RESEARCH JOURNAL OF HOLY CROSS COLLEGE AGARTALA

Volume 1, Issue 1
Year - 2025

Holy Cross College Agartala
Affiliated to Tripura University (A Central University)
Accredited by NAAC with 'A+' Grade (Cycle:02)
www.hccagt.ac.in

Research Journal Holy Cross College Agartala

Contents

RESEARCH JOURNAL OF HOLY CROSS COLLEGE AGARTALA:

A MULTIDISCIPLINARY PEER-REVIEWED JOURNAL

RESEARCH JOURNAL OF HOLY CROSS COLLEGE AGARTALA:

A MULTIDISCIPLINARY PEER-REVIEWED JOURNAL

ADVISORY COMMITTEE

RESEARCH JOURNAL OF HOLY CROSS COLLEGE AGARTALA:

A MULTIDISCIPLINARY PEER-REVIEWED JOURNAL

PEER-REVIEW TEAM

A Comparative Study of Financial Performance of Reliance Jio and BSNL in the Indian Telecommunication Sector

Mr. Somdev Roy Barman, Assistant Professor, Department of Business Administration, Holy Cross College, Agartala

Mrs. Sayanika Sengupta, Assistant Professor, Department of Business Administration, Holy Cross College, Agartala

Miss Kashmiri Saha, Student (3rd Semester), Department of Business Administration, Holy Cross College, Agartala

ABSTRACT

Today in this era of modernization, telecommunication sector plays a very vital role to connect peoples round the globe. India boasts the second largest telecommunications network in terms of total phone customers, including both mobile and landline phones. In terms of Internet subscribers, it also brags the third-largest base telecom network. According to available statistics made available by the Internet and Mobile Association of India (IAMAI), there are 821 million internet users in India by the end of 2022-23. Therefore, it is necessary to evaluate the effectiveness and financial performance of particular telecommunications businesses. Accordingly, an attempt has been undertaken to compare the financial performance of Reliance Jio and BSNL in the current study.

Keywords: *Financial performance, Telecommunication, Reliance Jio, BSNL*.

I. INTRODUCTION

Today in this era of globalization, telecommunication sector plays a very vital role to connect peoples round the globe. On the basis of total number of telephone users, India grips the second largest network in telecommunications network. Apart from that, it also has the third largest base of telecommunication network quantified on the basis of internet users which is recorded 821 million by the end of 2023 (IAMAI, 2023). Indian economy comprises of both private and public enterprises who manage the overall telecommunication services. As per the data of number of subscribers released by Statista[1], the market share of the telecommunication companies reveals that it is dominated by the private sector companies, namely Reliance Jio (424.52), Bharti Airtel (367.61), Vodafone Idea (241.32), in comparison to the public sector companies, like BSNL (107.71), and MTNL (2.76). As the telecommunication industry plays an important role in the economic growth of the country, it becomes necessary to evaluate the financial performance of the chosen telecommunications firms. Accordingly, the top operators, one from the private sector, and the other from the public sector has been chosen to get a deep insight about their financial performances over the past five years, i.e., from 2018-19 to 2022-23. Ratio analysis tends to work as a benchmark for financial analysis to evaluate the financial performance of any organization. Hence, various ratios i.e., net profit ratio, current ratio, debt-equity ratio, etc. will be considered to make a comparative financial analysis of Reliance Jio and BSNL telecommunication.

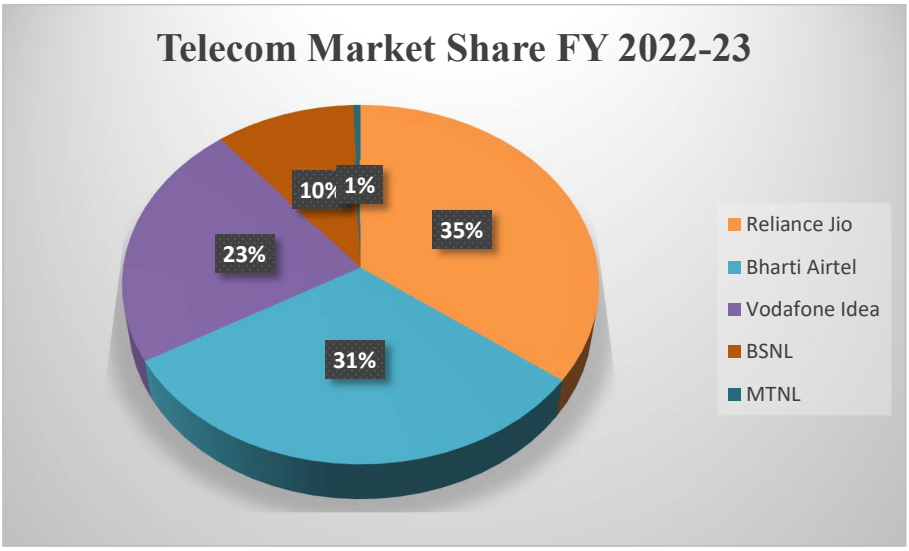
II. THE INDIAN TELECOMMUNICATION SECTOR IN BRIEF

The telecom industry in India has witnessed a phenomenal and manifold growth over the recent years (Swapna, 2012). India possesses the second-largest telecommunications network, as was previously said. In terms of internet subscribers, it also boasts the third-largest base telecom network. It is currently essential to the expansion of the Indian economy. The three main segments of the Indian telecommunications industry are television broadcasting, internet, and telephony. However, a number of contemporary network components, such as media gateways, mobile switching centers, digital phone exchanges, and signaling at the core, connected by a range of transmission systems, such as fiberoptics or microwave radio relay networks, will propel it into the next generation of networks. DTH, a new transmission network, has also become very popular in India in the television industry. India's radio broadcasting industry had a boost with the introduction of private FM. The Indian National Satellite System, or INSAT,

[1] https://www.statista.com/statistics/258794/mobile-telecom-subscribers-in-india-by-company/

was introduced by ISRO and has been a major contributor to the country's telecommunications infrastructure. India has a highly varied communication network that uses satellites, the internet, phones, radios, and televisions to link every part of the nation. The prices of mobile phones and mobile services have dropped dramatically as a result of intense rivalry between market competitors. All of these are contributing to the ongoing rise in the subscriber base. Figure 1 depicts the market share of the telecom companies in the Indian domain.

Figure 1: Market Share of Indian Telecommunication Companies



Source: India Brand Equity Foundation (IBEF), 2022-23

III. LITERATURE REVIEW

Rani (2018) through her study "A Comparative Study of Financial Performance of Indian Telecommunication Sector" found that the short-term liquidity position of BSNL was good but the long-term liquidity position was very low due to higher dependency on long-term borrowings.

Ezhil Maran (2020) through his research article "Financial Key Performance Indicators of Jio Infocomm" found that the capital structure seems to have a considerable effect on the cost of capital of Jio Telecommunication.

Muthusamy (2012) through his study "A Financial Analysis of Selected Telecommunication Companies in India" stated that the telecommunication industry has been aiding delivery of voice and data services at rapidly increasing speeds, and thus has been revolutionizing human communication.

Yadagiri & Rajaram (2018) in their research article "Analysis of Operating Performance of BSNL" made adequate calculations to assess the operating performance of BSNL in terms of revenue, total income, operational income, operating expenses, total expenses, employee benefit expenses, administrative, operating and other expenses, profit before tax, tax expenses and profit after tax.

Priyanka & Kumar Jha (2022) in their research Article "Profitability Analysis of Bharat Sanchar Nigam Limited (BSNL)" calculated the Net Profit Ratio, Return on Assets Ratio, Return on Equity, Earning Per Share and Cash Profit Ratio from the year 2001-02 to 2010-11 and concluded that the profitability ratios show fluctuating trends except last two years and the last two years ratios shows negative values except cash profit ratios.

Swapna (2012) in her research article "Telecommunication Sector in India – An Analysis" concluded that the telecom industry in India has witnessed a phenomenal and manifold growth over the recent years. In the country, personalized telecom access has become an essential necessity of life for a growing number of people. The telecom sector in India holds unlimited potential talking of future growth. In the nation, both public as well as private firms are vigorously enhancing their technologies in a venture to take the telecom industry in the country to a much higher development.

Pritish et. al. (2015) in their research article "An Analysis of the Indian Telecom Industry" concluded that the Indian Telecom Industry contributes significantly to the overall socioeconomic development of India. It is an essential tool for the growth of the nation and the various telecom service providers offer voice and data services to the customers across different regions of the country including both urban and rural areas thereby facilitating the growth of this industry.

The literature study provides information on several areas of the Indian telecommunications business, such as financial performance, profitability analysis, and operational indicators for significant participants such as BSNL and Jio. The absence of recent thorough studies that combine financial performance and operational effectiveness across a wider range of Indian telecom companies, however, is a clear research gap. Most studies focus on specific areas such as financial ratios or individual firm performance indicators, leaving a vacuum in understanding overall industry performance trends and comparative analysis. Further research

could delve into these elements to provide a more thorough picture of the sector's dynamics and difficulties.

IV. OBJECTIVES OF THE STUDY

The primary objective of this research is to provide a comprehensive comparative financial analysis of Reliance Jio and BSNL in the telecommunications industry deploying ratio analysis as the assessment tool.

V. RESEARCH METHODOLOGY

This methodology adopted for the present study is quantitative in nature, primarily focusing on the financial statements extracted from the annual reports of both Reliance Jio and BSNL over the preceding five years, i.e., from 2018-19 to 2022-23. In addition to that, various other secondary data sources like journals, research articles, reports, websites have been systematically utilized and referred for enquiry and systematically utilized keeping in mind the objectives of the study.

VI. DATA ANALYSIS AND INTERPRETATION

Table 1: Calculation of Net Profit Ratio

(Rs. In Crore)

Year	Reliance Jio			BSNL		
	Net Profit	Net Sales	Net Profit Ratio (%)	Net Profit	Net Sales	Net Profit Ratio (%)
2018-19	3679	46526	7.907	316796	2755457	11.497
2019-20	1626	58492	2.779	20410	265150	7.697
2020-21	1756	56370	3.115	14488	257323	5.63
2021-22	7288	70301	10.366	862	242868	0.354
2022-23	10331	77195	13.382	-6547	220499	-2.969

Source: Author's calculation based on figures extracted from the Balance Sheet of Reliance jio and BSNL.

The net profit margin of Reliance Jio grew considerably over the years, i.e., from 7.9% in 2018-19 to 13.38% in 2022-23, whereas, BSNL's performance went drastically down to negative figures indicating loss. From a net profit margin of 11.49% in 2018-19 to (2.96%) in 2022-23, BSNL incurred heavy losses and lost a major portion of the market share which is an indicative

that Jio was being preferred over it. The major reasons being flexible mobile tariff plans and implementation of high-speed internet at pocket friendly prices.

Table 2: Calculation of Current Ratio

(Rs. In Crore)

Year	Reliance Jio			BSNL		
	Current Assets	Current Liabilities	Current Ratio	Current Assets	Current Liabilities	Current Ratio
2018-19	152864	20202	7.566	224.22	208.68	1.074
2019-20	166654	33068	5.039	228.9	214.83	1.065
2020-21	210719	20178	10.443	208.31	171.13	1.217
2021-22	222398	20098	11.065	257.44	211.78	1.215
2022-23	265932	23707	11.217	305.72	267.9	1.141

Source: Author's calculation based on figures extracted from the Balance Sheet of Reliance jio and BSNL.

The comparison of current ratio data in between Reliance Jio and BSNL depicted that the former was much more solvent in paying-off the short-term obligations arising within a financial year. While, BSNL was also performing well in paying out the obligations it was incurring over the years but the margin was very low in comparison.

Table 3: Calculation of Debt Equity Ratio

(Rs. In Crore)

Year	Reliance Jio			BSNL		
	Total Debt	Shareholder's Equity	Debt Equity Ratio	Total Debt	Shareholder's Equity	Debt Equity Ratio
2018-19	188604	405322	0.465	250.32	76.75	3.261
2019-20	282870	391214	0.723	245.61	75.05	3.272
2020-21	217581	474483	0.458	209.9	78.28	2.681
2021-22	226263	471527	0.479	262.75	89.3	2.942
2022-23	197902	479094	0.413	434.18	104.07	4.171

Source: Author's calculation based on figures extracted from the Balance Sheet of Reliance jio and BSNL.

Through the calculation of Debt Equity Ratio, it has been observed that the debt-to-equity ratio was less than 1 throughout the entire study for Reliance Jio depicting a favorable position in comparison to BSNL whose debt-to-equity was ranging in between 3% to 4% in average. Things that attributed towards the favour of Reliance Jio was due to the fact that a major portion of the investors were getting connected to the company against the returns they were getting deploying their money. Summative, this had a positive impact on the overall debt-equity profile of the company.

Table 4: Calculation of Return on Assets

(Rs. In Crore)

Year	Reliance Jio			BSNL		
	Net Profit	Total Assets	Return on Assets	Net Profit	Total Assets	Return on Assets
2018-19	3679	775745	5.71	316796	327.07	3.521
2019-20	1626	971699	4.61	20410	320.66	3.785
2020-21	1756	873673	4.95	14488	288.18	4.653
2021-22	7288	878674	6.05	862	352.05	5.218
2022-23	10331	890565	6.32	-6547	538.26	5.635

Source: Author's calculation based on figures extracted from the Balance Sheet of Reliance jio and BSNL.

A comparison of return on assets ratio between the two revealed that Reliance Jio was again way ahead of BSNL. With the increase in the number of users getting connected to the company, Reliance Jio was making adequate profits which they further deployed on making assets that gave the overall ratio a good spin. BSNL was also having a decent return on assets ratio but failed in comparative terms. It's worth a mention that Reliance Jio was not only giving a tough competition to BSNL but also to the other rival telecommunication companies operating in the Indian sector, viz. Bharti Airtel, Vodafone Idea, and MTNL.

VII. FINDINGS

1. Net Profit Margin Growth: Reliance Jio's net profit margin climbed dramatically from 7.9% in 2018-19 to 13.38% in 2022-23, whereas BSNL's margin fell sharply from 11.49% to (2.96%) over the same period, showing serious losses and a reduction in market share.
2. Current Ratio Comparison: Reliance Jio displayed more solvency and ability to cover short-term obligations than BSNL, which managed liabilities but with a lesser margin.
3. Reliance on Debt Equity Ratio: Jio continuously maintained a debt-to-equity ratio below one, indicating a strong financial structure. On the other hand, BSNL's ratio varied from 3% to 4%, suggesting a greater dependence on debt funding.
4. In contrast to BSNL's difficulties, Reliance Jio's capacity to draw investors was emphasised by its competitive mobile pricing and high-speed internet offers.
5. Return on Assets (ROA): Reliance Jio outperformed BSNL and other rivals in the Indian telecom market thanks to a larger user base and wise asset investments.
6. Market Preference: Jio outperformed BSNL thanks to its adaptable tariff options and reasonably priced high-speed internet services, which helped it increase its market share.
7. Effect of Losses: BSNL suffered significant losses that hurt its position in the market and competitiveness, underscoring the difficulty of adjusting to changes in consumer preferences and industry trends.
8. Operational Efficiency: Reliance Jio's superior position in the market can be attributed to its operational efficiency, which is demonstrated by its greater profitability indicators and asset utilisation.
9. Competitive Landscape: By utilising its technology advancements and pricing tactics, Jio not only engaged in intense competition with BSNL but also with other significant telecom operators like Bharti Airtel, Vodafone Idea, and MTNL.
10. Strategic Advantage: In sharp contrast to BSNL's financial difficulties and dwindling market share, the results highlighted Jio's strategic advantages in terms of financial performance, liquidity, and investor trust.

VIII. CONCLUSION

Reliance Jio and BSNL, two leading players in the Indian telecom landscape, present a contrasting picture in terms of financial performance. While Reliance Jio, a relatively young entrant, has established itself as a dominant force with consistent profitability and revenue growth, BSNL, a state-owned company, faces challenges in turning around its financial situation. Reliance Jio's aggressive market entry strategy, coupled with innovative data-centric plans, has attracted a massive subscriber base and translated into strong financial performance. BSNL, on the other hand, struggles with legacy infrastructure, debt burden, and a competitive environment. Looking ahead, BSNL's future hinges on successful government revival plans, infrastructure modernization, and strategic business decisions. Reliance Jio, meanwhile, must navigate a maturing market while exploring new avenues for growth and diversification. It remains to be seen how these contrasting trajectories will evolve, shaping the future of the Indian telecom industry.

A V Kuttimalu Amma, An Unsung Heroineof Indian Freedom Movement

Dr..Tomina NS, Assistant Professor, Department. of Teacher Education, Holy Cross College, Agartala, Tripura.

INTRODUCTION

India's struggle for freedom is enriched by the remarkable and inspiring contributions of women. The nation has witnessed countless unsung heroines who selflessly dedicated their time and energy – volunteering, campaigning, protesting, fasting, and donating - to the cause of independence. Among them was A. V. Kuttimalu Amma, a prominent freedom fighter from the Malabar region of present-day Kerala. She was not only an ardent fighter for the nation's freedom but also a devoted social worker who worked relentlessly for the upliftment of women who were oppressed and the marginalized communities. Her active involvement spanned various social and political movements, including the Mahila Sangh and the Swadeshi movement. Her unwavering determination was evident as she continued to participate in the freedom struggle with the same zeal, even after being incarcerated multiple times during her political career. In spite of her very ordinary family background, she played a key role in awakening women for the freedom movement and driving social reform and promoting women's empowerment. This article focuses on her life and extra ordinary contributions to both freedom struggle and the socio-political transformation of India.

