±0.03	10.76±0.36	4.23	-
11	09.96±0.65	30.56±0.94	1.33±0.03	10.60±0.32	3.70	-
12	09.89±0.63	31.03±0.86	1.32±0.02	10.51±0.25	3.01	0.80±0.041
13	09.65±0.39	30.96±0.60	1.32±0.02	10.41±0.38	3.01	-
14	09.70±0.48	31.66±0.82	1.29±0.03	10.15±0.24	5.34	-
15	09.58±0.37	31.56±0.82	1.26±0.03	10.13±0.37	5.43	0.91±0.014
16	09.54±0.37	32.00±0.62	1.18±0.14	09.95±0.25	5.69	-
17	09.53±0.40	31.33±0.50	1.18±0.14	10.10±0.39	2.50	-
18	09.43±0.35	31.63±0.74	1.18±0.14	09.79±0.26	3.33	1.11±0.017
19	09.55±0.41	32.26±0.90	1.15±0.14	09.64±0.29	3.39	-
20	09.35±0.32	31.83±0.48	1.17±0.14	09.68±0.25	2.54	-
21	09.30±0.29	31.80±0.51	1.17±0.14	09.42±0.20	3.39	1.15±0.041

Table 4: Effect of continuous feeding of CO_2 at $\leq$0.005 LPM flow rate on the growth of *P. limnetica*, DCO_2, DO_2 level and pH of the MSWBG11 medium along with percentage CO_2 consumption/day

Days	pH (Mean±SD)	Temperature (Mean±SD)°C	DCO_2 (Mean±SD) mg L^{-1}	DO_2 (Mean±SD) mg L^{-1}	CO_2 consumption (%)	Biomass produced (Mean±SD) g L^{-1}
1	7.92±0.60	30.03±1.07	08.22±0.53	8.45±0.74	23.40	0.30±0.065
2	7.63±0.12	30.93±1.00	06.55±1.03	9.06±0.50	30.55	-
3	7.63±0.11	30.43±0.70	06.82±0.83	9.23±0.41	21.52	0.36±0.005
4	7.55±0.11	29.83±1.23	07.52±0.64	9.53±0.62	27.55	-
5	7.55±0.11	30.47±1.07	08.50±0.53	9.40±0.70	17.87	-
6	7.75±0.03	30.73±1.10	09.12±0.55	9.53±0.70	32.39	0.44±0.001
7	7.63±0.05	30.60±1.10	11.97±1.19	9.73±0.57	33.83	-
8	7.61±0.11	30.73±1.06	16.56±2.19	9.68±0.59	18.42	-
9	7.71±0.07	30.63±1.06	12.52±0.10	9.63±0.61	15.41	0.60±0.009
10	7.78±0.03	30.40±1.10	11.22±0.65	9.80±0.53	31.21	-
11	7.95±0.30	30.47±1.07	10.11±4.37	9.70±0.39	37.78	-
12	7.68±0.11	30.00±0.82	13.60±3.00	9.69±0.55	19.42	0.75±0.004
13	7.76±0.04	29.50±0.57	12.29±1.05	9.67±0.47	18.41	-
14	7.83±0.03	29.80±1.02	10.34±0.73	9.69±0.35	18.33	-
15	7.86±0.07	29.23±0.79	10.90±0.85	9.76±0.50	26.75	0.84±0.009
16	7.98±0.08	29.20±1.00	12.31±0.93	9.48±0.57	09.62	-
17	7.80±0.03	29.33±1.03	13.21±0.72	9.66±0.55	10.21	-
18	7.85±0.06	29.23±1.00	13.18±2.08	9.15±0.49	21.81	0.90±0.024
19	7.83±0.11	29.40±0.78	12.77±1.75	9.86±0.60	20.15	-
20	7.85±0.09	29.60±0.65	10.45±1.38	9.67±0.36	25.25	-
21	7.91±0.08	29.63±0.58	09.79±0.72	9.68±0.58	29.34	1.00±0.023

experiments were repeated three times. The mean of all the observations±standard deviation (SD) has been given in Table 2.

Effect of various CO_2 flow rates on CO_2 dissolution efficiency of medium: In the control experiment, the microalgae *P. limnetica* was grown in 60L photobioreactor without any artificial CO_2 supplementation. The initial inoculum was 0.3 g L^{-1} (standard is 0.25±0.05 g). The aeration rate was maintained at 4 LPM and the algal growth was continued for 21 days with the 12 h exposure of 185-222 µmol m^{-2} sec^{-1} light intensity every day. Then the amount of DCO_2 was noted and continuously recorded with the help of a data logger system. The associated pH change

was also noted with the pH sensor. The growth was measured in terms of the dry weight of biomass after every 3 days (Table 3).

In test experiments, the culture of *P. limnetica* was inoculated (0.25±0.05 g L^{-1}) in an MSWBG11 medium in the 60 L capacity flat panel photobioreactor. The culture was exposed to the white fluorescent light of 185-222 µmol m^{-2} sec^{-1} intensity for 12 h every day. The gaseous CO_2 fed into the medium in two different flow rates viz. ≤0.005 LPM (Set-I) and ≤0.001LPM (Set-II) continuously for a period of 21 days. The effect of CO_2 sparged on algal growth was interpreted in terms of biomass produced which was measured at the intervals of 3 days. The DCO_2, DO_2 associated pH change was also reported at every minute. All the experiments were repeated 3 times and their mean values have been tabulated in Table 4, 5.

In the end, CO_2 mass transfer coefficient per minute (KLa min^{-1}) was calculated for all the water or medium sources and also for the experiments of CO_2 sequestration studies. Then the average of percentage CO_2 consumption in all the three sets of experiments was calculated.

RESULTS AND DISCUSSION

Microalgal strain: To make biomass cultivation cost-effective selection of water source is very crucial. The cost of a water source could be more than the half financial investment in setting up the large scale microalgae cultivation industry. Hence, any water source other than fresh water is recommended for mass cultivation of microalgae. Keeping this approach in mind scientific research communities focusing on the utilization of seawater and so we are. To work with seawater selection of appropriate microalgal strain is very much essential. Here, cyanobacterial strains, *Pseudanabaena limnetica* (Lemm.) *Komárek* was shortlisted basis on its unique properties to thrive in hypersaline conditions. This is a halophilic, filamentous cyanobacterial species isolated from salt pans of Mumbai suburban region. It possesses the following important properties that make it a potential candidate for mass cultivation[8]:

- Sustains at high salinity up to 3.5% (35000 ppm)
- Tolerates high temperature of the tropical summer season, wherein daytime water temperature goes beyond 45°C
- Produces average biomass of ~ 1.5 g L^{-1} in 18 days
- Survives in the least nutrient-containing medium

Comparison of CO_2 dissolution in tap waters, seawater and MSWBG11 medium: In this experiment, the study of CO_2 dissolution capacity of different aqueous samples viz. tap water, seawater and MSWBG11 medium were studied. The experiment was conducted in 60 L flat plate photobioreactor. The CO_2 dissolution was studied at 4 LPM pneumatic agitation rate. The 100% pure compressed CO_2 was sparged through sintered glass spargers. The flow rate of CO_2 was controlled using rotameter and was maintained at 0.01 LPM. The bubble size generated through the sintered glass was less than 500 µm in diameter. The rate of CO_2 dissolution and the associated change in pH was noted with the help of the respective sensor. The dissolved CO_2 sensor In Pro5000 (Mettler Toledo India Pvt. Ltd.) was used which makes the online measurement of dissolved CO_2. The DCO_2 sensor uses the Severinghaus electrode for the potentiometric measurement of DCO_2. The sensor employs CO_2 gas permeable silicone membrane which is tightly stretched around a special engineered flat pH meter. The CO_2 gas from the sample or process diffuses across the membrane where it dissociates to form HCO_3^- and H^+ ions: The formed H^+ ions lead to a pH change of the inner electrolyte.

Initially, at time zero before sparging CO_2 into the tap water, the DCO_2 concentration was 2.00±0.23 mg L^{-1} and pH was 7.33±0.12 (Table 2, Fig. 1) and at the end of 1 h DCO_2 was increased to 3.03±0.11 mg L^{-1} and initial pH of 7.33±0.12 was reduced to 6.92±0.09. At the end of 2 h with continuous CO_2 sparging DCO_2 was increased to 5.10±0.16 mg L^{-1} but pH drastically decreased to 6.47±0.09, which will be detrimental for the algae.

Contrary to this when CO_2 sparging experiment was conducted in seawater, the initial level of CO_2 was a little higher. The DCO_2 value measured in seawater at time zero was 2.17±0.35 mg L^{-1} at 7.95±0.07 pH value. Whereas in tap water it was 2.00±0.23 mg L^{-1}. When the seawater was sparged with gaseous CO_2 for 1 h the amount of dissolved CO_2 was increased to 5.60±0.15 mg L^{-1} and pH reduced to 7.46±0.30. After 2 h of continuous CO_2 feeding, the number of dissolved CO_2 increased to 9.58±0.71 mg L^{-1} and pH was 7.22±0.06, which would be just sufficient for the growth of algae. The dissolved carbonate species in seawater provide an efficient buffering system. For instance, the addition of 1 µmol kg^{-1} of a strong acid such as HCl in distilled water at pH 7 reduces the pH very close to 6. The same addition to seawater at pH 7 only reduces the pH to 6.99. The seawater pH buffer mainly results of the capacity of CO_3^{2-} and HCO_3^- ions to accept protons[10].

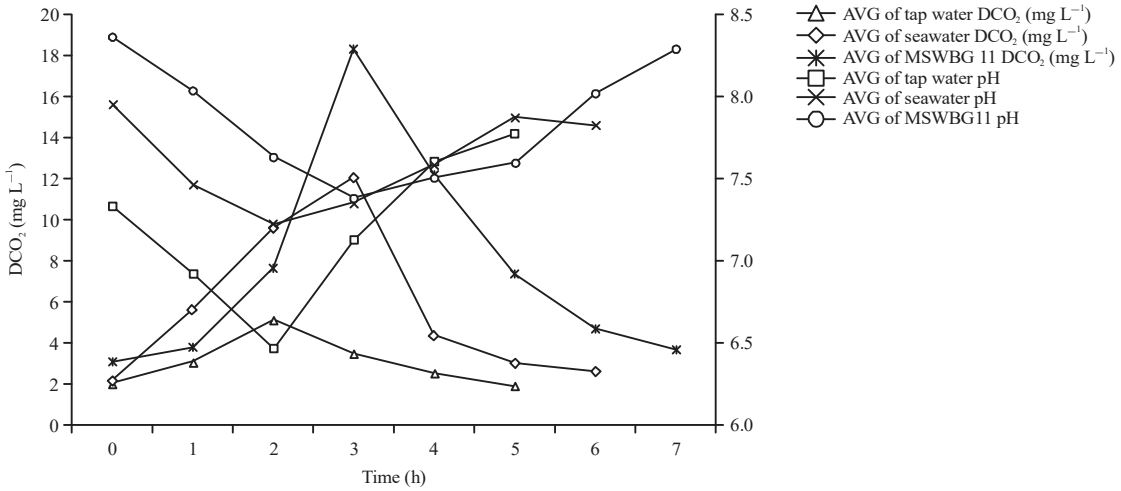

Fig. 1: Comparison of CO_2 dissolution in pneumatically agitated flat panel photobioreactor containing tap water, seawater and MSWBG11 medium
AVG: Average

The salinity of seawater is near to 3.8-4%, this always adjusted to 3.5% with the addition of the little volume of fresh water. The MSWBG11 medium was prepared by fortifying additional Na_2CO_3 in normal seawater BG11 medium (MSWBG11) (Table 1). In MSWBG11 medium amount of Na_2CO_3 added was 0.02 g L^{-1}, whereas in MSWBG11 ten times higher amount of Na_2CO_3 was added (i.e., 0.2 g L^{-1}). The optimum nitrate content in MSWBG11 is half in quantity ($NaNO_3^-$0.7 g L^{-1}) than the nitrate content of the standard medium ($NaNO_3^-$1.5 g L^{-1}). This concentration was the most suitable concentration for the growth of *P. Limnetica*[8]. Due to the addition of Na_2CO_3, the medium becomes alkaline. Such a medium has the capability of absorbing much more CO_2. owing to this cause, at the end of 3 h, the amount of DCO_2 was as high as 18.30±1.17 mg L^{-1}. Whereas in seawater when CO_2 was sparged for 3 h the DCO_2 level was reached to 12.05±0.98 mg L^{-1} only.

It has been experimentally proved that the weak alkali, Na_2CO_3, has a greater buffering capacity than the strong alkali $NaOH_3$. The optimal conditions for CO_2 absorption are obtained by maintaining a weakly alkaline aqueous pH of 9-10 by adding Na_2CO_3 as alkalinity buffering chemical at 27°C. And therefore the addition of extra Na_2CO_3 into the MSWBG11 medium, increases its ability to absorb and hold maximum CO_2 for a longer time. The major constraint of pneumatically agitated system is that the tremendous air already flows through it which might limit the CO_2 dissolution rate. But pneumatic agitation is the mandatory requirement to keep the algae freely floating in the culture system to support good growth.

In this experiment, our objective was to study the ability of different aqueous solutions to hold dissolved CO_2 when the pneumatic agitation is continued. Hence, in all the systems gaseous CO_2 was sparged for 3 h. The pneumatic agitation was continued and amount of DCO_2 was noted at every 1 h interval until it reaches back to nearly normal (Fig. 1). The experiments were conducted three times (n = 3) and mean±SD values of DCO_2, DO_2 and pH were noted in Table 2.

As mentioned earlier in tap water at zero h dissolved CO_2 was 2.00±0.23 mg L^{-1}, at the end of 2 h of continuous CO_2 sparging it was increased to 5.10±0.16 mg L^{-1}. At this time CO_2 sparging was stopped due to a sharp decline in pH which was decreased to 6.47±0.09. After 1 h of CO_2 termination and continuous pneumatic agitation, the amount of DCO_2 was decreased to 3.46±0.08 mg L^{-1}. After 2 h DCO_2 was 2.52±0.26 mg L^{-1}, which was still higher than its original DCO_2 level in spite of continuous pneumatic agitation.

In seawater system, the original DCO_2 level was 2.17±0.35 mg L^{-1}. After 3 h of CO_2 sparging, it was increased to 12.05±0.98 mg L^{-1}. The pH was decreased to 7.35±0.23. At this point, CO_2 feeding was stopped. After one h of CO_2 termination, the DCO_2 level drastically decreased to 4.36±0.39 mg L^{-1}. After 2 h, DCO_2 decreased to 3.02 ±0.27 mg L^{-1} and after 3 h it became 2.59±0.46 mg L^{-1}.

In MSWBG11 medium the original DCO_2 level was 3.04±0.56 mg L^{-1}. After 3 h of CO_2 feeding, it reached to 18.30±1.17 mg L^{-1} and the pH was 7.38±0.10, at this point the CO_2 feeding was stopped. After 1 h of CO_2 termination, it was decreased to 12.18±0.72 mg L^{-1}. After 2 h interval, it was 7.37±0.60 mg L^{-1} and after 4 h interval, the amount of DCO_2 was 3.34±0.37 mg L^{-1}. Thus MSWBG11 medium is not only allowing the maximum CO_2 to dissolve in it, without drastic pH drop but also hold DCO_2 for a longer duration, which would be suitable for algal growth.

The ocean is a large sink for CO_2 resulted from fossil fuel burning. When the CO_2 is directly injected into mid-depth of the ocean it dissolves in water to form carbonic acid and pH decreases[11]:

$$CO_2 (g) + H_2O \leftrightarrow H_2CO_3 (aq.)$$

The carbonic acid further dissociates to form bicarbonate ions and carbonate ions as shown in the following 2 steps:

$$H_2CO_3 (aq.) \leftrightarrow H^+ + HCO_3^-$$

$$HCO_3^- \leftrightarrow H^+ + CO_3^-$$

Increasing the alkalinity of the ocean using CaO, bicarbonates and ocean nourishment with NH_3^+ including other nutrients are some of the major approaches to accelerate an oceanic carbon uptake to lessen greenhouse gases[11].

Effect of varying CO_2 flow rate on CO_2 dissolution along with associated pH change in medium and its effect on the growth of microalgae *P. limnetica*: In present communication seawater based MSWBG11 medium, which is favorable for the growth of *P. limnetica* was used for the mitigation of CO_2.

As mentioned in material and methods the three experiments, viz. Control (without CO_2 feeding), Set-I (CO_2 feeding at $\leq$0.005 LPM) and Set-II (CO_2 feeding at $\leq$0.001 LPM) were carried out in triplicates. The readings for each triplet set was noted every day at a particular time and their mean along with standard deviation (SD) was calculated to check the significance of the data. To check the effect of CO_2 feeding on algal growth, the determination of the dry weight of the biomass was carried out on every third day by gravimetric analysis.

In the control experiment at day 1, DCO_2 was 1.97±0.07 mg L^{-1} and pH was 8.73±0.14. As the growth advanced, the CO_2 dissolved in the medium was consumed and that was associated with the increase in pH. On day 3, DCO_2 was reduced to 1.83±0.01mg L^{-1} and pH increased to 8.94±0.13. There was little increase in biomass from 0.33±0.025-0.37±0.016 g L^{-1}. On 6th day, DCO_2 was decreased to 1.60±0.02 mg L^{-1}, pH was increased to 9.44±0.40 and biomass was 0.39±0.008 g L^{-1}. On day 21st the DCO_2 was 1.17±0.14 mg L^{-1} and pH was 9.30±0.29. The biomass produced was 1.15±0.041 g L^{-1}. A gradual decrease in DCO_2 was observed as cell growth was continued. This also led to gradually increase the pH of the medium and it became alkaline when cell growth reaches to stationary phase as shown in Fig. 2. Thus, during the period of 21 days, DCO_2 consumed was almost ~0.8 mg L^{-1} with total biomass production of 1.15±0.041 g L^{-1}.

In the set I the microalgae *P. limnetica* was cultured in a 60 L photobioreactor with an initial inoculum size of 0.30±0.065 g L^{-1}. Pneumatic agitation was given at 4 LPM of air flow rate and artificial CO_2 was sparged at the flow rate of $\leq$0.005 LPM (Table 4). The biomass produced was interpreted after every 3 days up to 21 days. The amount of DCO_2 and associated pH change was noted every day. At day 1, DCO_2 was 8.22±0.53 mg L^{-1} and pH was 7.92±0.60. During 21 days period, the amount of DCO_2 was maintained between the range of 6.55±1.03-16.56±2.19 mg L^{-1} and pH was in the range of 7.55±0.03 to 7.95±0.30. The biomass produced at the end of the experiment was 1.0±0.023 g L^{-1}, which was less than the biomass obtained in the control experiment

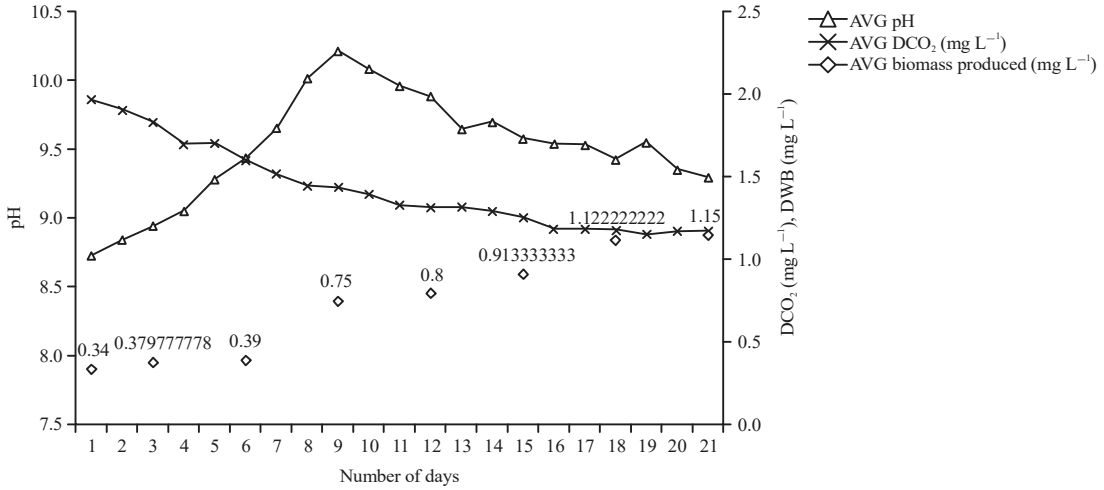

Fig. 2: Effect of growth of *P. limnetica* on DCO_2 level and pH of the modified Seawater BG11 medium
AVG: Average

(i.e., 1.15±0.041 g L^{-1}). It has been described in the scientific literature that microalgal cells can tolerate CO_2 up to a certain level after which it becomes detrimental for their growth[6]. High CO_2 concentration that is above the limit of cell's tolerance induces environmental stress and causes a biological reduction in the capacity of algal cells to sequester CO_2. Thus, 6.55±1.03 to 16.56±2.19 mg L^{-1} of DCO_2 concentration was found to be inhibitory to the growth of microalgae. And therefore in this case for continuous CO_2 sequestration by *P. limnetica*, the pure CO_2 should not be fed above 0.005 LPM flow rate.

The microalgal cultures in PBR are supplemented with 5-10% of CO_2 to ensure that algal cell will not be CO_2 limited. For every algal culture, there is a critical dissolved CO_2 concentration. If the concentration of DCO_2 drops down below critical level, the specific CO_2 uptake rate (SCUR) decreases. Hence, it is essential to monitor the dissolved CO_2 concentration in algal cultures. To monitor DCO_2 concentration indirectly, researchers have used dissolved O_2 to find out the value of critical CO_2 concentration and SCUR value[4] of CO_2. If a specific O_2 production rate (SOPR) and photosynthetic quotient are known, SCUR can be calculated. The SOPR increase with dissolve CO_2 concentration and come to halt at critical CO_2 concentration. Beyond which even if DCO_2 increased SOPR remains in the steady state. So, the graph of SOPR and pH as a function of dissolved CO_2 concentration is used for calculating critical CO2 concentration. For the culture of *C. vulgaris* critical CO2 concentration was achieved at about 7 mg L^{-1}.

In set II the CO_2 was sparged at the rate of ≤0.001 LPM (Table 5). The biomass, DCO_2 and pH changes were noted for 21 days. During these 21 days, the DCO_2 remained in the range of 2.71±0.35-3.78±0.80 mg L^{-1} and pH was in the range of 8.00±0.08 to 8.76±0.14. This DCO_2 concentration in the range of 2.71±0.35-3.78±0.80 mg L^{-1} was reported as the critical CO_2 level for this strain. The biomass produced at the end of 21 days was 1.2±0.038 g L^{-1} which was higher than the biomass obtained in the control experiment (i.e., 1.15±0.041 g L^{-1}). Thus, the low flow rate of CO_2 sparging i.e., ≤0.001 LPM, along with pneumatic agitation at 4 LPM was found to be the most suitable for maximum CO_2 mass transfer into the medium. This also favored better algal growth. The DCO_2 concentration maintained between 2-4 mg L^{-1} favors algal growth. Thus it is not economical to continuously sparge 10-15% of CO_2. Instead, sparging CO_2 at very low flow rate favors the mass transfer and is just sufficient for higher growth of the algae.

It has been depicted that needless high supply of CO_2 would have many negative effects on algae cultivation[12]. The lethal conditions such as severe mechanical shear, medium acidification, etc arise from higher CO_2 supplementation in a conventional way of algae cultivation. These practices consume much energy and resources which put the algae cultivation industry in a financial crunch. Therefore establishing the technology with low energy demand and with low CO_2 dosing relatively higher CO_2 mass transfer would be essential for cost-effective microalgal cultivation.

