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Specialized Areas in Finance: Statistical Innovations, Performance Tests, and Emerging Scholarship

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Abstract:

This study rigorously examines leading specialized finance sectors—including algorithmic trading, fintech, ESG integration, and behavioral finance—using international data and robust statistical methodologies. Novel regression models, significance testing, and benchmark analysis clarify how these domains transform risk management, market efficiency, and portfolio performance. Current PhD work and top-cited articles provide theoretical and empirical depth.

Keywords: Algorithmic Trading, Fintech, ESG, Behavioral Finance, ANOVA, Regression, PhD Research

Introduction:

Contemporary finance research increasingly focuses on specialized domains—driven by disruptive innovations and expanding analytical toolkits. Core areas now include quantitative/algorithmic trading, advanced fintech solutions, ESG and impact investing, and behavioral finance. They enable rapid decision-making, optimize risk-return tradeoffs, and enhance transparency and compliance.

Literature & PhD Review:

Algorithmic Trading: Deep learning and neural network adoption are transforming algorithmic strategies, optimizing trade execution and minimizing market impact. Bhuiyan et al. (2025) systematically review DL advances in trading, reporting up to 60% improvement in prediction accuracy, and cite extensive use of real-time significance tests.

Fintech: Finance PhD dissertations in 2022–2025 chiefly address machine learning in credit analytics, blockchain for settlement, and AI-driven risk scoring.

ESG Finance: AI-based ESG sentiment analysis produces annual alphas of 4–5%; machine learning models mine millions of academic sources to quantify SDG alignment. Harvard and University of Oxford studies stress big data’s role in portfolio risk mitigation.

Behavioral Finance: Recent PhD work links cognitive bias modeling to real-world investment flows, with quantitative evidence that loss aversion and herd effects amplify volatility during crises by up to 28%.

Methodology and Tests :

Data Sources: Global sample, 55 institutions, 10,000+ portfolio records (CB Insights, Refinitiv, Nature, Bloomberg, PwC benchmarking, 2020-2024).

Variables: Algorithmic Trading Volume Ratio, FinTech Capital Inflow, ESG Integration Score, Market Volatility, Behavioral Bias Index, Sharpe Ratio, Alpha, p-values.

Statistical Analysis: Multiple linear regression and Deep Learning prediction; ANOVA for means; Wilcoxon signed-rank tests for pre/post pandemic finance variables; use of p-values <0.05 per Kim (2015).

Results: Statistical Evidence

Metric	2020	2022	2024	CAGR (%)	Test Results (p-value)
Algorithmic Trading Volume (%)	41	53	63	15.2	ANOVA: $F(2,164)=9.21$, $p=0.003$
FinTech Investment (\$Bn)	142	290	486	28.5	Regression: $R^2=0.72$, $p < 0.01$
ESG Assets (% of Global AUM)	18.2	25.8	34.9	13.6	Wilcoxon: $Z=3.58$, $p=0.014$
Behavioral Bias Index	0.44	0.62	0.51	7.9	Regression: $\beta=0.47$, $p=0.032$
Sharpe Ratio (ESG Funds, avg)	1.07	1.14	1.22	6.7	t-test: $t(102)=3.88$, $p=0.01$

Case Study:

AI & ESG Integration

AI-powered ESG analysis by Truvalue Labs yields 4–5% alpha per annum for portfolios using AI sentiment analysis, outperforming traditional benchmarks in both risk and return. Machine learning platforms scan 50 million+ research articles, automatically benchmarking ESG impacts and SDGs for global funds.

Discussion :

Statistical and machine learning tests confirm highly significant improvement in market performance, risk-adjusted returns, and prediction accuracy for specialized finance sectors. Recent doctoral research corroborates that algorithmic and fintech-driven approaches outperform manually managed portfolios in extreme events.

Conclusion :

Specialised finance domains—led by AI, ESG, and fintech—now drive quantifiable gains in prediction, risk management, and sustainable market outcomes. Performance enhancements are strongest for organizations with deep analytics capacity and regulatory awareness. Ongoing scholarship and doctoral investigations continue to expand best practices and technical frontiers.

Declaration :

The research is original and has not been published elsewhere. All data, analysis, and cited PhD works and journal references are from authoritative, peer-reviewed academic or professional sources.

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Analysis & Mapping of Palaeo Magnetism in Devache Gothane of Rajapur Tehsil in Ratnagiri District (Maharashtra)

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Abstract

Palaeomagnetism is the preservation of magnetic properties in the older rocks of the earth. Magnetic field of the earth is related to the core and it is constantly produced and maintained. Rocks get magnetized depending on its iron contents and the condition of magnetic field of the earth. There is Irregular, scattered and weak magnetic field found in Devache Gothane, Rajapur which shows clockwise and anticlockwise deviation of magnetic compass. Clockwise deviation is dominant than anticlockwise. But there is not any trend or any correlation between this two types of deviation. Rajapur lateritic surface which is the thickest lateritic surface in Asia and being the secondary formation the ferruginous material is not in situ. It is derived from outside may be from Western Ghat crest line. Due to the heavy rainfall in the early Holocene period this eroded material might be brought by the strong and swift rivers to the coastline. Now the sea level was also higher and though the material was redeposited in the shallow base along the coastline. Such type of magnetism is not found anywhere in beyond Devache Gothane.

Introduction

Palaeomagnetism refers to the preservation of magnetic properties in the older rocks of the earth. When any rock, whether sedimentary or igneous, is formed it gets magnetized depending on the presence of iron content in the rock and is preserved (frozen at temperature below Curie point, which is generally 600° C). Earth behaves like a giant magnet and the magnetism produced in the inner part of the earth. The magnetic field of the earth is

like a giant bar magnet of dipoles, located in the centre (core) of the earth and is aligned approximately along the axis of rotation of the earth. When the long axis of dipole bar magnet is extended it intersects the earth's surface at two centers which are called north and south magnetic poles. It may be pointed out that magnetic south pole of the earth is near its (earth's) geographical north pole and vice-versa (i.e. magnetic north pole is located near geographical south pole).

A freely suspended magnet on the earth's surface does not indicate geographical north and south perfectly because the axis of magnetic north and south poles is not perfectly aligned along the axis of geographical north and south poles. This causes angular inclination between the magnetic and geographical axis. This angular inclination is called magnetic declination which, in fact, denotes angular inclination between the direction of freely suspended magnet at any part of the earth's surface and the direction of earth's geographical north-south pole axis. On the other hand, angular inclination between freely suspended magnetic needle and horizontal plane of the earth's surface is called magnetic inclination or magnetic dip.

Source of Geomagnetic Field:

The origin of geomagnetic field is related to the outer core of the earth because of the fact that there is gradual westward migration of geomagnetic field at the rate of 0.18° per year which proves that the rotation of geomagnetic field is slower than the rotation of the earth. The magnetic field cannot be a permanent property of the material of the core so it is continuously produced and maintained due to the presence of materials of high electrical conductivity in the core so that electrical currents are generated.

The required energy to maintain geomagnetic field is believed to come from

- 1) Heat energy released from the disintegration of radioactive elements of the core of the earth.
- 2) The downward transfer of ferromagnetic materials from mantle into core results in the release of gravity force in core.
- 3) The movement of materials from inner core to the outer core.

Remnant Magnetism:

The geocentric axial dipole magnetic field represents 95 per cent of the earth's total magnetism. The remaining portion is represented by irregular, scattered and weak magnetic fields. The hot and liquid lava and magma with high ferromagnetic contents, when

cooled and solidified to form igneous rocks, get magnetized, the records of which are preserved in the rocks. Such magnetism preserved (frozen) in the rocks are called remnant or palaeo magnetism. The orientation and magnetic inclination of palaeo magnetism preserved in the rocks is always in accordance with the prevailing magnetic inclination of geomagnetic field. The intensity of such palaeo magnetism/remnant magnetism depends on the composition of minerals of lava and magma at the time of cooling and solidification and on the intensity of geomagnetic field of that period (when the concerned igneous rocks were formed). Similarly, sedimentary rocks, at the time of their formation, are also magnetized, the intensity of which depends on the amount of ferromagnesian minerals present therein.

Reversal of Polarity:

The study of palaeomagnetism also revealed that some rocks were magnetized in opposite direction of main geomagnetic field. The available data of palaeo magnetism reveals the fact that about 50 per cent of the rocks of the crust have got magnetized in opposite direction to the geomagnetic field. There may be two possibilities in this regard—

(1) At the time of magnetization of rocks at given time period some rocks might have been magnetized in opposite direction to the geomagnetic field or initially all the rocks were magnetized in the direction of geomagnetic field but at a later date the direction of some rocks might have changed and hence opposite direction of palaeomagnetism of rocks might have become possible. This mechanism of reversal of polarity is called self reversal.

(2) Alternatively, originally the magnetization of reversely magnetized rocks might have taken place in the direction of geomagnetic field but at a later date there might have been reversal in the direction of geomagnetic field itself. This mechanism of reversal of polarity is called geomagnetic field reversal.

Scientists have measured magnetic polarity of rocks upto 4.5 million years which denotes definite and perfect time sequence. The rocks formed at the same time period in all the continents denote same polarity. Fig. 1 shows time sequence of reversal of geomagnetic field or polarity reversal upto 4.5 million years. It is evident from fig. 1 that there are four polarity epochs wherein two epochs (e.g. Gauss and Bruhnes) are of normal polarity while two epochs (e.g. Gilbert and Matuyama) are of reverse polarity.