Personal Life of Kuttimalu Amma and Entry into the Freedom Movement

Kuttimalu Amma was born in a very ordinary family on 23rd April 1905, in the distinguished AnakkaraVadakkathu family in Anakkara village of Palakkad District, Kerala.[1] Perumbalavil Govinda Menon and Madhaviyamma were her parents.[2]Her formal education was only up to class six but she was well versed in multiple languages and could give public speeches in

[1] http://cmsadmin.amritmahotsav.nic.in/unsung-heroes-detail.htm?s455; converted PDF, accessed on 14 August 2025

[2]https://en.wikipedia.org/wiki/A._V._Kuttimalu_Amma#:~:text=She%20was%20married%20to%20Kozhipurath,Malabar%20region%20in%20Madras%20presidency; accessed on 14 August 2025.

English, Tamil, Malayalam, Telengu and Kannada.[3] She grew up hearing stories about great personalities like Gandhiji, Sarojini Naidu and other great leaders who inspired her greatly. This created a passion in her to fight for the country and to be a part of national freedom movement. This ambition could actualise only after her marriage with Kozhippurath Madhava Menon the then Kerala Pradesh Committee member and the minister of Madras state. He gave immense support to her who was also actively involved in social activities other than being the minister of a state. Their marriage was not just a union of two individuals but a partnership dedicated to the country and the Indian National Congress. They had four children. Among them one served in Indian Army and retired as a Colonel.

Kuttimalu Amma was deeply connected to the party and shared a close relationship with the Gandhi family that she enjoyed the privilege of addressing Indira Gandhi affectionately as "Indu".[4] She "became a public activist in 1926 when Gandhiji visited Kerala as part of campaign for the upliftment of the Harijans."[5] They gave more importance to social life than family life and dreamt of an independent nation. She spent five years of her life in jail for the freedom struggle and learnt multiple languages from her fellow jail inmates. She dedicated her life for social services and humanitarian activities in independent India until her death on 14th April 1985.

Life as a Freedom fighter

Kuttimalu Amma proved herself to be a woman of exceptional courage and determination during India's freedom struggle. She actively participated in the movement and faced imprisonment multiple times for the cause of independence. In 1932, she joined the Civil Disobedience Movement, leading a group of women while carrying her two-month-old daughter in her arms – a bold act that demonstrated her fearless spirit. Despite being incarcerated several times due to her deep political involvement, her dedication never wavered. At one point, when authorities refused to allow her to take her infant along during an arrest, she firmly quoted significant laws and succeeded in getting her daughter with her. This act of defiance inspired many other women to step forward and contribute to the freedom movement.

[3]https://www.mathrubhumi.com/special-pages/mathrubhumi-100-years/articles/story-of-av-kuttimalu-amma-mathrubhumi-100-years-1.7795465; accessed on 23 August 2025
[4]https://www.mathrubhumi.com/special-pages/mathrubhumi-100-years/articles/story-of-av-kuttimalu-amma-mathrubhumi-100-years-1.7795465; accessed on 2025
[5]https://nitandhra.ac.in/main/Announcements/2022/akam/3.%20Revised%203.A.%20V.%20Kuttimalu%20Amma-converted.pdf; accessed 14 August 2025.

In 1940, when Mahatma Gandhi launched the individual Satyagraha, she played a leading role in organizing and motivating people, sending shock waves across the nation. On one occasion, while addressing a public gathering at Chavayur, the British authorities arrested her and sentenced her to one year of imprisonment for her relentless efforts toward India's Independence. In 1942, KuttimaluAmma was arrested again and imprisoned for two years for her active participation in the Quit India Movement. Soon after her release in 1944, she volunteered to take part in *Delhi Chalo* strike, where she and many other *satayagrahis* were arrested once more, demonstrating her unwavering commitment to the freedom struggle.[6]

Role of Gandhiji in Entry of Kuttimalu Amma in Freedom Movement

The Gandhian ideology on women's role in society inspired many women and encouraged them to take part in the freedom struggle. According to Gandhiji, women are 'pure, firm and self-controlled', 'self-reliant', and upholders of 'superior moral courage'.[7]His ideological emphasis on non-violence (pure, firm and self-control), self-reliance, and moral strength were inherent virtues of women, and that attracted many women and Kuttimalu Amma to join the national movement of freedom struggle.

At the time when Indian National Congress was formed, women's involvement in freedom struggle was minimal and mostly symbolic, though the membership was open for all from the beginning. However, Gandhian ideology changed this scenario by motivating women from all walks of life regardless of caste, creed, religion or colour, to participate actively. Gandhiji recognized the immense potential of women and inspired them to step forward, not only as supporters but as active participants in public life and the national movement. This approach empowered women to realize their inner strength and contribute significantly to India's independence struggle. A remarkable change occurred from the Civil Disobedience Movement in 1930 when Kuttimalu Amma along with many other women, organized protests by boycotting British Goods, breaking colonial laws and refusing to pay taxes. Until then, only women from elite families or party leadership circles had taken part in the movement

[6]https://indianculture.gov.in/node/2794864 discover culture from archives libraries and museums of India; accessed on 23.8.2025
[7]Mahima S. Acttuthan, "Gandhi on the role of women in freedom struggle", Article on and by Mahatma Gandhi, https://share.google/OuV6QfwZX13QuoyOa.; accessed on 21.08.2025.

openly, but Gandhiji's vision brought widespread female participation into the mainstream of the freedom struggle.[8]

Political Life of Kuttimalu Amma

The motive behind her freedom struggle urged her to be part of active politics and he involve in various levels of political movements. She was one of the founding members of All Kerala Women's League and Women's Indian Association and All India Women's Conference. She was also a member of All India Congress Committee, the Congress Working Committee and All Kerala Pradesh Congress Committee of which later she became the president. In those days it was very uncommon for a woman to contest in elections for the legislative assembly, when she won the election and served as Madras Legislative assembly twice in 1937 and 1946. She was also the Municipal Councillor of Calicut at that time.

The women of Malabar in Kerala for the first time participated in the freedom fight directly under the leadership of Kuttimalu Amma. She was then an active member of the Mahila Sangh in Calicut. Followed by the civil disobedience movement leader like Sardar Vallabhghai Patel and Pandit Madan Mohan Malviya along with many other activists were arrested. It directed to the observance of an 'All-India Political Sufferers' Day 'on 15th August 1930. Under the able leadership of Kuttimalu Amma, the Mahila Sangh attracted many to join this movement and became part of National freedom struggle directly by Mahila Sangh.[9] Her works were basically centered in Calicut where she encouraged other women to boycott foreign goods especially cloths and wear khadhi. As Swadeshi worker, she led the women to picket shop that were selling foreign goods.[10]

Women of Malabar entered political life with non-co-operation movement under the co-ordination of Kuttimalu Amma. It was not only women of Malabar participated in freedom movement, but also women from Travancore and Cochin also followed them. Amma was a strong inspiration for many notable women like Miss. Kallan and Makkapuzha Karthiayani

[8]https://www.nextias.com/blog/civil-disobedience-movement/#:~:text=The%20Civil%20Disobedience%20Movement%2C%20launched,and%20refusing%20to%20pay%20taxes., "Civil Disobedience Movement (CDM): Causes, Impact and Limitations", By NEXT IAS contributors; accessed on 21 August 2025.
[9]https://Indianculture.gov.in/node/2794864, "Indian Culture: A V Kuttimalu Amma", as accessed on 14 August 2025.
[10]"Indian Culture: A V Kuttimalu Amma", as accessed on 14 August 2025.

Amma, they were also from strong political families which was easy for them to follow the footsteps of Amma.

Kuttimalu Amma as a Social Reformer

Malabar became part of British Empire politically by the 1790s. Since then, it experienced significant interference from foreign powers through invasion and dominance. During the 19th Century, Malabar was marked by a rigid hierarchical order deeply affected by casteism, untouchability, and restricted access to public property and public places.[11] Education was limited exclusively to the elite class, while women were strictly forbidden from receiving education or participating in any socio-political activities. In such a challenging social environment, the entry of Kuttimalu Amma into public life brought a wave of social awakening and inspired ordinary people to challenge these oppressive norms.[12]

Her political involvement also has a social remark. In 1930,Kuttimalu Amma volunteered to be part of Gandhiji's Swadeshi Movement to promote Khadi against the foreign clothes along with the other social workers and became a popular figure among the public.[13] She encouraged and motivated women from every walk of life to participate in the freedom struggle. As philanthropist, she set up many orphanages, home for the destitute and juvenile homes for the young delinquents. Till today she is remembered for the efforts such as opening charitable institutions for the needy and downtrodden. Kuttimalu Amma's work was deeply appreciated by Gandhiji, Nehru and C Rajagopalachari and many other politically renowned people of the time.[14]

Kuttimalu Amma as a Humanitarian Activist

For Amma political life and social life were two wheels of the same cart. She was not only involved in freedom movement alone but was also concerned about the social problems as well. She wanted to work for the poor and the downtrodden people of the society. In her political life she was lovingly known as 'Oppa' by everyone including her husband and

[11]https://images.liverpoolmuseums.org.uk/2021-02/Dr%20CH%20Jayasree%20case%20study.pdf accessed on 23 August 2025
[12]https://indianculture.gov.in/node/2794864#:~:text=This%20was%20the%20first%20time,selling%20foreign%20cloth%20in%20Calicut.as accessed on 23 August 2025
[13]https://indianculture.gov.in/node/2794864#:~:text=This%20was%20the%20first%20time,selling%20foreign%20cloth%20in%20Calicut.as accessed on 23 August 2025
[14]https://www.veethi.com/india-people/a._v._kuttimalu_amma-profile-8721-30.htmaccessed on 23 August 2025

children.[15] In the field of social work, she was called 'Amma' by many. It was her daily routine to serve the poor and the needy. She found a Poor Homes society for the orphans at West Hill, in Kozhikode of present-day Kerala in 1937 and was the president of it till her death. She took care of the needs of the children in poor home and gave them education and other necessary needs.

Establishment of Orphanages

In pre-Independence era, orphanages were not common in Malabar and adjoining places. The establishment of homes for the poor were merely an accidental coincident and the social mentality of KN Kurup and Amma.[16]KN Kurup at that time was an employee in a British ship company. He happened to see a homeless old man suffering in the street and he felt pity for that sick and dying person. Kurup shared his mental agony with Amma who a likeminded person like him was. The service mentality of Kuttimalu Amma and the work efficiency of Kurup paved the way for the foundation of "Poor Home Society".[17] The institution began with just three orphan children but later it turned out to be a major centre for the poor and the homeless. While she stayed in Madras, Amma visited many other orphanages and social service centres in and around the city and the experience she helped her to manage the Poor Home Society efficiently. Poor Home Society gained the popularity of one of the best managed institutions of the time. Separate arrangements were made for men, women and children. Most of the inmates of Poor Home Society were homeless, sick and dying, destitute, blind, crippled and people with psychological or mental problems. Amma collected food, medicine, clothes and other necessary items for the inmates from generous people. Among the most charitable people was Jamnalal Bajaj whose generosity helped the society to grew gradually wide and large. In the year 1930-40 Amma started working for the lepers. In those days leprosy was considered as a social evil. Neither the government nor the society paid any attention toward the lepers. So Amma decided to rehabilitate them. In this regard she approached Mission Leprosy Hospital which had been working for the purpose of taking care of lepers but later they extended a great helping hand. This initiative was not easily accepted

[15]https://www.mathrubhumi.com/special-pages/mathrubhumi-100-years/articles/story-of-av-kuttimalu-amma-mathrubhumi-100-years-1.7795465Beena Govind A.V Kuttimalu Amma- Mathrurajyathinteyum 'mathrubhumiyudeyum Sevika (Servant of Motherland and Motherearth); accessed on 24 August 2025

[16]Col. A.V. Achuthan, "Ente Amma Ellavaruteyum Oppa", (Mal.), Mathrubhumi converted PDF; accessed on 23 February 2024

[17]https://www.mathrubhumi.com/special-pages/mathrubhumi-100-years/articles/story-of-av-kuttimalu-amma-mathrubhumi-100-years-1.7795465 Beena GovindA.V Kuttimalu Amma- Mathrurajyathinteyum 'mathrubhumiyudeyum Sevika (Servant of Motherland and Motherearth); accessed on 24 August 2025

by the people around and they protested against the mission. So later on, the hospital had to be shifted to Chevayur a place donated Abu Baker in memory of his father-in-law and named it S.M.M Koya leprosy home.[18]

Amma and her husband tirelessly worked to eliminate begging in Calicut. They have decided to give a coin as alms only once in a week. The beggers were taken to Poor Home Society compulsorily and were taken good care of them. However, Amma couldn't bring an end to begging completely. Children who were convicted with petty crimes were sent either to aMadrass or Vellore in TamilNadu or to Ranigunda in Andrapradesh separating them from general public for their rehabilitation so that they could re-enter the society as renewed human beings who could be a productive member of the society. Sait Nagjee Purushotham at Vallimadukkunnu donated 25 acres of land along with buildings were given for the rehabilitation of Juveniles.

Work for Juveniles

Kuttimalu Amma was not just a freedom fighter but also was a committed and dedicated social worker who wanted to bring radical changes in the society. She worked tirelessly for the women and children through various social service organizations.[19] She opened Juvenile homes and named as Balamandiram managed by Orphanage Samajam for children which was also the brainchild of Amma. More than one thousand children experienced the love and care of her. In all these social activities Amma received a helping hand from Parukutty who was her contemporary. In spite of her busy schedule Amma found time for visiting hospitals and orphanages to extend her helping hand. Seeing the tireless work and enthusiasm the government entrusted Amma the responsibility of other 'Poor homes' as well. Juveniles from all round the state were brought to Amma for her care. She wanted them to go back to the society as productive citizens who would contribute positively for the growth of the society. Amma's love and care won many hearts. Children at Poor Homes would wait for her visit because her motherly presence brought changes in their lives, who were caught as thieves, pick pocketers and involved in anti-social activities. Amma was greatly impressed and inspired by a catholic priest Kuriakose Elias Chavara who started "Pidiyari" or handful rice

[18]https://www.mathrubhumi.com/special-pages/mathrubhumi-100-years/articles/story-of-av-kuttimalu-amma-mathrubhumi-100-years-1.7795465; accessed on 24 August 2025
[19]https://www.academia.edu/143448805/Women_Social_Reformers_of_Kerala_A_V_Kuttimalu_Amma; accessed on 24 August 2025

meant for the poor and asked the women to continue contributing for the noble cause of helping the needy and the poor.[20]

Conclusion

The legacy of Kuttimalu Amma is a shining example of how determination and courage can overcome the barriers of tradition and oppression. Her life and work shattered traditional gender roles and proved that women could be powerful leaders in the fight for justice and freedom. Fearless participation in public protests, repeated imprisonments, and her leadership in mobilizing women made her a key figure in the national movement. She stands as a symbol of courage, sacrifice, and patriotism, inspiring generations to come. The unwavering spirit and active role in India's freedom struggle not only contributed to the independence of the nation but also paved the way for women's empowerment in modern India. The quote attributed to Mahatma Gandhi highlights that "When the history of India's fight for Independence, comes to be written, the sacrifice made by the women of India will occupy the foremost place."[21] In contrast, the contributions of such brave women have not been widely acknowledged. Those unsung heroines of history are supposed to be the true beacon of hope and inspiration in the annals of history. The study of life and contributions of A. V. Kuttimalu Amma reveals her enduring role as a source of hope and inspiration across generations.

[20]https://en.wikipedia.org/wiki/Kuriakose_Elias_Chavara accessed on 23 August 2025
[21]https://www.studymode.com/essays/Role-Of-Women-In-India-Freedom-707145.html?utm_source=chatgpt.com; cited on 21 August 2025.

Bibliography

1. https://indianculture.gov.in/node/2794864#:~:text=This%20was%20the%20first%20time,selling%20foreign%20cloth%20in%20Calicut.

2. https://www.inuth.com/india/women-freedom-fighters-of-india/how-av-kuttimalu-amma-fought-the-british-with-her-two-month-old-daughter-in-arms/

3. https://shodhganga.inflibnet.ac.in/bitstream/10603/13233/8/08_chapter%202.pdf

4. http://ir.amu.ac.in/5389/1/T%207399.pdf

5. https://testbook.com/question-answer/who-among-the-following-is-a-prominent-leader-of-t--655712a01c1e413c161284ce

6. https://shodhganga.inflibnet.ac.in/jspui/bitstream/10603/13233/11/11_conclusion.pdf

7. https://shodhganga.inflibnet.ac.in/jspui/bitstream/10603/20724/10/10_chapter%204.pdf

8. https://nitandhra.ac.in/main/Announcements/2022/akam/3.%20Revised%203.A.%20V.%20Kuttimalu%20Amma-converted.pdf

9. https://www.mathrubhumi.com/special-pages/mathrubhumi-100-years/articles/story-of-av-kuttimalu-amma-mathrubhumi-100-years-1.7795465

10. https://www.studymode.com/essays/Role-Of-Women-In-India-Freedom-707145

11. https://www.veethi.com/india-people/a._v._kuttimalu_amma-profile-8721-30.htm

12. https://www.academia.edu/143448805/Women_Social_Reformers_of_Kerala_A_V_Kuttimalu_Amma

13. https://en.wikipedia.org/wiki/Kuriakose_Elias_Chavara

Exploring the Significance of Micromorphological Studies in Plant Science

Dr. Somnath Kar, Assistant Professor, Department of Botany, Holy Cross College, Agartala

Abstract

To comprehend the complex structures and properties of plant tissues at the microscopic level, micromorphological research on plants is essential. The investigations provide useful insights into several elements of plant biology, including taxonomy, phylogeny, ecology, and therapeutic characteristics. Researchers may determine taxonomic relationships, reliably identify plant species, and infer evolutionary connections among taxa by studying micromorphological characteristics such as leaf epidermal patterns, trichome morphology, stomatal arrangements, pollen morphology, and seed coat traits. Micromorphological studies are crucial for understanding how plants adapt to various environmental situations such as drought, salt, and temperature stress, enhancing our knowledge of plant ecology and conservation. Micromorphological investigations are important in fundamental plant research and have practical implications in numerous sectors. Examining plant fragments at a microscopic level in medicinal plant research helps verify and manage herbal medicines' quality, ensuring their safety and effectiveness. Micromorphological studies of medicinal plants aid in identifying new bioactive chemicals and advancing the creation of medications. Micromorphological leaf features have been used in systematic studies for several taxonomic groupings to enhance plant classifications and comprehend the evolutionary lineage of plants.