Table 5: Effect of continuous feeding of CO_2 at ≤0.001LPM flow rate on the growth of *P. limnetica*, DCO_2, DO_2 level and pH of the MSWBG11 medium along with percentage CO_2 consumption/day

Days	pH (Mean±SD)	Temperature (Mean±SD) °C	DCO_2 (Mean±SD) mg L^{-1}	DO_2 (Mean±SD) mg L^{-1}	CO_2 consumption (%)	Biomass produced (Mean±SD) g L^{-1}
1	8.67±0.18	29.80±1.10	3.04±0.39	09.75±0.30	31.37	0.25±0.007
2	8.68±0.21	30.07±0.62	3.09±0.69	09.78±0.37	39.18	-
3	8.76±0.14	30.07±0.68	2.95±0.39	09.85±0.36	27.88	0.32±0.006
4	8.46±0.08	31.00±0.94	3.36±0.96	09.79±0.35	41.10	-
5	8.64±0.05	31.13±0.90	3.08±0.31	09.96±0.44	28.13	-
6	8.27±0.04	31.13±0.57	2.78±0.21	09.83±0.41	34.63	0.38±0.018
7	8.31±0.05	31.18±0.86	3.07±0.42	09.90±0.57	34.85	-
8	8.00 ±0.08	31.67±0.90	3.22±0.58	09.89±0.41	35.63	-
9	8.46±0.04	31.57±0.74	2.86±0.39	10.06±0.47	31.08	0.44±0.022
10	8.36±0.28	31.33±0.60	3.17±0.62	09.96±0.27	35.81	-
11	8.53±0.05	30.97±0.71	2.94±0.38	10.13±0.42	34.28	-
12	8.44±0.18	30.77±0.82	3.42±0.59	10.04±0.37	31.76	0.60±0.006
13	8.53±0.20	30.80±0.73	2.71±0.35	09.94±0.33	38.00	-
14	8.63±0.06	30.03±0.57	3.16±0.61	10.11±0.31	38.67	-
15	8.43±0.18	29.87±0.82	3.40±0.65	10.07±0.36	29.27	0.74±0.003
16	8.45±0.04	30.17±0.86	3.09±0.69	09.80±0.24	39.18	-
17	8.20±0.17	30.10±0.37	2.83±0.17	09.95±0.38	33.72	-
18	8.67±0.15	29.93±1.19	3.05±0.39	10.58±0.56	31.37	0.90±0.036
19	8.65±0.28	29.90±0.70	3.09±0.69	10.43±0.36	39.18	-
20	8.50±0.22	29.97±0.78	3.37±0.59	10.27 ±0.57	31.92	-
21	8.48±0.21	30.53±1.06	3.78±0.80	10.17±0.41	25.42	1.20±0.038

A group of scientist from Institute for Biotechnology and Bioengineering, Portugal, have studied the effect of various CO_2 concentrations and aeration rates on the growth of *Chlorella* sp. in 110 mL bubble column photobioreactor[13]. The aeration rates employed were 0.1, 0.4 and 0.7 vvm (liter volume of air per liter volume of liquid medium per minute) and the CO_2 was supplied in different concentrations viz. 2%, 6 and 10%. At lower CO_2 concentration i.e., 2% as the aeration rate increased the growth was also increased. At 0.1vvm aeration rate, the biomass productivity was 0.7 g L^{-1}/day and it was increased to 1.1g L^{-1}/day at 0.7 vvm. At 6% CO_2 concentration the optimum productivity was observed at 0.4 vvm i.e., 1.3 g L^{-1}/day. But, at 0.7 vvm it was decreased to 1.2 g L^{-1}/day. At 10% CO_2 concentration the optimum biomass productivity was observed at 0.4 vvm but it was lesser than 6% CO_2 concentration.

At lower CO_2 concentration as the air flow rate increased, the mass transfer coefficient increased consequently. CO_2 dissolution and O_2 stripping enhanced and more CO_2 were available for algal growth. But, at high CO_2 concentration, the CO_2 reaches to saturation point. Beyond this point even though the aeration rate was increased it does not contribute to mass transfer. Extra CO_2 is released to the atmosphere and does not remain in the medium for algal growth. Thus, an increase in air flow rate over a valid range is not efficient in increasing the microalgal growth. This should be always considered for cost-effective CO_2 absorption for greater growth of microalgae.

In our earlier studies, a 25 L horizontal tubular photobioreactor was used for CO_2 sequestration[14]. An indigenous thermotolerant strain Geitlerinema sulphureum was used for this purpose. The media was circulated through photobioreactor with the help of peristaltic pump at 100 rpm which facilitate the liquid medium to flow at 1 LPM speed. Compressed air was supplied at the rate of 0.1 LPM when no artificial CO_2 was sparged. The CO_2 content found at the outlet was 450 ppm. When the air was sparged at 0.1 LPM and artificial CO_2 was sparged at the rate of 0.01 LPM (9.09% CO_2 concentration), the amount of CO_2 detected at the inlet was more than 5000 ppm. The concentration of CO_2 at the outlet was 540 ppm. When the air was sparged at 0.1 LPM and CO_2 was sparged at a rate of 0.02 LPM (16% CO_2 concentration), the average CO_2 at the outlet was increased to 675 ppm. But when the air was sparged at 0.03 LPM (23% CO_2 concentration), the amount of CO_2 detected at the outlet was substantially increased to 1400 ppm. Thus, the low flow rate of CO_2 (0.02 LPM) was the most suitable for optimum mass transfer. In this experiments the CO_2 concentration at inlet and outlet air were measure but the actual amount of CO_2 dissolved in the medium was not known. The following equation which utilizes pH values is used for calculating the dissolved CO_2 concentration in the medium[12]:

$$[CO_2] = \frac{\left[10^{-pH} - 10^{pH-14} + \Delta\left(Na^+\right)\right]10^{-2pH}}{10^{-6.381-pH} + 2\times10^{-16.758}} \left(\text{mol } L^{-1}\right)$$

The titrimetric method is an another option to mathematically calculate DCO_2 and carbon consumption during biomass production of some microalgal species such as *Nannochloropsis oculate*[15]. Many researchers have used pH values for the determination of dissolved CO_2 concentration before and after dosing aqueous CO_2 into the culture medium. Whereas, some have used total organic carbon analyzer (TOC-VCSH, SHIMADZU) to detect total inorganic carbon in the medium[3].

In the present communication, a dissolved CO_2 sensor is used which makes the online measurement of dissolved CO_2 at various time intervals, through 21 days experimental period. The optimized 60 L PBR system assembled with sparger of 2 mm pore size and 4 LPM air flow rate was found to be ideal for optimum biomass production. At 4 LPM of pneumatic agitation, the CO_2 supply of very low CO_2 flow rate ($\leq$0.001 LPM) was the most suitable for better CO_2 mass transfer and algal growth.

Relation between flow rates, mass transfer rates and CO_2 capture efficiency: In the study where relation between mass transfer and growth rate was elaborately explained utilized an experimental setup comprised of 12 airlift photobioreactors (ALPs)[12]. Each of them was of 3 L capacity together arranged in 2 rows. *Dunaliella* culture were sparged with CO_2 enriched gas (5% CO_2+95% N_2) for 30 min each day with varying flow rates ranging from 0.3, 0.5, 0.7, 0.9, 1.1LPM. As the flow rate increased, CO_2 mass transfer coefficient (KLa min^{-1}) was increased. They also calculated CO_2 capture efficiency i.e., the amount of CO_2 absorbed over the amount of CO_2 fed at varying flow rates. They observed that CO_2 capture efficiency was reduced when the flow rate was increased, enhancing flow rates, KLa min^{-1} is enhanced but due to it the amount of undissolved CO_2 increases and that goes wasted. For higher dissolution of CO_2, dosing in lower flow rates or decreasing the bubble size to the nanoscale is beneficial.

The results obtained in present study showed resemblance with finding of the group of researchers from University of Sheffield, UK about the enhancement of mass

Table 6: Estimation of mass transfer coefficient (KLa min^{-1}) for tap water, seawater and MSWBG11 medium (with and without CO_2 feeding) along with average percentage CO_2 consumption

Medium	$[CO_2]^*$	$[CO_2]_0$	$[CO_2]_t$	$[CO_2]^*$-$[CO_2]_0$	$[CO_2]^*$-$[CO_2]_t$	$([CO_2]^*-[CO_2]_0)/([CO_2]^*-[CO_2]_t)$	KLa $min^{-1} = \ln([CO_2]^*-[CO_2]_0)/([CO_2]^*-[CO_2]_t)$	Average CO_2 consumption (%)
Tap water	5.03	1.75	3.15	3.28	1.88	1.745	0.557	-
Seawater	12.79	2.00	8.17	10.79	4.62	2.335	0.848	-
MSWBG11	25.36	2.30	18.19	23.06	7.17	3.216	1.168	-
Control	25.36	2.08	1.19	23.28	24.17	0.963	-0.038	4.36
CO_2 at ≤0.005 LPM	25.36	1.63	10.80	23.73	14.56	1.629	0.488	23.30
CO_2 at ≤0.001 LPM	25.36	3.09	4.90	22.27	20.46	1.088	0.084	34.00

transfer of CO_2 in microbubble driven airlift bioreactor[12]. In our study the ambient supply of CO_2, the KLa min^{-1} is negligible(-0.038). At ≤0.001 LPM of CO_2 feeding, there is little increase in KLa min^{-1} (0.084). At ≤0.005 LPM of CO_2 flow rate the KLa min^{-1} substantially improves to 0.488 min^{-1}. But when the percentage of CO_2 consumption was seen, the CO_2 feeding rate at ≤0.001 LPM was found to be far better. Before this, tap water, seawater and MSWBG11 medium were fed with CO_2 at 0.010 LPM flow rate with pneumatic agitation at 4 LPM to check the KLa min^{-1}. The value of KLa min^{-1} for tap water, seawater and MSWBG11 medium were 0.557, 0.848 and 1.168, respectively (Table 6). This proves that due to fortified carbonate in MSWBG11 the value of volumetric mass transfer coefficient is higher than any other water source. Details of percentage CO_2 consumption per day at different flow rates are indicated in Table 3-5. Table 6 shows the comparison between different types of water for KLa min^{-1} and the average percentage CO_2 consumption.

When no artificial CO_2 was supplied (Control experiment) the average CO_2 consumption was 4.36%. When CO_2 supplied at ≤0.001 LPM, the average value of CO_2 consumption was optimum i.e., 34.00%. But, when the flow rate was increased to ≤0.005 LPM the average CO_2 consumption decreased to 23.30%.

Effect of different CO_2 flow rates on O_2 removal: An additional supply of CO_2 contributes many benefits to algal cultures. It enhances algal metabolism, it acts as a buffering system to neutralize increased pH caused by algal growth. Furthermore, along with the microalgal growth, accumulation of generated O_2 in the culture medium is toxic to microalgal cells and it is one of the major limiting factors for scaling up of the bioreactor[16]. Introducing CO_2 in culture helps to strip off accumulated O_2 and prevents algal cells from toxicity. By increasing the concentration of dissolved CO_2, reducing the accumulation of O_2 level improves productivity[12]. Performance of bioreactor depends on high gas mass transfer for both CO_2 dissolution and O_2 removal.

In present communication in the control experiment when cultures were grown at ambient CO_2 concentration the amount of DO_2 determined was in the range of 9.42±0.20 to 10.76±0.36 mg L^{-1} (Table 3). When the cultures were sparged with ≤0.001LPM of CO_2, the DO_2 concentration ranged from 9.75±0.30 to 10.58±0.56 mg L^{-1} (Table 5) and when CO_2 was sparged at the rate of ≤0.005 LPM, the DO_2 concentration was in the range of 8.45±0.74 to 9.86±0.60 mg L^{-1} (Table 4).

CONCLUSION

In the current research, the direct measurement of dissolved CO_2 concentration was carried out while sequestering it with growing microalgae. The chosen indigenous halophilic strain *Pseudanabaena limnetica* (Lemm.) *Komárek* was found to be the suitable candidate for CO_2 sequestration studies along with mass cultivation. This strain thrives at high temperature and light intensity of the summer season and it was grown in actual seawater which will make the large-scale biomass production cost effective.

Previously designed, constructed and operationally optimized 60 L flat panel photobioreactor system for *P. limnetica* growth was successfully operated for CO_2 sequestration studies. MSWBG11 medium which containing additional carbonate was found to be a good source of the medium in which maximum CO_2 can be fortified and made available for algal growth.

To improve the biomass productivity CO_2 from the artificial source was provided in different concentrations. The continuous CO_2 supplementation at ≤0.001 LPM of flow rate showed enhanced biomass production. Volumetric mass transfer coefficient (KLa min^{-1}) was found to be increasing with an increase in CO_2 feeding rate. But, percentage CO_2 consumption by P. limnetica was found to be highest at ≤0.001 LPM CO_2 flow rate, which is making it an ideal flow rate for CO_2 mitigation and mass cultivation of this microalgal strain.

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Saloni D Kale
KET's V.G. Vaze College of Arts, Commerce and Science, Mithagar Road, Mulund (E), Mumbai, Maharashtra, India

Pranjali P Dhawal
Animal Biotechnology and Biochemistry Division, KET's Scientific Research Centre, Vaze College Campus, Mithagar Road, Mulund(E), Mumbai, Maharashtra, India

Siddhivinayak S Barve
KET's Scientific Research Centre, Vaze College Campus, Mithagar Road, Mulund(E), Mumbai, Maharashtra, India

Deepali K Karkhanis
KET's V.G. Vaze College of Arts, Commerce and Science, Mithagar Road, Mulund (E), Mumbai, Maharashtra, India

Corresponding Author:
Deepali K Karkhanis
KET's V.G. Vaze College of Arts, Commerce and Science, Mithagar Road, Mulund (E), Mumbai, Maharashtra, India

Fortification of yogurt containing isolated *Lactococcus lactis cremoris* with Fenugreek Seeds extract

Saloni D Kale, Pranjali P Dhawal, Siddhivinayak S Barve and Deepali K Karkhanis

Abstract
People in their everyday life in midst the bustling schedule have developed taste for go-to nutritious food products such as, nutrition bars, nutrition cookies, flavored yogurts, protein shakes, sugar-free juices, fruit juices with additional vitamins, probiotic pickle, and flavored teas. With emergence of fortified food items, increase in health awareness and changed outlook of consumers, has made food industry to adopt fortification of beverages and common food like cheese, bread, and yogurt with herbal extracts. Plant extract are known to have antioxidant, anti-diabetic, antimicrobial, and anti-cancer properties. Fenugreek, for instance, are rich in polyphenols and this class of secondary metabolites have strong antioxidant capacity in comparison to vitamins and carotenoids. Current study aims at extracting polyphenols from fenugreek seeds (PFFS). Total phenol content of PFFS was estimated using Folin Ciocalteau Method and it was calculated to be 182 µg of GAE/ 5 mg of FPPS. Lactic acid bacteria (LAB), *Lactococcus lactis cremoris* was isolated from homemade yogurt. Isolated *L. lactis cremoris* culture was used to prepare yogurt fortified with polyphenol fraction extracted from fenugreek seeds. The antioxidant activity of fortified yogurt was determined qualitatively using DPPH assay which showed immediate change in color from purple to yellow which is indicative of free radical scavenging activity.

Keywords: *Lactococcus lactis cremoris*, fenugreek, flavonoid, antioxidant

Introduction
Consumption of natural antioxidants through dietary supplements have shown to reduce cardiovascular and cancer risks. Naturally occurring antioxidants that are present in the vegetables are grouped into three categories, vitamins, carotenoids and phenolics [1]. Research, characterization and application of natural antioxidants is a mainstay of numerous research teams all over the world [2]. Phenols, particularly, have the ability to scavenge reactive oxygen species because of their electron donating property. In literature, phenols are shown to demonstrate higher antioxidant activity than vitamins and carotenoids [3].
Fenugreek or *Trigonella foenum-gracecum*, is a popularly known and variedly used plant, in day to day life [4]. Fenugreek constitutes of flavonoids, alkaloids, coumarins, vitamins and saponins. Fenugreek has been known to contain a great percentage of polyphenols that contribute to the antioxidant's property. Fenugreek is used as a traditional remedy for many disorders eg. Diabetes [5, 6], arthritis, irritation [7], hypercholesteremia [8, 9], among others. Fenugreek seeds are also known to contain gum, fiber, saponin and volatile content. Its high fiber content makes it suitable as an emulsifier, stabilizer or adhesive agent which have implications in food industry [10]. Human history mentions use of fenugreek seeds in flavors, essence and medicines [4].
Yogurt has been in increasing demand between the masses mainly because it's a "to go" food product and also nutritious. Yogurt is different from curd and is made by fermenting the milk with a yogurt starter culture (*Lactobacillus*, *Lactococcus*, *Streptococcus*) which helps in maintenance of gut microflora and flavoring agents to enhance texture and taste. Yogurt helps in maintaining cholesterol levels, blood pressure and aids digestion [11]. Long since it has been known that fruits, vegetables, and dairy products are healthy components of the diet according to food guides and nutritional guidelines. Recently it has been investigated that whole plant–based foods, probiotics, and prebiotics can modulate the microbiota, leading to cardiac health [12]. With emergence of fortified food items, increase in health awareness and changed outlook of consumers has made food industry to adopt fortification of beverages and common food like cheese, bread, and yogurt with herbal extracts [13].
Current study focuses on extraction of polyphenol content from fenugreek seed and its role as an antioxidant in fortified yogurt containing *L. lactis cremoris* as a starter culture.

A part of the work also involves isolation and characterization of probiotic microbe from preformed yogurt as an already available Yogurt can be a good source for isolation of Lactobacillus and Lactococcus species. This isolated and characterized probiotic microbe and polyphenol fraction of fenugreek seed (PFFS) will be utilized to produce a fortified yogurt with antioxidant property.

Material and Methods

MRS Broth and Agar (Himedia), UV-Visible Spectrophotometer (Cary 50), all chemicals used were of analytical grade, DPPH (Hmedia), all microbiological media, chemicals and broth used was procured from Himedia.

Extraction of polyphenols from fenugreek

Fenugreek seed were obtained from local market store from Mumbai, Maharashtra in the month of November, 2018. 50 g of the seeds were ground using a mechanical grinder to obtain uniform powder. The powdered seeds were then soaked in 80% methanol and kept at room temperature for 5 days. After incubation, the suspension was filtered and residue was collected after solvent evaporation. Water was added to the reside, heated for 2 min and reduced to form a viscous solution. The residue was washed by centrifugation at 5000 rpm for 10 min using deionized distilled water. The supernatent was collected and filtered through Whatman's Filter Paper No.1. The filtered aqueous layer was wahed several times with petroleum ether several times and aqueous layer collected was again washed with ethyl acetate containing glacial acetic (10%). The extract was kept in oven for 36 hours. This served as a polyphenol fraction (PFFS) obtained from fenugreek seeds and was stored at 4°C until further use [14].

Total phenol content

The total phenolic content (TPC) of PFFS extract was determined using a modified procedure mentioned by Kakodkar *et al*, 2019. [15] 120 µL of PFFS extract was mixed with 3 mL of Folin-Ciocalteau reagent and incubated for 10 mins. The solution was then neutralized with 3mL of 2% Na2CO3 solution and incubated in dark for 30 min for color development. Similar procedure was carried for gallic acid (Standard) with a range of concentration from 100-1000 µg/mL. The reaction mixture containing PFFS was measured at 765nm along with gallic acid. The absorbance was read for all the tubes. A standard graph was plotted using Gallic acid and calibration curve was obtained. The total phenolic content of PFFS was expressed as Gallic acid equivalent (GAE) in mg/g of dry extract.

Isolation of probiotic microbe from yogurt

Homemade Yogurt was used to isolate probiotic microorganism. 5g of curd was taken in a sterile flask and was diluted using saline. A loopful of solution was streaked onto Sterile MRS agar plate. The plates Was incubated for 24hrs at 37 ºC. A typical colony was selected which was were further streaked on MRS agar and the after incubation the plate was stored at 4 ^{0}C for further tests. Bacterial colonies were purified by sub-culturing in St. MRS broth.

Colony characterization for final identification

Colony characterization, gram staining, and biochemical tests were carried out and the identification of the strain was done by Bergey's Manual of determinative bacteriology [16]. Biochemical tests performed were test for carbohydrate metabolism, test for specific breakdown of products, utilization of specific substrate test, test for enzymes and metabolism of nitrate and amino acids.

Starter Culture

Isolated colony was enriched in St. MRS broth overnight. Approximately 10^7 cells were inoculated in the 10mL of pasteurized full cream milk in a sterile test tube. The inoculated milk cream was incubated in the water bath at 41 ^{0}C for 12 hrs. Yogurt formed was stored at 4 ^{0}C and used as a starter culture within 7 days.

Preparation of PFFS Yogurt

This included fermentation of milk with PFFS along with starter culture. Pre-warmed pasteurized milk (85mL) was taken in to a beaker. 10 mL of 20% fenugreek extract was added along with 5mg of starter culture. The mixture was incubated in water bath at 41 ^{0}C until the pH is dropped to 4.5. The prepared yogurt was stored at 4 ^{0}C for 14 days.

Qualitative antioxidant profile of PFFS yogurt using DPPH assay

Antioxidant activity of PFFS yogurt was determined using stable 2,2-diphenyl-1-picrylhydrazyl (DPPH) by the slightly modified method.[17] The solution of DPPH in methanol 6×10^{-5} M was prepared freshly. 10 ml of PFFS yogurt was distributed in 1.5mL eppendorf tubes and centrifuged at 10000 rpm for 10 min. The supernatant was collected and was using as a test solution for determining free radical scavenging activity. 100 µL of test was added to 100 µL of DPPH solution. Color blank was maintained to give a solution of 100 µL of test and 100 µL of methanol. Negative control used was of 100 µL of DPPH and 100 µL of Methanol. The test was conducted in 96 well plates. Color change was used to determine the antioxidant activity present in PFFS Yogurt.

Results and Discussions

Extraction of polyphenol fraction (PFFS) from Fenugreek Seeds

Methanol was selected as a solvent for extraction of Polyphenol Fraction (PF) as it shows better affinity towards polyphenols. Later water was added to the solution as polyphenol will get solubilized in aqueous fraction leaving residues to be absorbed by methanol. 50% water tends to increase the solubility of polyphenols lowering the viscosity. The centrifugation step concentrated the polyphenol [18]. Filtration removes polyphenols from other unwanted residues and petroleum ether was added to dissolve mixture of hydrocarbons. Petroleum also separates oils and fats from polyphenols in aqueous layer [19]. 0.02% Glacial acetic acid in Ethyl acetate finally extracted polyphenols from aqueous solution as ethyl acetate is a strong hydrogen bond acceptor and glacial acetic acid prevents oxidation of phenols [20]. Finally 1.42% of polyphenols were extracted from 100g of Fenugreek Seeds.

Total phenolic content of PFFS

Gallic acid was used as a standard for deriving calibration curve. From the curve the linear equation was observed and was found to be $y = 0.0008x + 0.0944$, $R^2 = 0.9869$. Based on this equation the TPC in PFFS was found to be 182 µg of GAE/ 5 mg of FPPS.

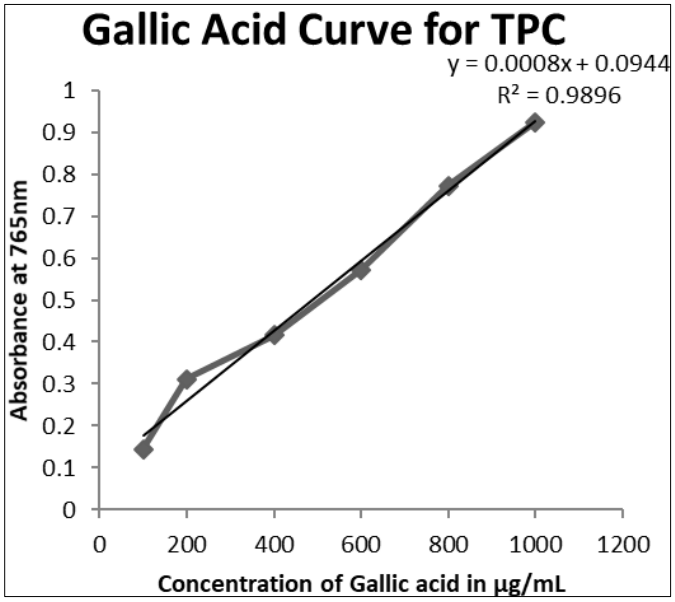

Fig 1: Standard Calibration Curve of Gallic Acid for TPC

Characterization of Probiotic Microbe isolated from Homemade Yogurt

Colony characterization and biochemical test results are given below as table 1 and table 2 respectively.

Table 1: Colony Characterization of Isolated Bacterial Colonies

Colony Characteristics	Results
Shape	Circular
Elevation	Raised
Margin	Entire
Color	Creamy white
Consistency	Mucoid
Surface	Glistening
Density	Opaque
Gram's Nature	Purple Cocobacilli

Table 2: Biochemical test for isolated colony from Homemade Yogurt (+): Positive (-): Negative

	Biochemical test	Results
1	Glucose	Acid (+) Gas (-)
2	sucrose	Acid (+) Gas (-)
3	lactose	Acid (+) Gas (-)
4	maltose	Acid (+) Gas (-)
5	cellobiose	Acid (-) Gas (-)
6	xylose	Acid (-) Gas (+)
7	indole	(-)
8	methyl red	(+)
9	voges Proskauer	(-)
10	citrate utilization	(-)
11	catalase test	(-)
12	oxidase test	(-)
13	growth in 4% NaCl	(-)
14	growth in 6.5% NaCl	(-)
15	nitrate reduction test	(-)

Selected colony was further sub-cultured and enriched in MRS broth and Bacteriological tests were carried out with respect to the Bergey's Manual of systemic bacteriology and Identification was done accordingly. Table 1. enlists the colony characteristics of isolated bacterial species and Table 2. gives results of biochemical tests. The obtained results were studied, compared and concluded using the Bergey's manual of systemic bacteriology. The bacterial strain is a coccobacilli, non motile, non spore forming, gram positive, sucrose, glucose, lactose and variably a maltose fermenter. It is a catalase, oxidase, voges Proskauer, indole, nitrate reduction test and Citrate test negative, although Methyl Red positive. the salt tolerance is very low too, since it ceased to grow in 4% NaCl. Thus the strain was identified to be a firmicute belonging to the family of Streptococcaceae, genus Lactococcus, species L. *lactis*. and is a sub specie of L. lactis called L. *lactis cremoris*

Preparation of Yogurt

L. lactis cremoris isolated from homemade yogurt was used as a starter culture prepare PFFS yogurt. Addition of starter culture helped to obtain a presumably characteristic yogurt. The phenol in the extract was added to influence the aroma and flavor of the yogurt. (Fig.1). The antioxidant activity of yogurt, also, maybe attributed to phenol content of fenugreek seeds.