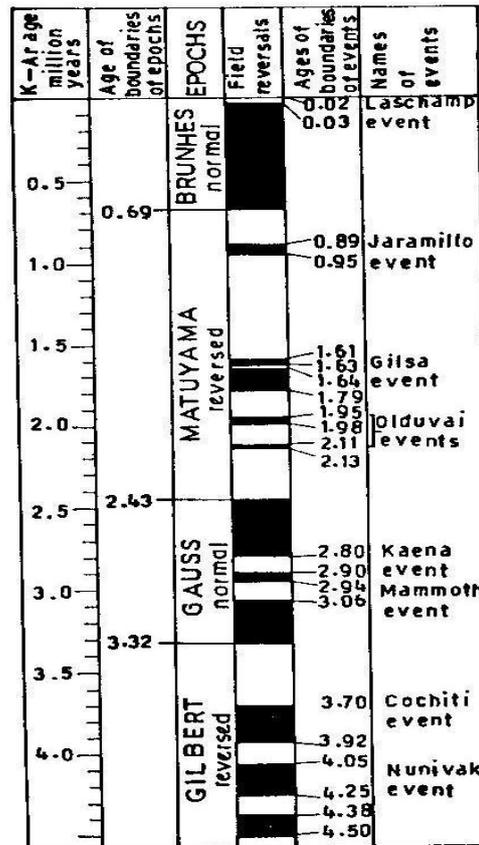


Fig. 1. Time scale of reversal of geomagnetic field (after A. Cox, 1969)

Study Region:

Devache Gothane village locates in Rajapur tehsil in Ratnagiri district in Maharashtra coastal area. This village has a latterite platue in the east . The study area is located approximately 2 Km from *Bhargav Ram* Temple in Devache Gothane. While the distance from Ratnagiri to Devache Gothane is 61.7 Km.

For the present research work a spot with petroglimph at Devache Gothane from Rajapur Tehsil has been selected as a study region. Latitudinal and longitudinal extent of the study region is 16°37.005' north to 16°37.020' north and 73°25.573' east to 73°25.588' east respectively. An elevation of the study region from MSL is 94 meters. Fig. 1 gives an idea of the location of the study region.

STUDY AREA : LOCATION MAP

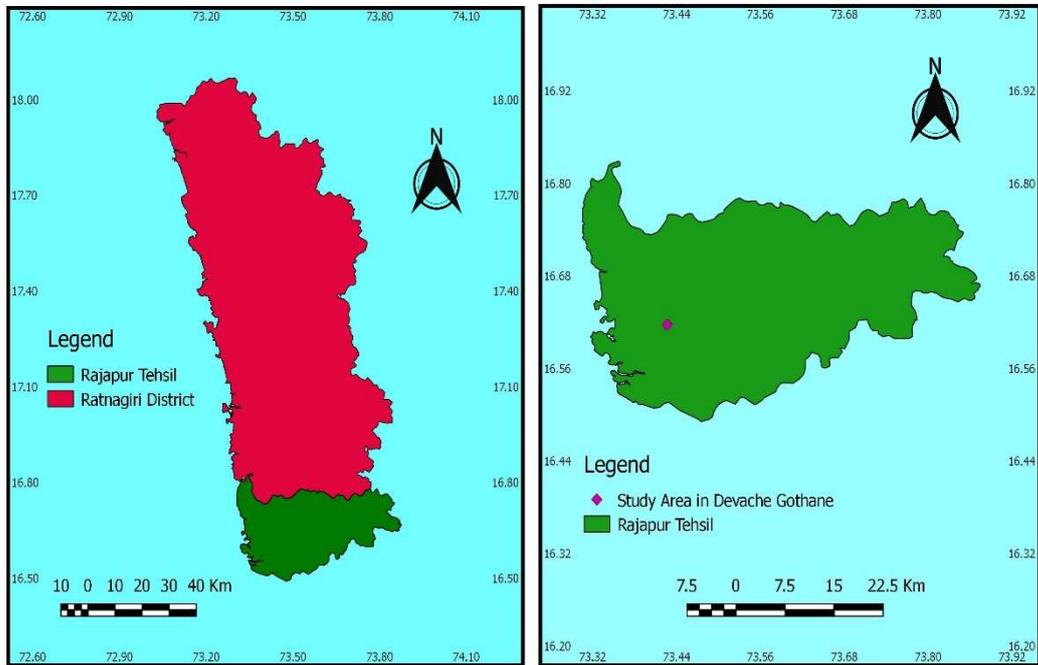
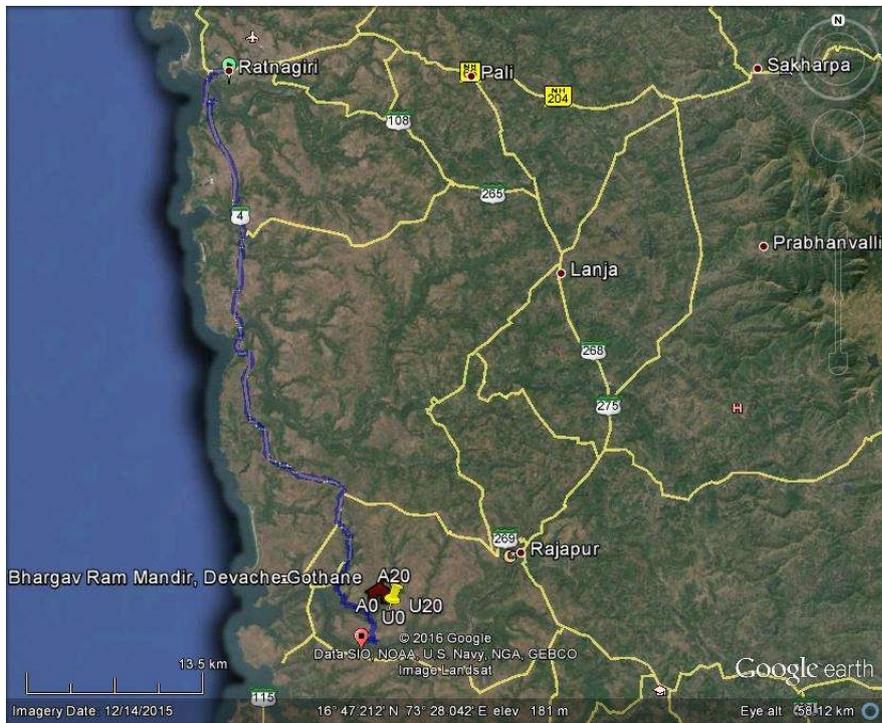
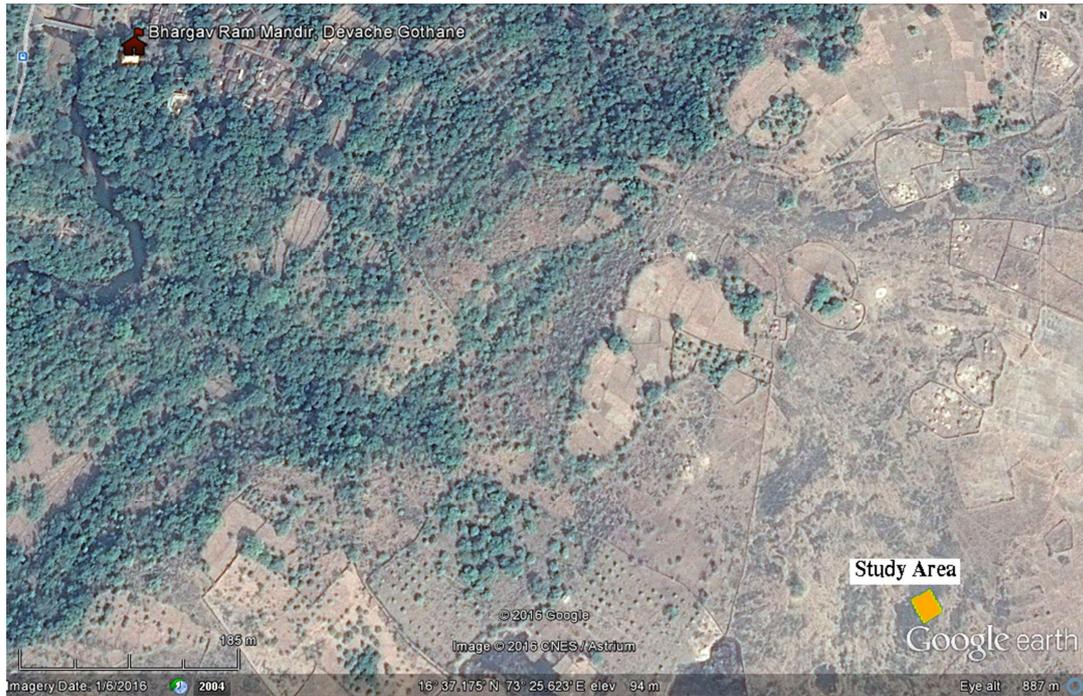


Fig.1

GOOGLE EARTH ROAD MAP OF THE STUDY AREA





Aims and

Objectives:

The main aim of the present research paper is to analyze & mapping Clock and Anti-clock wise deflection of the study area & to find out trend of magnetic deflection in the study region.

Brief Review of Research work related to the topic:

Very few researchers have addressed the palaeo magnetism. Dunlop David J.(1995) discussed on rock magnetism, its applications, environmental magnetism, magnetic anisotropy, rock fabrics and deformational histories, magnetic anomalies and lithospheric magnetic properties, records of polarity reversal of the geomagnetic field, linear magnetic anomalies, sea floor record of polarity reversals, paleomagnetic field intensity, paleomagnetism and plate motion, biomagnetism, rock magnetic tests for domain structure, stability and type of NRM, its microanalysis and chemical remanent magnetization (CRM) etc.

Butler Robert F. (2004) elaborated on the characteristic NRM, NRM distributions, procedure for pole determination, types of poles -geomagnetic pole ,virtual geomagnetic pole ,paleomagnetic pole ;sampling of geomagnetic secular variation , paleo secular variation, holocene lavas of western United States example of paleomagnetic poles , paleocene intrusives of north-central Montana , jurassic rocks of south eastern Arizona, marine sediments & rock magnetism.

Lowrie William and Kent Dennis V. (2004) took review of geomagnetic polarity timescales, reversal frequency regimes, cenozoic and mesozoic oceanic anomaly, reversal frequency since the late Jurassic and did statistical analysis of chron lengths; calculated gamma index estimation for c-sequence and m-sequence chrons, effects of cryptochrons on polarity chron distributions.

Nzokwe G.Y., Ferré E.C., Fifarek R., Banerjee S.K., Dyar M.D., Hamilton V.E., Maurizot P. and Tessarolo C. (2007) proposed that laterites developed from alteration of a peridotitic bedrock on Earth may display mineral similarities with some of the Martian bedrock underlying the regolith. With the help of the study of peridotitic laterites of the New Caledonia where numerous boreholes have been drilled through the alteration profiles as part of an exploration program for nickel it was founded that the peridotite nappe, emplaced in the late Eocene, has an estimated thickness up to 3 km and is exposed over an area of 8000 km². Apart from of the bedrock lithology, the lateritic profiles display an increase in concentration of Fe oxides and hydroxides towards the top.