Keywords: Micromorphology, Epidermal anatomy, Implications, Plants

Introduction

Understanding plants' complicated structures and properties at a microscopic level is of the utmost importance in plant science. Micromorphological studies provide a window into this tiny world and give essential insights into plant taxonomy, phylogeny, ecology, and therapeutic characteristics (Ohikhena et al., 2017). Micromorphological studies offer a glimpse into this realm.

Micromorphological investigations include the analysis of minute aspects of plant tissues, which often necessitates the use of sophisticated microscopy methods such as transmission electron microscopy (TEM) and scanning electron microscopy (SEM) (Yigit, 2016). These investigations allow researchers to investigate a wide variety of micromorphological characteristics, such as the patterns of the leaf epidermis, the morphology of the trichomes, the arrangements of the stomata, the morphology of the pollen, and the characteristics of the seed coat. Researchers can determine taxonomic connections, reliably identify plant species, and deduce evolutionary histories by examining these microscopic characteristics (Ohikhena et al., 2017).

Additionally, the value of micromorphological investigations goes beyond categorizing taxonomic groups. The findings of these investigations are used as vital resources in a wide range of scientific fields and practical applications. For instance, micromorphological characteristics have a significant role in the taxonomic description of species, which in turn helps with the identification and categorization of plants (Paul & Chowdhury, 2021). According to Doolabh et al. (2021), micromorphological exams are essential to medicinal plant research. These examinations contribute to the authentication of the plant, the quality control of the plant, and the introduction of bioactive chemicals.

In addition, investigations of micromorphology give information on the adaptation methods that plants use in response to various environmental situations, such as salt, temperature stress, and drought. To effectively handle the modern issues faced in agriculture and environmental conservation, it is vital to have a solid understanding of these adaptations (Lawal et al., 2021). In addition, investigating foliar micromorphology might reveal insights into sensory characteristics like taste, scent, and colour, which may have significant uses in herbal medicine and culinary activities.

Importance of Micromorphological Studies:

A. Taxonomic Classification:

The structural characteristics of plant species may be better understood via the use of micromorphological investigations, which assist in the process of taxonomic categorization. It has been shown that micromorphological investigations are very useful in the field of plant taxonomy and systematics. These studies provide essential data for the identification and categorization of species. Sophisticated methods like scanning electron microscopy (SEM) are used in research to

conduct a thorough investigation of minute structures. These structures include seeds, trichomes (also known as plant hairs), and leaf surfaces (Song et al., 2022). For taxonomic reasons, seed micromorphology has been the subject of a significant amount of research. Cai et al. (2013) investigated the seed coat patterns of 24 different species of Impatiens that were native to China. They classified the seed coats as either reticulate or protrusive. ErdiñR and Ataşlar (2022) used scanning electron microscopy (SEM) to investigate the characteristics of seeds and leaves belonging to the genus Saponaria (Caryophyllaceae), therefore discovering taxonomically significant characteristics. There have been many different plant groupings that have been classified with the use of trichome micromorphology. SEM was used by Ali and Al-Hemaid (2011) to conduct a study of the trichome diversity in Cucurbitaceae, which provided insights into the taxonomic potential of these plants. The study of leaf micromorphology is beneficial for taxonomic reasons. The micromorphological characteristics of the leaves of Korean Piperales were reported by Song et al. (2020), which contributed to the categorization of these plants. There have been several micromorphological investigations carried out on different plant parts, such as petals, stamens, and fruits, which have been of assistance in the process of taxonomic delimitation. For example, Delpeuch et al. (2022) investigated the micromorphology of the petals and stamens of Ranunculus species, which contributed to the identification and categorization of these plants. To successfully resolve taxonomic complexity, it has been shown that integrating micromorphological data with genetic and morphological evidence is one efficient method. Micromorphological investigations of a variety of plant components, such as seeds, trichomes, leaves, petals, stamens, and fruits, have yielded essential taxonomic insights. These studies have contributed to the identification of species, the categorization of species, and the resolution of taxonomic problems. Conventional morphological and molecular techniques are supplemented by these investigations, which are often carried out using scanning electron microscopy (SEM), which has become a crucial instrument in contemporary plant systematics.

B. Medicinal Plant Identification:

To identify medicinal plants, micromorphological investigations are very necessary. These studies allow researchers to differentiate between various species and validate the therapeutic characteristics of the plants analysed. Micromorphological investigations have shown themselves to be very useful in the process of identifying and authenticating medicinal plants, as well as in maintaining quality control and avoiding adulteration. In these investigations, modern methods

such as scanning electron microscopy (SEM) are used to investigate minute features such as seeds, trichomes (also known as plant hairs), and leaf surfaces. When it comes to the identification and authenticity of medicinal plants, micromorphological investigations perform a very important role. Stomata, trichomes, crystals, and vascular bundles are some of the microscopic characteristics of plants that are being investigated in this research. These characteristics have the potential to serve as unique identifiers for various kinds of plants (Ohikhena et al., 2017). It is possible to differentiate between species that are closely related by using micromorphological characteristics, which are valid sources of taxonomic information. When it comes to the identification of powdered medicinal plant materials, where macroscopic characteristics may not be obvious, these investigations are very helpful (Song et al., 2020). It has been shown that micromorphological investigations of different plant features, such as seeds, trichomes, leaves, and pollen, have proved to be quite helpful in the identification and authenticity of medicinal plants (Lawal et al., 2021). The diagnostic characteristics that are provided by these investigations, which are often carried out with the assistance of scanning electron microscopy (SEM), help differentiate closely related species, avoid adulteration, and ensure the quality and safety of medicinal plant products. Through the combination of molecular and chemical studies with micromorphological data, it is possible to establish a complete approach to the identification of medicinal plants and the implementation of quality control measures.

C. Comparative Analysis:

Understanding evolutionary linkages and ecological adaptations is facilitated by the ability to compare various plant species via comparative foliar micromorphological investigations. Micromorphological investigations are essential for comparing plant species and groupings since they provide vital information on evolutionary connections, taxonomy boundaries, and biogeographical trends. Researchers may analyze small structures like seeds, trichomes, and leaf surfaces using scanning electron microscopy (SEM) to gather important data for comparison. The examples below demonstrate the importance of micromorphological investigations in comparative analysis.

Seed micromorphology is often used in comparative studies to reveal evolutionary connections and taxonomy distinctions. Seed micromorphology is the tiny composition of seeds that might provide an understanding of the genetic connections across several species in a family. Research has been conducted on mapping seed micromorphology to study the evolutionary links within the

family Papaveraceae, which includes the well-known floral species poppy. Song (2022) performed thorough research on seed micromorphology in Impatiens to classify them at the infrageneric level, analyzing 117 species. They identified distinct structural characteristics of the seeds that might aid in distinguishing between various taxonomic levels.

Various research has investigated the correlation between seed micromorphology, phylogenetics, and taxonomy in different groups of organisms. The research emphasizes the usefulness of seed micromorphology in enhancing our comprehension of species and subspecies relationships, leading to more precise taxonomies. Studying trichome micromorphology has helped in comparing different characteristics, identifying evolutionary patterns, and determining taxonomic relationships. Porto et al. (2010) used comparative trichome micromorphology to define species boundaries in the genus *Cissampelos*. Studying the microscopic structure of leaves has been useful for comparing different species, revealing insights into evolutionary trends and regional distributions. James et al. (2021) conducted a study comparing leaf micromorphological characteristics of Euphorbia species from the Niger Delta Region of Nigeria to gain an understanding of their evolutionary links and biogeographical patterns.

Studying pollen micromorphology has helped with comparative studies, enhancing our comprehension of evolutionary processes and biogeographical distributions. Tsymbalyuk et al. (2022) conducted a comparative analysis of pollen micromorphology in *Valeriana* species to gain an understanding of their evolutionary connections and likelihood of hybridization. Khan et al. (2022) used comparative pollen micromorphology to clarify the taxonomic relationships of some species within the genus *Ficus* from Pakistan. By combining micromorphological data with DNA and morphological evidence, thorough comparative studies have been made possible. Shipunov et al. (2021) integrated micromorphological, genetic, and morphological data to review the classification and evolutionary connections within the Plantagineae. Micromorphological investigations are essential for comparing and analyzing plant species and groupings to understand their evolutionary connections, taxonomy boundaries, and biogeographical patterns. Researchers may analyze micromorphological characteristics of seeds, trichomes, leaves, and pollen to reveal evolutionary patterns, recognize distinctive traits for taxonomic categorization, and understand the historical distribution of plant groupings. Integrating micromorphological data with genetic and morphological evidence has enhanced comprehensive comparative studies, leading to a more profound knowledge of plant variety and evolution.

D. Anatomical Responses to Environmental Factors:

Plant micromorphology and anatomy react to their surroundings, providing information on stress tolerance and adaptations. Microscopic studies have been very important in comprehending how plants anatomically react to many environmental variables such as drought, salt, temperature, and pollution. Researchers may use modern methods like scanning electron microscopy (SEM) to study small features like trichomes, stomata, and leaf surfaces to discover how plants adapt and modify their structures to survive in challenging environments.

Drought stress has been discovered to cause micromorphological alterations in plants. Karabourniotis et al. (2000) noted higher trichome density and changed trichome shape in Olea europaea leaves as a mechanism for drought resistance. Drought stress causes alterations in stomatal development, leading to a rise in stomatal density in leaves and stems (Hamanishi et al., 2012).

Stomata are tiny openings located on the surface of leaves that facilitate photosynthesis and the transfer of gases between the plant's internal and exterior surroundings. Trichomes are tiny hairs on leaf surfaces that help control water loss by influencing stomata density and conductance (Chen et al., 2022).

Researchers are now investigating the impact of trichomes on water use efficiency (WUE) in water stress circumstances. Galdon-Armero et al. (2018) found that increased trichome density enhances water use efficiency (WUE), particularly under situations of water constraint, via reducing stomatal conductivity. Shahzad et al. (2021) discovered that increasing trichome density in Pima cotton plants led to decreased leaf area and lower leaf temperature, ultimately resulting in greater yield.

Salinity stress induces micromorphological adaptations in plants. Salinity stress may restrict plant development by reducing transpiration and preventing water loss, a response triggered by the presence of tiny stomata in salt-tolerant plants (Srivastava, 2022). Moreover, salt-tolerant plants retain stomatal openings in their leaves suited to salinity (Atta et al., 2023). The absence of stomatal closure and stomatal conductance are signs of adaptation to salt stress (Darwish et al.,

2023). Salinity stress may cause morphometric changes in plants, aiding in their ability to withstand stress and thrive in unfavourable settings.

Extreme temperatures may cause micromorphological alterations in plants. Patel et al. (2021) discovered that changes in stomatal patterning in Arabidopsis thaliana leaves were associated with reduced productivity and higher water use. Trichome quantification methods in *Arabidopsis thaliana* have been established by Wang et al. (2021).

Air pollution has been discovered to trigger micromorphological reactions in plants. Bargagli (1998) states that using tree leaves as aggregate bio monitors of air pollution is very beneficial for the environment. The leaves act as receptors for air pollution and absorb or filter pollutants. However, there has been limited focus on studying the morphological and anatomical characteristics of plants as indicators of their response to changes in urban environmental quality. Morpho-anatomical alterations have been identified as effective methods for assessing urban air quality (EL-Khatib et al., 2011).

According to Kabata-Pendias & Pendias (2001), several studies have shown alterations in plants due to a wide range of environmental pollutants. Most of this research has focused on physiological adaptations. These are some of the secondary modifications that take place in leaves when they are subjected to air pollution (Rao and Dubey, 1991). Changes such as reduced stomatal and epidermal cell size, decreased frequency, cell wall thickening, alterations in epicuticular wax deposition, and chlorosis may also occur. Some scientists (Masuch et al., 1992) considered the leaf epidermis as a bioindicator of environmental quality. Srivastava (1999) noted that significant damage to the outer layer of leaves affected the overall development of plants. The study highlighted the importance of cuticles and epidermal traits in assessing the susceptibility of different species to environmental contaminants.

Exposure to heavy metal stress may induce micromorphological changes in plants, including alterations in trichome density, stomatal features, and leaf surface structure. This is supported by other investigations, such as the one carried out by Guo, et al. (2023) and the one by Maleci et al. (2013). The variations may be caused by changes in plant hormones like abscisic acid or the influence of heavy metals on cellular metabolic processes, impacting plant physiology, water status, and morphology.

Micromorphological research has offered vital insights into how plants anatomically respond to environmental conditions such as drought, salt, temperature extremes, air pollution, and heavy metals. Researchers may get insight into the adaptation processes used by plants to deal with environmental stress by studying structural alterations such as variations in trichome density and shape, stomatal features, and leaf surface micromorphology. The discoveries have consequences for plant stress resistance, ecological adjustment, and possible uses in phytoremediation and biomonitoring.

E. Disease Diagnosis:

Correlating leaf micro-morphological traits with disease severity index (DSI) helps in diagnosing and monitoring plant diseases, which in turn assists in disease control. Micromorphological investigations are useful for diagnosing plant diseases by revealing information about the causative organisms and how they infect plants. Researchers may identify certain plant infections by analyzing minute components such as trichomes, leaf surfaces, and reproductive organs using scanning electron microscopy (SEM) to observe diagnostic characteristics and patterns. Examining trichome micromorphology may help diagnose diseases since infections often infect or modify trichome structures. Ali and Al-Hemaid (2011) showed the importance of trichome micromorphology in Cucurbitaceae for taxonomy and disease diagnostics. Microscopic examination of leaf surfaces may uncover distinctive characteristics linked to plant diseases. Modifications in leaf surface structures, such as the presence of pathogen structures, changes in epidermal cells, or adjustments in stomatal patterns, might suggest certain illnesses (Maleci et al., 2013). Studying the micromorphology of reproductive organs may help diagnose disorders that impact flowers, fruits, or seeds. Pathogen structures, malformations, or anomalies in reproductive organs may help diagnose illnesses that affect plant reproduction (Demilie, 2024).

Combining micromorphological data with genetic approaches and standard diagnostic procedures may improve the precision and dependability of plant disease detection. Integrating micromorphological data with pathogen identification, symptom analysis, and illness distribution patterns may provide a thorough diagnosis method (Nazarov et al., 2020). Microscopic analysis of plant features such as trichomes, leaf surfaces, and reproductive organs provides important information for the precise identification of plant diseases. Micromorphological analyses can help differentiate between diseases, understand how infections occur, and enhance traditional diagnostic methods for comprehensive disease management by identifying specific pathogen

features and patterns. Micromorphological studies play a crucial role in botanical study by offering vital information for taxonomy, ecology, conservation, agriculture, and medicine.

Methodologies and Techniques involved in micromorphological studies of plants

Plant micromorphological studies use a variety of methods and approaches to investigate minute structures and characteristics at the microscopic level. The investigations provide important information about the morphological, ultrastructural, and histochemical features of plant tissues and organs. Key elements are:

a) Scanning Electron Microscopy (SEM) provides high-resolution images of surface features such as epidermal cells, trichomes, and stomata. This method enables researchers to examine small details, helping them comprehend the surface morphology and adaptations for tasks such as gas exchange and protection (Yiğit, 2016).
b) Transmission Electron Microscopy (TEM) offers in-depth analysis of the ultrastructure of plant cells, revealing details of organelles such as chloroplasts, mitochondria, and cell walls. Transmission electron microscopy (TEM) aids in understanding cellular activities and structural compositions by viewing cellular components at a nanoscale scale (Doolabh et al., 2021).
c) Histochemical techniques include staining cellular components or chemical substances to observe their spatial distribution in plant tissues. Histochemistry offers insights into metabolic activities, physiological processes, and tissue specialization by focusing on certain molecules (Doolabh et al., 2021).
d) Light microscopy allows for the observation of plant tissues at reduced magnifications. The text offers a summary of tissue architecture, cell arrangement, and developmental patterns, which aids in examining the overall morphological characteristics and structural arrangement (Ickert-Bond et al., 2018).
e) Pharmacognostic investigations aim to find pharmacologically active chemicals in plant tissues. Pharmacognostic studies use microscopic inspection methods to identify and describe bioactive chemicals that may have therapeutic qualities (Khan et al., 2020).

Micromorphological studies are essential for comprehending the links between plant shape and function, adaptation processes, and evolutionary patterns. These methods and techniques are often combined with different staining processes, chemical treatments, and image analysis software to improve the observation and measurement of tiny structural characteristics in plants.

Challenges and Future Directions IN Micromorphological studies of plants

Micromorphological studies of plants are essential for understanding the intricate structures and features at the microscopic level, providing insights into plant anatomy, physiology, evolution, and ecological interactions. However, these studies face various challenges and offer exciting future directions for researchers.

Challenges:

a) Standardization of Methods: There is a lack of standardized protocols across laboratories for sample preparation, staining techniques, and imaging procedures, leading to discrepancies and limitations in data interpretation (Yiğit, 2016).
b) Interpretation Complexity: Understanding the functional significance of micromorphological traits requires integration with ecological and physiological data, posing challenges in interpretation (Ohikhena et al., 2017).
c) Technological Limitations: Existing microscopy techniques may have limited resolution and imaging capabilities, hindering detailed observation of fine structures within plant tissues (DeLeo et al., 1997).
d) Environmental Influences: Micromorphological traits in plants can be influenced by environmental factors, necessitating comprehensive studies across diverse habitats and conditions for robust conclusions (De Sousa Araújo et al., 2016).