Fig 1: Yogurt with *Lactococcus lactis cremoris* fortified with Polyphenols of Fenugreek Seeds

Qualitative DPPH Activity of PFFS Yogurt

10 ml of PFFS yogurt was distributed in 1.5mL eppendorf tubes and centrifuged at 10000 rpm for 10 min. The supernatant was collected and evaluated for DPPH activity. Upon addition of DPPH to supernatant there was immediate color change from purple to yellow (Fig.2) suggesting antioxidant activity of PFFS yogurt [21].

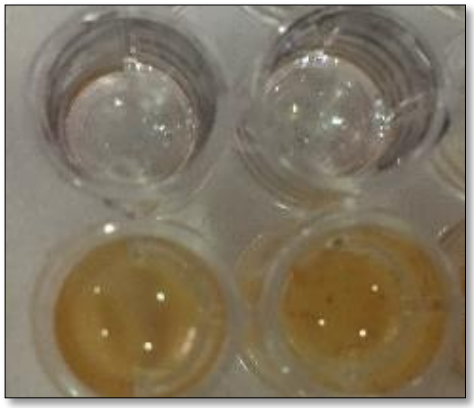

Fig 2: Qualitative DPPH activity of PFFS Yogurt

Conclusion

The polyphenol content from fenugreek seeds was used to prepare homemade yogurt with potent antioxidant properties. Polyphenol fraction from fenugreek seeds showed 182 µg of GAE/ 5 mg of FPPS phenol content. The isolation, characterization and identification of the LAB, revealed the

presence of *Lactococcus lactis cremoris*. The *L. lactic cremoris* was used to prepare as a starter culture to prepare yogurt. Polyphenolic extract of Fenugreek seeds was utilized to add flavor and aroma to the yogurt. The phenolic extract influenced the yogurt's antioxidant activity.[22] 20% of seed extract was used which gave immediate antioxidant activity upon addition of DPPH. In addition to the flavor, the fenugreek seed extract is also a potent candidate for extraction of polyphenols, its related antioxidant activity and its use in preparation of Yogurt.

Conflict of Interest

The authors declare no conflict of interest.

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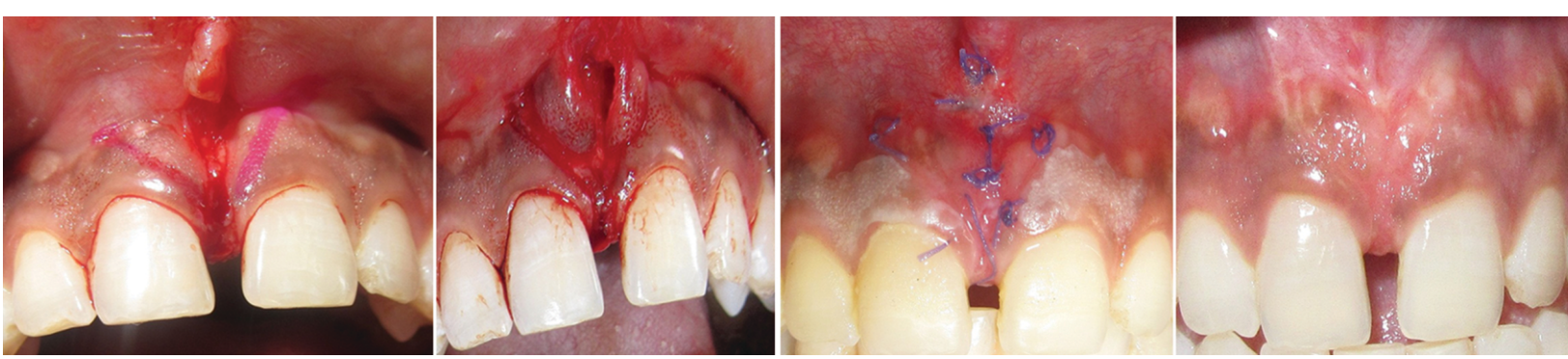

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Original Article

Coconut Oil Pulling – The Holistic Medicine: Evaluation of Efficacy of Coconut Oil Pulling Therapy as an Adjunct to Scaling in Diabetic Patients with Chronic Gingivitis – A Clinical and Microbiological Study

Shraddha Kode, Praneeta Kamble, Deepali Karkhanis[1], Rummana Khan[2]

Department of Periodontics, Nair Hospital Dental College, [1]Department of Biotechnology, KET's V.G.Vaze College, [2]Department of Microbiology and Plant Biotechnology, KET's Scientific Research Centre, Mumbai, Maharashtra, India

Abstract

Context: Oil pulling is the traditional medicine practised in ancient India. Limited scientific data is present illustrating the role of oil pulling. Therefore, we conducted a study to introduce a natural ingredient which can be used as an adjunct in diabetic patients. **Aim:** To evaluate the efficacy of Coconut Oil as an adjunct to scaling in diabetic patients with chronic gingivitis. **Material and Methods:** 60 Diabetic patients with Chronic Gingivitis were divided into 3 groups: Group A: Scaling and root planing only (n=20), Group B: Scaling and root planing followed by Coconut Oil Pulling Therapy (n=20) and Group C: Scaling and root planing followed by rinsing with 0.2% Chlorhexidine mouthwash (n=20). The following clinical parameters were recorded at baseline after SRP and 15 days post-treatment : Plaque index (P.I.), Gingival index (G.I.) & Total colony forming units (CFU/ml). **Results:** The method used for statistical analysis was repeated measure ANNOVA followed by post-hoc test. The results of the study demonstrated the difference in the reduction of all the scores to be clinically significant and not statistically significant. **Conclusion:** Thus, this study shows the positive effects of coconut oil pulling in the control and prevention of progression of gingival disease.

Keywords: *Coconut, diabetes, gingivitis, oil, oil pulling*

Clinical Relevance to Interdisciplinary Dentistry

- The community can benefit from the use of coconut oil which is a natural ingredient to resolve the inflammation and prevent further progression of gingival disease
- Coconut oil can be used as a safe adjunct to scaling in diabetic patients with chronic gingivitis for control or regression of gingival inflammation
- Coconut oil pulling is a home-based remedy which is beneficial to the society in preventing the adverse effects of gingival diseases, and thus improves the quality of life.

Introduction

Oil pulling is an ancient practice that is receiving renewed interest due to its use as an adjunct in peoples' oral hygiene routine.[1] To reduce the side effects of modern medicine, people are increasingly shifting toward ancient medicine. Oil pulling has proven to be the home-based remedy due to its beneficial effects on general and oral health. In 1990's, in the Union of Soviet Socialist Republics, Ukranian Physician Dr. F. Karach popularized this procedure as oil pulling by proclaiming that he cured himself from a blood disease after experimenting with oil swishing. Hence, oil pulling is also known as Karach's therapy after its discoverer.[2,3]

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Address for correspondence: Dr. Shraddha Kode, S/3 "A" Chitralekha, Vikram Nagar, Kalwa West, Thane - 400 605, Maharashtra, India.
E-mail: kshraa24@gmail.com

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In ancient times, it was practiced as kavala graha and kavala gandoosha.[3,4] Kavala graha or gandoosha is an Ayurvedic oral hygiene maintenance practice, wherein suitable amount of oil is held in the mouth on an empty stomach for some period of time and swished till it becomes thin and milky white after which it is spit out. Kavala graha involves comfortable amounts of oil and kavala gandoosha involves mouthful of oil used for swishing.[5-7]

Oil pulling should ideally be performed on an empty stomach and care should be taken that oil is not swallowed since the pulled oil contains bacteria and toxins.[1,8-10] Oil pulling should best be practiced in sitting position with chin up.[8] It is usually contraindicated for children <5 years of age due to increased risk of aspiration of oil.[9,10]

The aim of the study was to evaluate the clinical and microbiological efficacy of coconut oil pulling as an adjunct to scaling in diabetic patients with chronic gingivitis. In diabetic patients due to impaired wound healing and difficulty in adequately removing plaque by mechanical means, a great interest has been ensued in the use of adjuncts to mechanical approaches. Chlorhexidine has been so far considered as the gold standard treatment due to its superior antiplaque effect.[11] But due to the reported side effects, search for an alternative product continues and natural products are considered as good alternatives to these chemicals.[12]

Subjects and Methods

This was a clinical, interventional, case–control, open-labeled, single-center study involving use of coconut oil and chlorhexidine mouthwash after scaling. The study was approved by the Ethics Committee and registered with the Clinical Trials Registry (CTRI/2018/03/012689).

A total of 60 patients in the age group of 25–70 years with chronic gingivitis and controlled diabetes (on oral hypoglycemic drugs) with glycosylated hemoglobin (HbA1c) levels <7 were selected. The patients on insulin therapy, pregnant and lactating mothers, patients with drug allergy, and any systemic disease or adverse habits were excluded from the study.

The patients fitting the inclusion criteria were divided into three groups using computer0assisted randomization method as follows [Figure 1]:

a. Group A – Scaling and root planing (SRP) only (n = 20)
b. Group B – SRP followed by coconut oil pulling therapy (n = 20)
c. Group B – SRP followed by rinsing with 0.2% chlorhexidine mouthwash (n = 20).

The following clinical parameters were recorded at baseline before SRP and 15 days posttreatment:

1. Plaque index (PI) (Turesky–Gilmore-–Glickman Modification of Quigley–Hein, 1970)
2. Gingival index (GI) (Loe and Silness, 1963)
3. Total colony-forming units (CFU/ml).

Following the initial examination and assessment of HbA1c levels of diabetic patients with chronic periodontitis, baseline levels were recorded, and then, the patients were divided into three groups. SRP was performed on all the patients using ultrasonic scaler. Group B and Group C patients were given coconut oil sachets and chlorhexidine mouthwash bottles, respectively. The patients were recalled after 15 days to record the clinical parameters. Oral hygiene methods were standardized by providing standard toothpaste and standard toothbrush using modified Bass technique of tooth brushing twice daily.

In Group A, the control group was subjected to only SRP.

In Group B, the test group was instructed to perform oil pulling with coconut oil, one tablespoon of coconut oil on an empty stomach first thing in the morning for the next 15 days after undergoing SRP. The coconut oil was sipped, sucked, and pulled between the teeth for 15 min with rest in between. The swished oil was asked to be

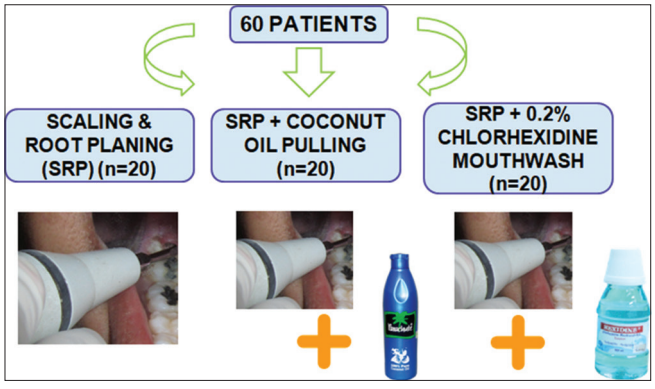


Figure 1: Schematic diagram showing three groups of patients fitting inclusion criteria

Figure 2: Sample collection for microbiological efficacy

withdrawn into a glass and then again swished to avoid jaw ache and fatigue till the viscous oil turned thin and milky white. This oil was told not to be swallowed as it contains bacteria and toxins. Oil pulling therapy was instructed to be preferably done on an empty stomach in the morning, followed by brushing of the teeth for its maximum action.

In Group C, the control group was instructed to rinse with 0.2% Chlorhexidine mouthwash (Hexidine®, ICPA, Mumbai) for 30 s, twice daily for the next 15 days along with SRP.

For assessing the microbiological efficacy, two samples were selected for aerobic and anaerobic microorganisms processing. The patients were instructed to wash their mouth using physiological saline. This saline was collected in a sterile container and serially diluted and placed in Mueller Hinton agar plates [Figure 2]. The agar plates were incubated at 37°C for 48 h for aerobic sample processing. After the incubation period, the number of colonies present in 1 ml of saliva was calculated by the formula:

Number of bacteria/ml = Number of colonies × dilution factor × amount plated

For anaerobic sample processing, the teeth surfaces were dried using gauze piece to prevent saliva contamination. Subgingival samples were collected from four different sites using sterile Gracey curette by inserting it into the deepest portion of the gingival sulcus parallel to the long axis of the tooth and moving coronally by scraping along the tooth surface. They were then transferred to vials containing enriched Robertson's cooked meat broth for maintaining its viability during transport. This sample was then processed under anaerobic conditions on anaerobic blood agar plates [Figure 2]. For maintaining anaerobic conditions, anaerobic jar with anaerobic gas generating system (GasPak) was used for 37°C for 48–72 h.

Results

It was observed that coconut oil pulling led to the improvement of oral health status. All the three groups showed significant difference in all the parameters measured at baseline and after 15 days. The statistical analysis method used was repeated-measure ANOVA followed by *post hoc* test.

The mean baseline PI scores were 3.28 (±0.48), 2.93 (±0.32), and 3.18 (±0.40) for Groups A, B, and C, respectively. The mean baseline GI scores were 1.92 (±0.20), 1.86 (±0.18), and 1.96 (±0.23) for Groups A, B, and C, respectively. The PI scores reduced to 2.62 (±0.52), 1.76 (±0.44), and 1.68 (±0.50) in Groups

Table 1: Significant reduction in the plaque index scores posttreatment

PLAQUE INDEX (P.I.) (Tureskey-Gilmore-Glickman Modification Of Quigley Hein, 1970)	PRE-TREATMENT	15DAYS POST TREATMENT
Group A	3.28 (± 0.48)	2.62 (± 0.52)
Group B	2.93 (± 0.32)	1.76 (± 0.44)
Group C	3.18(± 0.40)	1.68 (± 0.50)

Table 2: Significant reduction in the gingival index scores posttreatment

GINGIVAL INDEX (Loe and Silness-1963)	PRE-TREATMENT	15DAYS POST TREATMENT
Group A	1.92 (± 0.20)	1.52 (± 0.26)
Group B	1.86 (± 0.18)	1.18 (± 0.19)
Group C	1.96(± 0.23)	0.92 (± 0.22)

Figure 3: Improvement of clinical parameters in all the three groups posttreatment

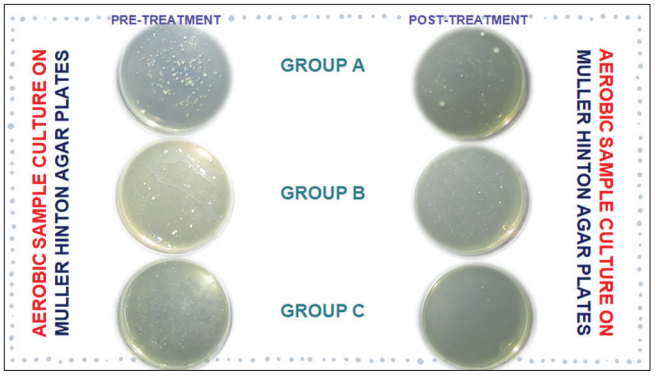


Figure 4: Significant reduction in aerobic colony-forming units posttreatment

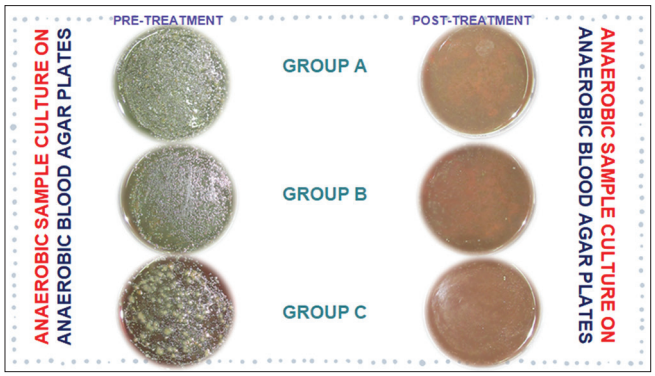


Figure 5: Significant reduction in anaerobic colony-forming units posttreatment

A, B, and C, respectively. Similarly, the GI scores reduced to 1.52 (±0.26), 1.18 (±0.19), and 0.92 (±0.22) in Groups A, B, and C, respectively. Thus, the results obtained showed that there was a significant reduction in Groups B and C posttreatment as compared to Group A [Tables 1, 2, 3 and Figure 3] [Graphs 1 and 2].

The aerobic colony-forming units also showed a significant reduction in Groups B and C posttreatment as compared to Group A. The baseline aerobic colony-forming units were 4.98×10^6, 4.13×10^6, and 4.59×10^6 CFU/ml for Groups A, B, and C, respectively. They reduced to 3.92×10^6, 2.42×10^6, and 2.95×10^6 CFU/ml in Groups A, B, and C, respectively. Thus, the microbiological results obtained showed that there was a significant reduction in Groups B and C posttreatment as compared to Group A [Table 4 and Figure 4 and Graph 3].

The anaerobic sample showed comparatively the same type of pinpoint colonies posttreatment. However, the matt texture of the colonies was reduced. There was reduction in the count seen visibly; however, the counts were not in the countable range [Figure 5].

The scores were statistically assessed using repeated-measure ANOVA by *post hoc* test. The difference in the reduction of all the scores was found to be clinically and statistically significant ($P \leq 0.05$) [Table 5].

Discussion

Plaque-induced gingivitis is the result of an interaction between plaque and the tissues and the inflammatory response of the host. It is associated with subtle microbial alterations as the plaque matures.[13,14] Oral hygiene measures reduce the incidence of plaque-induced gingivitis by decreasing plaque accumulation. Teshome and Yitayeh, 2016, in a systematic review and meta-analysis showed significant reduction of glycated hemoglobin and fasting plasma glucose level on type 2 diabetic and periodontal patients present with nonsurgical periodontal therapy.[15]

Table 3: Percentage reduction in plaque index and gingival index scores posttreatment

Table 3. PERCENTAGE REDUCTION	PLAQUE INDEX	GINGIVAL INDEX
Group A	11.1%	11.62%
Group B	24.94%	22.36%
Group C	30.86%	36.11%

Table 4: Significant reduction in the aerobic colony-forming units posttreatment

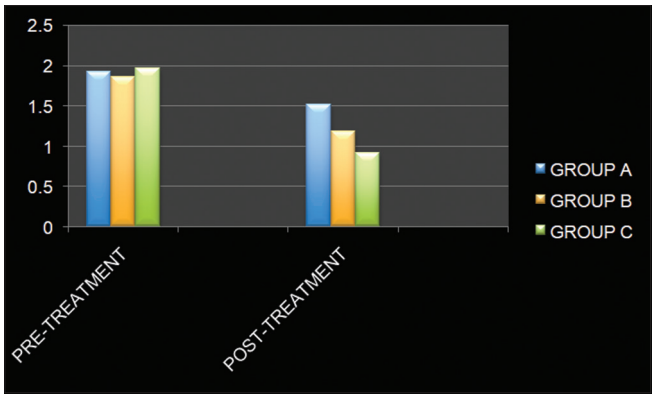
AEROBIC SAMPLE PROCESSING	PRE-TREATMENT CFU/ml	15DAYS POST TREATMENT CFU/ml
Group A	4.98×10^6	3.92×10^6
Group B	4.13×10^6	2.42×10^6
Group C	4.59×10^6	2.95×10^6

Table 5: Comparison between experimental groups

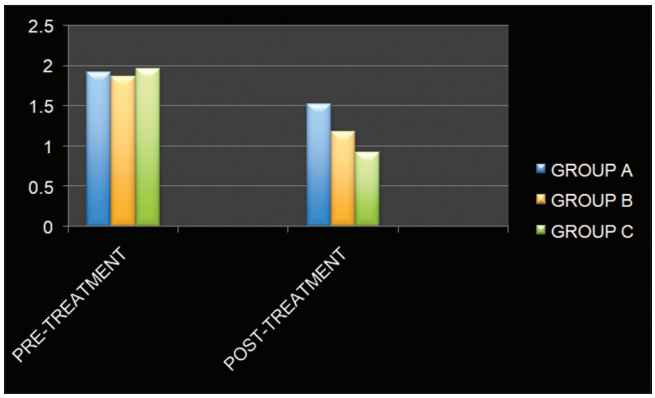
P VALUE	A vs B	A vs C	B vs C
PLAQUE INDEX	<0.001	<0.001	<0.001
GINGIVAL INDEX	<0.001	<0.001	<0.001
AEROBIC SAMPLE PROCESSING	<0.001	<0.001	0.06

Oil pulling is a folk remedy which is not widely practiced and lacks scientific basis. A systematic review by Bekeleski *et al*. in 2012 shows that oil pulling has certain benefits over commercially available mouthrinses such as nonchemical, nonalcoholic, low cost, and nonstaining, yet the effectiveness and the mechanism of action are unclear.[16] Whereas, a systematic review by Gbinigie *et al*. in 2016 shows that oil pulling may be as effective as chlorhexidine on certain oral hygiene markers and could serve as a low adjunct to toothbrushing.[17]

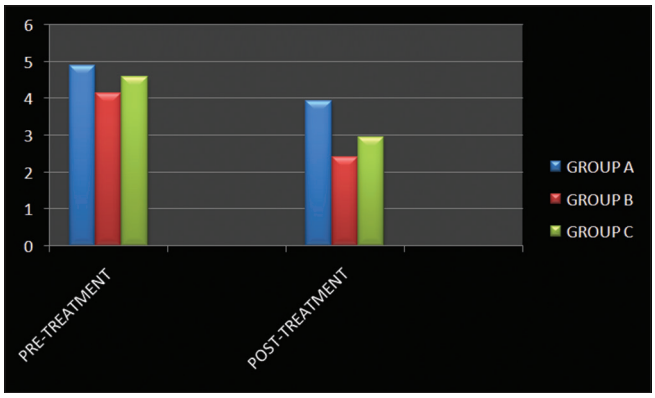
Similarly, this study shows oil pulling therapy to be as effective as chlorhexidine mouthwash in diabetic patients with chronic gingivitis. However, oil pulling does not replace dental therapy and is currently not



Graph 1: Graphical representation of significant reduction in the plaque index scores posttreatment



Graph 2: Graphical representation of significant reduction in the gingival index scores posttreatment



Graph 3: Graphical representation of significant reduction in the aerobic colony-forming units posttreatment

recommended by the American Dental Association as the sole treatment.[18]

Chalke *et al*. 2018 in a clinical study concluded that significant decrease in pre- and post-treatment scores of PI and GI was noticed from baseline to 15th and 30th day by an ancient oil pulling method using coconut oil.[19] An interventional study by Kaliamoorthy *et al*. 2018 stated that coconut oil is very effective compared to sesame oil in the reduction of severity of gingivitis.[20]

Various types of oils such as sesame, coconut, sunflower, corn, soya bean, palm, rice bran, and olive oil can be used for oil pulling.[21-25] Coconut oil has been proved to have wonderful effects on oral health. It contains predominantly medium-chain fatty acids of which 45%–50% include lauric acid which is otherwise present in such great amounts in breast milk. Lauric acid is also known for its anti-inflammatory and antimicrobial properties.

Other oils contain long-chain fatty acids which are not metabolized as easily as medium-chain fatty acids, and hence, stored as fat. This changes the property of coconut oil. The other chemical constituents in coconut oil include myristic acid, caprylic acid, capric acid, caproic acid, palmitic acid, palmitoleic acid, stearic acid, and linoleic and oleic acid. A study by Peedikayil *et al*. in 2015 showed the effectiveness of oil pulling with coconut oil as an adjuvant to brushing in decreasing plaque accumulation and plaque-induced gingivitis.[3]

Coconut oil is also effective against *Escherichia vulneris, Helicobacter pylori, Staphylococcus aureus,* and predominantly against *Candida albicans* and *Streptococcus mutans* species.[18,26,27] Hence, we conducted a study using coconut oil as an adjunct to scaling in diabetic patients with chronic gingivitis.

Many hypotheses have been put forward regarding the mechanism of action of oil pulling which are as follows:

1. Oil swishing action generates mechanical shear forces due to agitation which results in emulsification of oil. This further increases the surface area of oil and thus forms a thin film of oil over the tooth surface which can reduce plaque adhesion and bacterial coaggregation[28]
2. Alkalis in saliva react with oil to result in saponification or soap-like substance formation which has a cleansing action. This reduces the plaque adhesion[29]
3. Oil pulling results in significant reduction in gingivitis due to decreased plaque accumulation, emollient, and anti-inflammatory action
4. Oil pulling activates salivary enzymes, and this absorbs all the toxins from the blood and brings it to the oral cavity, thus getting rid of them. However, oral mucosa is not a semipermeable membrane. Hence, this theory remains questionable.