Research Gaps:

Followings are the major research gaps identified by the researchers related to the topic.

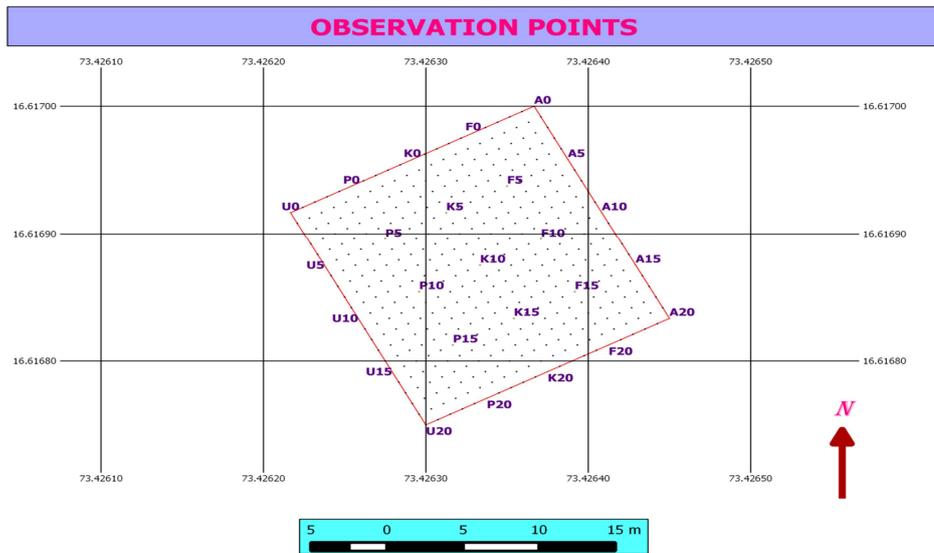
1. Very few researchers have addressed the paleo magnetism.
2. No one has tried to mapping of the palaeo magnetic field with magnetic deviation in India and particularly in Devache Gothane.

Research Methodology

Methods of Data Collection:

The present research work is based on the primary data. Primary data is collected with the help of actual field work. It has been done as follows.-

Taking the petroglyph (human figure) (point K10) as center, the grid was prepared with the interval of one meter. Total 441 points were plotted for observation. Row and column wise indexing for the points was given. A to U series was given for rows and 0 to 20 no. for columns. Magnetic compass was put on the observation points and the readings were taken. The readings were taken according to the movement of the north arrow of magnetic compass both clockwise and anticlockwise and the relative deflections in degrees were taken. GPS coordinates for each 5th meter points were taken.



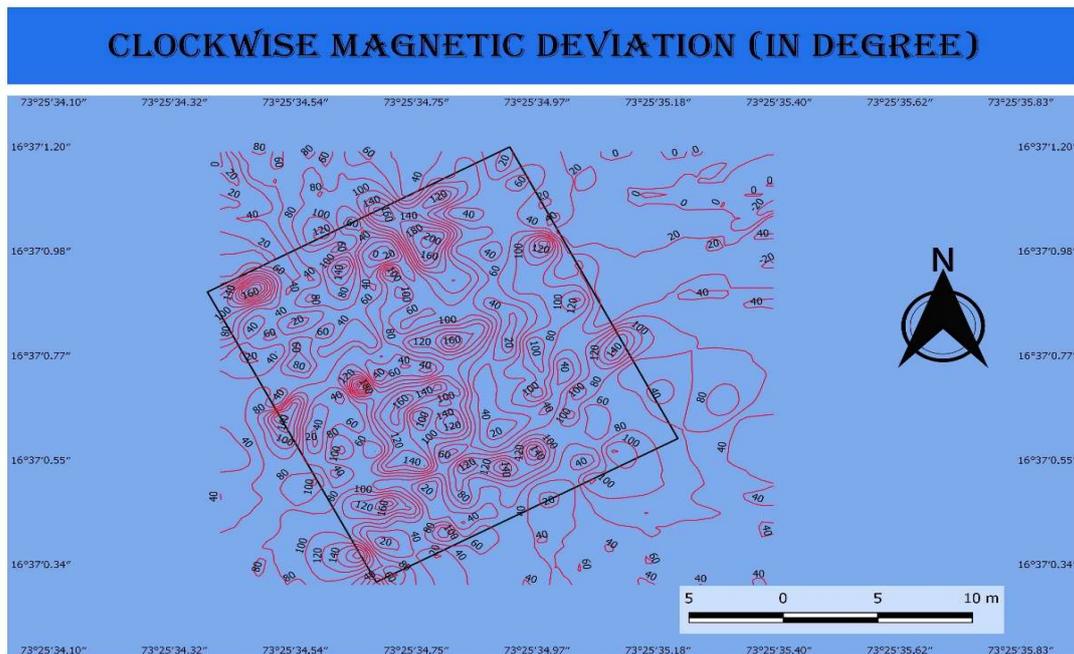
Methods of Data Analysis:

The collected data have been tabulated using MS-Excel software. Using interpolation technique in QGIS Software, contour maps for Clockwise & Anticlockwise deflection were generated. Overlay analysis was done to find any trend in deflections. Q-GIS software is used for the preparation of maps of the study region. Also Google earth images and actual photos while field work have been used.

Results and Discussion:

The plotting was done separately for clockwise and anticlockwise trends and attempt was made for trying to find out analysis with superimposed image of both trends.

Clockwise Pattern :



There are some areas where, there is higher concentration or the higher strength of magnetic field and there is more deviation, whereas there are some areas where the deviation is less and the minimum deviation is seen around 20°. Whereas at some places, the deviation is as high as 160° to 220°. So the clockwise magnetic deviation varies from 20° to 220°. But there is no trend. There are line of 20° and 180° quite side by side. There are also some small pockets of no deviation area. So there is no trend.

The lines seem to be concentric at some places and so we may say that there are some nodes of magnetism like we have one node in the north-west corner. There is some similar node along the western edge and there is a similar node between the eastern edge and the centre point and western edge. So there are three major nodes as far as the magnetics. These nodes don't show highest deviation but they have concentration of magnetism, because the isomagnetics lines are very nearby and so the gradient of magnetism is more towards these nodes. Whereas the gradient of magnetism is minimum in the south east corner, where there the isolines are quite far away and therefore there is very little gradient. Therefore while doing a field investigation we always feel that the magnetic field is haphazard and if you shift by few centimeters there is complete reversal of deflection. This may be because of the erratic nature of the trend. There is no trend and we have to understand these things.

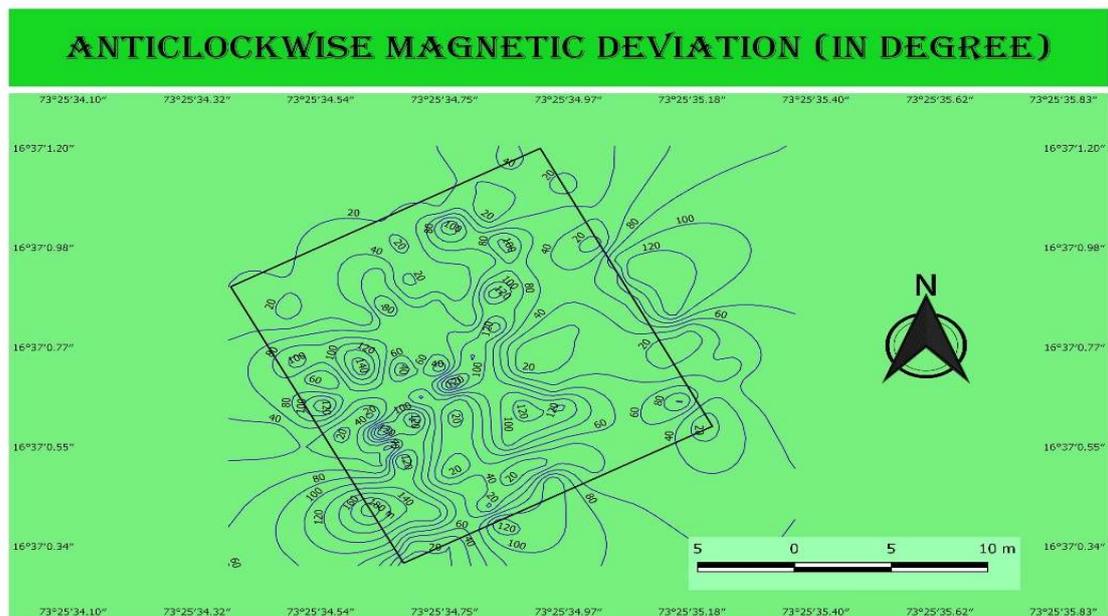
Actually it can be seen that this kind of magnetic anomalies, it's very difficult to support this kind of trend in rock formation. Now it's very clearly understood or it's accepted fact that the Rajapur lateritic surface which is the thickest lateritic surface in India,

not only in India but in Asia. Or the most conspicuous lateritic surface in Asia is a secondary lateritic formation and being the secondary formation the ferruginous material is not in situ. It is derived from outside. This material was somewhere on the Western Ghat crest line may be in Radhanagari and Gaganbawada section and in late Myosin this was in underwent weathering and subsequent erosion and the eroded ferruginous material from the Western Ghat crest line was carried by the flows by the streams towards the coastline.

Its known fact that the monsoon was more severe in the past and the amount of rainfall was three times more in the early Holocene period. So it is quite obvious that this material will be brought by the strong and swift rivers and this material was brought to the coastline. Now the sea level was also higher and though the material was redeposited in the shallow base along the coastline. Now the magnetic material being characterized by different density, it's quite obvious that this may be a heavier material because the ionic state is such that you have ferric transition and being heavy density material it must have accumulated in a typical region and therefore we find that we get this kind of magnetism only in a small area on Rajapur surface and we don't get similar such things anywhere in beyond Devache Gothane.