Future Directions:

a) Advancements in Imaging Technology: Continued development of imaging techniques such as confocal microscopy and cryo-electron microscopy can enhance resolution and

enable three-dimensional visualization of plant structures (Rodríguez-Santamaría et al., 2022).

b) Integration of Omics Approaches: Integration of micromorphological data with genomics, transcriptomics, and metabolomics can provide a holistic understanding of plant structures and functions (Zhang et al., 2020).
c) Big Data Analysis: Utilization of computational methods for large-scale data analysis can uncover patterns and associations in micromorphological traits, facilitating deeper insights (Yiğit, 2016).
d) Ecological Applications: Exploring micromorphological traits as indicators of plant responses to environmental change and adaptation strategies can provide valuable information for conservation and ecosystem management (De Sousa Araújo et al., 2016).
e) Taxonomic Descriptions: Detailed micromorphological studies can contribute to taxonomic descriptions and classifications, aiding in species identification and conservation efforts (Yiğit, 2016).
f) Phylogenetic Analyses: Integration of micromorphological data into phylogenetic analyses can elucidate evolutionary relationships among plant taxa, helping to refine evolutionary theories (Ohikhena et al., 2017).
g) Medicinal Plant Research: Micromorphological studies can assist in identifying pharmacologically active compounds within plant tissues, contributing to drug discovery and development (Yiğit, 2016).
h) Agricultural Applications: Understanding micromorphological adaptations of crops to environmental stressors can inform breeding programs aimed at developing resilient cultivars (De Sousa Araújo et al., 2016).
i) Educational Purposes: Micromorphological studies serve as valuable educational tools for students and researchers, fostering a deeper appreciation for plant diversity and biology (Ohikhena et al., 2017).
j) Conservation Biology: Micromorphological traits can be utilized as indicators of plant health and habitat quality, aiding in conservation assessments and management strategies (Rodríguez-Santamaría et al., 2022).
k) Environmental Monitoring: Monitoring micromorphological changes in response to environmental pollutants or climate change can provide early warning signs of ecosystem degradation and inform mitigation efforts (DeLeo et al., 1997).

l) These challenges and future directions highlight the multidisciplinary nature and immense potential of micromorphological studies in advancing our understanding of plant biology and ecology.

Conclusion

Microscopic studies of plants have been very important in several areas of plant biology, including taxonomy, systematics, medicinal plant research, and environmental studies. Researchers may use scanning electron microscopy (SEM) to analyze small structures like as seeds, trichomes, leaves, and reproductive organs to reveal diagnostic features, understand evolutionary connections, and explore plant adaptations and therapeutic qualities. Micromorphological data has helped classify and identify plant taxa, providing evidence to define species boundaries and resolve taxonomic challenges. The investigations have helped authenticate and standardize medicinal plant components, assuring quality control and safety in traditional medicine. Micromorphological examinations have uncovered adaptations and structural changes in plants in reaction to several environmental stressors including drought, salt, and pollution, providing insight into their resilience mechanisms. Studies conducted in vitro have used micromorphological methods to examine the growth and repair of plant structures in controlled environments, enhancing our knowledge of plant development. By combining micromorphological data with molecular, chemical, and classical morphological evidence, researchers may get a thorough knowledge of plant variety, evolution, and functional adaptations. With the advancement of micromorphological techniques, including enhanced imaging and quantitative analysis methods, these studies will become more important in tackling challenges in plant sciences like species identification, conservation, and sustainable agriculture.

GROWTH OF NATIONALISM IN THE PRINCELY STATES: A STUDY FROM GANDHIAN PERSPECTIVE.

Dr. Subhash Debnath, Assistant Professor, Department of History, Holy Cross College, Agartala

Abstract

During the colonial period, India mainly consisted of the provinces ruled by the British crown through their administrative machinery, i.e., viceroys, and princely states, which the British authorities referred to as Native States, ruled by the princes mostly independently. Though the princely states were recognised by the British crown as independent states and propagated a non-interference policy towards the princely states, virtually all of these states were ruled indirectly by the British. Although there was prolonged subjugation of the citizens in these states, people remained isolated from the mainstream of Indian nationalism for a long time. But with the passage of time, a wave of nationalism triggered in these states, and many of such states witnessed the incorporation of Gandhian ideology into their fight for self-determination.

Key words: Nationalism, western ideology, Colonial Subjugation, Gandhi, Symbolism, **Princely States/** Native States, Colonial Rule, Bulwarks of reaction, hegemony, Non-Cooperation Movement, Quit India Movement etc.

Introduction

The emergence of Indian nationalism is a multi-faceted phenomenon. Some called it a response to colonial rule. Some considered it an influence of western ideology, but at the same time, many scholars called it an impact of Indian culture and history that enabled Indians to fight against colonial subjugation. On the other hand scholar like Devajyoti, Biswas, & J.C. Ryan opined that ‘‘the nineteenth-century Indian nationalism implied two things: The construction of a cultural past and a political right to self- determination of the nation based on that past”[1]. However, it cannot be denied that Indian nationalism is the repercussion of colonial subjugation. People’s zeal to get independence from colonial bondage and repression was the viable force for the growth of Indian nationalism. Though the emergence of nationalism in colonial India is seen as a multi-faceted phenomenon, at the same time, the growth of political consciousness among the people living in those native

[1] Biswas, Devajyoti, &.Rya, J.C. (2022). *Nationalism in India Texts and Contexts*, Routledge, London. P. 2.

states cannot be seen as an isolated development. Unlike British India, a similar kind of socio-political subjugation was also experienced by the people of those native states. In such native states, the subjugation was in two ways: one was under direct repression under the Princes, and the second was under indirect control of British rule. Though the paper does not trace and elaborate on the concept of nationalism, it rather focuses on the emergence and growth of political consciousness for self-determination among the people of various princely states. In this regard, this paper tries to exemplify the development of national consciousness in various princely states within India during colonial times, as well as the role played by Gandhi and his political symbolism to nurture such consciousness among the people of different princely states.

Before analysing the emergence of nationalism among the people living in various princely states and the role played by Gandhi and his symbolism in this regard. This paper also makes an effort to critically understand the existing scholarship and literature on this subject. There is a good quantity of literature available on this subject. Bipan Chandra, in his book called 'India's Struggle for Independence extensively highlighted the emergence of a nationalist spirit among the subjects of princely states. He categorically highlighted the Congress's policy and its attitude towards Princely States politics. And how does it evolve from time to time? He also discussed how the political movements in different princely states changed with the beginning of the Gandhian era. There is another book called The People's Movement in the Princely States, edited by Y. Vaikuntham. Different chapters of the books speak about the circumstances in which the growth of nationalism in various princely states emerges. It also highlighted the active participation of women, peasants, and students in their political struggle against the princely authority as well as against the colonial regime. There are a few more books and articles, such as *The Indian Princes and Their States,* written by Barbara N. Ramusack, which basically projected a similar kind of history and background behind the growing discontent among the princely state and people's protest against the oppressive rule of their native princes While the existing scholarship speaks about the various phases of growth and development of the nationalist spirit among the state people, at the same time it speaks less about the impact of Gandhian politics and philosophy on cultivating the nationalist spirit among the native state people.

Thus, though there is a good quantity of literature available on this subject, there is still scope to study the growth of self-consciousness among the people living in various princely states under the guidance of Gandhian philosophy and practices. Therefore, the proposed paper is aimed at studying the development of nationalism in various native states from a Gandhian

perspective. It has also tried to trace the background and circumstances leading to the assimilation of the princely states people's movement into the mainstream of Indian nationalism.

Princely States and Imperial policy of association with them:

Before the advent of the British East India Company, most of the Indian subcontinent was directly ruled by numerous kings, Nawabs, independent Zaminders, and princes. Gradually, the British East India Company established its political hold in various parts of the country by annexing kingdoms until the great revolt of 1857. In this process, various princely states lost their independence and were gradually brought under direct colonial administration. During the colonial period, India mainly consisted of British India, which was directly ruled by the British Crown through the Viceroys and other administrative functionaries, and Princely States, which the British authority referred to as Native States ruled by the Native princes. Some of these states were very large, and some were small, with areas having mixed populations irrespective of caste, class, and religion. There were about 600 native states in India, ruled by Indian princes. After the revolt of 1857, these states were allowed to continue being ruled by the native princes. Though the princely states were recognised by the British crown as independent states and propagated for a non-interference policy towards their internal administration, virtually all of these areas were ruled indirectly by the British. In many such states, they have appointed British representatives such as political agents, residents, etc. An example can be drawn from many princely states, such as the princely state of Tripura, where a political agent was appointed in 1871 AD. These areas were ruled indirectly by the British through the princes themselves and through their political representatives. The Native States covered about one-third of India's territory and about one-fifth of India's population. The British direct annexation policy significantly shifted after the great revolt of 1957.

After the great revolt of 1857, the British authority was convinced that the native princes and the princely states could serve as great allies and supporters of the British government. Thus, the British had opted for a policy of preservation and a non-interference policy towards the internal matters of the princely states. Therefore, what we see is that loyalty was secured through honours, titles, money, and territories distributed lavishly in a series of vice regal durbars and the like. The common feature of all the princely states was that they accepted and recognised the paramount rule of the British government. In return, the British government affirmed their protection from external and internal threats. Many princes represented a

continuity of traditional state formation in India and remained autonomous rulers, exercising substantial authority and power within their states, until 1948[2]. The basic administrative features of all these princely states were authoritative. Most of the states had socio-economic and educational backwardness, where all civil liberties were curtailed by the states.

Moreover, to prevent the isolation of native states and any possible striving towards independence, the princes were integrated into British government institutions such as the Imperial Legislative Council (from 1861) and the Chamber of Princes, a consultative and advisory body that was set up in 1921 to counter increasing anti-British sentiments. Thus, a process of mutual cooperation and understanding took place between the British paramount ruler and the princes of different princely states.

Attitude of Princely states towards the growing Nationalism in their domain:

The basic administrative features of all the princely states were authoritarian and feudal in nature. The state people witnessed prolonged subjugation under the princes; they were debarred from a basic sense of liberty and mostly remained isolated from the mainstream of Indian political development for a long time. But with the passage of time, a wave of nationalism triggered in these states, and many of such states witnessed the incorporation of Gandhian ideology and practices into their fight for self-determination.

Although there were some enlightened rulers who adopted some liberal administrative policies, introduced reforms, and granted power for people's participation in state affairs, these features were very limited. Lakhiraj, Ruler of Rajkot, is an example of an enlightened ruler who introduced various reforms in administration. However, after his death, the state continued the authoritarian administration under his successors. Such examples of enlightened rule are very few.

To check the growing nationalism, under British influence, most of the native princes applied stiff resistance to prevent the growth of nationalism in their domain. As historian Bipan Chadra rightly pointed out, when the national movement was growing among the masses, British officers frequently instructed the princes of the various native states to watch and check the growth of the national movement. They were warned against expressing any

[2] Ramusack, Barbara N. (2004). *The Indian Princes and their States*, Cambridge University Press. P.2.

sympathy or extending any support to the national movement, as did the Maharaja of Baroda. Their activities relating to any kind of reform were under constant surveillance and often interfered with by British officers[3]. Thus, the colonial power used the native ruler as a tool to suppress any possible threat to their political and economic hegemony, and therefore the Native States were guaranteed their autocratic powers and backward mediaeval rule. Under stiff colonial control, these native states acted as 'bulwarks of reaction[4]' towards the growing patriotism in the princely states.

Congress and Gandhi's attitude towards the princely states

In the initial phase of Indian nationalism, both Gandhi and the Indian National Congress adopted the policy of non-intervention towards the princely states. The socio-political condition of the princely states was not on the mainstream agenda of Congress. Congress's attitude towards the cause of native states galvanised after the 1920s onwards. It was at the Nagpur session of the Indian National Congress in 1920 that the National Congress first made its policy towards native states clear when it adopted a resolution that called upon princes to give their states full responsibility for governance. During the Non-Cooperation Movement and thereafter under the Gandhian influence, it exerted a far greater influence upon the princely states; numerous local political organisations sprung up around this time. One such notable political organisation was the All India States' People's Conference (AISPC)[5] which came into being in 1927. Leaders like Maniklal Kothari, G.R. Abhayankar, and Balwantrai Mehta were some of the notable personnel behind the formation of this political organisation. A branch of INC was established in Hyderabad state in 1920, after the Nagpur session of the Indian National Congress.

"In 1920, for the first time, the Congress meeting for the annual session at Nagpur called on the princes to grant at once full responsible government in their States. But

[3] Chandra.Bipan,(1989). *Indias struggle for Independence*, New Delhi, Penguin. P. 355.
[4] Vaikuntham, Y (2004), People's movement in the princely states, Manohar.p. 25.
[5] In 1927 AISPC was founded to coordinate political activities in the princely states. AGGARWAL, J. C.. S. Chand's Simplified Course in Modern Indian History. India, S. Chand Limited, 2017. P.363. Initially Indian National Congress was hesitant to support and join the political activities of Princely states, but later on due to constant pressure from the princely states INC agreed to extend support and help the political movement of princely states. In 1939 Gandhi undertook a fast in the princely state of Rajkot to secure democratic rights to its people. Chopra, P. N.(2003). A Comprehensive History of India. India, Sterling Publishers, .P.265.

at the same time, the Congress resolutions made it clear that while people in the States (referred to as States' People) could become individual members of the Congress, they could not use the membership to interfere in the internal affairs of individual States. If they wished to do so it would have to be in their own individual capacity not in the name of the Indian National Congress. This applied to the British Indian members of the Congress as well."[6]

Though the National Congress was sympathetic towards the princely states and their political development, the Congress clarified that the princely states could not institute any political programmes in the name of the National Congress. On the other hand, they agreed and permitted any political movement and development to be carried out in the individual capacity of members or local political organisations.

A significant shift in the Congress policy of non-interference took place, especially after the Haripura Congress of 1938. People started organising themselves for the greater demand of better education, better health, better economic facilities, and more political rights. As early as 1939, Gandhi, in an interview, supported Congress's decision to not intervene in the internal affairs of princely states. He called it a perfect political policy because the people of these states had not yet become politically conscious. Gandhi opined, "The policy of non-intervention by the Congress was, in my opinion, a perfect piece of statesmanship when the people of the States were not awakened"[7].

During the Second World War, the Indian National Congress and Gandhi changed their outlook towards the native states. During the Ludhiana session of the All India States' People's Conference (AISPC) held in 1939, Jawaharlal Nehru was elected by its members as its president for the Ludhiana session, which effectively united the Princely States and British Indian freedom struggles together. On this matter, both Gandhi and the Congress changed their positions and agreed upon such unification for the country's political emancipation.

Influence of Gandhi and Gandhi an symbols

Mahatma Gandhi's presence in the political sphere in 1915 had a drastic impact on the freedom struggle in India. His dramatic appearance in the socio-political scenario changed

[6] Chandra. B, Amales Tripathi and Barun De. (2011) *Freedom Struggle*, National Book Trust-New Delhi, pp. 191-192.
[7] Gandhi, M. K. (1999). *The Collected Works of Mahatma Gandhi (Electronic Book)*, Vol.68. New Delhi: Publications Division Government of India, P.326

the tactics and methods of the freedom struggle in India. His ideas and practices received attention from all sections of society as well as from all parts of the country, which included the princely states as well. His thoughts and ideas had created a favourable condition for the inclusion of every section of society into the mainstream of Indian nationalism. In this manner, his political action through various symbols helped him connect the masses with his fight against colonial subjugation as well as the socio-political injustice that prevailed in India. Gopal Guru, in his article '*Gandhi's Power of Symbolism*' credited Gandhi for his effective uses of symbols and symbolic language, with an object to mobilise the masses against colonial subjugation as well as local configuration of power. His symbolic use of khadi and charkha had a massive impact on the nationalist mobilisation against the colonial power as well as against the feudal regime of native princes in various parts of the country.

Although the growth of nationalist spirit among the people of the princely states was very slow and steady, embargoes were imposed for all kinds of political activities of the state people. The feudal states impose severe punishment for any kind of sympathetic approach towards Indian nationalism and Gandhian ideology. Apart from that, in the absence of civil liberties, political organisation, and the Congress policy of non-intervention towards the princely states, the success of Gandhian methods for political action was limited in those states. The people were under constant surveillance by the feudal regime. Any political activities were brutally crushed by the state machinery. Even the projection of Gandhian symbols like Khadi and Charkha were banned in many princely states. Any sympathetic approach towards Gandhian ideology and nationalism was brutally repressed. Such a condition was reflected in Gandhi's own statement when he visited the princely state of Gwalior. Gandhi stated that he was shocked to see that there was no Khadi cloth or Swadeshi cloth. While investigating, he came to know that wearing a Gandhi topi or Khadi cap is strictly prohibited by the Maharaja of Gwalior. In this state, the non-cooperation movement is banned. Severe punishment is given for wearing Khadi cloth and keeping a charkha or spinning wheel, which is regarded as an offence [8].

Though the congress was reluctant towards the princely states, but the impact of national movement and Gandhian movement was so effective, that the British authority and the princely states were failed to check the rising wave of political awakening in the various princely states.[9] During the Non-Cooperation movement and Civil disobedience movement Spinning was widely popularise, prolonged lectures was organised to popularise Khadi.

[8] I Bid, Vol.24,P.69
[9] I Bid, pp-55-58

During the non-cooperation movement and civil disobedience movement, Gandhi's Charkha and spinning became very popular. People accepted Charkha as a potent symbol of political ideology and action against authoritarian rule. Prolonged lectures were organised in various princely states to promote and popularise Khadi. Gandhi's visit to various princely states like Hyderabad, Rajkot, etc. further accelerated the promotion of Khadi and Charkha. The idea of Swadeshi and boycott was widely practiced by the state people.