The coconut oil chosen for the study involved refined, cold-pressed, and easily available Parachute® oil (Marico Company). Cold-pressed oil retains the nutrition, aroma, and flavor. Trans fats are absent in cold-pressed oil. Hence, oil pulling is best performed using cold-pressed oils.[2] Parachute® oil is a purely edible oil, completely

natural with no additives, and Good Manufacturing Practice certified.

The disadvantages of oil pulling involved oily bland taste and jaw ache after swishing for 10–15 min. The complications of oil pulling could involve aspiration of microorganisms rich oil to resulting in lipoid pneumonia.[30]

Limitations of the study involved short sample size and short duration of follow-up. Therefore, extensive studies with larger samples, varying time periods, and long follow-up times should be carried out to establish the efficacy of oil pulling therapy.

Furthermore, although culture methods are considered to be the gold standard, the drawback involves that only cultivable bacteria can be cultured. Therefore, advanced molecular techniques are required for noncultivable and unidentified pathogens. Identification of specific microorganisms should be encouraged using special media, biochemical tests, and antimicrobial discs. This should be borne in mind by investigators in further studies.

Coconut oil pulling has following advantages over chlorhexidine mouthwash – no staining, no lingering after taste, no allergy, easily available, cost-effective, and better patient compliance. Thus, to avoid the deleterious effects of chemicals, it is better to switch to nature for its goodness.

Conclusion

Based on the currently available research, it can be concluded that oil pulling can be safely used as an adjunct to maintain good oral hygiene. This study proved that oil pulling therapy has clinically significant effect on chronic gingivitis in diabetic patients. Hence, if practiced daily, it can be developed into a healthy oral hygiene habit. Thus, there is a need to promote awareness among people of the long-lost practice of oil pulling.

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Conflicts of interest

There are no conflicts of interest.

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Screening of various extracts of *Garcinia indica viz*. leaf, seed, stem, root and fruit for UV protective activity and incorporation of extracts in Sun protective formulations.

Mamata Dike[*] , Renuka Thergoankar[2] and Manjushri Deodhar[3]
Department of Biotechnology[*], Department of cosmetology[2], Department of Botany[3] Kelkar Education trust's V.G. Vaze College of Arts, Science and Commerce, Mithagar Road, Mulund (E) Mumbai -81, India

Keywords: Benzophenones, SPF, Sunscreens, Kokum extract, UV absorbance

Abstract

Exposure to UV radiations from sun is major cause of sunburns, pigmentation as well as skin cancer; hence sun protecting compounds are essential commodities of life. The inorganic sun blockers viz. ZnO and TiO2 gives broad spectrum UV protection but, have drawback of skin whitening. The Organic compounds having UV protective ability both in UV A and UV B region include benzophenones. *Garcinia* species are known to produce different types of benzophenone like Garcinol, isogarcinol, xanthochymol, isoxanthochymol etc. In previous studies, natural benzophenones present in *Garcinia indica* were screened for UV protective activity. Out of Various extracts of fruit rinds of G. indica Viz. aqueous, ethanolic, methanolic, water, n-butanolic, hexane and Ethyl acetate were screened for UV protective activity. Initially the selected extracts were screened by spectrophotometric method. The maximum sun protective activity was found in ethyl acetate and n-butanolic extract in both UV A and UV B region. The ethyl acetate extract when incorporated in sun protective cream formulation gave SPF 3.43 and boot star rating five which indicates strong UV protective activity in UV A region. In present study, natural benzophenone in various parts of plant of *G. indica* like leaves, seeds, roots and bark were screened for UV protective activity. The extracts were also incorporated in sunscreen formulations and SPF was determined by SPF analyzer. The cumulative effect of *G. indica* extracts along with commercial UV protective compounds like TiO_2, benzophenone 3 and Uvinul A plus was also studied.

INTRODUCTION

Exposure to UV radiation has acute chronic and delayed effects on skin. UV radiation induced acute responses include inflammatory responses such as sunburn, pigmentation, hyperplasia etc. Chronic effects include Photo-aging and photo-carcinogenesis (Gasprro et al 1998). Solar radiations comprise of mainly three types of UV radiations viz. UV C (200-280 nm), UV B (280-320 nm) and UV A (320- 400 nm). UV C is the most biologically damaging but it is filtered out by ozone layer. UV B radiations have short wavelength and more hazardous

than UV A, while UV A radiations have long wavelength and can penetrate furthest into subcutaneous layer of skin tissue and generates radicals, which affect adversely to cellular proteins, lipids and even to DNA hence they are most harmful radiations than UV B. Hence there is need of photo protective products for protection from the harmful effects of UV radiations. Several chemical additives like TiO_2, ZnO_2 etc are used in sun protecting creams, but they causes skin whitening. Organic sun protective such as benzophenones have photo-instability. There is always a search for broad spectrum UV protective compounds. In our previous studies, we studied benzophenones from fruit rinds of *Garcinia indica* for UV protective activity (Dike et al 2013).

Bhat et al (2005) first reported the UV radiation absorbing ability of water soluble pigments of fruit extract of G. indica. But *Garcinia* fruit contains both water soluble pigments like, anthocyanins (Krishnamurthy et al 1981) and water insoluble pigments like Garcinol and isogarcinol. The water immiscible pigments extracted in ethyl acetate have been more effective for their UV protective ability (Dike and Deodhar, 2015). But apart from fruit extract the yellow compounds, garcinol, isogarcinol are also present in stem, seed pericarp, leaves and roots. The present investigation deals with UV protective activity of ethyl acetate extracts from various plant parts of *G. Indica*. The cumulative effects of the extracts with commercial sunscreen agents were also studied in terms of SPF.

MATERIALS AND METHODS

Fresh fruits of *Garcinia indica* were collected from Dr.Balasaheb Sawant Kokan Krishi Vidhyapith, Dapoli, Dist. Ratnagiri Maharashtra, India. Cosmetic grade benzophenone- 3, TiO_2 of Chemical international was used.

Reagents and Instruments

Ethyl acetate and ethanol of analytical grade (Merck) were used for experiments. Genesys 10 S UV-VIS spectrophotometer (Applied Bio system) was used for measuring UV absorption at wavelength 200-400 nm. UV-2000S Ultraviolet Transmittance Analyzer (Labsphere inc.USA) was used to analyze in vitro SPF or UV A protection factor analysis of various formulations.

Preparation of various extracts of *G. indica*

The ethyl acetate extract was fractionated with water 4-5 times using separating funnel till its pH increases to 6.This extracts were used for screening UV protective activity.

Comparison of activities of ethyl acetate extracts of various plant parts of *G. indica*

0.1 gm of dried ethyl acetate extract was re-suspended in 10 ml of ethyl acetate (10 mg/ml) and was used to screen for UV absorbance. From this stock, dilutions of various concentration ranging 0.01, 0.03, 0.05, 0.07, 0.09, 0.1 mg/ml were prepared using ethyl acetate as diluents.

Uvinul A plus (BASF) was used as a standard and 1mg/ml stock was used to prepare concentrations ranging from 0.01, 0.03, 0.05, 007, 0.09 and 0.1 mg/ml.

2.4 Measurement of UV absorption

Incorporation of Ethyl acetate extracts of fruit rinds in sun-protective formulation

The basic formulation of sunscreen having components shown in Table no.1, the ethyl acetate extracts were incorporated in 100 gm formulation at various amount . Dried ethyl acetate extract 5 gm was dissolved in double the amount of ethanol (w/w) and were incorporated in sun protective formulation. 5 gm of Uvinul A plus (BASF) was used as standard. The details of formulation are provided in Table .1.

SPF Measurement

SPF study was done with the help of UV-2000S Ultraviolet Transmittance Analyzer (Labsphere inc.USA) at V.G. Vaze College, Mumbai and Kelkar Trust's Scientific Research Center, Mulund, Mumbai. Basic sunscreen formulation was prepared which contained dried ethyl acetate extract dissolved in Ethanol and devoid of any other active sun protection factors (Table 1.).

RESULT AND DISCUSSION:

In earlier studies fruit rind extracts were screened for UV protective Activity and it was observed that water immiscible pigments were more protective pigments against UV radiations, rather than anthocyanidines (Dike et al 2013 loc cit, Dike and Deodhar, 2015 loc cit). Such pigments are also known to present in other parts of *Garcinia* v*iz.* seed, stem, leaves and roots. Therefore, a study was undertaken to find out UV protective activity of various parts of plant.

UV protective activity of ethyl acetate extracts of various parts of plant

Different parts of plant *viz.* stem, leaf, fruit rinds, roots and seed with seed-coat were soaked in ethyl acetate on rotary shaker for 4-5 days, thus obtained extracts were air dried and used for further study. Fig 1 represents the comparative UV absorbance of various ethyl acetate extracts (0.07 mg/ml) of *G. indica.* As shown in figure 1, root extract of *G. indica* was the most effective having UV absorbance in both UV A and UV B region. The fruit extract shows slightly less activity but it is also effective in both UVA and UV B regions. The seed extract shows UV absorbance only in UV B region while at UV A region it declines. Stem and leaf shows comparatively lower activity

Comparative study of UV protective activity of ethyl acetate extract various plant parts and Uvinul A plus.

Absorbance in UV B region:

Figure 2 represents the average UV absorbance in UV B region i.e. average absorbance at wavelength 320 nm, 300nm and 280 nm. At 0.01 mg/ml concentration, the highest absorbance (2.3) was found with root extracts. At this concentration the relative absorbance of Uvinul A plus which is frequently used in cosmetic formulations was only 1.3. At this concentration, UV absorption ability of root extracts was almost triples than extracts from seed or leaf or stem. The fruit extracts showed moderate UV absorbance (1.4). At slightly higher concentration i.e. 0.03 mg/ml the UV absorptive capacity of root extract increased drastically (UV absorbance 4). At this concentration the relative absorbance of Uvinul was only 3, while for fruit extract absorbance was 2. As the concentration increased to 0.05 and 0.07 mg/ml there was no change in absorbance of root extract, but at this concentration UV absorbance of Uvinul A plus and fruit extracts became almost equal to root extracts.

Absorbance in UV A region

These extracts behave differently in UV A region. Figure 3 exhibits average absorbance of extracts at 320 – 400 nm wavelengths. At lower concentration 0.01 mg/ml, Uvinul was most effective (absorbance 2.6) while the relative absorbance for root extract was only 1. But as the concentration of extracts increased to 0.07 mg/ml the garcinia extracts showed UV absorption capacity comparable to Uvinul. At 0.07 mg/ml the absorbance of Uvinul was 3.4, for fruit extract it was 3.6 and for root extract it was 3.3. These results suggest that in UV A region fruit extracts are more effective than root extracts. Hence it was used in further study to prepare sunscreen formulations.

Incorporating the *Garcinia* extracts into UV protective creams and SPF Determination

5 gms of each plant extracts was used for preparing 100 gms of creams to determine SPF of these extracts. The composition of sunscreen formulation is given in table no.1. The SPF of each formulation was determined with UV2000s UV transmittance analyzer. Various parameters were developed to indicate the degree of broad band protection given by sunscreen. Critical wavelength was one such metric, being the shortest wavelength at which the sunscreen absorbed 90% of the sun's energy. If the critical wavelength was 370 nm or greater, the formulation could be describe as having broad spectrum protection. In UK, star rating system was developed that awarded one to five stars depending upon the ratio of mean UV A/UV B absorbance. The higher the UVA absorption, the higher the ratio, and the greater the number of stars a product would earn. As seen in Table no. 2, for control cream, which did not contain any UV protective additive or phytochemical substances, the Average SPF was 1.47. Also it did not have any boot star rating, which is the indicator of UV A absorbance.

The cream formulation containing 5 gm of root extract had maximum UV protection ability. SPF of the cream prepared from root extract was as high as 7.19 and boot star rating four. Formulation containing fruit extract had average SPF 3.67 with boot star rating 4. Cream with seed extract had 2.70 SPF and boot star rating 3. The commercially utilized UV protective

compounds like TiO2, Benzophenone and Uvinul were also used in the formulation separately and the corresponding results were recorded. For benzophenone the SPF was 5.04, but it did not receive any boot star rating.The Tio2 containing formulation showed the SPF 2.99 with boot star rating 5, whereas Uvinul A plus in formulation having SPF 2.6 and boot star rating 5

Synergistic effect of extract with commercial UV protectants

In general 4 or 5 components are added in cosmetic formulations, thus the SPF of the product is cumulatively increased as high as 15-30. Therefore, it was necessary to study the synergistic effect of two or more components on sun protective ability. Hence herbal extracts in combination with commercial UV protective additives were tried 2.5 gm of Fruit extract with 2.5 gms of TiO_2 gives boot star rating three but its SPF is very less (1.5).In another combination of 2.5 gm fruit extract with 2.5 gms of Benzophenone, it gives good SPF (5.04), but no absorption of UV A region and it is not showing broad spectrum protection for this formulation. In another combination of only TiO2 and Uvinul A plus it showed SPF 2.6 with boot star rating five. 3 gms of fruit extract was combined with 1.5gms of TiO2 or Uvinul A plus 1.5gms and sun protective activity of the cream was determined and SPF was found to be 8.7 with boot star rating five and critical wavelength 384 nm (above 370 nm) which indicates that this is broad spectrum UV protective formulation. From Above results we can conclude that fruit extract of *G. indica* gives synergistic effect to increase SPF from 2.6 to 8.7. Thus it can serve as a good UV protective agent with broad spectrum protection.

CONCLUSION

Profuse UV protective ability at UV A region was found in Fruit extracts of *G. indica* while UV protective ability in UV B region was found in root extracts. These extracts along with commercial UV protectants show cumulative increase in SPF and Boot Star rating for formulation

Acknowledgement

We are thankful to Kelkar Education Trust's Scientific Research centre, Mulund, Mumbai for providing help to analyse SPF of sunscreen formulation. We would like to thank Department of Cosmetology and Perfumery V. G. Vaze College for providing lab facilities. We also appreciate the help provided by Dr. B. B. Sharma (Principal, V. G. Vaze college of Arts, Science and commerce, Mulund, Mumbai) for providing facilities and his constant support.

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Tables:

Table 1: Components of sun protection formulations (100 g^{-1}).

Ingredients	**5% extract (% w/w)**
Caprylliccapryltriglyceride	2
Isopropyl myristate	4
Cetostearyl alcohol	2
Stearic acid	3
Propyl paraben	0.02
EDTA	0.02
Glycerin	4
Triethanolamine	0.42
Methyl paraben	0.25
Water	69.29
Dried ethyl acetate extract	5
Ethanol	10

Table No.2: Results of SPF of ethyl acetate extract of various parts of plant of *G. indica* (5%) incorporated in sunscreen formulation

Sr. No	Test Samples	Parameters				Average
		Scans	1	2	3	
1.	CONTROL	**SPF**	1.46	1.48	1.46	**1.47**
		Standard Deviation	0.01	0.01	0.01	0.01
		UVA/UVB Ratio	0.216	0.218	0.220	0.218
		Critical Wavelength	356.20	356.80	357.20	356.73
		Boots Star Rating	No Rating	No Rating	No Rating	No Rating
2.	BENZOPHENONE	**SPF**	4.98	5.14	4.99	**5.04**
		Standard Deviation	0.19	0.14	0.27	0.20
		UVA/UVB Ratio	0.519	0.521	0.510	0.517
		Critical Wavelength	360.83	360.67	359.83	360.44
		Boots Star Rating	No Rating	No Rating	No Rating	No Rating
3.	TiO2	**SPF**	3.00	2.99	2.98	**2.99**
		Standard Deviation	0.04	0.04	0.08	0.05
		UVA/UVB Ratio	0.952	0.957	0.957	0.955
		Critical Wavelength	387.00	387.00	387.00	387.00
		Boots Star Rating	*****	*****	*****	*****
4.	UVINUL A PLUS	**SPF**	2.32	2.32	2.35	**2.33**
		Standard Deviation	0.04	0.04	0.04	0.04
		UVA/UVB Ratio	1.638	1.638	1.638	1.638
		Critical Wavelength	375.80	376.00	375.80	375.87
		Boots Star Rating	*****	*****	*****	*****
5.	LEAF EXTRACT	**SPF**	1.28	1.27	1.27	**1.27**
		Standard Deviation	0.01	0.01	0.02	0.01
		UVA/UVB Ratio	0.648	0.650	0.649	0.649
		Critical Wavelength	381.80	381.40	381.80	381.67
		Boots Star Rating	***	***	***	***
6.	SEED EXTRACT	**SPF**	2.70	2.71	2.69	**2.70**
		Standard Deviation	0.05	0.04	0.02	0.04
		UVA/UVB Ratio	0.635	0.634	0.630	0.633
		Critical Wavelength	379.00	379.20	379.00	379.07
		Boots Star Rating	***	***	***	***
7.	FRUIT EXTRACT	**SPF**	3.68	3.67	3.67	**3.67**
		Standard Deviation	0.09	0.07	0.05	0.07
		UVA/UVB Ratio	0.849	0.850	0.848	0.849
		Critical Wavelength	385.40	385.40	385.20	385.33
		Boots Star Rating	****	****	****	****
		SPF	7.22	7.16	7.20	**7.19**

		Standard Deviation	0.26	0.07	0.14	0.16
8.	**ROOT EXTRACT**	UVA/UVB Ratio	0.830	0.829	0.829	0.829
		Critical Wavelength	384.00	384.00	384.00	384.00
		Boots Star Rating	****	****	****	****

Table No: 3: Synergetic effect of fruit extracts with commercial UV protective compounds.

Sr. No	Test Samples	Parameters				Average
		Scans	**1**	**2**	**3**	
		SPF	5.27	4.93	5.43	**5.21**
7.	**FRUIT EXTRACT+ BENZOPHENONE**	Standard Deviation	0.62	0.32	0.85	0.60
		UVA/UVB Ratio	0.465	0.462	0.462	0.463
		Critical Wavelength	359.00	358.33	358.33	358.55
		Boots Star Rating	No Rating	No Rating	No Rating	No Rating
		SPF	1.51	1.50	1.48	**1.50**
8.	**FRUIT EXTRACT+ TiO_2**	Standard Deviation	0.01	0.02	0.05	0.03
		UVA/UVB Ratio	0.776	0.774	0.776	0.775
		Critical Wavelength	385.00	385.00	385.00	385.00
		Boots Star Rating	***	***	***	***
		SPF	2.64	2.61	2.64	**2.63**
9.	**TIO2 + UVINUL A PLUS**	Standard Deviation	0.04	0.03	0.05	0.04
		UVA/UVB Ratio	1.496	1.496	1.496	1.496
		Critical Wavelength	379.00	379.00	379.00	379.00
		Boots Star Rating	*****	*****	*****	*****
		SPF	8.89	8.75	8.73	**8.79**
10.	**FRUITEXTRACT+ TIO2 + UVINUL A PLUS**	Standard Deviation	0.08	0.24	0.35	0.22
		UVA/UVB Ratio	1.272	1.276	1.283	1.277
		Critical Wavelength	384.60	384.40	384.00	384.33
		Boots Star Rating	*****	*****	*****	*****

Figures:

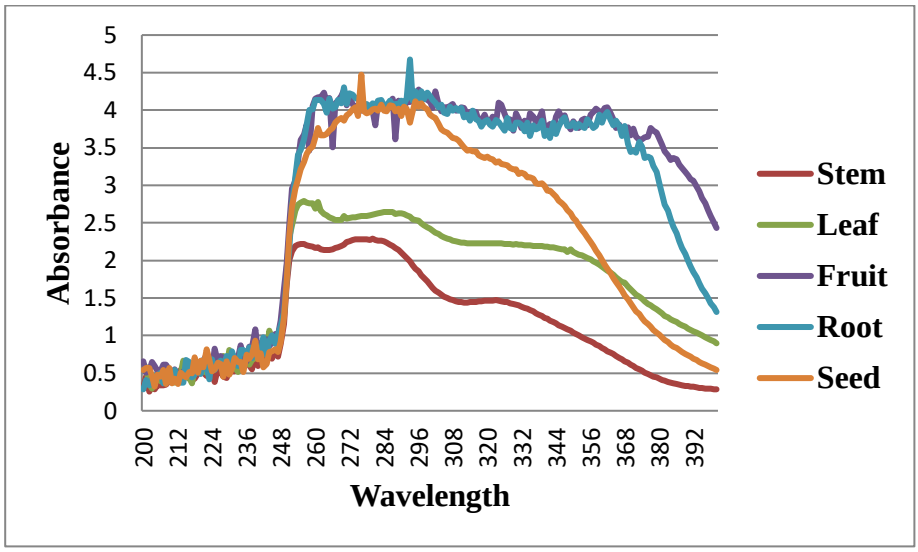

Fig 1: Comparative UV absorption ability of various extracts of *G. indica*.

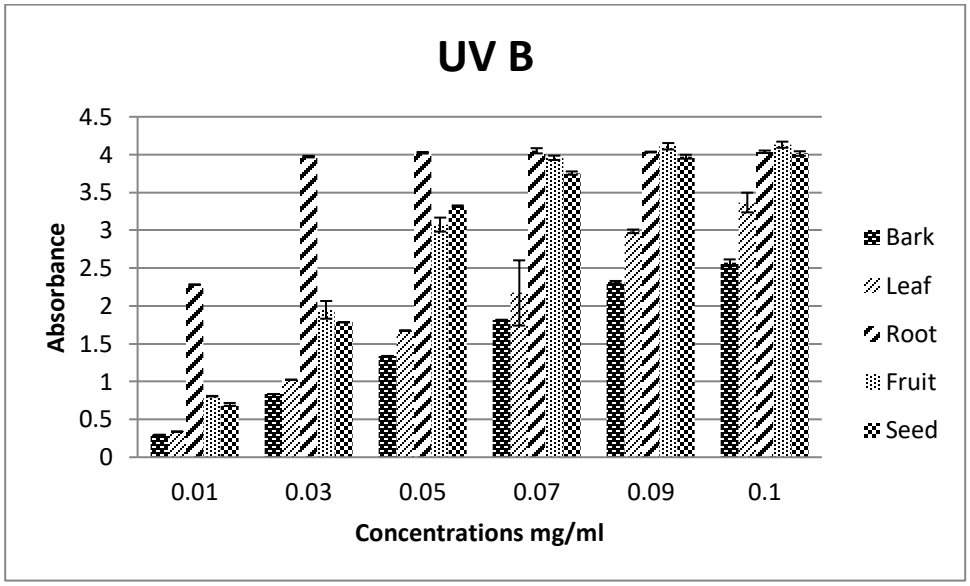

Fig 2: UV absorption ability of ethyl acetate extracts of various parts of plant *viz.* stem, leaf, root, fruit and seed of *G. indica* in UV B region.

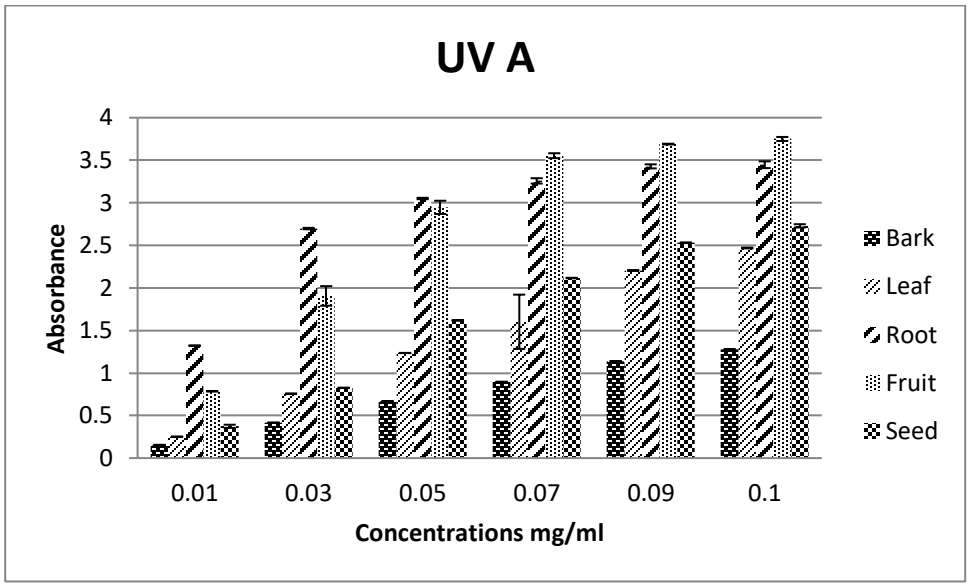

Fig 3: Comparative activity of ethyl acetate extracts of various parts of plant *viz.* stem, leaf, root, fruit and seed of *G. indica* and Uvinul A plus in UV A region.