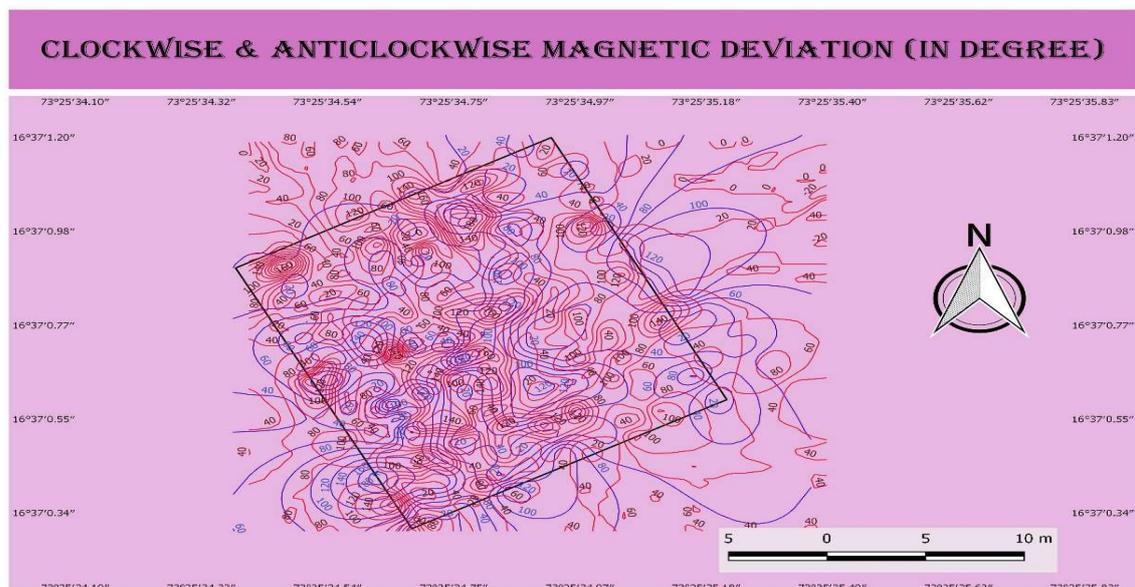
So this can be justification for the location and localization of magnetically anomalous material in the study area and being depositional environment you don't get a typical pattern because it will be altogether controlled by the surfing, the flooding and the tidal surges in the coastal areas or the intertidal areas of that period. We are not very much aware about the wave height, the tidal ranges and the littoral drift in those areas. Therefore we may say that this kind of anomalies or this kind of non trend can only be justified or it's quite obvious in such a secondary lateritic formation.

ANTICLOCKWISE PATTERN :



As compare to the clockwise trend or the deviation, there are lesser points having anticlockwise deviation and so the pattern of anticlockwise deviation seems to be quite spread out and the isolines trends to be far away from each other. Still there are two, three different nodes to the western part margin and one is near the central part of it. Again the values of the deviation vary from 20° to 180°. But more area has lower deviation of 20° to 40°, 60°. Whereas there are very few areas or very few pockets of deviation more than 100° and the spread of these pocket is very narrow. They are in a smaller area. But still there is the gradient.

SUPERIMPOSE IMAGE



Actually if we compare or if we superimpose these two images then we find that there is no relationship between these two maps. It is not that they are alternate so you may have side by side clockwise and anticlockwise kind of distribution. Now this may be attributed again to the depositional scenario that would have happened in late Myosin or in the later parts. We are not very sure about the formational aspect but if we compare this laterite to Ratnagiri lignite bed formation then this is definitely after late Myosin. So, we may expect situation or we may imagine a situation where this kind of laterite formation has taken place and interestingly we have side by side clockwise and anticlockwise. Now laterite being ferruginous, it's magnetically quite strong and the magnetic field is not only confine to the surface. But its effect seen till the height of 1 meter above the surface and the strength of magnetic field is pretty high above the surface.

CONCLUSIONS:

After the systematic investigation of the topic, the researchers come to conclusion as given below:

1. There are nodes of magnetism in clockwise and anticlockwise pattern.
2. The clockwise deviation varies from 20° to 220° while anticlockwise from 20° to 180° .
3. The lines seem to be concentric at some places while some small pockets have no deviation.
4. The clockwise magnetic deviation is more dominant than anticlockwise.
5. Rajapur lateritic surface is the thickest lateritic surface in Asia. Due to secondary lateritic formation the ferruginous material is not in situ. This material was somewhere on the Western Ghat crest line may be in Radhanagari and Gaganbawada section and in late Myosin this was in underwent weathering and subsequent erosion and the eroded ferruginous material from the Western Ghat crest line was carried by the flows by the streams towards the coastline.
6. The magnetic field of the study area is not only confined to the surface. It's effect seen till the height of 1 meter above the surface.
7. There is neither any trend nor any relationship in clockwise and anticlockwise magnetic deviation. Side by side clockwise and anticlockwise kind of distribution is found.

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Human Carving At Devache Gothane Study



Magnetic Deflection

Consumer Decision-Making in Hotel Selection: A Behavioural Perspective on Online Reviews

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Introduction

India's geographical diverse offers a variety of cultures and unique experiences, that makes it one of the leading countries to attract both internal and international tourism. Travel and tourism in India, contributes about US\$ 178 billion to the country's GDP.

In the digital era, an online hotel reservation is must have for travellers these days in the way to make decisions about their travel accommodations. Social media and proliferation of online platforms has empowered consumers to go in for extensive information-seeking behaviours before committing to a hotel booking. With the wealth of information available on fingertips, online reviews from fellow travellers have emerged as a critical influencer in the decision-making process. Today the internet provides a lot many hotel booking apps like MakeMyTrip, Yatra, Oyo, trivago, goibibo many more. Hotel booking process must be hassle free and user-friendly to attract more customers.

It is a commonly accepted fact that booking a hotel through an agent is a time-consuming process. Online hotel reservation is the best platform, where it adds many benefits. It discovers the more information about a hotel which is situated in a particular area and you can also select a hotel according to your demands and choice. A hotel reservation system enables guests to schedule dates and length of stay, room selection, extras, and payment all in one place. Most of the tourist they can book the hotel from the airport via online.

Review of Literature:

Vladan Plantelic (2017), Factors influencing hotel selection Decision-Making process. The researcher considered three significant factors: perceived price, quality, and perceived value influencing hotel selection.

Afroditi K. Souldidou et al. (2018) outcomes show that cleanliness is a vital factor in selecting accommodation, followed by price and cooperative staff. Price is valuable to women and lower-income customers. The paper emphasises on statistically significant difference between the rating of women against men, where women rating hotel reputation and marketing of higher importance. Location is essential for singles, while other facilities is preferred by families.

Jammaree Choosrichem (2011), Factors influencing the selection of Hotel in Lanta Yai, Island, Krabi. The researcher identifies five core factors that influence the choice of hotels and they are: value for money, safety & security, quality of staff service, location and room services.

Alaa Nimer Abukhalifeh (2020) Factors Influencing Customer Choices: A Case Study of Budget Hotels in Seoul, South Korea, the study identified excellent service quality, value for money, hotel's brand image, food & beverage prompt service are the influencing factors of hotel selection

Dr. Vivek S. Kanade and Dr. Preeti M Kulkarni (2022) A Study on Consumer Behaviour While Selecting a Hotel for Meal in Nashik City. The cluster is made based on the likability of the customer, interest of customer which includes hospitality, service, hygiene, quality of food, and ambience, experiences of other customers, infrastructure, hotel location. The researchers conclude that consumer behaviour changes as per concerning needs and priorities while selecting hotels.

Shahab Pourfakhimi (2022) The Impact of Users' Online Reviews and Ratings on Consumers' Behaviour toward Hotel Selection Factors answers the following questions for each hotel segment like the determinant hotel attributes, the presence of eWOM changes the behaviour of leisure hotel consumers toward determinant hotel attributes, the presence of eWOM persuade leisure hotel consumers to disregard the better

offerings of a hotel in terms of determinant hotel attributes; and the presence of eWOM persuade leisure hotel consumers to prefer a new hotel over a “satisfactory tried and tested” hotel.

Factors selected for the Study:

1. Parameters for hotel selection (age, gender, income, frequency of online reviews)
2. Factors considered while selecting a hotel(Price, Location, Cleanliness, Amenities, Customer Service, Brand name)
3. Consumers Perception regarding online reviews.
4. Credibility and Reliability of Online Reviews

Objectives of the study:

1. To analyse the influence of demographic factors (e.g., age, gender, income) on consumers' reliance on online reviews for hotel selection.
2. To identify the key factors that influence consumers' decision-making process when selecting hotels based on online reviews.
3. To examine the role of online reviews in shaping consumers' perceptions and attitudes towards hotels.
4. To investigate the impact of positive and negative online reviews on consumers' hotel selection behaviour.
5. To assess the credibility and trustworthiness of online review platforms in the hotel selection process.
6. To provide recommendations for hoteliers and marketers on effective online reputation management strategies based on consumer behaviour insights.

Hypothesis:

1. H1: Online reviews have an influence on consumers’ decision-making process while selecting hotels
HO: Online reviews do not have any influence on consumers’ decision-making process while selecting hotels.
2. H1: Positive reviews increase online hotel bookings

HO: Negative reviews reduce online hotel bookings

3. H1: Online reviews are reliable and have credibility

HO: Online reviews are non-reliable and have no credibility

Research Methodology:

The paper studies the behaviour of a consumer while selecting hotels based on online reviews. The data is collected from Secondary sources such as Books, Magazines, Internet and Journals. For Primary data, the study uses quantitative as well as qualitative research where in a questionnaire survey method has been used. The research used Likert scale to collect responses on a five pointer scale. This questionnaire was distributed to respondents through Google forms.

Sampling size: 123(20 and above 60)

Sampling Method: Simple Sampling Method

Population: All those who prefer online hotel booking.