Many letters from Gandhi to Mirabehn suggest the growing nationalism and Gandhian thought in princely states like Kangra State, where the people adopted the Khadi and Charkha programmes as a part of their protest methods and adherence to Gandhian ideology. A similar example was portrayed by Gandhi in his writing, where a poet of Bhavanagar State, known as Prabhashankar Pattani, composed verses on the spinning wheel, Khadi, and Swaraj. Gandhi's call for Khadi and spinning was adopted in a small village in Bhavnagar State.[10]

Meanwhile, there are few princely states that recognise the importance of Gandhi's constructive programme as a potential force for economic growth and the eradication of poverty in their domain. Taking the example of Hyderabad and Mysore, where the princely authority urged the people to accept Khadi and Charkha work, by 1928, officials of princely states like Mysore and Hyderabad recognised the importance of Gandhi's Khadi mission. On one occasion, the Finance Minister of Hyderabad explained the importance of the Khadi movement in the following manner: He said that in old times, our widowed sisters, who had no other means of earning, used to support their family by spinning and sewing. He suggested to his audience that by popularising such means of livelihood, you will not only be able to economically support our people, especially women, but also help them from moral degradation by providing such supportive work for filling their spare time. The inference can be drawn from the speech of Finance Minister of Hyderabad which was narrated by Gandhi in his writing as **"**But the most important thing to which I wish to draw your attention is our home industries... For the sake of illustration, I would mention spinning and weaving. If they could be revived in our towns and villages, it would be a great achievement. Quite till the other day, spinning and weaving were commonly practised in our homes. Not only in the huts of the poor but also in the homes of the rich and well-to-do, young girls and their matrons used to utilize their leisure time by spinning; and a variety of things for household use, like carpets, sheets, coverlets, table-cloths, etc., were prepared out of the yarn thus spun.

[10] I Bid, vol-96, p-13

Respectable widows who had no other means of livelihood have used to support themselves and their children by spinning and sewing. By popularizing this occupation, you would not only augment the slender resources of the people but by providing them with useful work for filling their spare time and save them from falling a prey to many a temptation. I hope that the energetic officials of our Department will make a beginning in this direction this year. I shall carefully go through the next year's report to see how many of us have taken to this good work."[11] Though they publicly praised the Khadi mission, beneath that, they have continued their authoritarian rule. Moreover, some of the princely states maintained a good relationship with the Indian National Congress and Gandhi. Even some princes were in the good books of congressmen, and they even financially contributed to the local congress and allowed the state officials to attend the congress session. Princely States like Mysore, on its part, successfully created a favourable image for itself. Gandhi was invited as a state guest in Mysore, and when Gandhi visited him, the Maharaja appeared in khadi clothes and was seen spinning, which was most dear to Gandhi. A Khadi experimental centre was opened in the state of Mysore. Thus, Gandhi and the National Congress felt no cause against their rule. But the actual situation of the people behind such a facade was yet to be realised by the nationalist leaders. It was probably one of the factors behind the slow growth of a full-fledged movement in those states until the 1930s. From such a background, women leaders emerge in states like Hyderabad and Mysore. They took the Swadeshi vow, popularised Khadi and Charkha, called for boycotts of Maharaja's administration and foreign goods, and organised lectures. Gandhi's visit to Mysore further accelerated that development.

One of the fascinating events of colonial Indian history was the rapid entry of Indian women into nationalist politics, especially after the advent of Mahatma Gandhi into the mainstream of nationalist politics. Gandhi's call for women to play a greater role played a significant role in the mobilisation of women against oppressive rule. Gandhi deliberately evoked symbols like Ardha-Nari, Shakti, and Sita, which helped him bring the women folk into the mainstream of the Indian freedom struggle. They enthusiastically participated in the mass movement organised by the Indian National Congress and Mahatma Gandhi. Gandhi persuaded the women to take the Swadeshi vow and actively participate in his khadi mission by accepting spinning and wearing khadi. He asked women to emulate the virtue of Sita, who is characterised as a symbol of Swadeshi. The propagation of swadeshi caught the imagination of the people from various groups, including the princely states, and soon they

[11] I Bid, vol-43, p.421

took to spinning khadi. Wearing khadi became common among men and women all over the country. During Gandhi's visit to the princely state of Hyderabad, a special meeting with women was arranged at the Prem Theatre. An association under the chairmanship of Padmaja Naidu started immediately after the visit of Gandhi to propagate the use of Khadi and Swadeshi goods. More and more women, mostly from the backward communities, started working in the charkha factories. Along with the local leaders, women like Gyan Kumari Heda and others started working actively to propagate satyagraha. They tried to awaken the women of the state through Charkha Sangham. The political activities of the women of princely states, which were ignited through the Satyagraha movement, gained momentum in Quit India and played a significant role in the joining of princely domains in the Indian Union. A large number of women from various princely states actively participated in the anti-colonial struggle as well as against their princely authority.

In connection with the national movement, Rewa, a princely state, was a pioneer. As early as the twentieth century, the Congress movement gained prominence and made an impact on the Princely States of Rewa. During the non-cooperation movement, a few people from Baraundha, a state in Baghelkhand, visited Allahabad, where they got an opportunity to listen to the lectures of Pt. Matilal Nehru and other national leaders. Upon hearing the lectures about countries freedom struggles, they were so impressed. After returning, they formed the Congress at Baraundha in 1921.[12]

With the beginning of the August Movement of 1942, the Congress abandoned its policy of non-interference in the internal affairs of princely states and invited the state people to actively participate in the country's freedom struggle. Many rallies, protests, and Dharnas were organised at different places in various princely states, such as Rajkot, Jaipur, Patiala, Mysore, Hyderabad, Travancore, and Orissa. Some of the state people's movements, like Rajkot's Satyagraha and the Temple entry movement for untouchables in the state of Travancore, were supported and guided by Gandhi. The State Peoples Movement was organised by various political and non-political organisations such as the Arya Samaj, Hindu Mahasabha, Praja Mandal, Hyderabad State Congress, etc. During the protest, Swadeshi and boycott were widely promoted. Slogans such as 'Gandhi Ka Charkha Chalana Padega, Goron ko London Jana Padega' (Gandhiji's spinning wheel will have to be spun, while the Whites

[12] Siddiqui, A. U. (2004). *Indian Freedom Movement in Princely States of Vindhya Pradesh*. India, Northern Book Centre, p.64

will have to return to London) [13] were shouted during the movement and soon became popular throughout the state. During the Quit India Movement, a large number of students started protesting against the oppressive rule of the Mysore government; they dressed in Khadi, wore Gandhi caps, and carried the Tri-Colour national flag. In one such instance, the Satyagrahis forced the village patel of Mysore state, who was the symbol of state authority, to wear khadi dress.

The above discussion leads to the conclusion that Gandhian ideology and practices significantly influenced the transformation of the Indian nationalist struggle into a mass movement. His symbolic uses of various objects like Khadi and Charkha and his symbolic interpretation of Indian culture like Sita, RamRajya, etc. act as a potent weapon towards galvanising nationalist feeling among the mass population of India. The effectiveness of Gandhian symbolic acts is not limited to British India alone; these symbols were incorporated widely into the movement initiated in various princely states as well.

Conclusion: During colonial rule in India, the British government delicately erected an invisible wall between 'British India' and 'Princely India' by ruling the latter indirectly through hereditary princes, who were supposedly completely autonomous but subject to British suzerainty. Unlike in British India, the people of the native states were strictly controlled and monitored by both the native princes and the British government. On the other side, the Indian National Congress had, from the very beginning, followed a policy of non-interference in the affairs of the states, which Mahatma Gandhi also advocated. But despite this policy of non-interference, nationalism began to exert its influence on the states. The non-interference policy of Congress shifted after 1939, and the freedom struggle was extended to the state people as well. And in this regard, Gandhian charisma and his used symbols, i.e., Khadi and Charkha, Sita, etc., serve as a cornerstone towards crystallising nationalist spirit among the state people. Thus, the people of the states formally joined the struggle for Indian independence.

[13] Indian History Congress*, (2000). Transactions of the Indian History Congress, Volume 61, Issue. The University of California.* P.701.

In silico assessment of the antibacterial activity of β-carotene

Mr. Kanak Chakraborty, Assistant Professor, Department of Human Physiology, Holy Cross College, Agartala

Abstract

Staphylococcus aureus (*S. aureus*) is a versatile pathogen known for causing a spectrum of human infections, necessitating a deep understanding of its pathogenesis for effective intervention. Despite being part of human flora, *S. aureus* harbors virulence factors facilitating pathogenicity, including exotoxins, cell wall-associated proteins, and enzymes. Notably, its exotoxins play pivotal roles in various infections, disrupting host cell membranes and inducing inflammation. Moreover, *S. aureus* evades immune responses through proteins like protein A (Sortase A) and biofilm formation. The present study aimed to investigate the antimicrobial potential of β-carotene, a natural carotenoid, against *S. aureus*. Molecular docking results revealed that β-carotene has a good binding affinity to *S. aureus* Sortase A (SrtA), suggesting its potential as a SrtA inhibitor. These findings underscore β-carotene's antimicrobial efficacy and therapeutic potential against antibiotic-resistant bacteria, presenting promising alternatives to conventional antibiotics.

Keywords: Mango peel extract*, Staphylococcus aureus,* Molecular docking, Sortase A, Quercetin

1. INTRODUCTION

A multifaceted and aggressive pathogen, Staphylococcus aureus (*S. aureus*) can cause a wide range of human illnesses, from mild skin infections to devastating systemic disorders. It is essential to comprehend the pathophysiology of *S. aureus* infections to create efficient therapeutic and preventive measures. Gram-positive *S. aureus* bacteria frequently colonize healthy people's skin and mucous membranes. Even though *S. aureus* is a common component of human flora, it has a variety of virulence traits that allow it to spread illness in ideal circumstances. These virulence factors, which aid in adherence to host tissues, immune detection evasion, and the uptake of nutrients from the host environment, include cell wall-associated proteins, exotoxins, enzymes, and cell surface components. (Cheung *et al.*, 2014). A diverse

range of exotoxins, such as hemolysins, leukocidins, and superantigens, are produced by *S. aureus*, which is one of its primary virulence factors. Numerous *S. aureus* infections have these exotoxins at a critical stage in their development. One such toxin that *S. aureus* secretes is called alpha-toxin, and it has the ability to break host cell membranes, causing inflammation and tissue damage (Berube and Wardenburg, 2013). Moreover, *S. aureus* has a number of ways to elude host immunological reactions. The bacteria makes proteins such protein A, which attaches to the Fc region of immunoglobulins and prevents host immune cells from opsonizing and phagocytosing the particles (Foster *et al*., 2014). Additionally, *S. aureus* has the ability to create biofilms, which are organized bacterial communities covered in extracellular matrix and which shield antimicrobial drugs and host immune responses (Otto, 2018). Apart from its virulence factors, *S. aureus*'s pathogenicity is also influenced by its adaptability to various host conditions. Due to its ability to transition between several metabolic states, the bacteria may thrive and spread throughout the skin, respiratory system, and bloodstream, among other host niches (Thurlow *et al*., 2013). Because methicillin-resistant *S. aureus* (MRSA) and other antibiotic-resistant forms of the bacteria have emerged, *S. aureus* infections continue to pose a serious clinical issue despite advancements in medical research. Due to the serious threat that MRSA prevalence poses to public health, alternative therapeutic approaches such as the development of vaccinations and novel antimicrobial drugs that target important virulence factors are desperately needed (Tong *et al*., 2015). Bacterial infections remain a critical global health threat, causing significant mortality and morbidity. While introducing antibiotics and improved hygiene practices in the twentieth century initially reduced infection-related deaths, the emergence of antibiotic-resistant microorganisms has led to a resurgence of infections (Pimenta *et al.*, 2014). Recognizing the urgency for new therapeutic strategies, the World Health Organization highlights the reliance of 80% of the global population, especially in developing regions, on traditional plant-based remedies for primary healthcare (Sakkas and Papadopoulou, 2017). Natural carotenoids are well known for their anti-oxidant property and also shown to have antimicrobial and anticancer efficacy (Sinha *et al*.,2023). This manuscript aims to investigate the antimicrobial potential of β-carotene, a natural carotenoid against bacterial pathogens, offering sustainable alternatives to combat antibiotic resistance.

2. METHODS

Protein preparation

The AI-based modeled structure of *S. aureus* SrtA was fetched from AlphaFold data (AF-Q2FV99-F1) (Jumper *et al*., 2021), and optimization was done using UCSF Chimera (Pettersen *et al*., 2004).

Ligand preparation

The 3D conformer of the ligand β-carotene is downloaded from PubChem (PubChem CID: 5280489) and optimized in Avogadro.

Molecular docking

This study aims to elucidate the binding affinities of compounds like Beta-carotene, with Sortase A (SrtA) proteins of *S. aureus*. Docking analyses were conducted using Autodock v 4.2.6 (Hue *et al*., 2007) for the compound of interest. The receptor and target compounds were saved in pdbqt format after merging non-polar hydrogens. Molecular docking was executed within a grid box of dimensions 18 x 30 x 18 Å, necessitating the creation of grid boxes with specific dimensions and 0.3 Å spacing. Protein-ligand complex docking experiments adhered to the Lamarckian Genetic Algorithm (LGA) framework. The molecular docking trials were conducted, consisting of 50 solutions, a population size of 500, 2,500,000 evaluations, and a maximum generational number of 27, while maintaining default settings for all other parameters. Upon completion of the docking process, RMSD clustering maps were generated by re-clustering using clustering tolerances of 0.25, 0.50, and 1 to identify the optimal cluster with the lowest energy score and highest population.

Toxicity risk prediction

The risk of toxicity may be caused by the ligand molecule also predicted using OSIRIS property explorer (Sander *et al*., 2001).

3. RESULTS

Molecular docking

All the binding energy scores are calculated from the best cluster (95%) that falls within the lowest RMSD 0.25 Å. The β-carotene has a binding affinity with Srta ΔG – 7.0 kcal/mol, forming van der Waals interaction with Pro91, Thr93, Ala104, Glu105, Glu106, Leu169 and Arg197 residues and pi-pi interaction with Ala92, Pro94, Leu97 and Ala118 and pi-alkyl interactions with His120, Phe122, Tyr187 and Trp194 residues (Figure 1).

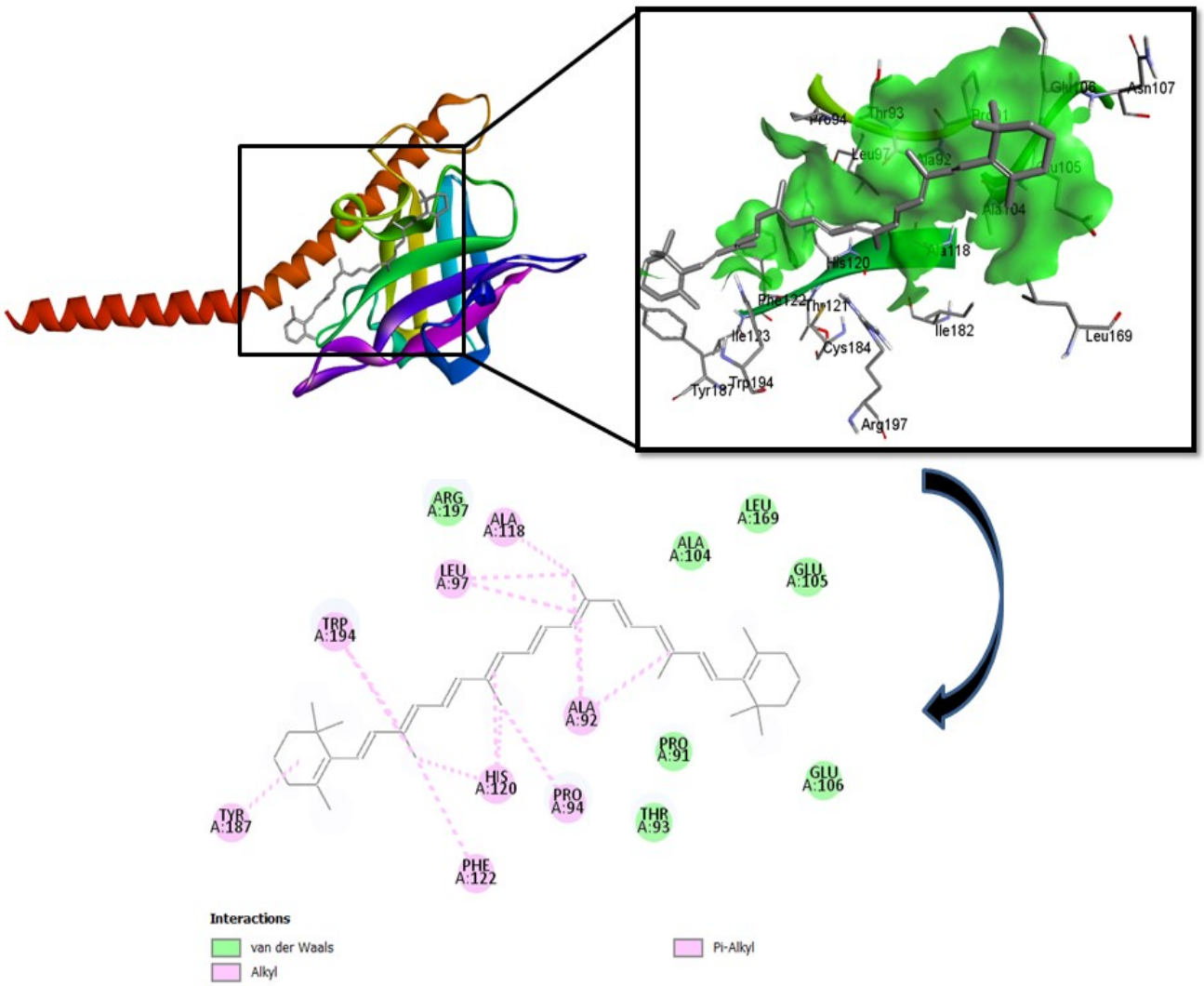


Figure 1: Docking pose of β-carotene with SrtA (left panel), the 3D surface of ligand binding cavity (upper right panel), and 2D interaction of quercetin with SrtA (lower left panel).