Research Article

Green synthesis of silver nanoparticles using cauliflower waste and their multifaceted applications in photocatalytic degradation of methylene blue dye and Hg^{2+} biosensing

J. Kadam[1] · P. Dhawal[2] · S. Barve[2] · S. Kakodkar[1]

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Abstract
Green synthesis of silver nanoparticles (AgNPs) using plant extracts has emerged as a viable environment-friendly method. The aim of the study was to biosynthesize AgNPs using cauliflower (*Brassica oleracea* var. *botrytis*) waste extract and further test their potential applications in photocatalytic degradation of methylene blue (MB) dye and Hg^{2+} biosensing. Optimum extract concentration, $AgNO_3$ concentration, pH and temperature required for biosynthesis of stable AgNPs were determined by UV–visible spectroscopy. FT-IR, XRD, SEM, TEM, SAED, XPS and BET analysis were performed for characterizing AgNPs. MB dye degradation using AgNPs was determined by analyzing the intensity of dye absorption maxima at 664 nm. Specificity and sensitivity of biosynthesized AgNPs for Hg^{2+} ions were studied for assessing their biosensing abilities. Optimum conditions needed for biosynthesis of stable AgNPs were observed to be 3 ml extract, 0.5 mM $AgNO_3$, pH 8.5 and microwave-assisted heating at 600 W for 5 min. FT-IR analysis showed that the extract contained necessary functional groups that facilitated biosynthesis of AgNPs. XRD, SEM, TEM, SAED, XPS results confirmed the formation of AgNPs. BET analysis showed that AgNPs had an average size of 35.08 nm and surface area of 19.22 m^2/g. Maximum MB dye degradation percentage of 97.57% was obtained at 150 min without any significant silver leaching thereby, signifying notable photocatalytic property of AgNPs. Biosensing studies showed that AgNPs were specifically able to detect up to 0.1 mg/l Hg^{2+} ions. In summary, cauliflower waste served as a useful source of reducing agents for biosynthesizing AgNPs with promising environmental applications.

Keywords Silver nanoparticles · Biosynthesis · Cauliflower · Biosensor · Dye degradation

1 Introduction

Nanoparticles have gained immense importance in recent times due to their diverse application in the field of science and technology. By definition, they are described as microscopic particles that have size smaller than 100 nm in at least one dimension [1, 2]. Their microscopic size, morphology and distribution enable them to possess unique biological, chemical and physical properties that are distinctly different from those of individual atoms and molecules [2, 3]. Metal nanoparticles have been extensively explored due to their diverse applications in the areas of catalysis, biosensing, medicine, drug delivery etc. [1, 4–8]. In particular, silver nanoparticles (AgNPs) have received close attention due to their unique physicochemical properties [9–12].

Colloidal silver particles have been reported to act as effective antimicrobial agents against bacteria and viruses [11, 13–15]. They also possess promising catalytic activity, which enable them to degrade harmful synthetic dyes

✉ S. Kakodkar, shrutibaadkar3@gmail.com | [1]Department of Biotechnology, Vinayak Ganesh Vaze College of Arts Science and Commerce, Mulund, Mumbai, Maharashtra 400081, India. [2]KET's Scientific Research Centre, KET's V.G. Vaze College Campus, Mulund, Mumbai, Maharashtra 400081, India.

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such as methylene blue (MB), congo red, methyl orange and methyl red [2, 3, 11, 16–19]. Additionally, they have also been shown to act as efficient sensors for detecting heavy metals like mercury and copper ions [20, 21]. These AgNPs can be produced by physical, chemical and biological methods. Physical and chemical methods of synthesis pose a threat to environment due to the use of reducing and stabilizing agents that are known to be both toxic and non-biodegradable [14, 15]. Alternatively, biological synthesis or 'Green Synthesis' of AgNPs is considered a novel approach due to its numerous advantages such as eco-friendly nature, ease of production, feasible large-scale synthesis and lack of requirement of harmful chemical agents [9, 10, 15, 16]. Biological method essentially makes use of plant extract or microorganisms for synthesizing AgNPs. However, from the viewpoint of industrial feasibility, plant mediated green synthesis of AgNPs is considered to be more economic and safer as compared to microbe-assisted synthesis since handling and maintaining microbial cultures is often tedious [16].

Green synthesis method principally produces nanoparticles using capping and reducing agents present in plant extracts. Plant extracts can be acquired from vegetative parts such as stem, leaves, fruits, roots and flowers. These parts are rich sources of reducing agents such as membrane proteins, phenols, flavonoids and other secondary metabolites [22–24]. In addition to this, plant extracts also contain capping agents such as extracellular tannic acids, peptides and enzymes [24]. Considering the array of biomolecules present in plants, appropriate selection of suitable plant material is of utmost importance for obtaining the right combination of these agents. Several research studies have successfully synthesized AgNPs using extracts prepared from fresh plant material of *Ocimum sanctum* (Tulsi), olive leaf, *Amaranthus gangeticus* (Chinese red spinach), *Citrullus lanatus*, *Datura stramonium,* coffee, *Azadirachta indica* (neem), *Matricaria recutita* (Babunah), *Aloe vera* etc.[11, 15, 20, 21, 25–29]. Alternatively, fruit and vegetable wastes have also been utilized for synthesizing AgNPs with the purpose of curbing their overwhelming burden on the environment [24, 30–32].

Biowaste, in the form of vegetable or fruit waste, has become a major environmental concern due to its improper disposal. Among vegetables, India ranks second worldwide in cauliflower production, accounting for approximately 35% of total worldwide production [33]. Cauliflower (*Brassica oleracea* var. *botrytis*) forms an integral part of routine diet in India. As a habitual practice, cauliflower leaves are peeled off from the vegetable floret and discarded before cooking. Also, a huge amount of superfluous cauliflower leaves are removed prior to selling in vegetable markets and later dumped improperly. This improper disposal leads to unwarranted growth of harmful microorganisms. In view of their ill effects, cauliflower and several other vegetable wastes are being extensively studied with an intention of finding their alternate applications as biofuels, compost etc. Cauliflower leaves are rich sources of polyphenols that, as mentioned above, are promising reducing agents for nanoparticle synthesis [34]. Previous research studies have synthesized AgNPs using fresh cauliflower and revealed their promising applications as antibacterial and antifungal agents against pathogens like *Escherichia coli*, *Staphylococcus aureus*, *Klebsiella Pneumoniae*, *Bacillus subtilis*, *Candida albicans* and *Aspergillus* sp. [35–37]. Another research study showed that AgNPs synthesized from fresh cauliflower floret extract display promising antioxidant and anti-cancerous properties [38]. However, till date, research on green synthesis of AgNPs using cauliflower waste and analysis of their possible environmental applications has not been explored in detail.

Therefore, in light of the above and the need for finding meaningful alternate applications of cauliflower waste, the aim of the present work was to synthesize AgNPs using extract obtained from discarded cauliflower leaves. Further, the study also assessed potential environmental applications of biosynthesized AgNPs in photocatalytic degradation of harmful MB dye and biosensing of Hg^{2+} ions.

2 Materials and methods

2.1 Preparation of cauliflower leaf waste (CLW) extract from waste *Brassica oleracea* var. *botrytis*

Discarded cauliflower (*Brassica oleracea* var. *botrytis*) leaves were collected from local market in Mumbai. These leaves were thoroughly washed with tap water and further rinsed with dechlorinated water. The washed leaves were then shade dried for 7 days and later ground using mechanical blender. Then, 10 g of dried powder was added to 100 ml dechlorinated water. The mixture was boiled for 5 min and later filtered. The filtrate obtained was used for biosynthesis of AgNPs.

2.2 Biosynthesis of AgNPs

For biosynthesis of AgNPs, a typical reaction mixture consisted of 3 ml of CLW extract, 1 ml of 5 mM $AgNO_3$ and 6 ml deionised water. The solution was heated in microwave at 600 W for 5 min with intermittent mixing after which, it was further incubated in dark for 24 h. Formation of AgNPs through CLW extract mediated reduction of Ag^{1+} to Ag^0 was studied by observing the color change of the reaction solution. Formation of AgNPs was also confirmed

by spectrophotometric analysis. The optical absorption of biosynthesized AgNPs was investigated at a wavelength range of 250–600 nm using Cary 50 UV–visible spectrophotometer, operated at a resolution of 1 nm.

2.3 Optimization of parameters

Parameters such as CLW extract concentration, $AgNO_3$ concentration, pH and temperature were optimized for biosynthesizing AgNPs. $AgNO_3$ solution and CLW extract were used as negative controls. The optimum conditions needed for successful bioreduction of silver ions and their subsequent nucleation into AgNPs were determined by spectrophotometric analysis of AgNPs after 24 h incubation in dark at room temperature.

2.3.1 Concentration of CLW extract

The effect of CLW extract concentration on biosynthesis of AgNPs was studied by setting up the reaction using different volumes of CLW extract (1, 2, 3, 4 and 5 ml). The appropriate volume of extract needed for forming suitable AgNPs was determined by studying the absorption spectra of nanoparticles.

2.3.2 Concentration of $AgNO_3$ solution

Optimum $AgNO_3$ concentration for nanoparticle synthesis was studied by setting up the reaction mixtures with different $AgNO_3$ concentrations (0.5, 1.0, 1.5, 2 and 2.5 mM). Optimum $AgNO_3$ concentration was determined by assessing the absorbance of nanoparticles spectrophotometrically.

2.3.3 Temperature

The aforementioned reaction mixture for synthesizing AgNPs was subjected to different temperature conditions namely, microwave-assisted heating at 600 W (5 min), heating at 100 °C (1 h), and room temperature (24 h). Each reaction tube was kept at room temperature for 24 h after synthesis. The appropriate temperature condition was assessed by analyzing the absorbance spectra of these nanoparticles.

2.3.4 pH

The optimum pH was studied by subjecting the standardized reaction mixture of 3 ml CLW extract, 1 ml of 5 mM $AgNO_3$ and 6 ml deionised water to different pH conditions (6.5, 7.5, 8.5, 9.5). The reaction solution was adjusted to desired pH using 0.1 N NaOH. Optimum pH was determined by studying the absorbance spectra of AgNPs.

2.4 Purification of AgNPs

For purification of nanoparticles, the reaction solution was centrifuged for 10 min at 10,000 rpm. The pellet obtained was washed with dechlorinated water and centrifuged at 10,000 rpm for 10 min until a clear supernatant was obtained. The washed pellet was dried overnight at room temperature. The dried AgNPs were weighed and further characterized to evaluate their shape and size.

2.5 Characterization of biosynthesized AgNPs

After purification, biosynthesized AgNPs were further characterized using FT-IR analysis, XRD, SEM, TEM, SAED at Sophisticated Analytical Instrumentation Facility (SAIF) at IIT Bombay. FT-IR analysis, was performed for determining the functional biomolecules in CLW extract that served as reducing and stabilizing agents for biosynthesizing AgNPs. FT-IR spectrum was recorded in the range of 3500–500 cm^{-1} using Bruker Vertex 80, 3000 Hyperion microscope with FT-IR system. The crystalline structure of synthesized AgNPs was examined by XRD using panalytical empyrean powder diffractometer with Cu K alpha radiation at 1.54184 Å. Field emission gun-scanning electron microscopy (FEG-SEM) was performed using Jeol JSM-7600F FEG-SEM for examining surface morphology of nanoparticles. Transmission electron microscopy (TEM) and selected area diffraction pattern (SAED) analysis was performed using field emission gun-TEM 300 kV for evaluating morphology and size of nanoparticles. X-ray photoelectron spectroscopy (XPS) was conducted using thermo Fischer scientific K-Alpha XPS for determining the surface chemical composition. Surface area and pore size of AgNPs was determined using BET High Speed Surface Area and Pore Size Analyzer at ICAR-CIRCOT, Mumbai.

2.6 Photocatalytic degradation of MB dye

Photocatalytic activity of biosynthesized AgNPs against MB dye was assessed. 5 mg of biosynthesized AgNPs was added to 50 ml of 1 mg/l MB solution. MB solution of the same concentration was used as control. Both test and control suspensions were mixed thoroughly on a shaker at 100 rpm for 30 min after which, the solutions were kept under sunlight and monitored. Next, 2 ml aliquots were removed at time intervals of 30 min till significant discolouration was observed. The aliquots were centrifuged at 10,000 rpm for 5 min. The absorbance of MB dye was measured in resultant supernatant of control and test solutions at 664 nm wavelength. Percentage of MB dye

degradation in test and control at respective time interval was calculated using the following formula:

$$\% \text{ Degradation} = 100 \times \left(A_0 - A\right)/A_0$$

where, 'A_0' is the initial absorbance of MB dye solution and 'A' is the absorbance of MB dye solution obtained after each time interval. Further, the leaching of AgNPs into the solution was studied by analyzing the MB dye solution after 150 min. For this, centrifugation of the dye solution containing AgNPs was done and, the supernatant obtained was further analyzed by ICP-atomic emission spectroscopy (AES) at SAIF labs at IIT Bombay for determining the level of silver leaching that may have occured during the photodegradation reaction.

The photocatalytic activity of biosynthesized AgNPs was evaluated by studying the degradation of phenol (5 mg/l), which is a colourless organic pollutant [39]. In the presence of sunlight, the aliquots of treated solution were taken at equal time intervals. The decrease in peak intensity of phenol at 270 nm was studied and considered to be indicative of decomposition of phenol.

The active species involved in the photocatalytic reaction were detected using trapping experiments. For this, the effect of 1 mM IPA (a quencher of •OH), 1 mM triethanolamine (a quencher of h^+) and nitrogen purging (a quencher of $\bullet O_2^-$) on the photocatalytic degradation process was investigated [40]. The method employed was similar to the aforementioned photocatalytic test.

The stability and reusability of biosynthesized AgNPs were evaluated by performing a recycling study of AgNPs using earlier photocatalytic experiment. The biosynthesized AgNPs were separated after MB photodegradation reaction by centrifugation and subsequently washed using distilled water. Then, these separated AgNPs were reused in MB degradation experiment and, the percentage degradation of the dye after every cycle was determined.

2.7 Biosensing of Hg^{2+} ions

2.7.1 Specificity

Biosynthesized AgNPs were tested as nanosensors for detecting Hg^{2+} ions at room temperature. For demonstrating the specificity of biosynthesized AgNPs for Hg^{2+} ions, AgNPs were tested against various metal ions such as Hg^{2+}, Co^{2+}, Pb^{2+}, Mn^{2+}, Mg^{2+}, Zn^{2+}, Ni^{2+}, Na^+, K^+, Ba^{2+}, Cu^{2+}, Al^{3+} and Fe^{3+}. For this, 1 ml aliquot of 20 mg/l salt solution was treated with 100 µl of as-synthesized AgNPs. A solution of 100 µl of as-synthesized AgNPs in 1 ml distilled water was used as control. Control and test solutions were allowed to stand at room temperature for 10 min. The results were visually analyzed by comparing the colour of test solution to that of the control.

2.7.2 Sensitivity

AgNPs were further tested to determine their limit of detection for Hg^{2+} ions. To demonstrate this, different concentrations of $HgCl_2$ solutions (20 mg/l, 1 mg/l, 0.1 mg/l, 0.01 mg/l, 0.001 mg/l) were treated with 100 µl of as-synthesized AgNPs. After 10 min incubation at room temperature, the solutions were visually analyzed for any colour change and, their absorption spectra were studied between 250 and 600 nm wavelength using a spectrophotometer.

3 Results and discussion

3.1 Optimization of parameters for biosynthesis of AgNPs

Green synthesis of nanoparticles has emerged as a novel approach in the field of nanotechnology due to its ability to provide effective control over growth and stabilization of nanocrystals [41]. Several research studies have used the green approach for synthesizing AgNPs in order to address the problem of environmental pollutants and harmful microorganisms. For this, such studies have majorly relied and proven the potential use of fresh plants as a reducing source for nanoparticle synthesis. However, the practical applicability of such systems on a large scale entails using large quantities of fresh plant material and this, can in turn inadvertently impact the ecosystem balance. Alternatively, lab scale culturing of such fresh plants for availing their growth and use in nanoparticle synthesis is also tedious. In view of this, it is advisable to rely on the readily available large amount of bio-waste for obtaining useful nanoparticles. In the current study, cauliflower vegetable waste was used for biosynthesizing AgNPs. The present study employed the idea of 'waste to wealth' and tested nanoparticle synthesis as an alternative method for converting cauliflower waste to useful AgNPs.

It is known that plant extract concentration, $AgNO_3$ concentration, pH, and temperature are some of the defining factors that affect the rate of synthesis of nanoparticles and their quality [9]. Hence these parameters were optimized to obtain AgNPs of desired size and morphology. During standardization, the initial assessment of nanoparticle formation was done by observing the colour change of the solution. The CLW extract imparted a characteristic yellow colour. Interestingly, reaction between $AgNO_3$ and extract led to a change in colour from yellow to reddish brown. This may be attributed to the surface plasmon

resonance (SPR) of biosynthesized AgNPs [42]. Optimum parameters for biosynthesis of AgNPs were further confirmed by studying their SPR absorption band since it provides vital information regarding size and number of nanoparticles formed [9, 42].

The first parameter considered for standardization was concentration of CLW extract. All reaction tubes displayed a distinct colour change from yellow to reddish brown. It was further observed that lower extract concentration (1 ml and 2 ml) did not yield a prominently sharp absorption peak (Fig. 1). However, when the volume of the extract was increased to 3 ml, a sharp peak was noted at 422 nm wavelength. This may be attributed to the formation of small sized AgNPs. Further increase in extract concentration to 4 ml and 5 ml caused the absorption peak to shift to 436 nm and 445 nm respectively. These peaks also exhibited evident broadening thereby, suggesting an increase in nanoparticle size. Higher concentration of CLW extract provides more reducing agents that might abruptly accelerate the process of nucleation and affect the growth of nanoparticles [43]. Based on these results, 3 mL CLW extract was considered optimum for producing desired AgNPs.

The next factor considered for optimization was $AgNO_3$ concentration (Fig. 2). For this, $AgNO_3$ concentrations ranging from 0.5 to 2.5 mM were considered. AgNPs synthesized using 0.5 mM $AgNO_3$ showed sharp absorption peak at 424 nm (Fig. 2). It was further observed that the peak shifted to wavelengths 445 nm and 437 nm in the reaction system containing 1.0 mM and 1.5 mM $AgNO_3$ respectively. Also, further increase in $AgNO_3$ concentration to 2.0 mM and 2.5 mM yielded AgNPs that displayed broad peaks at 424 nm and 408 nm respectively. Based on these findings, 0.5 mM $AgNO_3$ was considered as the optimum concentration for biosynthesizing AgNPs.

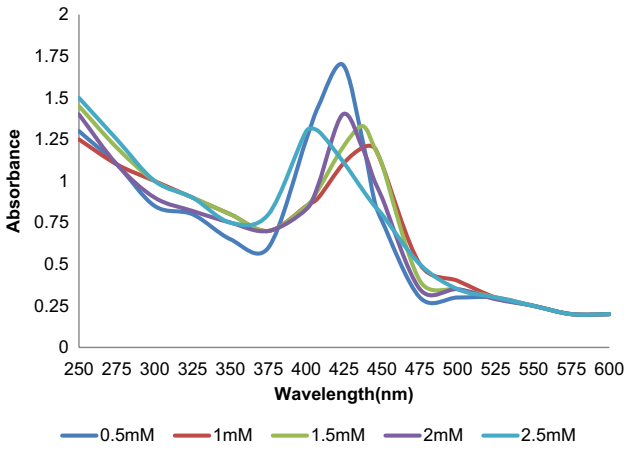

Fig. 2 UV–visible spectra of biosynthesized AgNPs at different $AgNO_3$ concentration (0.5 mM, 1.0 mM, 1.5 mM, 2.0 mM, 2.5 mM)

The third parameter considered for optimization was temperature (Fig. 3). There was no characteristic colour change observed in the reaction system incubated at room temperature. Also, UV–visible spectral analysis of this system, displayed no significant peak in the wavelength range of 400–500 nm (Fig. 3). AgNPs synthesized at 100 °C displayed broad SPR absorption band at 421 nm. On the other hand, AgNPs synthesized by microwave assisted heating produced sharp absorption peak at 411 nm. Microwave mediated synthesis, as compared to conventional heating, facilitates rapid heating and facilitates nucleation of metal nanoparticles thereby, aiding in nanoparticle synthesis [44]. Thus, due to favourable kinetics and rapid nanoparticle synthesis, microwave assisted heating was considered as the preferred condition for producing AgNPs in the current study.

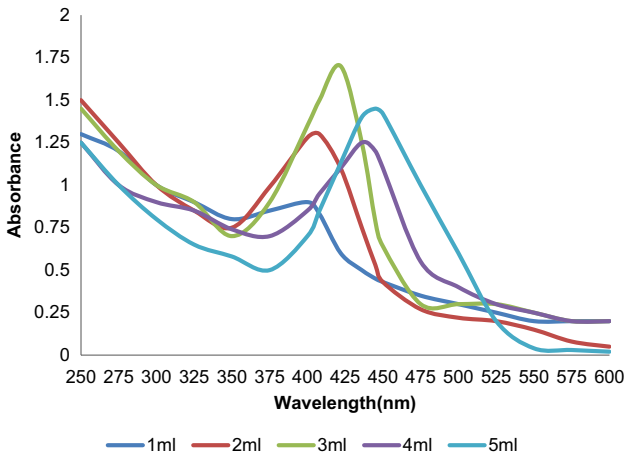

Fig. 1 UV–visible spectra of biosynthesized AgNPs at different CLW extract concentration (1 ml, 2 ml, 3 ml, 4 ml, 5 ml)

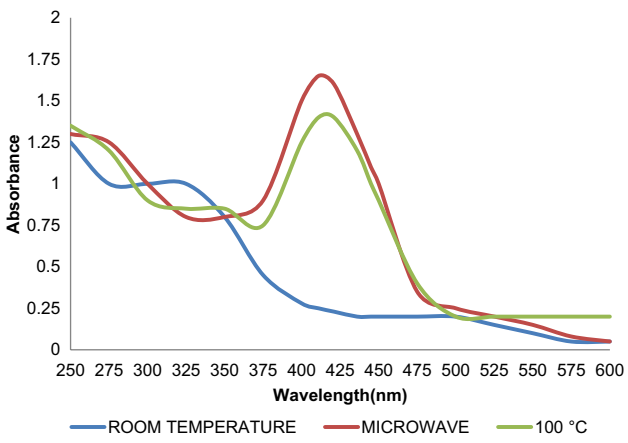

Fig. 3 UV–visible spectra of biosynthesized AgNPs at different temperature conditions (room temperature, microwave 600 W, 100 °C)

The final parameter considered for optimization was pH. pH influences nanoparticle synthesis by altering the charges of biomolecules [45]. Owing to the charge alteration, nanoparticle synthesis is suppressed at acidic pH and enhanced at alkaline conditions [9]. In the present study, the unaltered pH of the reaction mixture was 5.5. At this pH, SPR band of biosynthesized AgNPs was observed at 445 nm (Fig. 4). Increase in pH of the reaction system to 6.5 displayed evident absorption band broadening. Further increase in pH to 7.5 and 8.5 caused spectral shift of SPR absorbance band to 425 nm and 411 nm respectively. However, the absorption peak obtained at pH 7.5 was noted to be broad in size. On the other hand, a sharp narrow peak was seen at pH 8.5, indicating synthesis of small sized AgNPs. Further increase in pH to 9.5 led to a decrease in the absorbance intensity and peak broadening at 411 nm. Based on these findings, pH 8.5 was considered optimum for biosynthesis of AgNPs. Based on the above results, the optimized reaction parameters considered for biosynthesizing AgNPs were: 3 ml CLW extract, 0.5 mM $AgNO_3$, pH 8.5 and microwave assisted heating at 600 W for 5 min. These biosynthesized AgNPs were observed to be stable for one month when stored at room temperature.

3.2 FT-IR analysis

FT-IR analysis was performed to detect functional groups of biomolecules in CLW extract that may be responsible for reducing silver ions. The FT-IR spectra of CLW extract showed prominent absorption bands at 3404.74 cm^{-1}, 1622.51 cm^{-1}, 1508.12 cm^{-1}, 1410.99 cm^{-1} and 1078.93 cm^{-1} (Fig. 5a). 3404.74 cm^{-1} and 1622.51 cm^{-1} correspond to O–H stretching in carboxyl and amino groups present in amino acids and stretching vibrations of aliphatic C=C group respectively [46, 47]. The absorption band at 1508.12 cm^{-1} represent amide II in protein [48]. The absorption band at 1410.99 cm^{-1} represent stretching vibrations of C=O groups in aromatic rings [46]. On the other hand, absorption peak at 1078.93 cm^{-1} are due to ether linkages that may be contributed by flavanones present in the extract [49].