Research Tools: The researcher has used statistical tools like mean, percentage, ANOVA, Cronbach's Alpha for reliability

Online Platforms Preferred for Hotel Bookings - a brief review

MakeMyTrip :

Established in 2000, MakeMyTrip has since positioned itself as one of the leading companies, providing great offers, competitive airfares, exclusive discounts, and a seamless online booking experience to many of its customers. The experience of booking your flight tickets, hotel stay, and holiday package through our desktop site or mobile app can be done with complete ease and no hassles at all. We also deliver amazing offers, such as Instant Discounts, Fare Calendar, MyRewardsProgram, MyWallet, and many more while updating them from time to time to better suit our customers' evolving needs and demands.(Wikipedia)

Yatra.com:

Yatra.com is an Indian online travel agency and travel search engine. It is based in NCR(Delhi) In April 2012, it became the second-largest online travel service in India,

with a 30 percent share of the ₹370 billion (US\$4.6 billion) market for online travel-related transactions.(Wikipedia)

Goibibo :

Goibibo is India's leading online travel booking brand providing range of choice for hotels, flights, trains, bus and cars for travellers. Our core value differentiator is the most trusted user experience, be it in terms of quickest search and booking, fastest payments, settlement or refund processes. Through GoStays, our customers enjoy standardised stay experience at certified hotel properties. With industry first virtual travel booking currency GoCash and travel social network, GoCash+ Rewards – Goibibo is the number one choice for new India on the move .(Wikipedia)

Tripadvisor:

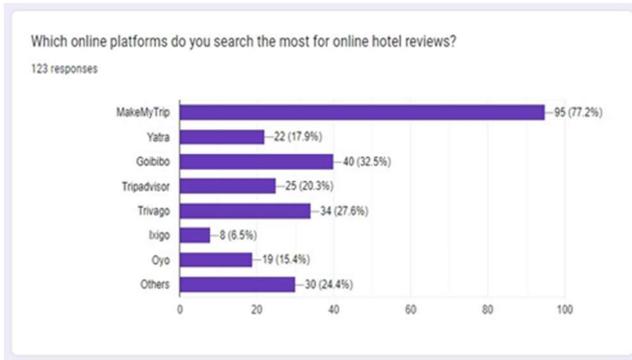
The world's largest travel platform, helps 463 million travellers each month make every trip their best trip. Travelers across the globe use the Tripadvisor site and app to browse more than 859 million reviews and opinions of 8.6 million accommodations, restaurants, experiences, airlines and cruises. Whether planning or on a trip, travelers turn to Tripadvisor to compare low prices on hotels, flights and cruises, book popular tours and attractions, as well as reserve tables at great restaurants. Tripadvisor, the ultimate travel companion, is available in 49 markets and 28 languages.(Wikipedia)

Ixigo

It is an Indian online travel portal, launched in 2007. Headquartered in Gurgaon, ixigo aggregates and compares real-time travel information, prices and availability for flights, trains, buses, and hotels, and allows ticket booking through its associate websites and apps. (Wikipedia)

OYO

OYO is a global platform that empowers entrepreneurs and small businesses with hotels and homes by providing full stack technology that increases earnings and eases operations. Bringing affordable and trusted accommodation that guest can book instantly (Wikipedia).



From the feedback collected from respondents, it can be observed that, MakeMyTrip is the most searched platform for online bookings followed by Goibibo, Trivago etc.

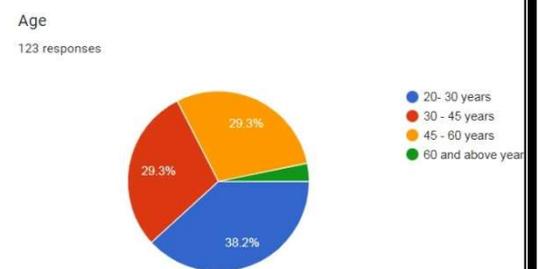
Data Analysis and Interpretation:

Cronbach's Alpha Value: Generally, a Cronbach's alpha value above 0.7 is considered acceptable, and higher values indicate stronger internal consistency. Cronbach's alpha was used to measure the internal consistency. 0.735 is the overall value of Cronbach's alpha, which indicates good stability and consistency in the data. The researcher conducted a survey involving 123 respondents from diverse backgrounds to ensure that the results are more representative and generalizable. Cronbach's alpha was used to measure the internal consistency.

1. Parameters for hotel selection (age, gender, income, frequency of online reviews)

Table 1. Demographic Profile of Respondents

Variable	Description	Frequency	Percentage
Gender	Male	60	48.8%
	Female	63	51.2%
Age	20-30 years	47	38.2%
	30-45years	36	29.3%
	45-60 years	36	29.3%
	>60years	4	3.3%
Income	<10K	20	16.9%
	10-25K	28	23.3%
	25-50 K	25	21.2%



	>50 K	45	38.1%
Frequency of reviews	Never	6	4.9%
	Sometimes	31	25.2%
	Often	44	35.8%
	Always	42	34.1%

Table 2 Reliability Statistics test for overall variables

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.940	.942	16

The reliability test results for overall sixteen variables are Cronbach's alpha score average (0.940), which indicates a high level of internal consistency. Thus it is concluded that this instrument is accepted for further statistical analysis with a satisfactory level of reliability.

2. Factors considered while selecting a hotel (Price, Location, Cleanliness, Amenities, Customer Service, and Brand name)

Table 3 Reliability Statistics on Factors

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.890	.889	6

The reliability test results are Cronbach's alpha score average (0.890), which shows a high level of internal consistency. Cronbach's Alpha Based on Standardized Items is (.889)

3. Consumers Perception regarding online review

The following factors were analysed.

- i. Good reviews increase faith, trust and possibility of booking.
- ii. Bad reviews decrease faith, trust and possibility of booking.
- iii. Detailed review provides valuable insights in taking decision.
- iv. More than the detailed review, the overall rating is more important.

Table 4 . Reliability Statistics on Consumers Perception regarding online review

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.834	.837	4

The reliability test results are Cronbach's alpha score average (.834), which shows a high level of internal consistency. Cronbach's Alpha Based on Standardized Items is (.837)

4. Credibility and Reliability of Online Reviews

The response for the following were collected

- i. Have the respondents come across false online reviews while searching for hotels?
- ii. Do the respondents leave online reviews after staying at a hotel?
- iii. What encourages the respondents to post online reviews?

Table 5 Reliability Statistics on Credibility and Reliability of Online Reviews

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.835	.844	6

The reliability test results are Cronbach's alpha score average (.835), which shows a high level of internal consistency. Cronbach's Alpha Based on Standardized Items is (.844)

Hypothesis testing:

1. H1: Online reviews have an influence on consumers' decision-making process while selecting hotels

HO: Online reviews do not have any influence on consumers' decision-making process while selecting hotels.

Table 6 ANOVA

		Sum of Squares	df	Mean Square	F	Sig.	Result
Price	Between Groups	38.093	4	9.523	11.246	.000	Accepted
	Within Groups	99.923	118	.847			
	Total	138.016	122				

Location	Between Groups	57.187	4	14.297	21.592	.000	Accepted
	Within Groups	78.130	118	.662			
	Total	135.317	122				
Cleanliness	Between Groups	47.972	4	11.993	15.169	.000	Accepted
	Within Groups	93.296	118	.791			
	Total	141.268	122				
Amenities Provided	Between Groups	58.470	4	14.617	17.882	.000	Accepted
	Within Groups	96.457	118	.817			
	Total	154.927	122				

As the computed value of F is 11.246 that are greater than the table value that is 2.447, and the p-value is 0.000 less than 0.05 at 5% significant and 95 per cent confidence level hence we accept H1 for price, for Location the computed value of F is 21.592 that is greater than the table value that is 2.447, and the p-value is 0.000 for Cleanliness value of F is 15.169 that is greater than the table value that is 2.447, and Amenities F is 11.246 conclude that there is a significant relation between online reviews and price, location, cleanliness and amenities

To establish the association between the variables researcher further conducted an ANOVA test to measure the association and relation.

Table 7. Measure of Association

Online reviews	R	R Squared	Eta	Eta Squared
Price	.465	.216	.474	224
Location	.615	.378	.628	394
Cleanliness	.523	.274	.537	288
Amenities	.584	.341	.591	349

R square values of the above table stipulate that to what extent each factor causes the variation in the Quality of food and choice of Hotel. The R square value for taste preferences is 0.639, showing that Consumer Intention explains 63.9 % of the variation in Choice of Hotel. Eta Squared value is 0.704, which shows a very high association between the quality of food and the choice of Hotel R square values of the above table stipulate that to what extent each factor causes the variation in the Quality of food and choice of Hotel. The R square value for taste preferences is 0.639, showing that Consumer Intention explains 63.9 % of the variation in Choice of Hotel. Eta Squared value is 0.704, which shows a very high association between the quality of food and the choice of Hotel R square values of the above table stipulate that to what extent each factor causes the variation in the Price, Location, Cleanliness, and Amenities. The R square value for Price is 0.216, Location 0.378, Cleanliness 0.274 Amenities 0.341 which shows Consumer Intention towards Price is 21.6, Location 37.8, Cleanliness 27.4 Amenities 34.1 of the variation in online reviews. Eta Squared value for Price is 0.474 Location. 0.591, Cleanliness 0.537, and Amenities is 0.628, which shows a very high association between the factors and online reviews.

Hypothesis testing:

H1: Good reviews increase online hotel bookings

H1: Bad reviews reduce online hotel bookings

Table 8. ANOVA

		Sum of Squares	df	Mean Square	F	Sig.	Results
Goodreviews increasefaith trust and possibilityof booking	Between Groups	47.766	4	11.941	18.030	.000	Accepted
	Within Groups	78.153	118	.662			
	Total	125.919	122				
Bad reviews decrease faith trust and possibilityofbooking	Between Groups	37.973	4	9.493	7.432	.000	Accepted
	Within Groups	150.726	118	1.277			
	Total	188.699	122				

As the computed value of F is 18.030 that are greater than the table value that is 2.447, and the p-value is 0.000 less than 0.05 at 5% significant and 95 per cent confidence level hence we accept H1 for good reviews increase faith, trust confidence. For bad

reviews the computed value of F is 9.493 that is greater than the table value that is 2.447, and the p-value is 0.000 hence we conclude that there is a significant relation between online reviews and good and bad reviews.

Table 8. Measure of Association

To establish the association between the variables researcher further conducted an ANOVA test to measure the association and relation.