Toxicity risk prediction

The Ligand molecule β-carotene has no toxicity risk like mutagenicity, tumorigenicity, irritability, and reproductive impact on human as predicted by OSIRIS property explorer

4. DISCUSSION

New ways of making antibiotics include going after virulence by curtailing the production of toxins and the release of virulence factors, preventing bacteria from sticking to host cells and biofilm formation, halting or reducing down contact between bacteria, and diminishing virulence. In the fight against drug resistance, Sortase A inhibitors have been created as an option for traditional antibiotics. They work by stopping the harmful processes of a bacterial infection. Utilizing molecular docking methods, we discovered that β-carotene might be a new *S. aureus* sortase A inhibitor.

Carotenoids are crucial because they play a role in preventing the development of several diseases caused by damage from free radicals. Additionally, they have been found to have antibacterial properties (Sen *et al*., 2019). Carotenoid pigments are often obtained by humans from their food, primarily by consuming vegetables, fruits, and animal products. Carotenoids have the ability to act as antioxidants by neutralizing photosensitizers, reacting with singlet oxygen, and removing peroxy radicals (Frengova *et al*., 1994). Multiple studies have demonstrated that carotenoids possess antioxidant and antibacterial characteristics, making them potential therapeutic agents for combating many types of cancer and other disorders. The reference is from a study conducted by Kumaresan *et al*. in 2008 (Kumaresan *et al*.,2008).

In our *in silico* assessment, also we found that β-carotene can successfully interact with the key residues of SortA of *S. aureus* and may inhibit its activity. However, further *in vivo* study is required to establish the fact.

In essence, this study demonstrates that β-carotene has the capacity to effectively block *S. aureus* Sortase A, making it a suitable candidate for further research. Additionally, the study

confirms the strong antibacterial properties of *S. aureus*. These findings add to the increasing amount of research that supports the use of plant-derived chemicals as natural antibacterial agents, providing possible alternatives to traditional antibiotics.

5. CONCLUSION

In conclusion, the study underscores the evolving landscape of antibiotic development, emphasizing novel strategies targeting bacterial virulence and employing sortase A inhibitors as viable alternatives to conventional antibiotics. By elucidating the potential of β-carotene as a *S. aureus* sortase A inhibitor through molecular docking techniques, this research illuminates a promising avenue for combating bacterial infections in chronic wounds.

ACKNOWLEDGMENTS

We would like to thank the Principal of Holy Cross College for the infrastructural support. We would also like to thank the central library and R&D Cell of the college.

CONFLICT OF INTEREST

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Eminence of depression, anxiety, and stress among the college-going students of Tripura.

Dr. Ashish Kumar Singha, Assistant Professor, Department of Human Physiology, Holy Cross College, Agartala

Abstract: Academic stress is the most important cause of mental health problems in college going students both in Asian as well as western countries. It affects thoughts, feelings, and the behavior of a person. Though some amount of stress is necessary for motivation and improves performance, overstress causes negative effects. The aim of the study is to measure the levels of depression, anxiety, and stress among the college students of age group 19-23 years and predict the status of prevalence of these psychological disorders among the teenagers and young adults of Tripura. The study was performed on randomly selected 60 college students (30 female and 30 male students) of Holy Cross College, Agartala, Tripura; using DASS21 questionnaire as a standard scale for prediction. Results of the study shows that 22% of the students have severe depression, 42% of students have severe anxiety and 6% of students have severe stress. The prevalence of depression, anxiety, and stress were high among all the students, whereas prevalence of severe anxiety was significantly higher among the students. More studies are recommended to determine the factors leading to these mental disorders.

Keywords: Depression, anxiety, stress, Tripura, DASS21.

Introduction:

Mental health is one of the most important health indicators that causes considerable morbidity [1]. According to the World Health Organization (WHO) report in 2008, one every five adults experienced mental disorders in the past year and 29.2% had a history of mental illness during their lifetime. To improve mental health, WHO has developed an evidence-based mental health program for the years 2013-2020 [2].

Depression is a mood disorder which is characterized by short-term emotional responses to a serious health condition associated with impaired daily functioning accompanied by symptoms, such as sadness and frustration, feelings of guilt, insensibility, and loss of interest [3].

Depression is a common psychiatric disorder in the world, affecting more than 300 million people worldwide [4]. Anxiety disorders are defined as a group of mental disorders characterized by an unpleasant feeling with uneasiness or worry about future events or the fear of responding to current events. It may occur without an identifiable triggering stimulus [3]. In 2013, one out of every nine people in the world had at least one of the anxiety disorders [5;6]. In stress, a person's lack of compliance with environmental conditions leads to psychological and biological changes, and the person is at risk of becoming ill [7].

Nearly a quarter of adults in the United States have psychiatric disorders, and almost half of them experience at least one mental illness during their lives [8]. A systematic review and meta-analysis for global prevalence showed that the countries of Eastern Asia show an estimated one-year/lifetime prevalence less than other areas. The prevalence of one year among sub-Saharan African countries is low, while the highest lifetime prevalence was reported in Anglo-Celtic countries [9].

The prevalence of having mental disorder over the past 12 months among Iranian population aged 18-64 years in 2011 was 23.6%, followed by anxiety disorders (15.6%). Two thirds of the patients had moderate to severe mental disorders [10]. Recent findings indicated an increase in the prevalence of psychiatric disorders between 1999 and 2015 in Iranian adults [2]. There is a variation in the prevalence of mental disorders in different Iranian provinces and across various groups from 11.7% to 38.9%. It is necessary to conduct further studies on the general population and use validated inventories to monitor changes in the future [11;12].

Several studies reported the prevalence of mental disorders in Yazd province. However, estimations from previous studies demonstrated inconsistency in the prevalence of mental disorders, especially depression, reporting the highest prevalence of depression (54.3%) in Iran [13] and the lowest level of happiness among the Iranian provinces [14]. These differences may be due to non-representative sampling or using different inventories. Given that a large population-based study on psychiatric disorders has not been conducted in Yazd until now, such study was needed. Most similar studies were conducted on small groups of Yazd population, such as diabetic patients, college students, and truck drivers [15;13;14]. Comparison of findings with previous population-based studies may help health system managers to design and implement appropriate interventional strategies for health promotion.

The study aims to investigate the status of depression, anxiety and stress among the college-going students in Tripura using a highly approved questionnaire (DASS21) as a standard scale of measurement or prediction.

Materials and Methods:

Location of Survey: This survey has been conducted among the students at Holy Cross College, Agartala, Lembucherra, Tripura (West).

Period of survey: From May 2023 to June 2023.

Preparation of Questionnaire: Depression, Anxiety, and Stress Scale, commonly known as DASS21 questionnaire has been used as the standard scale of prediction for the study.

Population sampling: The age group of the population frame for the study was teenagers and young adults (college-going students) aged 19 to 23 years. 60 random individuals (30 female students and 30 male students) were selected as subjects.

Conduction of the Survey: Data were collected using a questionnaire named DASS21. DASS21 (Depression, Anxiety and Stress Scale) Questionnaire is a different, simple, and approved instrument for assessing depression, anxiety, and stress both in clinical settings and in the community [16;17]. The questionnaire has been elaborated and the questions along with their explanations has been circulated among the subjects through Google Forms as per the convenience of the subjects. The subjects are then asked to score the questions once their consent of participation in this survey is confirmed.

DASS21 is a short screening tool that measures depression, anxiety, and stress by a 21-item self-report questionnaire. For each disorder, seven questions are considered, and the final score is obtained by the total score of the questions related to it. Each question was scored using a Likert scale, ranging from 0 (did not apply to me at all/never) to three (applied to me very much, or most of the time/almost always). Higher scores indicated a higher level of disorder by a specific classification scoring. Individuals are classified as normal, mild, moderate, severe, and very severe based on their responses. Also, this tool can detect stress symptoms from depression and anxiety [18]. Comparing the results from DASS-21 with the diagnosis of psychiatric interviews showed the sensitivity and specificity of 75% to 89% for this tool and its potential for accurate screening of depression, anxiety, and stress [19;20].

Statistical Analysis: All the statistical analysis were done using Windows Microsoft Office Excel 2007.

DASS21

Name: Date:

Please read each statement and circle a number 0, 1, 2 or 3 which indicates how much the statement applied to you **over the past week.** There are no right or wrong answers. Do not spend too much time on any statement.

The rating scale is as follows:

0 Did not apply to me at all
1 Applied to me to some degree, or some of the time
2 Applied to me to a considerable degree or a good part of time
3 Applied to me very much or most of the time

1 (s)	I found it hard to wind down	0	1	2	3
2 (a)	I was aware of dryness of my mouth	0	1	2	3
3 (d)	I couldn't seem to experience any positive feeling at all	0	1	2	3
4 (a)	I experienced breathing difficulty (e.g. excessively rapid breathing, breathlessness in the absence of physical exertion)	0	1	2	3
5 (d)	I found it difficult to work up the initiative to do things	0	1	2	3
6 (s)	I tended to over-react to situations	0	1	2	3
7 (a)	I experienced trembling (e.g. in the hands)	0	1	2	3
8 (s)	I felt that I was using a lot of nervous energy	0	1	2	3
9 (a)	I was worried about situations in which I might panic and make a fool of myself	0	1	2	3
10 (d)	I felt that I had nothing to look forward to	0	1	2	3
11 (s)	I found myself getting agitated	0	1	2	3
12 (s)	I found it difficult to relax	0	1	2	3
13 (d)	I felt down-hearted and blue	0	1	2	3
14 (s)	I was intolerant of anything that kept me from getting on with what I was doing	0	1	2	3
15 (a)	I felt I was close to panic	0	1	2	3
16 (d)	I was unable to become enthusiastic about anything	0	1	2	3
17 (d)	I felt I wasn't worth much as a person	0	1	2	3
18 (s)	I felt that I was rather touchy	0	1	2	3
19 (a)	I was aware of the action of my heart in the absence of physical exertion (e.g. sense of heart rate increase, heart missing a beat)	0	1	2	3
20 (a)	I felt scared without any good reason	0	1	2	3
21 (d)	I felt that life was meaningless	0	1	2	3

DASS-21 Scoring Instructions

The DASS-21 should not be used to replace a face to face clinical interview. If you are experiencing significant emotional difficulties you should contact your GP for a referral to a qualified professional.

Depression, Anxiety and Stress Scale - 21 Items (DASS-21)

The Depression, Anxiety and Stress Scale - 21 Items (DASS-21) is a set of three self-report scales designed to measure the emotional states of depression, anxiety and stress.

Each of the three DASS-21 scales contains 7 items, divided into subscales with similar content. The depression scale assesses dysphoria, hopelessness, devaluation of life, self-deprecation, lack of interest / involvement, anhedonia and inertia. The anxiety scale assesses autonomic arousal, skeletal muscle effects, situational anxiety, and subjective experience of anxious affect. The stress scale is sensitive to levels of chronic non-specific arousal. It assesses difficulty relaxing, nervous arousal, and being easily upset / agitated, irritable / over-reactive and impatient. Scores for depression, anxiety and stress are calculated by summing the scores for the relevant items.

The DASS-21 is based on a dimensional rather than a categorical conception of psychological disorder. The assumption on which the DASS-21 development was based (and which was confirmed by the research data) is that the differences between the depression, anxiety and the stress experienced by normal subjects and clinical populations are essentially differences of degree. The DASS-21 therefore has no direct implications for the allocation of patients to discrete diagnostic categories postulated in classificatory systems such as the DSM and ICD.

Recommended cut-off scores for conventional severity labels (normal, moderate, severe) are as follows:

NB Scores on the DASS-21 will need to be multiplied by 2 to calculate the final score.

	Depression	Anxiety	Stress
Normal	0-9	0-7	0-14
Mild	10-13	8-9	15-18
Moderate	14-20	10-14	19-25
Severe	21-27	15-19	26-33
Extremely Severe	28+	20+	34+

Lovibond, S.H. & Lovibond, P.F. (1995). Manual for the Depression Anxiety & Stress Scales. (2nd Ed.)Sydney: Psychology Foundation.

Result and discussion:

According to the fall 2007 American College Health Association-National College Health Assessment [21], a national survey of approximately 20,500 college students on 39 campuses, 43.2% of the students reported "feeling so depressed it was difficult to function" at least once in the past 12 months. More than 3,200 university students reported being diagnosed as having depression, with 39.2% of those students diagnosed in the past 12 months, 24.2% currently in therapy for depression, and 35.8% taking antidepressant medication. Among the students surveyed, 10.3% admitted "seriously considering attempting suicide" within the past 12 months and 1.9% attempted suicide during that period.

Although the above data may seem surprising to some, it is not to most mental health clinicians and administrators at U.S. colleges. According to the 2008 National Survey of Counselling Centre Directors, 95% of respondents believe that there has been a trend in recent years of an increase in the number of students with serious psychological problems. In 2008 an estimated 26% of counselling centre clients were taking psychiatric medication, up from 20% in 2003, 17% in 2000, and 9% in 1994 [22]. And although the rate of suicide among college students may have decreased in recent decades, suicide remains the third leading cause of death among adolescents and young adults.

In my study, a total of 60 college students (30 female and 30 male) were randomly selected as subjects for the study. In total extremely severe depression, anxiety, and stress were found in 11, 19, and 3 (**Table-1, 2 and 3**) of the students in Holy Cross College, Agartala. Whereas the symptoms of the disorders were severe in 9, 6, and 15 within sample population, respectively. Moderate symptoms were present in 20, 13 and 13 of the students. On the other hand, 10, 9 and 15 of the subjects had mild symptoms of the disorders. Significantly out of all the students in total 10, 13 and 14 of the subjects were found normal and had no sign and symptoms of depression, stress or anxiety.

Levels of Depression	No. of Female Students	No. of Male Students	No. of Total Students Affected
Normal Depression	3	7	10
Mild Depression	8	4	10
Moderate Depression	12	8	20
Severe Depression	2	7	9
Extremely Severe Depression	5	6	11

Table-1: Total number of male and female students have the symptoms of different levels of depression (N=60).

Levels of Anxiety	No. of Female Students	No. of Male Students	No. of Total Students Affected
Normal Anxiety	5	8	13
Mild Anxiety	4	5	9
Moderate Anxiety	8	5	13
Severe Anxiety	4	2	6
Extremely Severe Anxiety	9	10	19

Table-2: Total number of male and female students have the symptoms of different levels of anxiety (N=60).

Levels of Stress	No. of Female Students	No. of Male Students	No. of Total Students Affected
Normal Stress	6	8	14
Mild Stress	7	8	15
Moderate Stress	8	5	13
Severe Stress	7	8	15
Extremely Severe Stress	1	2	3

Table-3: Total number of male and female students have the symptoms of different levels of stress (N=60).

The status of depression:

Kumar et al., in 2017 conducted a study on 830 valid respondents (students at higher secondary schools on Manipur) using DASS21 questionnaire as a standard scale and found out that the prevalence of depression among 830 students were 19.5% of them found extremely severe depressed. The study indicated a high prevalence of 80.5% students for symptoms of different degrees of depression [23]. Findings of previous studies performed all over the world also indicate a large proportion of adolescents having these psychiatric disorders [13;14;15;21;22]. Like the prevalence found in their study, the prevalence of depression 41.5% in a study conducted in Saudi Arabia [24] among secondary school girls. The prevalence of depression was higher among girls a finding which is seen in other studies.

The findings of this study indicate moderate depression symptoms are higher in female students; nearly 44% against 24% of male students. On the other hand, severe depression is very high in male students; 24% against 4% of female students. Extremely severe depression is slightly

high in male students; 24% against 20% in female students (**Table-4**). Whereas mild symptoms are higher in female students; 28% against 12% in male students. 10% of total students are normal.

Levels of Depression	Percentage of Female Students	Percentage of Male Students	Percentage of Total Students Affected
Normal Depression	4%	16%	10%
Mild Depression	28%	12%	20%
Moderate Depression	44%	24%	34%
Severe Depression	4%	24%	14%
Extremely Severe Depression	20%	24%	22%

Table-4: Percentage of male and female students have the symptoms of different levels of depression (N=60).

The prevalence of anxiety:

Mirzaei et al. in 2019 conducted a study on prevalence of anxiety among adult men and women of Yazd Province using DASS21 as a standard scale. In this study, a total of 9965 people participated [13]. The symptoms of anxiety were found in 32.2% of adult residents of Yazd Greater Area. The symptoms of the disorders were moderate to very severe in 20.2% of the population. The prevalence and severity of symptoms in older adults were significantly higher than the younger population. Also, 32.2% of the adults had symptoms of anxiety, which was more in women compared to men (41.9% vs 36.7%).

In this study, moderate anxiety symptoms are higher in female students; nearly 32% against 20% of male students. Severe anxiety is also slightly higher in female students; 16% against 8% of male students. However, extremely severe anxiety is slightly higher in male students; 44% against 40% in female students **(Table-5).** Mild symptoms are also slightly higher in male students; 8% against 4% in female students. 14% of total students are normal.

Levels of Anxiety	Percentage of Female Students	Percentage of Male Students	Percentage of Total Students Affected
Normal Anxiety	8%	20%	14%
Mild Anxiety	4%	8%	6%
Moderate Anxiety	32%	20%	26%
Severe Anxiety	16%	8%	12%
Extremely Severe Anxiety	40%	44%	42%

Table-5: Percentage of male and female students have the symptoms of different levels of depression (N=60).