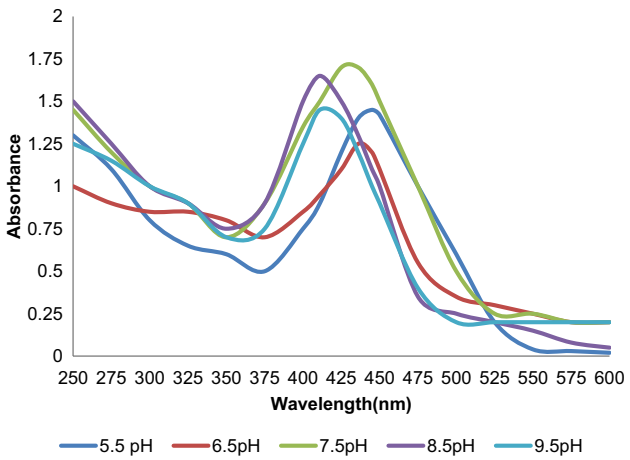

Fig. 4 UV–visible spectra of biosynthesized AgNPs at different pH (5.5-unaltered, 6.5, 7.5, 8.5, 9.5)

It was observed that purified AgNPs spectra showed shift in the peaks along with reduced absorption band intensities at 3452.60 cm^{-1}, 1638.61 cm^{-1}, 1601.59 cm^{-1} and 1411.60 cm^{-1} (Fig. 5b). These results indicate that –OH functional group, aliphatic C=C and C=O groups in aromatic rings could be the contributing factor aiding in reduction of silver and stabilization of AgNPs. Additionally, FT-IR spectra of AgNPs also revealed disapperance of absorption bands previously observed in CLW extract at 1508.12 cm^{-1} and 1078.93 cm^{-1} indicating that functional groups in proteins and flavonoids could also be the possible attributing factors. FT-IR spectra of AgNPs also displayed additional low intensity peaks at 2926.27 cm^{-1}, 2854.65 cm^{-1}, 1036.39 cm^{-1} and 1008.24 cm^{-1} that correspond to C–H bond stretching, bending vibrations of C–OH and C–O bonds respectively [17, 46]. These reducing functional groups have been reported to facilitate formation of stable metal nanoparticles due to their strong affinity towards metal ions. The current findings thus suggest that CLW extract possesses the necessary functional groups required for mediating biosynthesis of stable AgNPs.

3.3 XRD analysis

Crystalline nature of biosynthesized AgNPs was studied using XRD analysis. The Bragg's reflection was observed at 38.4°, 44.3°, 64.2° and 77.3° and indexed at 111, 200, 220, and 311 facets of the face centred cubic crystal (fcc) structure. These values agree well with those reported for silver (face centre cubic structure) by joint committee on powder diffraction standards, File No. 04-0783. On further substituting the wavelength value of 1.5404 Å in Scherrer's formula $D = (0.9\lambda \times 180°)/\beta\cos\theta$, the average grain size of biosynthesized AgNPs was found to be 10 nm. The XRD data confirms that biomolecules in CLW extract reduced silver ions to silver metal.

3.4 FEG-SEM analysis

Shape and surface morphology of biosynthesized AgNPs was assessed by FEG-SEM analysis. The surface morphology of biosynthesized AgNPs indicated that they were predominantly even shaped and spherical in nature (Fig. 6).

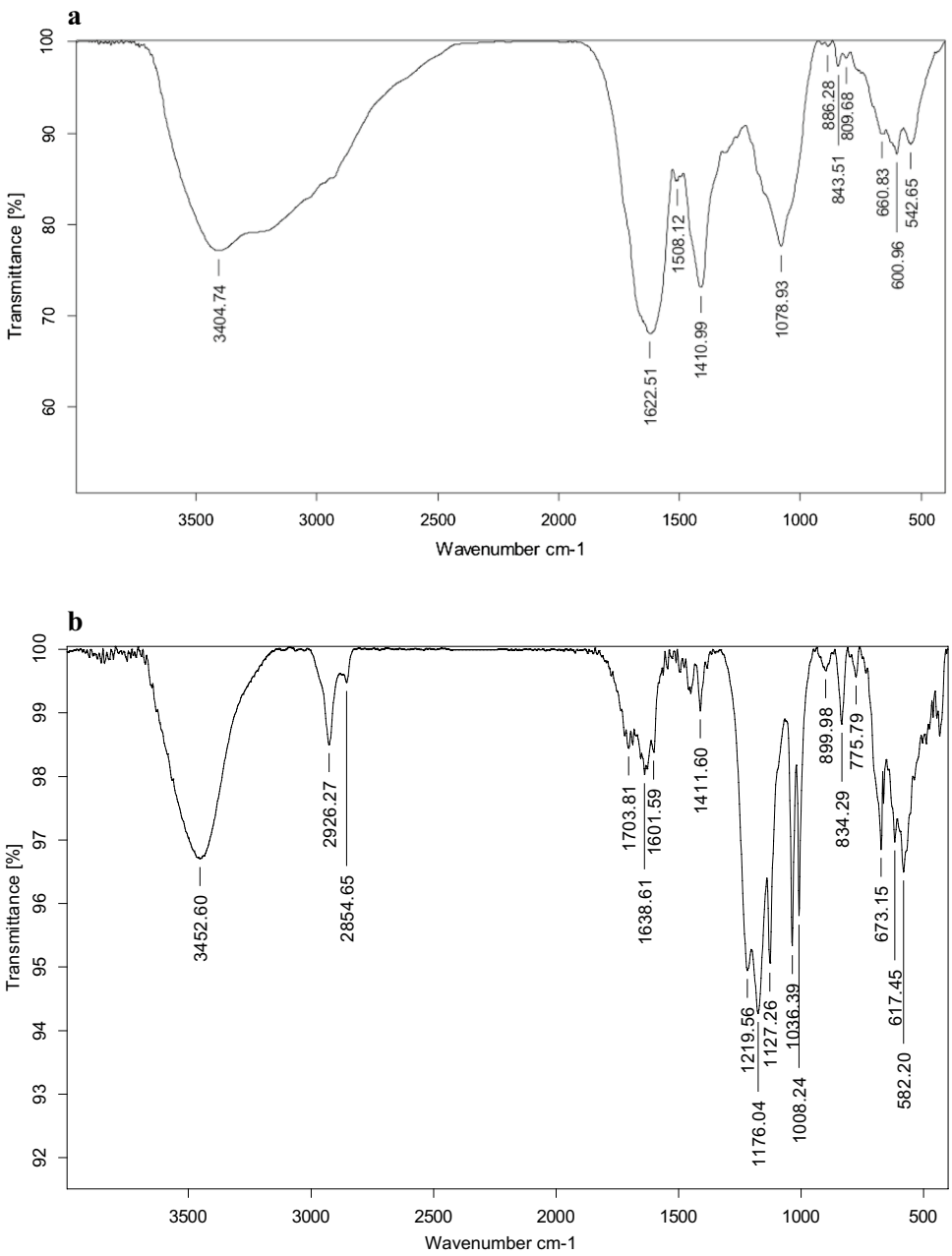

Fig. 5 **a** FT-IR spectra of CLW extract. **b** AgNPs synthesized using CLW extract

3.5 TEM and SAED pattern study

TEM analysis revealed the spherical morphology of bio-synthesized AgNPs (Fig. 7a). The size of nanoparticles ranged between 5 and 50 nm (Fig. 7b). The crystalline nature of AgNPs was studied by SAED pattern analysis. The results of SAED analysis were in agreement with that of XRD. The characteristic diffraction rings were indexed as (111), (200), (220) and (311) which are consistent with fcc lattice structure typically observed for AgNPs.

3.6 XPS analysis

Figure 8 displays XPS spectrum of AgNPs in the range of 0–1300 eV. The spectrum revealed high resolution XPS signal of Ag 3*d* region confirming the presence of Ag. The Ag 3*d* region displayed characteristic peaks at 374.08 eV and 368.08 eV which are attributed to Ag $3d_{3/2}$ and Ag $3d_{5/2}$ orbits of metallic silver [50]. A peak at 284.68 eV was noted in C(1*s*) spectrum corresponding to C–O bond which is in accordance with the above FT-IR results [51]. The O(1*s*)

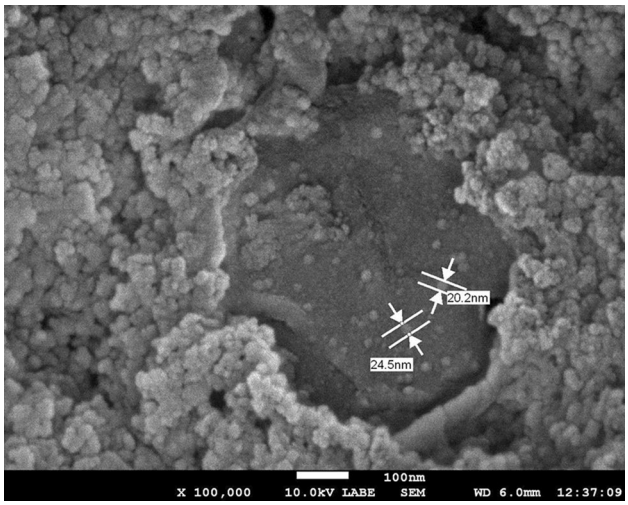

Fig. 6 SEM image displaying spherical shape of biosynthesized AgNPs

region displayed an intensity at binding energy 532.68 eV which also corresponds to the interaction between carbon and oxygen in C–O bond [52]. Thus, the above XPS results provide strong evidence of presence of metallic Ag in our biosynthesized nanoparticles.

3.7 BET analysis

BET analysis of AgNPs was conducted for determining average size, surface area and pore size of nanoparticles [53]. The surface area and average pore radius of biosynthesized AgNPs were found to be 19.22 m^2/g and 7.1 mm respectively. Considering that the nanoparticles were found to have spherical shape in TEM-imaging, BET results were further used to calculate average equivalent particle size by using the equation $D_{BET} = 6000/(\rho S_w)$ (in nm) where, D_{BET} is the average diameter of a spherical particle, S_w represents obtained surface area of the powder in m^2/g, and ρ is the theoretical density in g/cm^3 [54]. The analysis revealed the average nanoparticle size to be 35.08 nm. Table 1 displays BET experimental results of biosynthesized AgNPs. The D_{BET} nanoparticle size value was found to be within the range obtained using TEM-SAED imaging.

3.8 Photocatalytic degradation of MB dye

Synthetic dyes are commonly used in textiles, paper, adhesives, cosmetics, food, ink, medicines etc. [3]. MB is a heterocyclic azo dye which is commonly released through the effluents of textile industries. It depletes oxygen from the surface of water bodies which in turn affects aquatic flora and fauna. In addition to being an environmental hazard, it is also known to cause toxicity in humans [3]. Hence,

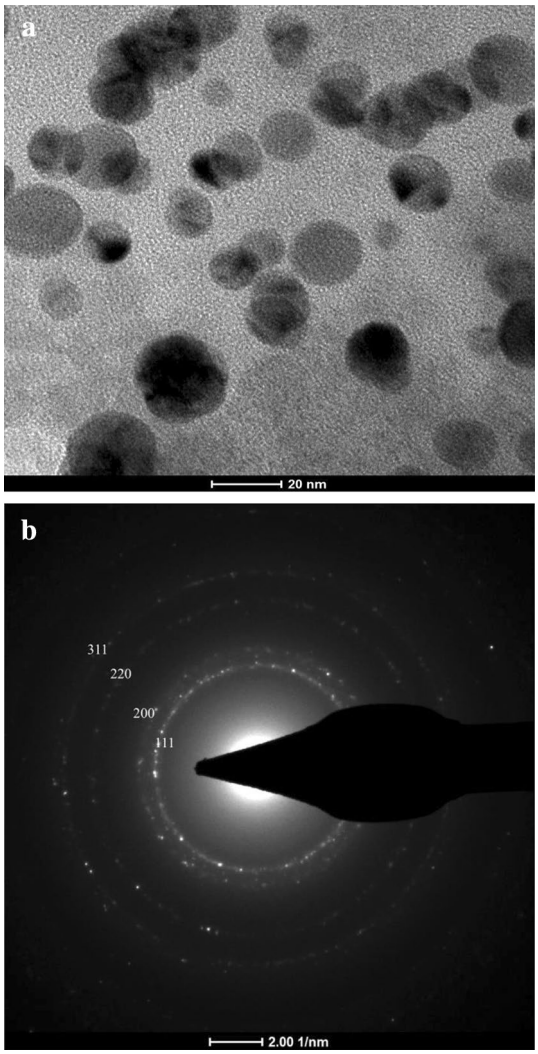

Fig. 7 **a** TEM image of biosynthesized AgNPs. **b** SAED pattern of biosynthesized AgNPs

degradation of MB dye in effluents is highly warranted in order to eradicate its deleterious effects. AgNPs of appropriate size and shape possess high surface area to volume ratio that enable them to act as excellent catalysts in dye degradation [17–19]. The current study investigated the potential photocatalytic activity of biosynthesized AgNPs against MB. MB solution underwent visible colour change on addition of nanoparticles. Initially, the colour of MB solution was deep blue which later turned dark green on addition of AgNPs. Subsequently, under sunlight exposure, the intensity of dark green colour further reduced with increase in time. The extent of degradation of MB using biosynthesized AgNPs was monitored by UV–visible spectrophotometer. The absorption maxima for MB was found to be centred at 664 nm wavelength. The control MB solution which was also exposed to sunlight showed no significant colour change and MB degradation (Table 2).

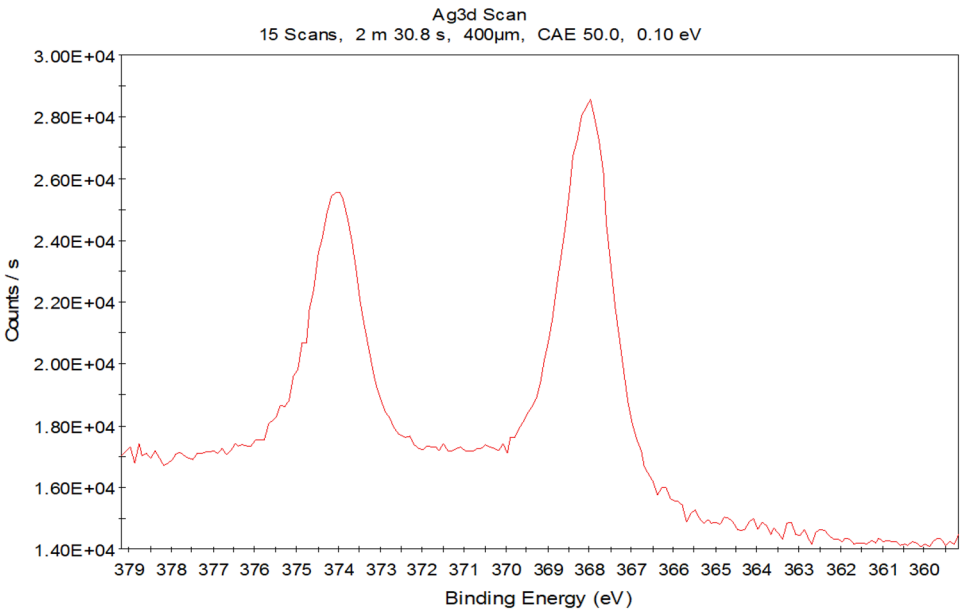

Fig. 8 XPS spectrum: Ag 3*d* peak scan

Table 1 BET results of biosynthesized AgNPs

Sample	BET surface area (m^2/g)	Average pore radius (nm)	Cumulative pore volume of pores (cm^3/g)	Average particle size D_{BET}
Ag–Np	19.22	7.1	6.827×10^{-2}	35.08 nm

Table 2 Percentage degradation of MB dye

Time interval (min)	MB dye degradation (%)	
	Control	Test
0	–	–
30	6.31	36.89
60	9.71	44.17
90	9.71	75.24
120	9.71	87.38
150	9.71	97.57

Control: MB dye solution

Test: MB dye solution + biosynthesized AgNPs

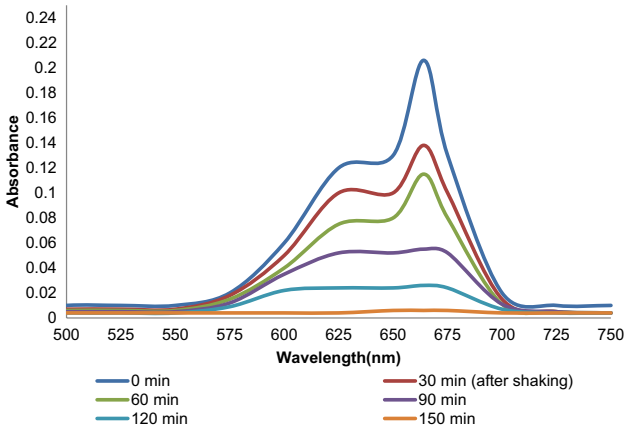

Fig. 9 UV–visible spectra of methylene blue dye in the presence of biosynthesized AgNPs at different time intervals

Table 3 Summary of kinetic parameters of degradation reaction of MB dye

Reaction	K (min^{-1})	$t_{1/2}$ (min)	R^2
No AgNPs	0.00265	261.5	0.84540
AgNPs	0.02308	30.0	0.89926

However, in the presence of AgNPs, a reduction in MB absorption band was noted with increase in time (Fig. 9). Maximum photocatalytic degradation of MB was assessed by noting the time required for the MB absorption band to approach the baseline. Based on this principle, the maximum percentage of nanoparticle-mediated MB dye degradation was found to be 97.57% at 150 min (Table 2).

Kinetic parameters and correlation coefficients are presented in Table 3. Linear regression of *ln* (C/C_0) (where, C = concentration of dye at time (t) and C_0 = concentration of dye at time 0 h) confirmed pseudo-first order nature of reduction of MB dye in presence of AgNP catalyst (Fig. 10). As seen in the table, the photodegradation reaction occurred almost 9 times faster in presence of AgNPs thereby, highlighting its significance in dye degradation. AES results showed that MB dye solution alone without AgNPs contained 0.013 mg/l Ag^+. The supernatant

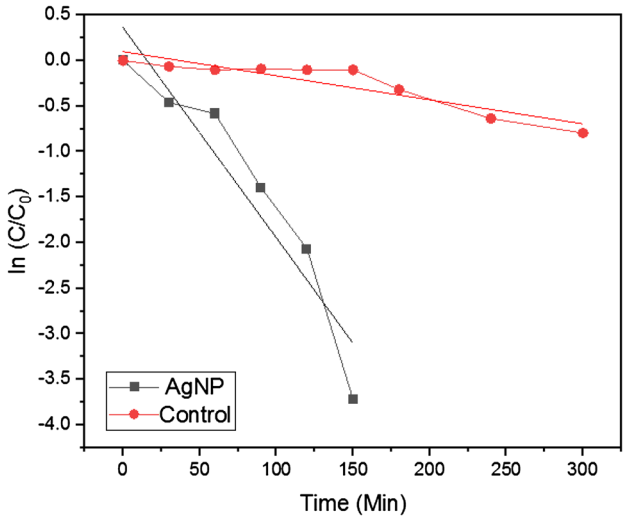

Fig. 10 $ln(C/C_0)$ versus time (min) plot for the photodegradation of MB dye

obtained after maximum MB degradation using AgNPs contained 0.103 mg/l of Ag^+, thereby indicating an increase of 0.09 mg/l Ag^+ ions in the solution. However, it should also be noted that this observed increase in silver ions in the solution after the reaction is well within its permissible limit in water (0.1 mg/l) as per the guidelines recommended by the World Health Organization (WHO). Table 4 highlights previous research done on MB dye degradation using AgNPs as photocatalyst in the presence of sunlight. Based on these findings, it can be concluded that our biosynthesized AgNPs can act as efficient photocatalyst in MB dye degradation without causing any significant silver leaching. However, further studies assessing the ability of these AgNPs in degrading MB in industrial effluent samples are warranted to further corroborate the current findings.

Further, the study used phenol as a colourless organic pollutant for proving that the fading of MB dye was due to photodegradation and not dye sensitization. The UV–visible spectrum of phenol was studied for evaluating its degradation under sunlight in the presence of biosynthesized AgNPs. The absorption band of phenol at 270 nm decreased in the presence of AgNPs, whereas no change in absorption spectrum was noted in the control phenol solution without AgNPs (Fig. 11a, b). This nanoparticles mediated prominent reduction in phenol confirms that AgNPs facilitate photocatalytic degradation.

Active species trapping experiment was performed for determining the mechanism of observed photodegradation (Fig. 12a, b). The addition of IPA resulted in significant decrease in photocatalytic degradation wherein, only 22.56% of MB was degraded after 150 min. Addition of triethanolamine to the reaction mixture caused a dye reduction of 63.03%. Conversely, deoxygenation of MB solution resulted in negligible change in the degradation. This suggests that hole (h^+) and hydroxyl •OH radical act as main active species in the photodegradation process of MB dye using our biosynthesized AgNPs. Based on these observations, the possible mechanism of photodegradation is proposed in Fig. 12b. When the MB dye and AgNP system is irradiated with sunlight, electrons in the valance bond (VB) are excited to conduction bond leading to same number of holes (h^+) in the VB. The photo-generated electrons in the catalyst are captured by O_2 leading to formation of $^{\cdot}O_2^-$, which in turn forms $OH^{\cdot}$ and further oxidize MB dye to form CO_2 and H_2O. On the other hand, h^+ holes react with existing OH^- to form $OH^{\cdot}$ which in turn aids in photodegradation of the dye. However, in the current system the photo-induced •OH are suggested to play the most vital role in photodegradation of MB dye as maximum inhibition of dye degradation was observed in the reaction system containing its quencher i.e. IPA.

The results of photodegradation of MB dye using recycled AgNPs for every run are displayed in Fig. 13. The recycled AgNPs demonstrated good photocatalytic activity up to four successive cycles. However, it was noted that the time required for attaining maximum MB degradation increased with each cycle. Based on these results, it can be

Table 4 Comparison of results of current study with previously reported data on AgNP mediated photocatalytic degradation of MB dye in presence of sunlight

Reducing agent for AgNP synthesis (extract)	MB dye Conc (mg/l)	AgNPs (mg/l)	Reducing agent	% Degradation	Time required	References	Leaching
Casuarina equisetifolia	1	100	Sunlight	35–40	300 min	[2]	–
Morinda tinctoria	10	100	Sunlight	95.3	72 h	[16]	–
Pomegranate Peel	10	100	Sunlight	89	48–72 h	[55]	–
Durio Zibethinus seed waste	10	100	Sunlight	73.49	180 min	[56]	–
Ageratum conyzoides	10	200	Sunlight	100	105 min	[57]	–
Gymnema Sylvestre	10	100	Sunlight	95	420 min	[58]	–
Cauliflower leaf waste	1	100	Sunlight	97.57	150 min	Present study	0.09 mg/L

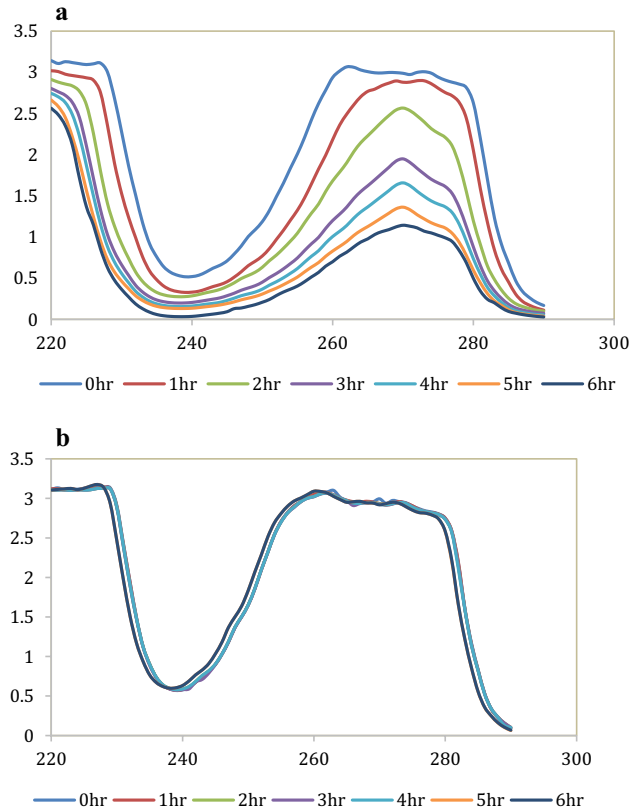

Fig. 11 **a** UV–visible spectra of phenol in presence of biosynthesized AgNPs. **b** UV–visible spectra of phenol in absence of AgNPs

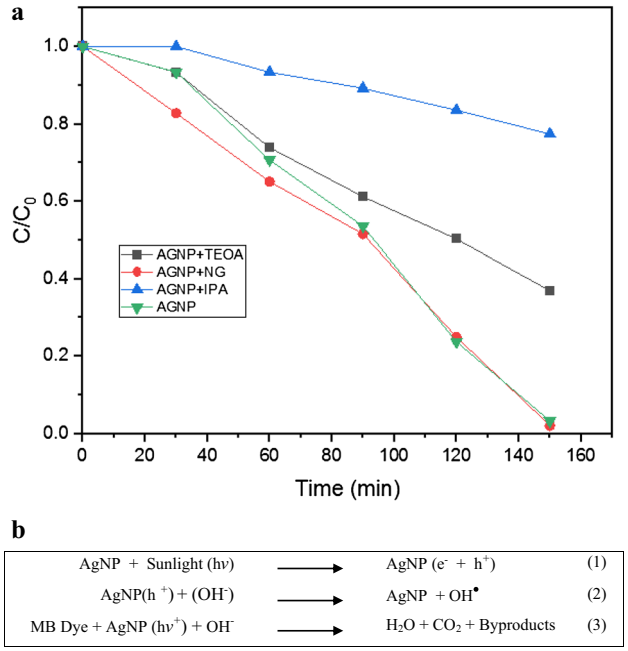

Fig. 12 **a** Effect of different radical scavengers on the photocatalytic degradation of MB dye using biosynthesized AgNPs. **b** Possible photocatalytic mechanism of biosynthesized AgNPs in degradation of MB dye

concluded that our biosynthesized AgNPs act as efficient photocatalyst with good stability and reusability. These AgNPs can be recycled for long-term application in the degradation of MB dye.