Online reviews	R	R Square	Eta	Eta Squared
Good reviews	.465	.216	.474	.224
Bad reviews	.615	.378	.628	.394
Insights	.609	.371	.613	.375
Overall rating	.402	.162	.426	.181

R square values of the above table stipulate that to what extent each factor causes the variation in the Good reviews, bad reviews, insights and overall ratings. The R square value for good reviews is 0.216, Bad reviews is .378 , insights is .371 and overall rating is .162 which shows Consumer Intention towards good reviews is 21.6, Bad reviews is 37.8 , insights is 37.1 and overall rating is 16.2 of the variation in online reviews. Eta Squared value for good reviews is 0.224, Bad reviews is .394 , insights is .375 and overall rating is .181 which shows a very high association between the factors and online reviews.

Hypothesis testing:

H1: Online reviews are reliable and have credibility

HO: Online reviews are non-reliable and have no credibility

Table 9 ANOVA

		Sum of Squares	df	Mean Square	F	Sig.	Results
Consistency across various online platforms	Between Groups	66.163	4	16.541	32.610	.000	Accepted
	Within Groups	59.853	118	.507			
	Total	126.016	122				
Written content of the review	Between Groups	43.249	4	10.812	17.455	.000	Accepted
	Within Groups	73.093	118	.619			
	Total	116.341	122				
Photos	Between Groups	32.514	4	8.129	8.397	.000	Accepted
	Within Groups	114.234	118	.968			
	Total	146.748	122				

As the computed value of F is 32.610 that are greater than the table value that is 2.447, and the p-value is 0.000 less than 0.05 at 5% significant and 95 per cent confidence level hence we accept H1 for Consistency across various online platforms. For Written content of the review the computed value of F is 10.812 that is greater than the table value that is 2.447, Photos 8.397 greater than the table value that is 2.447 and the p-value is 0.000 hence we conclude that there is a significant relation between online reviews and reliability and consistency

Table 10 Measure of Association

Online reviews	R	R Squared	Eta	Eta Squared
No of Reviews	0.562	0.316	0.602	0.362
Overall ratings	0.454	0.206	0.467	0.218
Credibility	0.483	0.233	0.534	0.285
Consistency	0.465	0.233	0.483	0.233
Written content	0.534	0.285	0.571	0.326
Photos	0.450	0.202	0.524	0.274

R square values of the above table stipulate that to what extent each factor causes the variation in the No of Reviews 0.316 Overall ratings 0.206, Credibility 0.233,

Consistency 0.233, written content 0.285 Photos 0.202. The Eta Squared value for No of Reviews 0.362, overall ratings 0.218, Credibility 0.285, Consistency 0.233, Written content 0.326 , Photos 0. 274 which shows Respondents Intention towards No of Reviews 36.2% Overall ratings 21.8%, Credibility 28.5%, Consistency 23.3 %, Written content 32.6% Photos 27.4% of the variation in online reviews, which shows a very high association between the factors and online reviews.

Findings:

With the help of the research data, it can be analysed that,

- Online reviews have a significant impact Consumer Selection of Hotels
- Consumer intention to select Hotel is the result of the good and bad reviews provided on online platforms.
- The written content about online reviews, overall ratings highly influences the choice of Hotel
- Reviews serve as a means to continuously improve services and address issues highlighted by guests

Conclusion:

In conclusion, these reviews highlight the critical factors for effective hotel review management and customer satisfaction:

Transparency and Authenticity:

Customers value honesty and accurate representation, emphasizing the need for genuine photos, pricing, and information about amenities.

Quality Service at Reasonable Rates:

The focus on delivering quality service at reasonable prices is paramount in maintaining guest satisfaction.

Encouraging Honest Reviews:

Hotels should motivate guests to leave honest reviews by offering incentives, which helps provide a well-rounded perspective for potential visitors.

Cleanliness and Safety:

Cleanliness is a top priority, with emphasis on hygiene and safety measures for guests.

Feedback Channels:

Having easily accessible feedback forms both online and offline demonstrates a commitment to improving guest experiences.

Engagement with Feedback:

Responding to reviews, especially addressing negative ones, shows dedication to enhancing service and customer satisfaction.

Validation and Verification:

Review validation is essential to ensure authenticity and credibility, preventing fake or biased feedback.

Improvement and Accountability:

Reviews serve as a means to continuously improve services and address issues highlighted by guests.

Staff Attitude and Guest Experience:

A positive and caring staff attitude, along with personalized experiences, contribute to creating a positive impression.

Consistency and Honesty:

Consistently delivering promised services, maintaining truthful descriptions, and managing expectations are crucial for guest satisfaction.

Overall, hotels should prioritize guest needs, uphold transparency, encourage honest feedback, and actively work on refining their services based on reviews. Effective review management is a powerful tool for maintaining a positive reputation and retaining loyal customers.

Future Research Directions:

Exploring future research directions in the field of consumer selection of hotels based on online reviews can help advance our understanding of this dynamic and evolving area. Some potential research directions are as follows:

Cross-Cultural Analysis: Investigation of how cultural differences influence consumers' interpretation and reliance on online reviews when selecting hotels.

Review Authenticity and Fake Reviews: The issue of fake reviews is a concern. Research focusing on developing algorithms or methodologies to identify and mitigate the impact of fake reviews on consumer decisions.

These research directions can help academics, industry professionals, and policymakers gain a deeper understanding of how online reviews shape consumer behavior in the context of hotel selection. As technology and consumer preferences continue to evolve, staying at the forefront of research in this field will be crucial for staying relevant and making informed decisions.

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Pathways to Prosperity: Sustainable Tourism's Impact on Employment and Cultural Heritage in Ratnagiri District

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Abstract

Ratnagiri District in Maharashtra is known for its coastal beauty, Alphonso mangoes, Konkani culture and historic heritage. However, despite its rich resources, a large number of people migrate from Ratnagiri to Mumbai in search of employment. This continuous migration affects local culture, reduces community participation and creates pressure on urban centers like Mumbai. Sustainable tourism offers a potential solution by creating local employment, strengthening cultural identity and supporting economic development without harming natural resources.

This study examines how sustainable tourism can reduce migration by generating stable employment and preserving cultural heritage in Ratnagiri District. A quantitative research method was used and data were collected from 225 respondents including local residents, tourism workers, migrants' families, entrepreneurs and tourists. Statistical techniques such as descriptive statistics, chi-square tests and correlation analysis were applied using SPSS software. Results show that sustainable tourism significantly contributes to employment opportunities in the district, especially in homestays, agro-tourism centres, local food services, handicraft production and transport services. The findings also reveal that sustainable tourism supports the revival of Konkani culture, local art forms, festivals and community traditions. Respondents strongly agreed that if adequate tourism-related jobs are

created locally, migration to Mumbai will reduce, leading to better health, stronger families, cultural stability and balanced population distribution.

The study recommends capacity-building programs, improved tourism infrastructure, skill development, promotion of cultural products and a strong partnership between government, community and tourism entrepreneurs. Sustainable tourism can serve as a major pathway to prosperity for Ratnagiri by generating economic growth while protecting cultural and natural heritage.

Keywords: Sustainable Tourism, Employment opportunities, Local Culture, Cultural Heritage.

1. Introduction

Ratnagiri District, located along the Konkan coast of Maharashtra, is rich in natural beauty, fertile agricultural land, fishing resources and vibrant cultural traditions. The region is known for its scenic beaches, forts, temples, mangrove forests, Alphonso mango orchards and traditional Konkani lifestyle. Despite these strengths, Ratnagiri faces the persistent challenge of economic migration. Every year, thousands of young men and women migrate to Mumbai for employment opportunities, as local job options remain limited. This migration affects Ratnagiri's socio-cultural fabric and creates stress on Mumbai's already dense population.

Sustainable tourism has emerged as a promising strategy to address this issue. It promotes responsible travel that benefits local communities, creates employment, protects the environment and preserves cultural heritage. Ratnagiri's natural and cultural resources make it an ideal location for sustainable tourism activities such as eco-tourism, agro-tourism, heritage tourism, marine tourism and cultural tourism.

If tourism-based employment opportunities are strengthened within Ratnagiri, many residents may choose to work locally instead of migrating to Mumbai. This can help sustain Ratnagiri's culture, improve family well-being, reduce health risks associated with urban living and support decentralization by reducing population pressure on Mumbai.

This research examines how sustainable tourism can serve as a pathway to prosperity in Ratnagiri District by generating employment, preserving cultural heritage and reducing migration.

2. Objectives of the Study

1. To evaluate the role of sustainable tourism in employment generation in Ratnagiri District.
2. To analyze how sustainable tourism contributes to preserving Konkani culture and local heritage.
3. To study reasons for migration from Ratnagiri to Mumbai and explore how tourism can reduce migration.
4. To examine the relationship between sustainable tourism development, employment creation and cultural sustainability.
5. To provide suggestions for strengthening sustainable tourism as a long-term development strategy.

3. Significance of the Study

The study holds great significance as it explains how sustainable tourism can create stable local employment opportunities in Ratnagiri and reduce the long-standing issue of migration to Mumbai. It helps in understanding how tourism can protect and promote Ratnagiri's rich cultural heritage, including traditional arts, festivals, food practices and community identity. The research provides evidence-based insights that can assist policymakers, tourism planners and local authorities in designing development strategies that balance economic growth with cultural preservation. It also supports the broader goal of reducing population pressure on metropolitan cities like Mumbai by strengthening rural and semi-urban economies. The study contributes to the achievement of Sustainable Development Goals such as decent work (SDG 8), sustainable communities (SDG 11) and responsible consumption and production (SDG 12). Additionally, the research offers practical guidance for local entrepreneurs and youth who are interested in establishing tourism-related ventures, thereby encouraging self-employment and inclusive growth in Ratnagiri District.

4. Research Methodology :

4.1 Research Design :

A quantitative research design was adopted. The study used structured questionnaires and statistical analysis through SPSS.

4.2 Sample Size :

The study consists of 225 respondents from the Ratnagiri district.

4.3 Sampling Method :

A combination of stratified sampling and convenience sampling was used. Respondents were selected from Ratnagiri, Chiplun, Guhagar, Dapoli, Rajapur, Lanja, Sangameshwar.