The level of stress among the students:

Gamage and Herath, in 2021 conducted a cross-sectional study measuring levels of stress and associated factors amongst the undergraduate students in Sri Lanka using DASS21 questionnaire as a standard scale of prediction [25]. The study shows that stress within the distressed levels in the current sample are much less, as its 20%. However, this was further explored through their existing mental health conditions as they responded to a question asking them "have you ever suffered from a mental disorder?" The results showed that 22 (7.4%) males and 40 (5.5%) females answered they were suffering from a mental disorder. Furthermore, for the question asking them about taking medication for mental health problems there were 7 males (3.3%) and 9 females (2.0%) who answered that they are taking medicine for mental health problems. More study reveals that, women had 11.8% more stress than men. Moderate to severe intensity of stress was also significantly higher in women than men (40.9% vs 29.1%). Younger adults aged 20-29 years were more under stress than other age groups, and stress significantly decreased with increase in years of education.

Current study reveals that moderate stress symptoms are higher in female students; nearly 24% against 16% of male students. On the other hand, severe stress effects almost equal number of female and male students i.e. 28%. Extremely severe stress is slightly higher in male students; 8% against 4% of female students **(Table-6).** Whereas mild symptoms are slightly higher in female students; 20% against 16% in male students. 28% of total students are normal.

Levels of Anxiety	Percentage of Female Students	Percentage of Male Students	Percentage of Total Students Affected
Normal Stress	24%	32%	28%
Mild Stress	20%	16%	18%
Moderate Stress	24%	16%	20%
Severe Stress	28%	28%	28%
Extremely Severe Stress	4%	8%	6%

Table-6: Percentage of male and female students have the symptoms of different levels of depression (N=60).

Overall status of depression, anxiety and stress:

Previous research studies have indicated high prevalence of depression amongst new entrants compared to students in other years of study [26]. From a study conducted within a distance-learning University, it was shown that anxiety was a significant factor that influenced

students' academic performance [27]. This type of data provide directive to Researchers for conducting studies on psychological well-being of undergraduate students, so the outcomes will provide evidence-based data to develop interventions and improve their quality of life at university level [28]. Amongst the many studies conducted with university students on their psychological and mental health problems, few studies have examined psychological distress related to medical [29;30] and non-medical undergraduates [31].

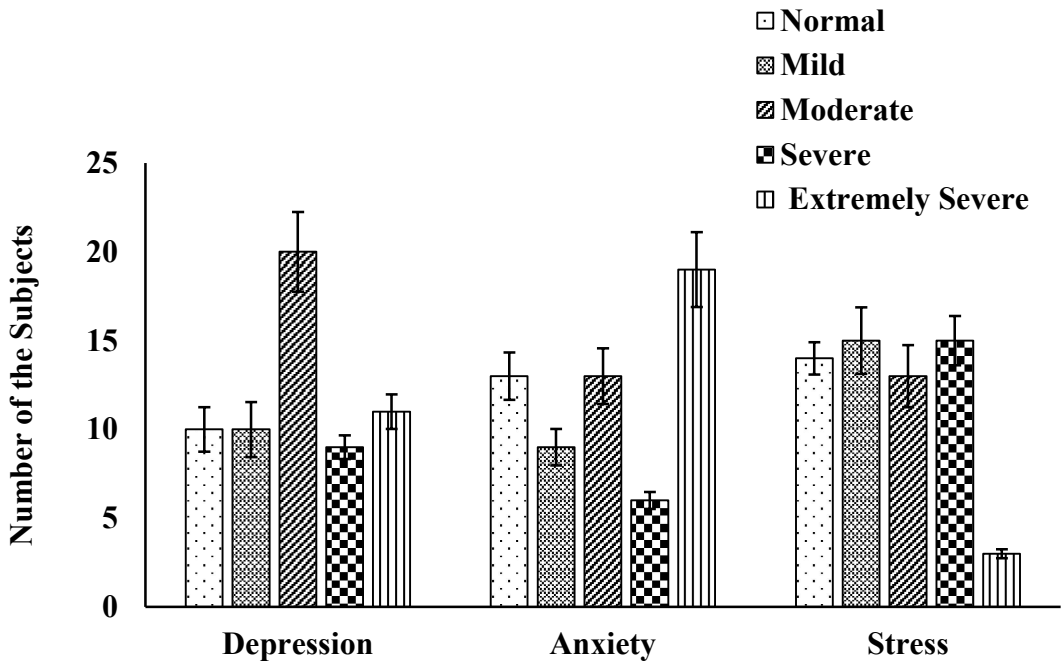


Figure-1: Graphical representation showing the total numbers of subjects in different levels of depression, anxiety and stress.

The current study is to measure the different levels of depression, anxiety, and stress among the college students of age group 19-23 years and predict the status of prevalence of these psychological disorders among the teenagers and young adults of Tripura. The study was indicated that out of 60 students 11 number of students has extremely severe depression whereas 10 students had no sign of depression (**Figure-1**). The status of having anxiety among the students as per survey showing that out of 60 students 13 number of students had no sign of anxiety whereas 19 number of students exhibiting extremely severe anxiety, which was most dominant mental health issue among the students. On the other hand, out of 60 students only 3 students had sign of extremely severe stress whereas 15 number of students were normal.

Conclusion:

The present study reveals higher intend of the prevalence of symptoms of depression, anxiety, and stress among the students at Holy Cross College, Agartala. The sample size is of 60 students, out of which are 30 male students and 30 female students; within the age group of 19-23 years and all are unmarried. It is admissible that the sample size used in the study is much less so, there is a scope to increase authenticity of the interpreted results by using higher sample size in future. The burden of mental disorders continues to grow with significant impacts on health. Instead of pursuing advanced lifestyles in urban area, having educated background, and economically stable families of study population, the prevalence of these disorders has alarmingly been high. This demands more root-cause analysis; etiological and interventional studies to investigate the causes of their high prevalence and to prevent and control these disorders. More studies are needed to evaluate the contribution of probable factors, such as daily stress, social media, interpersonal skills, and economic problems.

Acknowledgement:

The authors thanks to Principal Father and Vice-Principal Father to give the permission of conducting the survey and all the faculty members of Department of Human Physiology for their important inputs to improve the work.

Conflict of interests:

The authors declare no potential conflicts of interest.

Contribution of authors:

JC design the study, conducted the study, analyzed the data, and wrote the manuscript. AKS finalized the study design, check the data and analysis, and finalized the manuscript.

Microbial contamination of packaged drinking water versus tap water from Agartala municipality, Tripura

Dr. Sandeep Roy Sarkar, Assistant Professor, Department of Human Physiology, Holy Cross College, Agartala

ABSTRACT

Background: The quality of drinking water is of great concern to mankind, but unfortunately the drinking water supplies have a long history of being contaminated by a wide spectrum of microbes. The reason of increased uses of packaged drinking water is due to an assumption that the packaged water is safer to consume than the tap water and its use will help to protect from water-related diseases. So, the main objective of this study was to find out the presence or absence of microbial contamination in packaged drinking water and that of tap water.

Methods: Total of 40 drinking water samples (20 packaged water and 20 tap water) were analysed for microbial contamination and pH. The methods used were spread plate method and Gram staining. pH meter was used for measuring pH.

Results: Sixty percent of the packaged water samples and 90% of the tap water samples were found to be contaminated with heterotrophic bacteria. The most prevalent bacteria in all the drinking water samples were gram-positive rods. All the tap water samples and 50 % of the packaged water samples had pH in the acceptable range.

Conclusion: Most of the municipal tap water samples and a significant number of packaged drinking water samples were found to be contaminated with one or more than one type of bacteria. On the basis of our findings, it can be concluded that comparatively, the packaged drinking water may have been safer (than tap water) to drink. It is suggested to boil the water before consumption.

Key words: Bacteria, Microbial contamination, Gram-positive rods, Drinking water, Agartala.

INTRODUCTION:

Water covers more than 70 % of the earth's surface but freshwater is only less than 3%. The amount of freshwater available for human consumption is only 0.01 % (Ahmed et al., 2015). This small proportion of the total water is becoming polluted due to various activities like indiscriminate disposal of municipal and industrial wastes and large-scale applications of chemicals in agriculture, that introduce various harmful substances to the water bodies which result in widespread water-borne diseases (WHO, 2011). Water is essential for the life, but many people lack the accessibility to clean and healthy water and die as a consequence of water-borne infections. Since the dawn of human civilization, water supply is an integral part of society for various purpose e.g. drinking, agriculture, Industry, household etc. Much of the health problems in the developing countries are largely due to the unavailability of safe drinking water (Soomro et al., 2011; Gvay, 2017).

According to an estimate, 80% of all infections and over one-third of demises in the developing countries are caused by the intake of polluted drinking water. Water pollution with pathogenic microorganisms is one of the serious threats to human health, particularly in developing countries. As per the report of the World Health Organization (WHO) about 600 million cases of diarrhea and dysentery, and 46000 infant deaths were stated per year because of polluted water and insufficiency of sanitation (Dey, 2012). Escherichia coli (E. coli) infections associated with drinking contaminated water remain a major public health concern as its presence signifies fatal illnesses such as diarrhea (Singh et al., 2001; Thevenon et al., 2012). In fact, several studies have shown that the bacterial composition within drinking water samples are highly diverse, with total cell concentrations that typically range from 1,000 to 100,000 bacterial cells per milliliter (Martínez-Santos et al., 2017; Prasanna & Reddy, 2009). Contaminated water can cause a spectrum of diseases ranging from self-limiting gastrointestinal disturbances to severe life threatening infections (Proctor & Hames, 2015). According to World Health Organization (WHO), 80 % of the diseases in developing countries are either water or sanitation related (Akoto & Adiyiah, 2007).

Numerous studies conducted worldwide have explored the bacterial diversity in water habitat (Irone et al., 2014). The leading cause of waterborne disease outbreaks includes E. Coli, Shigella, Salmonella, excessive fluoride, copper, etc. The development of antibiotic resistance among bacteria is considered as a universal threat to human health. Studies revealed that,

antibiotic resistant bacteria, at least for some classes of antibiotics, may be more prevalent in tap water sources (Gomez et al., 2012; Narciso-da-Rocha et al., 2013).

METHODOLOGY:

The study was conducted from April to May, 2022. Twenty no. of packaged drinking water bottles were collected from different roadside shops and food vendors of Agartala city and adjoining areas. Before collection the samples were checked for batch no., date of manufacturing and expiry. These includes bottles from different manufacturers. Each of the sealed bottles were transported aseptically to the laboratory. For the collection of tap water, the Agartala municipality was divided into 20 approximately equal parts. Within each part, 1 roadside tap was selected randomly, thereby 20 no. of tap water samples were collected in sterile bottles.

The water samples were transported to the laboratory of Human Physiology of Holy Cross College, Agartala in ice box within 2 hrs of collection. Analysis of the water sample was done within 6 hrs of collection. Detection of bacterial contamination in water samples was done using spread plate method and Gram staining. pH meter was used for measuring pH.

For microbial analysis, the following steps were used:

1. **Sterilization**: The culture plates, glass goods, culture media, etc. were sterilized in autoclave.
2. **Preparation of culture media**: 28gm of nutrient agar was dissolved in 100 ml of distilled water.
3. **Sterilization of culture media**: Sterilized in autoclave.
4. **Preparation of nutrient agar plate**: After sterilizing the laminar air flow cabinet, 15 ml of nutrient media was poured in the culture plate and allowed to solidified for 1hr. Then 40 microliters of the sample water were spread to the plates using a glass spreader. The culture plates were kept in an incubator for overnight.
5. **Preparation of antibiotics**: 1 antibiotic tablet (500 mg) is dissolved in 500 ml of autoclaved water. The antibiotic concentration applied in the culture plates is 500 µg. Antibiotics, viz., penicillin, cephalosporin, ampicillin and tetracycline are used in this study.

RESULTS:

This study found that the microbial growth in day 1 (after 12 hrs. of incubation) is countable. In day 2 (after 24 hrs. of incubation) microbial growth is much more rapid and uncountable in tap water samples. The bacterial cells found in different water samples has shown resistance to antibiotics including penicillin, cephalosporin, ampicillin and tetracycline (fig-1).

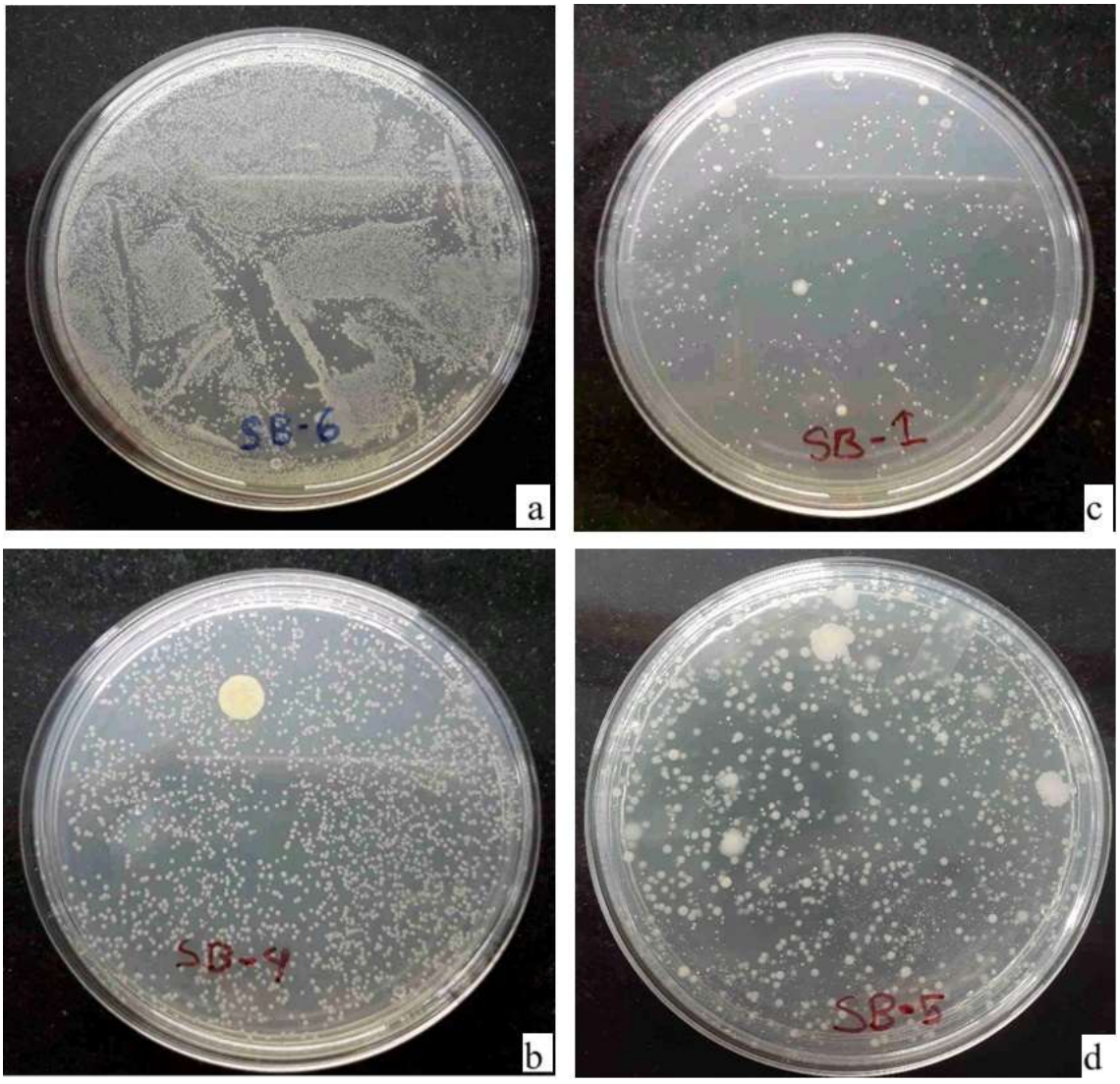


Figure 1: Culture plates showing growth of bacterial colonies (a, b= packaged drinking water; c, d= tap water).

Sixty percent of the packaged water samples and 90% of the tap water samples were found to be contaminated with heterotrophic bacteria. Gram staining revealed that the most prevalent bacteria in all the drinking water samples were gram-positive rods. One hundred percent of the tap water samples and 50 % of the packaged water samples had pH in the acceptable range.

DISCUSSION:

Infectious diseases, caused by pathogens are the leading cause of death in the world. The past two decades have seen the emergence of many new pathogenic infectious disease. Many of these are caused by anthropogenic changes, such as water resources development, climate warming, and interaction between humans and animals both domestic and wild(Pramod et al., 2014).

In this study, the bacteriological quality of packaged water was found to be comparatively better than that of tap water and this which was consistent with the findings some other studies (Oluyege et al., 2014; Afiukwa et al., 2010). The poor microbial quality of the tap water might be due to the ineptness of the disinfection processes used in drinking water treatment or due to distribution from contaminated sources. Bottling the water without proper treatment or contamination during packaging or handling by the local manufacturers for financial benefit might be one of the reasons behind the poor microbial quality of the packaged drinking water. And further, the authorities responsible for monitoring the quality of bottled water might not be strict in the places where the bottled water was found to be more contaminated.

Sixty percent of the bottled water samples were contaminated with heterotrophic bacteria which was comparable with the findings of many studies (Warburton et al., 1992; Warburton, 2000). Although the microbial concentration in processed water is initially low, it can develop into high level during storage (Stickler, 1989). The reasons for this may be due to the high level of oxygen provided to the water during processing, larger surface area provided by the container, higher temperature, and the nutrients arising in the container (Kassenga, 2007; El-Salam, 2008). The use of bottled water is only based on the assumption of purity and this can be misleading. In our study, all the tap water samples had acceptable pH. Resistance of up to 70 to 100% were reported against penicillin and cephalosporin antibiotics (Yasin, 2012; Islam et al., 2010).