3.9 Biosensing of Hg^{2+} ions

Mercury ions are considered to be one of the most toxic heavy metal ions that can severely impact human health and other living organisms. Several conventional detection methods are used for detecting Hg^{2+} ions such as inductive coupled plasma mass spectrometry, atomic absorption spectroscopy, fluorescent sensors and electrochemical methods [59–62]. However, these techniques face limitations due to their cost, time-consuming sample preparation and complex experimental procedures [63]. Alternatively, simpler methods such as colorimetric assays have gained immense attention due to their simple and rapid principle of Hg^{2+} detection [63, 64]. Amongst these,

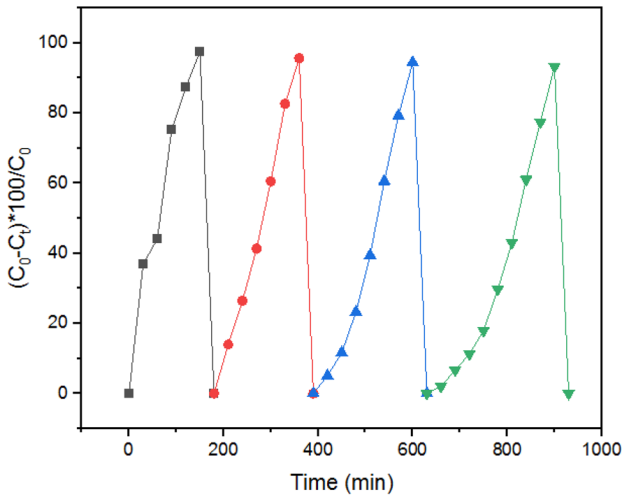

Fig. 13 Reusability of biosynthesized AgNPs in MB dye degradation. (1st cycle-black, 2nd cycle-red, 3rd cycle-blue, 4th cycle-green)

silver and gold nanosensor based colorimetric assays are considered promising owing to their unique physicochemical properties. However, AgNPs are considered to be more

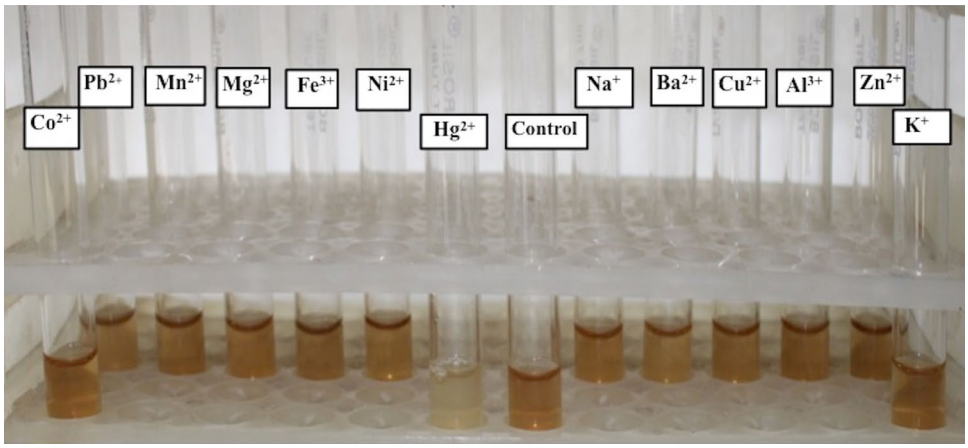

Fig. 14 Image displaying reaction between various metal ions and as-synthesized AgNPs

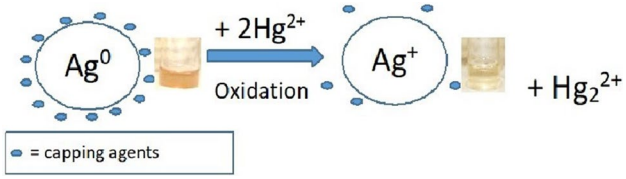

Fig. 15 Schematic illustration of mercury sensing

effective as sensors as compared to gold nanoparticles due to their cost-effectiveness and high extinction coefficients [64].

In view of this, the present study evaluated the possible application of as-synthesized AgNPs as biosensors for Hg^{2+} detection. The specificity of as-synthesized AgNPs for Hg^{2+} was studied by noting their reaction with other metal cations such as, Co^{2+}, Pb^{2+}, Mn^{2+}, Mg^{2+}, Zn^{2+}, Ni^{2+}, Na^{+}, K^{+}, Ba^{2+}, Cu^{2+}, Al^{3+}, Fe^{3+} in addition to Hg^{2+} ions. It was found that colour of the reaction mixture of Hg^{2+} ions and as-synthesized AgNPs changed from brown to pale yellow (Fig. 14). This colour change may be attributed to the redox reaction between zero valent silver and divalent mercury ions. A probable mechanism of interaction between AgNPs and Hg^{2+} has been proposed in (Fig. 15). Upon interaction of Hg^{2+} solution with as-synthesized AgNPs, decrease in the absorbance intensity was noted due to redox reaction between silver and mercury ions leading to aggregation and Ag-Hg amalgam formation [65]. Redox reaction happens due to the fact that standard reduction potential of Hg^{2+}/Hg (0.85 V) is higher than that of Ag^{+}/Ag (0.80 V) [66]. Thus, oxidation of Ag^{0} to Ag^{1+} (of

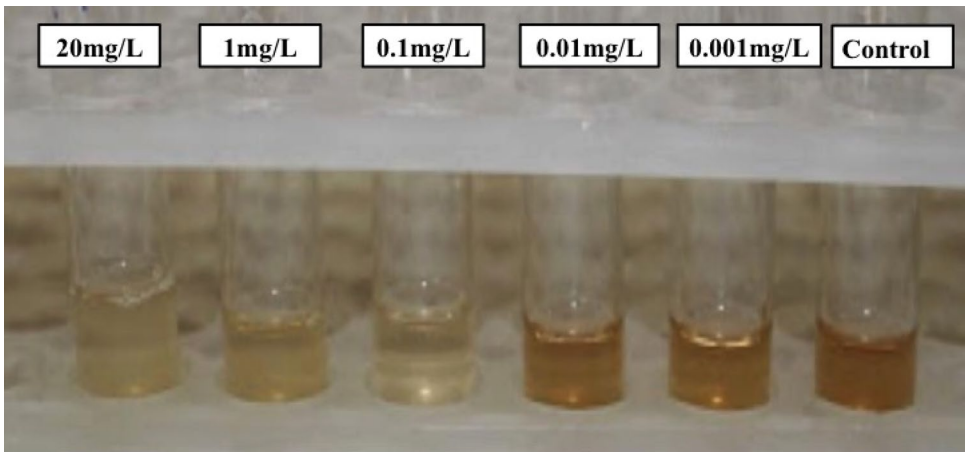

Fig. 16 Image displaying reaction between different concentrations of Hg^{2+} ions (20 mg/l, 1 mg/l, 0.1 mg/l, 0.01 mg/l, 0.001 mg/l) and as-synthesized AgNPs

AgNPs) changes the colour of the reaction solution from brown to pale yellow. In contrast, no colour change was observed when as-synthesized AgNPs were added to other metal ion solutions. Most of the transition metals, alkali and alkali earth metals cannot oxidize Ag^0 to Ag^{1+} as their standard reduction potential are lower than that of Ag^+/Ag [66]. These results show that the colorimetric sensor method developed using as-synthesized AgNPs is highly specific for Hg^{2+} ions.

Considering the specificity results, we further evaluated the sensitivity of our silver nanosensors for Hg^{2+} ions. For this, varied concentrations of Hg^{2+} solutions were tested with as-synthesized AgNPs. UV–visible spectral analysis was carried out for studying the interaction between Hg^{2+} ions and as-synthesized AgNPs. A visible colour change from brown to pale yellow was observed when as-synthesized AgNPs were added to 20, 1, and 0.1 mg/l Hg^{2+} solutions (Fig. 16). These findings were further supported by spectrophotmetric analysis wherein, a decrease in nanoparticle SPR absorption band intensity was noted at 411 nm wavelength. This decrease in absorption band intensity highlights possible interactions between Hg^{2+} ions and AgNPs (Fig. 17). However, no colour change was observed in reaction sets with 0.01 and 0.001 mg/l Hg^{2+} ions. This indicates the lack of sensitivity of AgNPs for these Hg^{2+} concentrations. Based on these findings, the limit of Hg^{2+} detection by as-synthesized AgNPs was concluded to be 0.1 mg/l. Table 5 summarizes the limit of Hg^{2+} detection obtained in previous studies using as-synthesized AgNPs. These results show that as-synthesized AgNPs of the current study can serve as highly sensitive biosensors for selectively detecting Hg^{2+} ions.

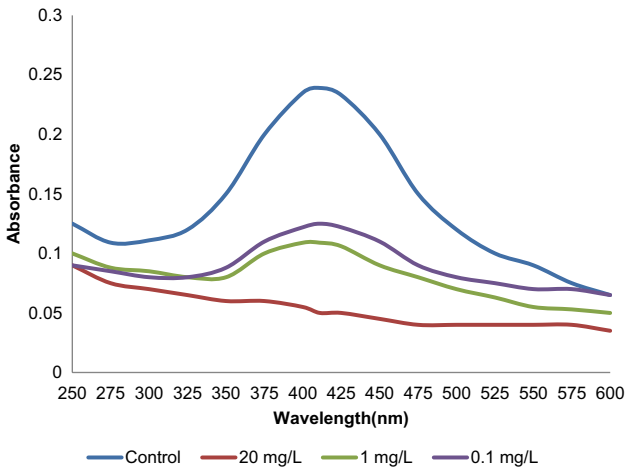

Fig. 17 Absorption spectra of AgNPs in the presence of different Hg^{2+} ions concentrations (20 mg/l, 1 mg/l, 0.1 mg/l)

4 Conclusion

In summary, the present study demonstrated that a natural renewable biomass such as cauliflower vegetable waste could be utilized as a biological source for biosynthesizing AgNPs with diverse environmental applications. The green method used for biosynthesis of AgNPs was reliable, eco-friendly, cost-effective and less time-consuming. UV–visible spectroscopy results indicated a signature absorption band for AgNPs. Further characterization revealed that the unique molecular composition of CLW extract provided the necessary reducing agents for nanoparticle synthesis. Biosynthesized AgNPs further displayed promising photocatalytic activity for degrading MB dye. These nanoparticles also demonstrated efficient colorimetric sensing ability for detecting Hg^{2+} ions. Based on these results, it can be concluded that these biosynthesized AgNPs can serve as a remarkable multipurpose tool for degrading MB dye in industrial effluents and detecting mercury based environmental pollutants.

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Table 5 Comparison of studies on Hg^{2+} sensing using as-synthesized AgNPs

Reducing agent for AgNP synthesis (extract)	Volume of as-synthesized AgNPs	Limit of detection of Hg^{2+}	References
Matricaria recutita (Babunah)	1 ml	49.8 µM	[21]
Soap-root plant	2 ml	2.2 µM	[67]
Burmese grape fruit	3 ml	47.60 µM	[68]
Ficus carica (fig) stem	100 µl	1.06 µM	[69]
Cauliflower leaf waste	100 µl	0.49 µM	Present study

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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हिंदी कथा साहित्य में गाँधीवादी चेतना

महात्मा गांधी ने भारत भूमि की स्वाधीनता के लिए अपना संपूर्ण जीवन समर्पित कर दिया। वे जनमानस में सत्य, अहिंसा, प्रेम, एकता, शांति, सद्भाव, सर्वधर्म सम्भाव, समानता एवं मानवता की भावना जागृत करने के लिए सतत् संघर्षशील रहे। गांधीजी के आदर्शों का प्रभाव जहाँ हिन्दी के कथा साहित्य पर संपूर्णता में व्याप्त हुआ है, वहीं कविता साहित्य भी इससे अछूता नहीं रहा।

भारतीय सनातन संस्कृति सत्य, अहिंसा एवं समन्यवादी संस्कृति है, इसलिए रामायण एवं श्रीरामचरितमानस के रचनाकारों ने श्रीराम के चरित्र को आदर्श मानकर उनके चरित्र का निर्माण किया एवं एक आदर्श राज्य की कल्पना की। गांधीजी भी श्रीराम के चरित्र से प्रभावित थे एवं राम राज्य की कल्पना को साकार करना उनका परम उद्देश्य था। इसलिए, जब राष्ट्रीय आंदोलन के नेतृत्व का मौक़ा उन्हें मिला तो गांधीजी ने उस आंदोलन को शांति से लड़ने का आग्रह अपने राष्ट्रवादी देशभक्तों से किया एवं हिंसा का मार्ग छोड़कर अहिंसा के मार्ग पर चलने की हिदायत दी। यही कारण था कि उस समय के तथा उनके बाद के हिन्दी साहित्य एवं पत्रकारिता पर भी उनके व्यक्तित्व का प्रभाव पड़ना स्वाभाविक ही हो गया था। जहाँ प्रेमचंद एवं जैनेंद्र जैसे कथाकारों ने अपनी कथाओं में आदर्श चरित्रों का निर्माण किया वहीं कविताओं में मैथिलीशरण गुप्त जैसे राष्ट्रवादी कवियों ने भी एक व्यापक आदर्श प्रस्तुत की।

हम हिन्दी साहित्य पर महात्मा गांधी के प्रभाव को स्पष्ट एवं व्यापक रूप में देख सकते हैं। उनके चिंतन-दर्शन, राष्ट्र नवनिर्माण एवं स्वराज की कल्पना को हिन्दी साहित्यकारों ने अपनी रचनाओं का विषय बनाया। साहित्य समाज का दर्पण होता है और समाज में हो रही घटनाओं का समकालीन एवं उसके बाद के साहित्य पर प्रभाव पड़ना अनिवार्य हो जाता है। गांधीजी जो अपने-आप में एक शांति के आंदोलनकर्ता थे एवं तत्कालीन राष्ट्रीय आंदोलन की घटनाओं के शांति के प्रणेता थे। अतः उनके द्वारा किए गए कार्यों को हिन्दी साहित्यकारों ने साहित्य में स्थान दिया एवं उनके मूल्यों एवं आदर्शों को साहित्य की प्रत्येक धारा में अभिव्यक्त किया। अतः गांधीजी के मूल्यों एवं आदर्शों का हिन्दी साहित्य में तत्वधारिता रूप में अपनाना समीचीन प्रतीत होता है।

सत्य महात्मा गांधी के जीवन दर्शन का ध्रुवतारा है। निरपेक्ष सत्य को उन्होंने ईश्वर के साथ समीकृत किया है। इनके अनुसार सत्य ही ईश्वर का दूसरा नाम है। पूर्ण सत्य में सभी प्रकार के ज्ञान (चित्त) भी समाहित हैं और वह ज्ञान शाश्वत आनंद का स्रोत है। इसलिए हम ईश्वर को सच्चिदानंद के नाम से पहचानते हैं। महात्मा गांधी के इन विचारों का प्रभाव हम जैनेंद्र की 'वे तीन' शीर्षक कहानी में पाते हैं। गांधीजी के विचारों के प्रभाव को उनकी कहानियाँ 'फांसी', 'वातायन', 'एक रात', 'पाजेब' आदि में देखा जा सकता है और साथ ही उपन्यास 'सुनीता' में भी देखा जा सकता है। महात्मा गांधी का मत था कि शुद्ध सत्य की ओर अग्रसर होने के लिए मनुष्य को अपनी अंतरात्मा की आवाज़ को समझना चाहिए जिससे हमारा जीवन शुद्ध हो और हम पूर्ण शाश्वत सत्य को समझें। सत्य का चित्रण विष्णु प्रभाकर ने अपने कहानी संग्रह 'मेरी प्रिय कहानियाँ' में किया है। इनकी 'वापसी' कहानी में रामसिंह विद्वेष की आग में जलते हुए सोचता है कि "मैं उसके परिवार को दर-दर का भीख मँगवाऊँगा, भिखारी बनाऊँगा।" लेकिन जब उसे सत्य का बोध होता है और आत्म ज्ञान की चक्षु दृष्टि खुलती है तो वह घर में लगी आग से अपनी जान की बाज़ी लगाकर सौतेल भाइयों को बाहर निकालता है। यह हृदय परिवर्तन अचानक नहीं, बल्कि गांधीवादी दृष्टिकोण का ही प्रभाव है।

धर्म के विषय में गाँधीजी का कहना था कि धर्म जीवन का परम ध्येय है, आत्मदर्शन है, सभी धर्मों का सामंजस्य है, सबकी भलाई के लिए प्रयत्नशील है एवं देशप्रेम को ही अपना कर्तव्य मानता है। गांधी के इन विचारों का प्रतिबिम्ब विष्णु प्रभाकर की कहानी 'उस दिन' की पात्रा मंजू के माध्यम से देख सकते है। मंजू सांप्रदायिकता एवं तनावपूर्ण बर्बर वातावरण में एक मुस्लिम बालक को अपने घर में शरण देकर मानवीय धर्म का पालन करती है। गांधीजी के मानवीय धर्म का उत्कृष्ट उदाहरण हमें राधेलाल विजधावने 'अतृत' की कहानी 'एक सूत्र' में प्राप्त होती है। फरीदा का विवाह हिन्दू-मुसलमान के झगड़ों का कारण बन जाता है। तब उसका मामा कहता है- क्या कोई भी

धर्म संप्रदाय इंसानियत का गला घोटने की अनुमति देता है? तो फिर आप हिन्दू-मूसलमान के चक्कर में मानव धर्म को क्यों भूल जाते हैं? आप एक-दूसरे से गले मिलकर मानव धर्म को क्यों नहीं अपनाते?

गांधीजी ने अपने पत्र 'हरिजन' में ईश्वर को जीवन की शक्ति माना है और वही शक्ति हमारा जीवन है। जो व्यक्ति उस महान शक्ति के अस्तित्व को इंकार करता है, वह उस अनंत शक्ति के उपयोग से इंकार करता है और इस प्रकार शक्तिहीन रहता है। स्वरूप कुमार बख्शी के 'निर्झर कन्या' कहानी संग्रह की दो कहानियाँ 'बुलबुल' और 'जीवन की सात समस्याएँ' के किंचित अंश महात्मा गांधी की उक्त धारणा की पुष्टि करते हैं। 'जीवन की सात समस्याएँ' कहानी में पर्णकुटी निवासिनी आध्यात्मिक शक्ति संपन्न महिला के पास एक व्यक्ति जीवन की सात समस्याओं के समाधान के लिए जाता है और महिला के प्रबोधन से युवक अंततः समझ जाता है कि वास्तविक रोग कैंसर नहीं, मन की तृष्णा ही कैंसर है और उसकी औषधि प्रभु की कृपा है।

गांधी ने सत्य की खोज के लिए सेवा को आवश्यकता माना है। गांधीजी की इस विचारधारा को आधुनिक साहित्यकारों ने शिरोधार्य किया है। इनमें बलदेव उपाध्याय की 'पतिव्रता का व्रत', स्वरूप कुमार बख्शी की 'बुलबुल', 'कुरूप कन्या', 'प्यार कभी बूढ़ा नहीं होता' एवं सोमवीरा की 'धरती बेटी' शीर्षक कहानी का उल्लेख मिलता है। 'बुलबुल' कहानी में बुलबुल नर्स बनकर रोगियों एवं घायल पशु-पक्षियों की सेवा करती है।

भारत के समाज-सुधारकों में एक प्रमुख नाम महात्मा गांधी का भी है। समाज सुधार की दिशा में किए गए सुधार नदी उद्धार, सांप्रदायिक एकता, हरिजनोद्धार, मद्यपान निषेध संबंधी विचार प्रशंसनीय हैंगांधीजी के स्वराज्य का स्पष्ट प्रभाव प्रेमचंद में दिखाई देता है। इन्होंने अपने प्रसिद्ध और अंतिम लेख 'महाजनी सभ्यता' में कहा है- "धन्य है वह समता जो मालदारी और व्यक्तिगत संपत्ति का अंत कर रही है .....पर जो सत्य है एक दिन उसी की विजय होगी।" 'गबन' में एक नेता पर तीखा व्यंग्य करते हैं- 'तुम सुराज का नाम लेते हो उसका कौन रूप तुम्हारे सामने आता है .....जब तुम्हारा राज हो जाएगा तब तुम गरीबों का खून पी जाओगे।' विष्णु प्रभाकर की 'सुराज' शीर्षक कहानी में स्वतंत्रता की प्राप्ति के बाद का संघर्ष, 'धरोहर' में बंगाल के अकाल, 'आजादी' में गांधीजी का स्वतंत्रता प्राप्ति हेतु किया गया संघर्ष, 'मेरा वतन' में राष्ट्रीय प्रेम और 'भारत माता की जय' में सांप्रदायिक दंगे के वर्णन में प्रभाव दृष्टिगत होता है।

गांधीजी ने अस्पृश्यता निवारण का व्रत लिया था। उनका मानना था कि हम सभी एक ही अग्नि की चिंगारियाँ हैं, उसी ईश्वर के जीव हैं। वह हरिजनोद्धार कर अस्पृश्यता का अंत करना चाहते थे। इनके हरिजनोद्धार का प्रभाव लक्ष्मीनारायण की 'आनेवाला कल' शीर्षक कहानी में मिलता है। सोमा वीरा ने अपनी कहानी 'अंगूठी' में "जलपान कर लेते तो तुम्हारी जाति चली जाती पर मेरे देह का स्पर्श करने से तुम जाति च्युत न हुए।" प्रेमचंद ने गोदान में दलितों का वर्णन दमितपात्र के रूप में नहीं किया है- सिलिया का बाप ठाकुर झिंगुरी सिंह से कहता है कि "झगड़ा कुछ नहीं है ठाकुर, आज हम मातादीन को चमार बनाकर छोड़ेंगे या उनका और अपना रकत एक कर देंगे।"

गांधीजी दहेज प्रथा तथा नारी उद्धार के प्रबल समर्थक थे। उन्होंने वेश्या वृत्ति समस्या, विधवा विवाह, दहेज समस्या और नारी शिक्षा की दिशा में काफी प्रयास किए जिनका प्रभाव आधुनिक साहित्यकारों पर भी पड़ा है। विधवा विवाह के समर्थन की दृष्टि से सोमा वीरा की 'रेत के टीले' और 'बिंदिया' कहानी का नाम उल्लेखनीय है। सोमा वीरा ने 'रेत के टीले' में गांधीजी की शब्दावली में कहा- "मंगलमय भगवान की भी यही मनोवृत्ति है। फूल झड़ जाता है, उसकी जगह नई कली खिला देते हैं। ममतापूर्वक बनाई गई जीवन की गाड़ी के पहिए के अकस्मात टूट जाने पर दूसरे पहिए को निरुद्देश्य भाव से घसीटते देख उनकी आंखों में आँसू भर जाते हैं।"

स्त्री जाति की प्रगति और स्वतंत्रता की राह में गांधीजी दहेज का एक बहुत बड़ा रोड़ा मानते हैं। । प्रेमचंद के 'निर्मला' उपन्यास में भी दहेज पीड़ित महिला का जीवन दर्शाया गया है। 'सेवासदन' में सामाजिक घृणित वेश्यावृत्ति की समस्या को उजागर किया गया है। इलाचंद्र जोशी, उपेंद्रनाथ अश्क, विनोद शंकर व्यास और विष्णु प्रभाकर ने भी अपनी कहानियों में वेश्या समस्या से संबंधित चित्र खींचे है। गांधीजी ने नारी उद्धार के विषय में कहा है- "जब तक हम अपने यहाँ की स्त्रियों को माँ, बहन, बेटी समझकर उनका आदर करना नहीं सीखेंगे तब तक भारत का उद्धार