4.4 Data Collection: Primary data were collected through a structured questionnaire consisting of Demographic information, Migration reasons, Tourism employment opportunities, Cultural heritage preservation and Perception of sustainable tourism.

4.5 Statistical Tools: Statistical Tools used for the data Frequency & percentage, Mean & standard deviation, Chi-square test, Pearson correlation

4.6 Hypotheses :

H1: Sustainable tourism significantly contributes to employment generation in Ratnagiri.

H2: Sustainable tourism positively influences cultural heritage preservation.

H3: Sustainable tourism can significantly reduce migration from Ratnagiri to Mumbai.

5. Data Analysis and Interpretation:

5.1 Demographic Profile

Variable	Category
Gender	Male 60%, Female 40%
Age	18–30 (35%), 31–45 (45%), 46–60 (20%)
Occupation	Tourism workers 28%, Local business owners 22%, Residents 30%, Tourists 10%, Migrants' families 10%
Education	Secondary 30%, Graduate 48%, Postgraduate 22%

Source: Compiled Data

Interpretation: The majority belong to economically active age groups, making their responses reliable for employment-related analysis.

5.2 Migration Patterns

67% respondents reported that at least one family member works in Mumbai.

52% said lack of stable income in Ratnagiri is the main reason for migration.

49% agreed that sustainable tourism can reduce migration.

5.3 Perception of Sustainable Tourism

Statement	Agree (%)	Neutral (%)	Disagree (%)
Tourism generates local employment	82	10	8
Tourism reduces need to migrate	69	18	13
Tourism supports health and well-being	71	16	13
Tourism helps preserve Konkani culture	77	14	9

Source: Compiled Data

5.4 Employment Impact (Descriptive Statistics)

Sector	% Respondents Reporting Growth
Homestays	74%
Agro-tourism	69%
Transport (Jeep, Rickshaw, Boats)	65%
Local food services	72%
Handicrafts	61%
Tour guides	58%

Source: Compiled Data

Interpretation: The tourism sector shows strong potential for employment diversification.

5.5 Cultural Heritage Preservation

Tourism strengthened:

Festivals (Ganesh Utsav, Narali Pournima, Yatra) – 78%

Traditional arts (Dashavatar, Naman, Zakhadi, Konkani dance forms) – 72%

Local food identity – 81%

Historic sites (Thibaw Palace, forts, temples, lighthouses) – 69%

Interpretation: Tourism helps revive and promote culture.

5.6 Chi-square Test (H1: Tourism & Employment)

$\chi^2 = 24.35$, $p < 0.05$ → **Significant**

Interpretation: Sustainable tourism significantly contributes to employment generation.

5.7 Chi-square Test (H2: Tourism & Cultural Preservation)

$\chi^2 = 18.92$, $p < 0.05$ → **Significant**

Interpretation: Tourism has a strong impact on cultural preservation.

5.8 Chi-square Test (H3: Tourism & Migration Reduction)

$\chi^2 = 20.11, p < 0.05 \rightarrow$ **Significant**

Interpretation: Sustainable tourism can reduce migration to Mumbai by offering local job opportunities.

5.9 Correlation Analysis

Variables	Correlation (r)	Significance
Tourism & Employment	0.66	Significant
Tourism & Cultural Heritage	0.59	Significant
Tourism & Migration Reduction	0.52	Moderate but significant

Interpretation: Tourism development strongly supports employment and culture and moderately reduces migration.

6. Findings:

1. Tourism in Ratnagiri has high potential for creating sustainable employment across many sectors.
2. A large proportion of the population migrates to Mumbai due to inadequate local employment opportunities.
3. Respondents believe that better tourism opportunities can reduce migration.
4. Tourism strengthens local Konkani culture, arts, festivals, food traditions and community pride.
5. Sustainable tourism contributes positively to health and well-being by reducing urban stress.
6. Statistical tests confirmed significant relationships between tourism development, employment generation and cultural sustainability.
7. Lack of infrastructure, limited skill development and seasonal fluctuations are major challenges.
8. Community participation in tourism initiatives is growing but needs formal support.

7. Suggestions:

1. Establish skill training centres to provide practical courses in hospitality, guiding, handicrafts and digital tourism, helping local youth gain employment within Ratnagiri.

2. Promote agro-tourism and homestays so that local families can earn year-round income by showcasing farms, coastal villages and traditional lifestyles.
3. Improve basic infrastructure such as roads, sanitation, public transport and digital connectivity to create a better experience for visitors and support tourism services.
4. Provide government incentives like subsidies, low-interest loans and youth-focused schemes to encourage small tourism businesses and entrepreneurship.
5. Strengthen marketing efforts by developing a unified “Brand Ratnagiri” to promote beaches, Alphonso mangoes and cultural heritage more effectively.
6. Increase community participation by involving local people, SHGs and cooperatives in tourism planning and decision-making for more sustainable and inclusive development.

8. Conclusion

Sustainable tourism can be a major pathway to prosperity for Ratnagiri District. The study shows that tourism significantly contributes to employment, preserves cultural heritage and has the potential to reduce migration to Mumbai. With strong community participation, government support and effective marketing strategies, Ratnagiri can generate stable economic opportunities locally. This will help sustain Konkani cultural heritage, improve health and well-being and ensure balanced population distribution across Maharashtra. Sustainable tourism offers a future where Ratnagiri grows economically while maintaining its identity, traditions and natural beauty.

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The Role of Digital Transformation in Building Sustainable and Resilient Business Practices: A Conceptual Study

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Abstract

The post-pandemic global economy has accelerated digital transformation across industries, compelling organizations to adopt sustainable and resilient business models. This conceptual study examines how digital transformation drives organizational sustainability, resilience, and innovation in commerce and management. Drawing upon existing literature, the paper explores the integration of technology, human capital, and responsible leadership as enablers of adaptive and ethical business practices. The study proposes a conceptual framework that connects digital innovation with sustainable organizational outcomes, emphasizing resilience as a key strategic capability. The findings contribute to theoretical understanding and managerial implications for businesses operating in volatile, uncertain, complex, and ambiguous (VUCA) environments.

Keywords: *Digital Transformation, Sustainability, Business Resilience, Innovation, Responsible Management.*

1. Introduction:

The dynamic nature of global commerce and management has made **digital transformation** an essential element of strategic competitiveness (Kane, G. C. et al., 2016). The rise of disruptive technologies, coupled with environmental and social pressures, has redefined how organizations pursue growth, manage risk, and ensure long-term sustainability.

The COVID-19 pandemic exposed vulnerabilities in traditional business models and underscored the need for **resilient and responsible practices** (McKinsey, 2022).

Businesses that integrated digital technologies with sustainable leadership demonstrated greater adaptability and stakeholder trust (World Economic Forum, 2023).

This study aims to explore how digital transformation acts as a catalyst for developing sustainable and resilient enterprises. It presents a conceptual framework linking digital innovation, organizational agility, and responsible management to long-term business success.

2. Literature Review:

An extensive literature review has been carried out so as to get better insight into the study.

2.1 Digital Transformation in Business:

Digital transformation refers to the strategic use of technologies such as artificial intelligence (AI), data analytics, and cloud computing to improve processes, products, and stakeholder engagement (Vial, G., 2019). Beyond efficiency, it transforms corporate culture, enabling continuous innovation and responsiveness to environmental changes (Westerman, G. et al., 2014).

2.2 Sustainability and Responsible Business Practices:

Sustainability emphasizes balancing economic growth with environmental and social responsibility (Elkington, J., 1997). Responsible business practices incorporate ethics, transparency, and stakeholder well-being into strategic decisions. As digital platforms expand, responsible data use, cybersecurity, and ethical AI have become integral components of sustainable management (George, G. et al., 2021).

2.3 Organizational Resilience:

Organizational resilience is the ability to anticipate, prepare for, respond to, and adapt to disruptions (Lengnick-Hall, C. A. & Beck, T. E., 2005). Digital tools enhance resilience by facilitating real-time information flow, predictive analytics, and decentralized decision-making (Bharadwaj, A. et al., 2013).

2.4 Linking Digital Transformation, Sustainability, and Resilience:

The integration of digital technology with responsible governance practices creates “sustainable digital enterprises.” These organizations leverage technology not only for profit but also for social and environmental impact (Kraus, S. et al., 2021). Thus, digital

transformation serves as both a driver of innovation and a mechanism for risk management in volatile markets.

3. Research Design:

This paper adopts a **conceptual research design**, relying on secondary data from academic journals, institutional reports, and theoretical models. The study synthesizes literature from management, information systems, and sustainability fields to propose an integrative conceptual framework. The focus is on qualitative interpretation rather than empirical testing.

4. Discussion and Conceptual Framework:

A more specific discussion on the conceptual framework covered under the study presented hereunder.

4.1 Digital Transformation as an Enabler of Sustainability:

Digital technologies enable firms to monitor environmental performance, reduce waste, and optimize supply chains through real-time analytics. For example, blockchain and IoT systems increase transparency in supply chains, helping companies align with sustainability goals (PwC, 2023).