Drinking Water Management system should include chlorine and other disinfection method like UV treatment which play a significant role in removal of bacteria or the water must be bailed before consumption. If further study takes place on microbial pollutant in different drinking water samples, a positive result may expect.

CONCLUSION:

This study revealed that most of the municipal tap water samples and a significant number of packaged drinking water samples distributed around Agartala municipality were found to be contaminated with one or more than one type of bacteria. The bacterial cells found in different water samples has shown resistance to antibiotics. The package drinking water and the tap drinking water are not fully hygienic to consume. Drinking tap water can cause severe bacterial outbreak. Comparatively, the packaged drinking water may have been safer to drink. It is suggested to boil the water before consumption.

ACKNOWLEDGEMENT

Dept. of Botany and Zoology, Holy Cross College, Agartala is acknowledged for providing the access of some lab instruments.

Widening the view: Locating the Chances and Problems of advanced technological innovations in the English language Teaching and Practice.

Mr. Tirthankar Laskar, Guest Teacher, Department of English, Women's College

Abstract

This research paper focuses on the evolution process of teaching learning system of English. Right from the beginning there was traditional based learning which was all about face-to-face interaction, textbook based learning etc. But as the progression was moving, there comes a shift in the learning methods which takes the learner towards traditional technology and from there also, it is found that advanced technology-based learning and practice has taken over and it is getting settled in overall education system and it is crafting the minds of the students as a tech innovator. This research paper also focuses on the chances and problems that advanced technology-based learning and practice has brought in and how does a student deal with it, living amidst an era which is taken over by technology and innovation respectively.

Keywords

Advanced technology, innovation, pedagogical approaches, flexible learning, software, web tools, collaborative learning.

Introduction

The 21st century has been a generation of difference. It has maximised to such a level of the development of technology that today the scenario of education has gone down to the hands of technology and its adaptations. The influence of technology has nevertheless restructured human survival. The framers of the traditional method of teaching- learning has undergone into alteration as the integration of the technical devices with English language teaching and learning has taken the level of interaction into a new sphere. The use of Online form of teaching-learning is nevertheless a significant pedagogical approach where the unification of the practical learning stands as a benefit.

The proficient way of accelerating the teaching learning system through technical tools share certain attributes which makes effective learning and communication thought provoking. In the era of digitization, the implementation of the concept of digital harmony in the field of teaching and learning can be related to the expression of serving the purpose of flexible learning environment where the teaching and learning practice gets into the student-centric mode.

Therefore, the framers of the English language teaching and practice trans-fitted the radical process of technical innovations where English language teaching practice alongside learning becomes a systematic and enhanced version of method with techniques and ideas mixing in it increasingly.

The productivity of technical or ICT based combinations in the teaching learning practice indicates at the multiple avenues and variety of resources starting from - social meeting platforms like - Zoom, Webex for material resources websites and also for study source accesses.

Today when we look at the technology getting amalgamated with the English language teaching and learning, it can be sensed that it is not only in one part of the world, but in every part of the world, where any kind of geographical barrier is not an endpoint rather it brings out things as new and available in its own way in order to ensure that there are endless and numerous occasions which can promote the digital proposition on a successful note.

Carol A. Chapelle in her book "English Language Leaning and Technology", mentions and affirms about the modes of deliverance of education in the learning and development system and hence the technology-based education is questioned to her readers as whether this

can be taken as agreed mode of behaviour. This leads the readers to crystal's analysis of the registers which speaks about the positivity of the electronic medium.

Research Objectives

1. To make the learner's learning pragmatic with the various technique-centric approaches.
2. To prepare the classroom with equipped usage of electronic and technological devices.
3. To enhance the prompt use of software and web tools in order to develop the classroom interaction with skills.
4. To increase efficiency in the outcome-based learning practice with the introduction of technological form of learning and eradicate the traditional based classroom mode of learning.
5. To also delve into the present new millennium scenario of the transition from traditional technology to the advanced technology-based learning.

The research questions are as follows:

RQ1. What are the chances and problems in the English Language Teaching practice through technical tools and combinations?

RQ2. How does present day technical learning influence the advanced technology-based learning system that there is transition from traditional technology?

Research Methodology and Materials

As an informative and pragmatic learner in my teaching career, coming across to numerous students and learners from different social and cultural backgrounds who aspire to prefer outcome-based learning, focus primarily on technology-based learning and practices and also to special advancements. As per the Literature review and interactive session with them alongside, the students in the present scenario of post-pandemic era identity and relate themselves with the trend of advanced technology in ELT.

The qualitative participatory study of the feedback of the students gave me a comprehensive review to understand their preferences. From the diverse sample of participants, interviews and focus groups, the qualitative data analysis technique is used and analysed. The thematic analysis is done as it is open ended response. Thus, to give an overall distilled summation is to mention that the employment of mixed methods like - qualitative participatory research study, observation research study helped in the methodology as the interaction with the diverse number of students gave their response on - advanced online platforms, developed

interactive softwares, adaptive learning materials and also use of AI with virtual reality creating virtual environment helps in providing a nuanced understanding of advanced technology based learning on English Language teaching and practice.

By encompassing these aspects in research studies, an in-depth understanding of how contemporary technology impacts ELT and how effective various language learning resources are can be accomplished.

Review of Literature

From the review of Literature, it can be understood that this study of advanced technology-based learning in English language teaching is a vast route of exploration. The researchers focus on the emphasized learning to increase potentiality, improvement in language acquisition and proficiency and integrated training for effective progress of ELT. Furthermore, a distinguished view from the lens of the critic defines many challenges and issues such as inequalities in teacher training that can aggravate educational qualities.

Critics have also mentioned and referred that often the advanced technology-based learning in ELT impede meaningful interpersonal communication which are crucial for language acquisition. As this gives birth to dehumanisation concern where authentic face to face interaction gets diminished. Moreover, scholars from various institutions highlight that there is a significant challenge where there lies a digital division. As, unequal access can give birth to educational disparities and limited opportunities which ensures inclusive strategies that empowers the advanced technology to benefit all the learners and students.

In the book, "Visible Learning and the Science of How We Learn"(2009) by Gregory C. R. Yates and John Hattie, provide insight lies on visible learning. This directly focusses on the pedagogical approaches where the digital tools when used effectively contribute positively to students' achievements but this meta-analysis explains the impact of various teaching strategies.

In the book, "Evaluation of Evidence-Based Practices in Online Learning: A Meta-Analysis and Review of Online Learning Studies"(2010) by Barbara Means, Yukie Toyama, Robert Murphy, Marianne Bakia & Karla Jones, enhance on the idea of advanced technology

and the student's engagement where their opinion goes for the technology which can enhance engagement and outcome-based learning and practice. And those who are technological oriented have the easier grasp of online learning abilities than those who are on face-to-face interaction. Thus, providing an average height finding.

Through the summary of the review of literature, there is an abundance of different perspectives on the function and effects of advances in technology in ELT, provided by critics and scholars, providing for a rich and complex exchange of conversation.

Findings and Discussion

The traditional educational environments and methods of teaching were cornerstones of the English language learning in the pre-digital era. Learners relied on printed resources for learning, and educators regarded chalkboards and books to be important tools. The teaching process was primarily the task of the teacher, who frequently utilised oral instruction to highlight phrases, grammatical structures, and the pronunciation.

The various stages can be said as – the collaboration between printed materials and classrooms, the limited availability of resources and regional learning, and eventual transition to early digital tools. The emergence of electronic devices into educational institutions in the 1980s and 1990s marked a dramatic change. Personal computers were equipped with language acquisition software in the beginning stages of digital tools. Conventional written documents started to be enhanced by multimedia content, incorporating video and audio files. Languages labs and studios with tape players and headphones became available within this time, allowing students to practice language skills like listening and speaking. English language teaching and learning experienced an enormous shift as internet access grew in popularity in the second half of the 20th century. The establishment of international connection, collaborative platforms as well and internet-based services emerged around that time.

Very soon it was seen that the online classes and online classrooms have been made available by e-learning systems which arose as the internet system evolved. With the use of these platforms, online instruction was made possible, allowing students access the materials and take part in discussions at their own pace. The concept of ‘Blended learning’ came in which helped offline and online learning becoming popular. Social networking sites, and online communities are instances of online platforms which promoted shared and assimilated learning

through providing learners an opportunity to converse, exchange substances, and communicate with native speakers.

Chances of advanced technological innovations in the domain of English Language Teaching

The evolution from the non-digital to the digital era in English language teaching and learning has been significant in nature, reflecting modifications to educational methods and the integration of technology. This approach commences with traditional methods and gradually incorporates innovative tools and technologies that have completely transformed the area of acquisition of languages

Artificial intelligence, adaptive education, and interactive content are just a few of the latest innovations and technologies that mark the present-day digital age of teaching the English language. Applications associated with language learning depend heavily on artificial intelligence (AI). Artificial intelligence (AI)-powered solutions enable improved speaking, listening, and comprehension of languages through improved recognition of speech, processing of natural language, and customised suggestions.

Some of the technology-based applications and softwares used in English learning and practice are namely – Google Bard, Chat GPT. An efficient instrument that has grown increasingly common in English language practice and instruction is Google Bard. Its use into language instruction has transformed traditional methods by offering a wealth of tools and features for educators as well as students. But like with every technology breakthrough, its application in educational contexts needs to be guided by ethical concerns. Google Bard's vast reading accumulation is one of its biggest contributions to language practice. In order to create a more customised and engaging atmosphere for learning, teachers may develop a wide range of reading lists based on the hobbies and skill levels of their students. Moreover, pupils can independently travel texts due to the tool's established dictionary and thesauruses, which improves their lexical acquisition and understanding of context abilities. Moreover, an over dependence on Google Bard might lead to a decline in analytical and problem-solving abilities. Teachers' ought to use the technology sparingly, using it as an additional resource rather than a crutch. A comprehensive growth of language skills is ensured by encouraging students to do independent research and analysis outside of the platform. The subject of educational fairness

is brought up by Google Bard's accessibility. Not every student may have equal access to technology, which might lead to a gap between those who can take use of the advantages of the instrument and those who cannot. In order to develop inclusive teaching practices that accommodate a variety of learning contexts and resources, educators must be aware of this digital gap. The appropriate use of the instrument in evaluations is an example of ethical usage that goes beyond the classroom. Google Bard can make grading procedures more efficient, but it also raises questions regarding the validity of student work and plagiarism detection. By implementing these ethical values, Google Bard may really strengthen the English language education processes by offering students with the ability they need for success in a sophisticated, expanded environment. Thus, the advanced technology providing the complete opportunity to the student from a learner-centric approach.

With its sophisticated natural language processing powers, ChatGPT has a lot of promise for use in English language practice and instruction. Making use of this technology can improve language learning opportunities and provide students a tailored, interactive approach. ChatGPT can be a useful resource for tailored education. It may adjust activities and information to match each learner's level of skill. This individualised approach considers the various requirements of pupils and provides focused assistance in areas that need development. Because of this, students may advance at their own speed while concentrating on certain language skills that need work. A major advantage is ChatGPT's ability to involve learners in meaningful dialogues, allowing them to develop and improve their ability to communicate in English. Learning may be quicker, more confident, and enhance vocabulary and grammar when it is modelled after actual conversations. The conversation style of ChatGPT provides a fun atmosphere wherein students may use language rules in real-life scenarios, improving their understanding of the English grammar. In addition, specific guidance regarding how to utilise ChatGPT in learning situations are also needed. As opposed to encouraging technology to take the place of human interaction in educational settings, teachers ought to emphasise the additional function it serves and encourage students to embrace it as a tool that complements traditional methods of instruction. Putting technology and human-led education in check is essential to creating an extensive atmosphere for learning. Hence, it can be found that ChatGPT provides incredible opportunities to enhance the English language through both instruction and practice. Its conversational characteristics, flexibility, and rapid feedback offer for an interesting and customised method of learning. But it's crucial to devote careful consideration to moral concerns including confidentiality, ethical usage, and the potential biases. Teachers

may use ChatGPT to create interesting and effective language acquisition environments by including it cautiously and responsibly.

Additionally, there are some more technology-based learning in the digitized era. Using mobile devices, including smartphones and tablets, to improve language learning experiences is known as mobile-assisted language learning, or MALL. MALL can be used in addition to conventional classroom training. Mobile devices may be used by teachers to enhance their classes, and students can utilise applications to get more practice and reinforcement. It is crucial to consider the preferences of language learners, technology limitations, and how well mobile activities fit into the larger language learning objectives while implementing MALL. Computer assisted language learning is made up of a variety of components and techniques. Customised language learning apps like Duolingo, Rosetta Stone, or Babbel often use gamification elements to make learning more engaging and dynamic. Platforms like Coursera, edX, or specialist language learning websites offer structured online courses with multimedia content, assessments, and occasionally live interactions. Tools that provide live virtual language training, such as Zoom or Google Meet, enable real-time contact between teachers and pupils. Screen sharing, chat, and breakout rooms are often included with these systems. The quality of the material, learner motivation, and the use of technology into well-thought-out language learning methodologies are all important elements that affect how effective CALL is. Technology-enhanced language learning includes a range of resources and methods. Through the use of virtual reality (VR) apps, language learners may practise in realistic settings, improving their speaking and listening abilities. By improving accessibility, interactivity, and customisation to personal preferences, these technologies seek to provide a more engaging and productive learning environment for language learners.

Some more powerful tools from advanced-technology used in English language teaching and practice are – Voyant, Grammarly and Quillbot. Firstly, Voyant aims towards text research and exploration. A great deal of text may be analysed by users to find patterns and gain knowledge about the content. Voyant is a useful tool for researchers, academics, and anybody working with large amounts of textual data. Secondly, another tool for paraphrasing statements without altering their sense is QuillBot. Rewriting substance and avoiding plagiarism are made simpler with the use of artificially intelligent systems to understand the context and provide alternative language. To reword and add variety to their work,

professionals, students, and writers commonly employ QuillBot. Thirdly, Grammarly is a proficient writing tool that provides style suggestions along with punctuation, grammar, and spelling checks. It provides real-time repairs, links with multiple platforms, and provides comprehensive justifications for requested modifications.

Grammarly can help writers, learners, professionals, and anyone else who wishes to write more effectively and precisely.

Problems of advanced technological innovations and softwares in the domain of English Language Teaching

Though as a next-generation AI assistant, Google Bard has a lot of potential, its success will depend on how well it handles issues with privacy, prejudice, competition, and ethics. Particularly in the domain of English Language Teaching, there may be privacy problems. There may be concerns concerning the collection, storage, and use of personal information because Google Bard may rely on user data for customisation. Additionally, biases in the training data of Google Bard may cause it to provide replies that are damaging or prejudiced. It will always be difficult to control and rectify such prejudices.

The ability of Google Bard is to generate responses that resemble those of a human aroused concerns about its misuse, including deepfakes and AI-assisted misinformation campaigns. For the active and effective English learning and teaching, Google Bard has to address the ethical challenges raised by these applications, as it consists of data privacy concerns and regulatory hurdles.

Due to its lack of real-time verification features, ChatGPT occasionally produces biased or factually erroneous information. It might be abused by professionals and students for assignments like essay writing, which would compromise academic integrity. Therefore, it does not always accomplish the ideas in a perfect generative manner. For the linguistic research studies, Voyant might not be able to supply alternative, more powerful NLP tools with advanced statistical or machine learning models for in-depth language study. While handling the huge datasets or intricate queries, it may become slower. Moreover, there are also chances of finding problems while using the Grammarly software, as they may not be able to improve

their own grammar in a complete sense. Hence, its recommendations can also occasionally be quite basic or inappropriate for creative writing.

Quillbot has a plagiarism detector, although it only allows for a limited number of tests, which may not be enough for academic users. While it offers grammatical checking, Quillbot's tool is not as advanced as Grammarly's, making it less appropriate for overall writing aid. Thus, limiting the conducive learning environment for language learners in a certain manner.

Consequently, the shift from conventional technology to cutting-edge technology-based education has brought in versatile Virtual classrooms, adaptive learning systems, and online platforms are examples of advanced educational technology. Real-time interaction between students and teachers, customised content delivery, and flexible learning schedules are all made possible by these technologies. As a result, it has become a crucial responsibility to train the future generation of instructors with specific training and guidance that are entirely dedicated to tech-friendly and integrated classroom teaching and learning, also known as the interconnected method of teaching and learning. This can also provide opportunity to work on a variety of projects and occupations that cannot be completed alone.

Conclusion

Finally, it comes down to technology and its ability to function in the sociolinguistic environment. This will create momentum for collaborative learning by gathering information from many sources, such as content presentation files, online quiz practices, social-media meeting sessions, and so on. In sum, it indicates multiple learning alternatives. Furthermore, augmented reality and interactive simulations enhance practical comprehension. All things considered, these advancements make learning more engaging and fruitful.

Bibliography/ References

1. Papert, Seymour., (1980). *Mindstorms: Children, Computers, and Powerful Ideas*. Basic Books.

2. Vygotsky, Lev., (1934). *Thought and Language.* The MIT Press.

3. Hattie, J., & Yates, G. (2014). *Visible Learning and the Science of How We Learn*. Routledge.

4. Garrison, D. R., & Vaughan, N. D. (2008). *Blended Learning in Higher Education: Framework, Principles, and Guidelines*. Jossey-Bass.

5. Means, B., Toyama, Y., Murphy, R., Bakia, M., & Jones, K. (2010). *Evaluation of Evidence-Based Practices in Online Learning: A Meta-Analysis and Review of Online Learning Studies*. US Department of Education.

6. Selwyn, N. (2016). *Education and Technology: Key Issues and Debates*. Bloomsbury Publishing.

7. Literature, English Composition, Arts & Humanities,.(2023) https://libguides.southernct.edu/digitalhumanities/tools

Holy Cross College Agartala

Jubatara, P.O. Lembucherra, Tripura West-799210

www.hccagt.ac.in