नहीं होगा।" गांधीजी का सामाजिक प्रभाव अमृतराय और फणीश्वर नाथ रेणु ऊपर भी दृष्टिगोचर होता है। रेणुजी का 'नित्य लीला' और 'तबे एकला चलो रे' में नारी के प्रति समाज का हीनबोध उद्‌घाटित होता है।
राजनीतिक क्षेत्र में महात्मा गांधी के स्वदेश और राष्ट्र विषयक विचार महत्त्वपूर्ण हैं। वे इस देश को एकता के सूत्र में बाँधने वाले महान नायक थे। इनके राजनीतिक प्रभाव विनोदशंकर व्यास के 'स्वराज कब मिलेगा' कृति में परिलक्षित होता है व्यासजी ने अपनी कहानियों में रेणु राष्ट्र प्रेम के अंतर्गत असहयोग आंदोलन, धरना-जुलूस आदि का वर्णन किया है। राष्ट्रीय भावना के संदर्भ में विष्णु प्रभाकर की 'खंडित पूजा' और 'नागफांस' कहानी भी उल्लेखनीय है।
गांधीजी बहुजन हिताय एवं ग्राम स्वराज्य के पक्षपाती थे जिनका प्रभाव हम प्रेमचंद और उनके परवर्ती साहित्यकारों पर भी देखते हैं। गांधीजी के समान ही प्रेमचंद का व्यक्तित्त्व सरल एवं सादगी से भरा हुआ था और वे भी बहुजन हिताय के प्रबल समर्थक थे। उनका साहित्य ग्रामीण जीवन एवं शोषित जनता पर अत्यधिक लिखा गया है। 'गोदान', 'गबन', 'कर्मभूमि', 'कायाकल्प' आदि के कृषक जीवन की मार्मिक झाँकी प्रस्तुत की है एवं एक आदर्श कृषक समाज की अवधारणा को निरूपित किया है।

इस प्रकार हम देखते हैं कि आधुनिक हिन्दी साहित्य पर गांधीजी का प्रभाव पूरी परिशुद्‌धता के साथ व्याप्त है। महात्मा गांधी ने भारत भूमि की स्वाधीनता के लिए अपना संपूर्ण जीवन समर्पित कर दिया। वे जनमानस में सत्य, अहिंसा, प्रेम, एकता, शांति, सद्‌भाव, सर्वधर्म सम्भाव, समानता एवं मानवता की भावना जागृत करने के लिए सतत् संघर्षशील रहे। उनका विचार था कि ऊँच-नीच, अमीरी-गरीबी और छुआछूत, अन्याय, उत्पीड़न तथा किसी प्रकार की हिंसा न हो और समस्त भारतवासी निर्भय होकर शांतिमय जीवन व्यतीत कर सकें। अतः हिन्दी साहित्य पर उनके विचारों का प्रभाव पड़ना स्वाभाविक ही है। उनके विचारों को हिन्दी साहित्य के अधिकांश साहित्यकारों ने अपनाया और उनको अपनी रचना का विषय बनाया। कथा साहित्य में जहाँ प्रेमचंद, रेणु, जैनेंद्र, अश्क, स्वरूप कुमार बख्शी विष्णु प्रभाकर आदि की रचनाओं में गांधी विचार एवं उनके आदर्शों को देखते हैं, वही मैथिलीशरण गुप्त, सुभद्रा कुमारी चैहान, माखनलाल चतुर्वेदी, भवानी प्रसाद मिश्र, बालकृष्ण शर्मा नवीम आदि कवियों में भी देखने को मिलता है।

■ डॉ. अर्चना दुबे
सहायक व्याख्याता
वी.जी. वझे केलकर महाविद्‌यालय, मुलुंड

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“स्त्री के सामाजिक यथार्थ से परिचय कराती : मर्यादा”

स्त्री को आद्य शक्ति माना गया है। ब्रहमा, विष्णु, महेश को शक्ति प्रदान करनेवाली भी स्त्री रूपा ही है। स्त्री ही प्रजनन का कार्य करती है और स्त्री ने ही ‘पृथ्वी’ रूप में समूचे संसार का भार उठाया हुआ है इसलिए धरती को ‘माँ’ कहकर पुकारा जाता है। शक्ति स्त्री का ही पर्यायवाची है परंतु वर्तमान में स्त्री की सामाजिक स्थिति आज भी सोचनीय है। आज जहाँ विश्व स्तर पर नारी विजय-परचम लहरा रही है वहीं सामाजिक व पारिवारिक हिंसा का शिकार बन रही नारी भी विद्यमान है। उसी तरह जहाँ नारी को देवी, ममता, दया, करुणा, सहनशीलता का रूप माना जाता है वहीं हमें नारी छल, कपट, कटुता, विद्रोहिणी रूप में भी परिलक्षित होती है।

कथाकार ‘कमलेश बख्शी’ वर्तमान हिन्दी कहानी की एक ऐसी लेखिका हैं जिनकी कहानियों में नारी के विविध रूप देखे जा सकते हैं। इनकी कहानियों में नारी पात्र अपनी अलग-अलग विशेषताओं के साथ सामने आती है। कहीं ये पात्र बहुत मजबूत और कहीं बहुत कमजोर नजर आते हैं। बख्शी जी के कहानी संग्रह ‘मर्यादा’ में बीस कहानी संग्रहित हैं। इन कहानियों में चित्रित नारी पात्र सामाजिक व पारिवारिक समस्याओं का सामना करती है, उनसे जूझती, लड़ती तो कहीं समझौता कर घुटने टेकती दिखाई पड़ती है।

बख्शी जी की कहानी ‘बे गड्डी चढ़ गई’ की मुख्य नारी पात्र बे एक विशिष्ट चरित्र के साथ सामने आती है। जो जीवनपर्यंत परिस्थितियों से समझौता करती है। बे अपने पति द्वारा लायी गई सौतन को भी बड़ी सहजता से स्वीकारती है और सौतन के मरने के बाद उसके बच्चों को भी प्रेम से अपनाती है। पति के अंतिम अवस्था तक उसकी सेवा भी करती है। इतना ही नहीं सौतन के आने पर वह स्वेच्छा से हवेली छोड़कर उसके पीछे के हिस्से में रहने लगती है और वहीं से हवेली का सारा करोबार संभालती है। इस दौरान भूलकर भी हवेली में पैर नहीं रखती। यहाँ तक कि आँख में फुंसी होने की खबर तक पति तक नहीं पहुँच पाती, ना दवा-दारू ही करती है जिस कारण वह अपनी एक आँख भी गँवा बैठती है। परंतु बे ने ना कभी जीवन से शिकायत की ना अपने पति से। पति जब दूसरी पत्नी की मृत्यु के पश्चात उसे दुबारा हवेली में वापस लेने आता है तब उसकी यह हालत देखकर कहता है-- “बोल न भाग, सौतन के बच्चों को भी तुमने गले लगा लिया, इतना अन्याय तेरे साथ हुआ फिर भी तू ने उफ्फ नहीं की! मैं शर्मिंदा हूँ। अब लौट चल अपनी हवेली में...।” बख्शी जी की यह नारी पात्र कहीं भी अपने अधिकारों के लिए आवाज उठाती नहीं दिखती है। लेखिका शायद भारतीय समाज की उस नारी को इसके माध्यम से अभिव्यक्त करना चाहती है जिसने अपने ऊपर होनेवाले असंख्य अत्याचारों के विरुद्ध कभी मुँह नहीं खोला। हमारे उत्तर भारत में एक कहावत कही जाती है ‘बेटी और गाय एक समान होती है जिसे किसी भी खूँटे से बाँध दो वो

बँध जाती है और कटने को तैयार रहती है।' इसी तरह बे भी अंत तक अपने पत्नी धर्म व मातृ धर्म का पालन करती है।

इसके विपरीत 'शृंग से सागर' कहानी की सोना बद्रीनाथ में रहनेवाली गरीब पहाड़ी कन्या है जो अपनी सुंदरता और भोलेपन के कारण अपनी दादी के साथ दर्शन करने आए अपूर्व का दिल जीत लेती है और वह उससे इतना अधिक आकर्षित होता है कि परिवार के विरुद्ध जाकर सोना से विवाह कर उसे घर लेकर आता है। परंतु वह शहर में आकर यहाँ कि सुख-सुविधाओं और चकाचौंध की ओर तो बखूबी आकर्षित होती है लेकिन अपने गाँव की मिट्टी और यादों को नहीं भुला पाती। वह शहरी फैशन व तामझाम को तो अपनाती है पर सभ्यता नहीं अपनाती। अपूर्व के पढ़ाने पर भी वह न पढ़ना चाहती है न सभ्य बनना चाहती है और ना ही ससुराल के रीति-रिवाजों व रहन-सहन को अपनाना चाहती है बल्कि सास और पति के विरुद्ध ही कार्य करती है। इतना ही नहीं वह ससुराल में भी झगड़ पड़ती है और सबसे कटी-कटी रहती है। धीरे-धीरे उसकी महत्त्वाकांक्षा बढ़ती चली जाती है और परिवार के विरुद्ध जाकर अपने घर में काम करनेवाले पहाड़ी नौकर के साथ खूब हँसती-बोलती है और उसे चोरी-चोरी घर भी बुलाती। अंत में इसी पहाड़ी नौकर के साथ सारे गहने-पैसे लेकर भाग जाती है-- "कुछ दिन बाद ही रसोई में सोयी आया को बाहर से कुंडी बंद कर वह गहने कपड़े ले भाग गई।" यह कहा जाता है कि पुरुष ही महिला को छलता है परंतु वर्तमान में महिलाओं का भी एक ऐसा वर्ग बन गया है जिनके द्वारा पुरुष प्रताड़ित किए जाते हैं, छले जा रहे हैं।

इसी तरह 'जिंदगी का एलबम' की नायिका केटी ब्राउनी अविवाहित माँ और एक स्वच्छंद नारी के रूप में सामने आती है। केटी ब्राउनी एक विदेशी महिला है जो कि चकाचौंध की जिंदगी में जीनेवाली एक भटकी हुई लड़की है। भौतिक संसाधनों के पीछे भागनेवाली यह लड़की अपनी अनर्गल इच्छाओं, लालसाओं और वासनाओं को पूरा करने के लिए तथा जिंदगी का मजा लूटने के लिए कसीनों में काम करने लगती है और वहाँ की रंगीन दुनिया और चकाचौंध के प्रभाव में आ जाती है-- "साथ की अनुभवी लड़की ने सलाह दी, आनंद लूटो-कइयों के साथ घूमों फिर एक को चुन शादी कर लेना और अल्हड़ केटी उसमें बहने लगी।" इस बीच वह गर्भधारण कर लेती है और न्यूयार्क के 'होम फॉर अनमैरीड मदर' में जाकर बच्चे को जन्म देती है। अपने इसी पैसे की लालच, अति महत्त्वाकांक्षा, स्वच्छंद व अत्याधुनिक जीवनशैली के चलते वह लगातार पथभ्रष्ट होती चली जाती है और एक दिन बिना लाइसेंस वाले जिप्सी ड्राइवर द्वारा उसकी हत्या कर दी जाती है।

एक और कहानी 'क्षितिज' भी विदेशी पृष्ठभूमि पर ही आधारित है। इसकी नायिका पैम अपने प्रेमी जैरी के साथ सुनहले भविष्य के सपने बुनती है। जब दोनों के माता-पिता को पता चलता है तो वे असहमती जताते हैं-- "पैम के माँ-बाप कहते हैं- कुछ समय और एक-दूसरे को समझो। अभी बहुत छोटे हो- पैम पहले तुम नौकरी ढूँढो। हम इस उम्र में शादी के पक्ष में

बिल्कुल नहीं हैं।'' माता-पिता के बार-बार मना करने के बावजूद भी जैरी और पैम लिव इन में रहने लगते हैं और कुछ दिन बाद ही विवाह कर लेते हैं। जैरी के साथ विवाह के बाद कुछ दिन में ही पैसे की तंगी होने लगती है। जैरी चाहता है कि पैम भी कोई नौकरी करे पर इसी बीच पैम गर्भवती हो जाती है। जैरी अपनी आर्थिक स्थिति देखते हुए पैम पर गर्भपात के लिए दबाव डालने लगता है। फिर भी पैम बच्चे को जन्म देती है और इस वजह से जैरी पैम से चिढ़ने लगता है अपने बच्चे से भी वह नफरत करने लगता है। जैरी इन सबको अपने प्रगति पथ पर बाधा मानने लगता है और इस बीच अपने साथ काम करनेवाली धनवान लड़की के करीब होने लगता है। रोज-रोज के कलह से तंग आकर पैम बच्चे को लेकर कुछ दिन के लिए अपनी सहेली के घर रहने चली जाती है यह सोचकर की शायद बच्चे और उसकी गैर-मौजूदगी में पति को उनकी कमी का एहसास हो लेकिन जब वह लौटकर आती है तो वह पाती है कि पति सबकुछ बेचकर, घर में ताला लगाकर वहाँ से हमेशा के लिए चला जाता है। पैम को सदमा सा लगता है और तभी उसकी नजर दीवार पर लगे 'शेल्टर फॉर होमलेस वुमन' के पर्चे पर पड़ती है और वह उस पते की ओर बढ़ जाती है। इस कहानी के माध्यम से लेखिका ने भावनाओं में बह जानेवाली लड़की का चित्रण किया है जो जीवन में सही निर्णय नहीं ले पाती।

आजीवन त्याग व अंतर्मन से लड़ती 'मर्यादा' कहानी की नायिका अंजली जो एक वेश्या है और सेठ अविनाश ठाकुर के हाथों बेच दी जाती है वह बचपन से ही इस धंधे से घृणा करती है और मन में एक परिवार की आशा लिए है कि कोई उसे अपनी पत्नी बना के पारिवारिक जिंदगी देगा। परंतु यथार्थ के सामने अपने सपनों को बिकता पाती है। सेठ की रखैल बनकर रहती है पर मन में एक उम्मीद होती है कि पत्नी भले ना माने पर पत्नी का प्रेम और आदर मिले। सेठ बैठकर साथ समय बिताए, बातें करे। सेठ केवल उसे भोग्या के रूप में लाया था-- "वह रखैल है... रखैल... किसी की पत्नी नहीं-- उसने अपना सिर दीवार से टिका दिया - वह केवल भोग्या है। इसलिए तो वह लायी गयी है, खरीदी गयी है - अच्छी रकम देकर।'' पर वो जिद कर एक बच्चा पैदा करती है। वह इस उम्मीद में रहती है कि सेठ उस बच्चे को पिता का नाम दे पर वह ना उसे अपना नाम देता है न ही उसकी बीमारी में पिता का कोई फर्ज अदा करता है-- "उनका नाम बच्चे के साथ नहीं जुड़ सकता। क्या लोग जानते नहीं - ऑफिस वाले - उनके बच्चे - पत्नी - कौन नहीं जानता - बच्चा उनका है।'' अंजली के गर्भावस्था से लेकर बच्चे के पैदा होने तथा उसके बीमार होने तथा एक पैर में लकवा मारे जाने जैसी सभी विकट परिस्थितियों में सेठ का ड्राइवर त्रिलोचन ही अंजली और उसके बच्चे का ध्यान रखता है। वह पूरी कहानी में एक पिता और पति का कर्तव्य पूरा करता नजर आता है परंतु जब वह अंजली को सब कुछ छोड़कर उसकी पत्नी बन जाने का प्रस्ताव रखता है तथा इसके बच्चे को अपना नाम देना चाहता है-- "तब अंजली उस प्रस्ताव को अस्वीकार कर देती है क्योंकि वह सेठ द्वारा खरीद कर लाई गयी है और सेठ की इच्छाओं को पूरा करना ही अपना कर्तव्य मानती है, नहीं तो वैश्याओं का कोई धर्म-ईमान नहीं होता, यही

सोचा जाएगा-- "नहीं - नहीं - त्रिलोचन कभी न आना - मुझे मर्यादा निभानी है - फिर तुम्हारे गंगाजल की जिंदगी में कीचड़ नहीं डालूँगी - कभी - नहीं।'' इसलिए वह अपने गृहस्थ और भविष्य के सुखमय जीवन की तिलांजली दे देती है।

इस कहानी की अंजली उन औरतों का प्रतिनिधित्व करती है जो लोगों द्वारा आजीवन शोषित होती हैं। भोग्या बनकर जीती हैं और भोग्या रूप में ही मर जाती हैं। समाज में ये कभी सम्मान की जिंदगी नहीं पाती बस एक विशेषण बनकर रह जाती हैं।

'एक मुलाकात' की नायिका जो दूसरी औरत के लिए अपने पति द्वारा त्यागी एक तलाकशुदा औरत है जो एक छोटी सी नौकरी कर अपने दोनों बच्चों सुधीर और सुनीता का पालन-पोषण करती है। बच्चे जब बड़े होते हैं तो अपने अभावग्रस्त जीवन और पिता के आलीशान और शानो-शौकत की तुलना करते हैं और माँ से कहकर वहाँ रहने चले जाते हैं-- "जहाँ तक वह सोचती है - पितृस्नेह से कहीं अधिक पिता के ऐश्वर्य, वैभव ने खींचा होगा उसे रोना नहीं चाहिए - बच्चे बड़े हो गये हैं वे अब स्वयं निर्णय ले सकते हैं।'' परंतु पिता के घर सब कुछ होकर भी प्रेम और संस्कार का अभाव पाते हैं। सौतेली माँ, सौतेले भाईयों द्वारा अपमानित होकर डरे सहमें से बच्चे अपनी माँ के पास फिर अपने घर वापस लौट आते हैं-- "एक मुलाकात ने हमारी आँखें खोल दी - चमकने वाली सभी चीजें सोना नहीं होती - हम सच ही पापा के ऐश्वर्य से आकृष्ट थे - लेकिन वह आकर्षण रेत की दीवार-सा ढह गया।'' कहानी में नायिका माँ का चरित्र उभरकर सामने आता है जो अपने उजड़े गृहस्थ जीवन में से अपने मातृत्व का रंग भरी हुई है और अपने पति के बाद इन बच्चों को खो देने के डर से संपूर्ण जीवन संघर्ष करती है। इस कहानी में नारी आत्मविश्वासी महिला के रूप में सामने आती है और पुरुष समाज को चुनौती देती है कि एक नारी भी स्वयं के बल पर अपना जीवन निर्वाह कर सकती है। इसी क्रम में वह माँ के कर्तव्य का भी निर्वाह करती है और बच्चों को अच्छा नागरिक बनाने का भरसक प्रयास करती है।

वहीं 'नियति' कि राधिका जो बचपन से पूरे परिवार की जिम्मेदारी अपने कंधों पर उठाए रहती है और फिर प्रशांत जो जीवन में असफल इंसान है और बड़ा संगीतकार बनना चाहता है उसे सफल होने में पूरा सहयोग करती है परंतु प्रशांत विवाह के उपरांत अपनी महत्त्वाकांक्षा के पीछे राधिका को नजरअंदाज करने लगता है। वह घर में होकर भी अपने आपको परित्यकता पाती है। शिकायत करने पर जवाब में पति से "नाराज क्यों होती हो। जिनकी गोद सूनी है उससे पूछो। एक तो दो-दो बच्चे से गोद भर दी ऊपर से...।'' धीरे-धीरे प्रशांत परिवार से पूरी तरह कटता गया और बाहरी दुनिया में रमता गया इतना ही नहीं बच्चे की बीमारी हो या राधिका की, वह कमरे में झाँकने तक न जाता। अंत में राधिका उसे छोड़कर बच्चों के साथ मायके चली जाती है-- "शायद हम एक दूसरे को पहचान नहीं पाये थे। हमारे रास्ते एक नहीं थे। मैंने एक घर को चुना था - तुमने विस्तृत दुनिया के खेल का प्रांगण

चुना।'' एक साल बाद प्रशांत नींद की गोली खाकर आत्महत्या कर लेता है। इस कहानी में बख्शी जी ने उस नारी का चित्रण किया है जो पुरुष की महत्त्वाकांक्षा के सामने हार जाती है।

'दूसरा बनवास' की बसंती अपने पियक्कड़ पति गनपत के हाथों आए दिन बुरी तरह पिटती, मार खाती और फिर भी खिलखिलाती रहती-- "अगो बाई मेरे को बहुत हँसी आती थी - दाँत तुड़वाकर अकल आई।'' दूसरों के घर झाड़ू-पोंछा करती और बेटे और पति का पेट भरती पर जीवन में सुख का मुँह न देखी। पति के मरने के बाद सास, ननद और उसके बाद बेटा भी केवल दुःख ही देता है आजीवन जूझती है। बेटा भी बड़ा होकर पियक्कड़ निकल जाता है-- "ये काम नहीं करेगा, सकल तो बाप जैसी अकल भी वही है। कल पी आया... '' पूरी जिंदगी नरक सी रही उसकी पति के साथ भी जीवन वनवास सा कटा है और फिर बेटा बड़ा होगा तो जीवन में सुधार की उम्मीद लिए जीती रही, पर जब वह भी पिता जैसा ही निकलता है तो उसे लगता है जैसे नरक खत्म ही नहीं हुआ अपितु दूसरा बनवास शुरू हो गया-- "बची जिंदगी भी नरक हो गयी - मेम साहब - मेरा नसीब देखो... मेरा वनवास कटा लगता है बारह साल बाद फिर वनवास मिल गया - दूसरा वनवास।''

इस कहानी के माध्यम से बख्शी जी ने मुंबई के उस वर्ग विशेष का चित्रण किया है जहाँ महिलाओं द्वारा पुरुष पलता है और महिला मेहनत करती है, मार खाती है, पुरुष आजीवन प्रताड़ित करता हे और आगे जाकर बच्चे भी उसी राह पर चल पड़ते हैं।

'आश्वस्त' कहानी की नायिका अपने मंदबुद्धि बेटे के लिए पूरी कहानी में संघर्ष करती नजर आती है। जब उसे पता चलता है कि बच्चा मानसिक रूप से कमजोर है वह दूसरे बच्चों से अलग है और वह कभी ठीक नहीं हो सकता तो वह भीतर ही भीतर टूटकर रह जाती है। बच्चा मंदबुद्धि है इसके लिए भी माँ को ही दोषी नजरों से देखा जाता है, बाद में एक बेटी भी होती है रीटा। उसे पढ़ने के लिए हॉस्टेल में भेज दिया जाता है जिससे थॉमस के बीमारी का शिकार उसे न बनना पड़े। सास-ससुर, पति का बर्ताव हमेशा रूखा रहता है-- "सास-ससुर का और पति का कठोरता से कह देना - उसे अंदर ले जाया करो जब कोई आये तो। उसे समझ न आता बच्चे का मंदबुद्धि होने में उसका क्या कसूर है।'' पति पीटर ने थॉमस की उपस्थिति अपने जीवन में अस्वीकार कर दिया था। थॉमस की बीमारी और गड़बड़ियों की खीझ पत्नी पर उतारता। वह थॉमस की देखभाल और चिंता में चार दीवारी में सिमटकर रह जाती है। वह अपने बेटे थॉमस को स्वावलंबी बनाने का संकल्प लेती है और धीरे-धीरे जब थॉमस समझदारी की बातें करने लगता है, ग्रीटिंग कार्ड्स बनाता और खुद बेच भी आता दुकानों में हर रविवार अकेले चर्च जाता और आ जाता तो माँ आश्वस्त होने लगती है कि उसके पंद्रह वर्षों की मेहनत सफल हुई-- "वह फिर किरणों की डोर थामे आकाश तक पहुँचने के सपने देखने लगी।'' इस कहानी में लेखिका ने एक आशावादी महिला का रूप चित्रण किया है जिसकी आशावादी विचारधारा और मेहनत का ही प्रतिफल है कि उसका मंदबुद्धि बालक स्वावलंबी बन जाता है।

'गुनाहों की जिंदगी' में तीन बेटियाँ रीता, गीता, मीता है जो अपने गैर जिम्मेदार पिता के द्वारा शोषण का शिकार बनती है। यह कहानी पत्र के प्रारूप में लिखा गया है यह पत्र मिता अपने पिता को लिखती है जो जिंदगी के गुनाहों से हार चुकी है और इस गुनाहभरी जिंदगी में ढकेलने का श्रेय उसे पिता को जाता है। वह अपने पिता से बेहद घृणा करती है और उस पिता को मित द्वारा यह पत्र क्रोध, क्षोभ व घृणा के भाव से लिखा गया है।'' पिता घर के प्रति और अपनी बेटियों के प्रति अपनी जिम्मेदारी का बिल्कुल निर्वाह नहीं करता और फक्कड़ व्यक्तित्व का होने के कारण बेटियों की जिंदगी खराब हो जाती है। बड़ी बेटी अपने से दोगुना पुरुष के साथ भागकर विवाह कर लेती है तो गीता अपने ससुराल में तीन पीढ़ी की भोग्या बनकर रह जाती है और मीता डाकुओं के गिरोह में फँस जाती है और डाकुओं की सरदार बन जाती है। इस कहानी में गैर-जिम्मेदार पिता के कारण बेटियों की जिंदगी प्रभावित होती है।

इस प्रकार कथाकार कमलेश बख्शी जी ने अपनी कहानी के माध्यम से समाज में व्याप्त स्त्री के विविध चरित्र का चित्रण बड़े ही सजगता से किया है।

■ डॉ. अर्चना दुबे
सहायक व्याख्याता
वी.जी. वझे केलकर महाविद्यालय, मुलुंड

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