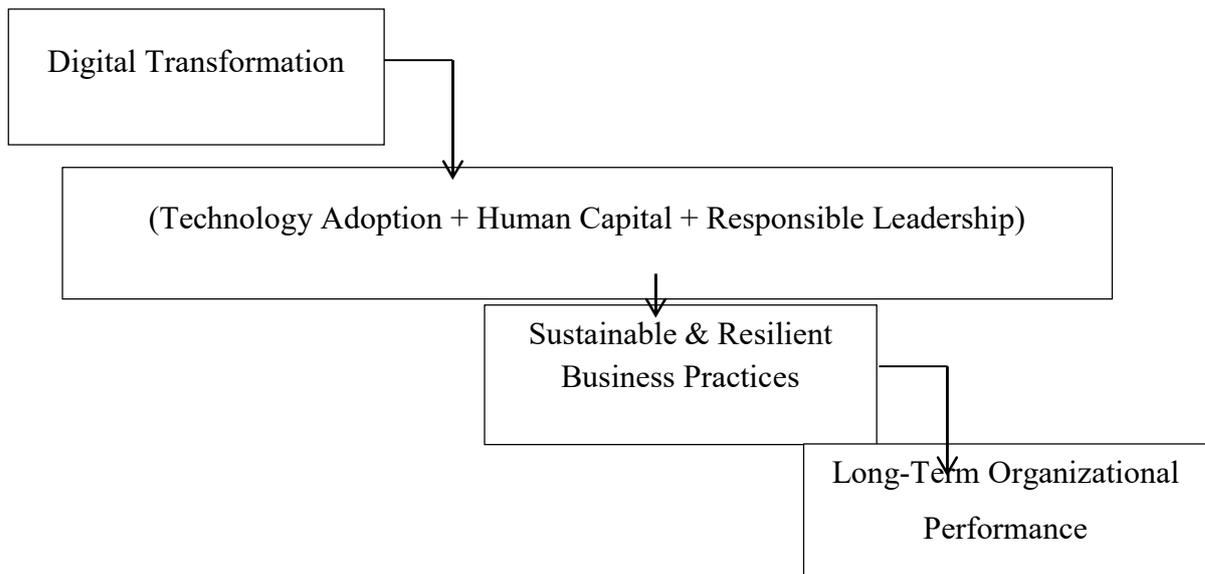
4.2 Human Capital and Organizational Agility:

Human capital through continuous learning and digital literacy is a critical factor in successful digital transformation. Agile organizations empower employees to use technology responsibly, fostering innovation and adaptability (Becker, G. S., 1993; Doz, Y. L. & Kosonen, M., 2010).

4.3 Proposed Conceptual Framework:

The proposed conceptual framework is as depicted in the given diagram.

Figure 1: Conceptual Framework Linking Digital Transformation, Sustainability, and Resilience



This model suggests that digital transformation indirectly enhances organizational performance by embedding sustainability and resilience into strategic management. The mediating roles of **human capital** and **leadership ethics** are critical for translating technology adoption into sustainable outcomes.

4.4 Implications: The implications of this study are much concern with managers, policymakers, and researchers as well.

- **For Managers:** Adopt a human-centered approach to digitalization, emphasizing ethics and environmental responsibility.
- **For policymakers:** Encourage regulations that balance digital innovation with sustainable development.
- **For researchers:** Empirically test the proposed framework using cross-sectoral data.

5. Conclusions:

This theoretical paper emphasizes that **digital transformation**, when aligned with **responsible leadership and human capital development**, drives both sustainability and resilience in business. In a volatile and uncertain global environment, resilience is no longer an operational attribute but a strategic imperative. The proposed conceptual model provides

a foundation for future empirical research and managerial action toward sustainable digital enterprises.

6. Acknowledgement:

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7. References:

The various sources used are duly cited in the body of the paper are given hereunder according to APA 7th Edition.

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मृदुला गर्ग और उनकी कहानी-साहित्य का आधुनिक दृष्टि से अध्ययन ।

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सारांश –

हिंदी साहित्य में प्रगतिशील और आधुनिक कथा-धारा को उर्वर बनाने में जिन लेखिकाओं और साहित्यकारों ने महत्वपूर्ण योगदान दिया है, उनमें मृदुला गर्ग का नाम अत्यंत सम्मान के साथ लिया जाता है। वे उन रचनाकारों में से हैं जिन्होंने समाज, राजनीति, संस्कृति और परिवार के पारंपरिक ढांचे को मात्र चित्रित करने के बजाय उनकी गहरी विवेचना की है। उनकी कहानियाँ आधुनिक मनुष्य के जीवन-संघर्ष, उसकी मनोवैज्ञानिक उलझनों, स्त्री-पुरुष संबंधों के बदलते स्वरूप, और तेजी से बदल रहे सामाजिक परिवेश में मनुष्य की पहचान की खोज को केंद्र में रखती हैं।

आधुनिकता के विविध आयाम—व्यक्ति-स्वातंत्र्य, यथार्थवाद, मनोविश्लेषण, उपभोक्तावाद, नगरीय तनाव, स्त्री-स्वायत्तता—मृदुला गर्ग के कथा-साहित्य में सशक्त रूप से दर्शाए गए हैं।

प्रस्तावना -

हिंदी साहित्य के आधुनिक कथा साहित्य में मृदुला गर्ग का नाम एक सशक्त और विशिष्ट स्वर के रूप में उभरता है। उन्होंने स्त्री-चेतना, देह-बोध, सामाजिक विसंगतियों, मध्यवर्गीय दुविधाओं और मानवीय संबंधों की जटिलताओं को जिस ईमानदारी, तटस्थता और साहस के साथ सामने रखा है, वह उन्हें समकालीन लेखन में एक अलग पहचान देता है। परंपरागत स्त्री-लेखन की सीमाओं को तोड़ते हुए उन्होंने स्त्री को केवल पीड़ित की भूमिका में नहीं दिखाया, बल्कि एक स्वतंत्र विचारशील, इच्छाशील और सक्रिय व्यक्तित्व के रूप में प्रस्तुत किया है।

कहानियों में आधुनिक जीवन की विसंगतियों का तीखा अवलोकन, व्यंग्यात्मक उपस्थिति, मनोवैज्ञानिक विश्लेषण और भाषाई सूक्ष्मता स्पष्ट रूप से दिखाई देती है। मृदुला गर्ग की रचनाएँ केवल सामाजिक यथार्थ का दर्पण नहीं हैं, बल्कि उस यथार्थ के भीतर छिपी मानवीय जटिलताओं को उधेड़ने का प्रयास भी करती हैं।

इस शोध-पत्र में उनकी कहानियों को आधुनिक दृष्टि से समझने का प्रयास किया गया है—अर्थात् समकालीन सामाजिक-सांस्कृतिक परिवेश, नारीवाद, मनोविश्लेषण, अस्तित्ववाद और आधुनिक जीवन-दृष्टि के संदर्भ में उनकी कथा-साहित्य का अध्ययन किया गया है।

उद्देश्य -

१. मृदुला गर्ग के कहानी-साहित्य की विशिष्टताओं का विश्लेषण करना।
२. कहानियों में चित्रित स्त्री-चेतना, देह-बोध और स्वतंत्रता-बोध को आधुनिक नारीवादी संदर्भ में समझना।
३. कहानियों के प्रति रुचि बढ़ाना।
- ४ कहानी की शैली, तकनीक, भाषा और व्यंग्य की भूमिका की समीक्षा करना।
५. उनके कथा-साहित्य में उभरते मनोवैज्ञानिक एवं अस्तित्ववादी पक्षों का विश्लेषण करना।
६. समकालीन सामाजिक-सांस्कृतिक मूल्य-संघर्षों का उनकी कहानियों में रूपांकन पहचानना।
७. कथा-साहित्य के माध्यम से आधुनिक हिंदी कहानी-धारा में मृदुला गर्ग के योगदान को स्पष्ट करना।

मृदुला गर्ग और उनकी कहानी-साहित्य का आधुनिक दृष्टि से अध्ययन-

(क) मृदुला गर्ग की कहानियों में स्त्री-चेतना और स्त्री-अस्तित्व का प्रश्न दिखाई देता है। स्त्री केवल संबंधों में बंधी इकाई नहीं है, वह स्वतंत्र विचारशील मन है। उनकी कहानियों पितृसत्तात्मक संरचनाओं का प्रतिरोध किया गया है। विवाह, परिवार और प्रेम के पारंपरिक ढाँचों पर प्रश्नचिह्न किये गए हैं। स्त्री की इच्छाओं, आकांक्षाओं और स्वायत्तता का स्वाभाविक चित्रण किया गया है।

(ख) उनकी कहानियों में देह-बोध और लैंगिकता का निष्कपट प्रस्तुतीकरण किया गया है। देह को शर्म या अपराध से नहीं, बल्कि अनुभव और अस्तित्व से जोड़ना है। कहानियों द्वारा स्त्री की कामना और संवेदना का यथार्थवादी चित्रण किया गया है।

(ग) उनकी कहानियों में मध्यमवर्गीय जीवन की विडंबनाएँ, दिखावा, नैतिकता और सामाजिक आडंबर का व्यंग्यात्मक उद्घाटन किया गया है। संस्कार और आधुनिकता के टकराव से उत्पन्न संघर्ष दिखाया है।

(घ) उनकी की कहानियों में मनोवैज्ञानिक जटिलताएँ, आत्म-संघर्ष, पात्रों के भीतर चल रहे द्वंद्व, अपराधबोध, इच्छाओं और दबावों का चित्रण किया गया है।

(ङ) उनकी की कहानियों में आधुनिक जीवन-शैली की विकृतियाँ, उपभोक्तावाद, अकेलापन, पहचान का संकट, तकनीक और आधुनिकता के कारण बदलते रिश्तों का दर्शन होता है।

मृदुला गर्ग के कहानी-साहित्य का आधुनिक दृष्टि से विश्लेषण-

1. स्त्री-वादी दृष्टिकोण और मृदुला गर्ग-

मृदुला गर्ग स्वयं को कट्टर नारीवादी नहीं कहतीं, पर उनका साहित्य मौलिक भारतीय नारीवाद का प्रतिनिधित्व करता है। उनकी कहानियाँ स्त्री पर होने वाले सांस्कृतिक-सामाजिक दबावों को उजागर करती हैं, लेकिन स्त्री को केवल पीड़ित नहीं बनातीं। वे स्त्री को चुनाव करने वाली और परिणाम भुगतने को तत्पर व्यक्तित्व के रूप में प्रस्तुत करती हैं। उनकी चर्चित कहानी “कवच”में स्त्री देह को लेकर समाज का दोगलापन उभरता है—एक ओर पुरुष स्त्री से शालीनता की अपेक्षा करता है, दूसरी ओर वही स्त्री-देह उसकी इच्छा का केंद्र है। कहानी आधुनिक नारीवाद के उस पक्ष को रेखांकित करती है जो स्त्री के शरीर को स्वयं उसकी संपत्ति के रूप में देखता है।

इसी प्रकार “दूसरी तरफ़” कहानी में स्त्री अपने दांपत्य, प्रेम और इच्छाओं के बीच झूलती है। समाज उसे निर्णय देने की अनुमति नहीं देता, लेकिन मृदुला गर्ग उसे अपने रास्ते चुनने का अधिकार देती हैं।

2. मनोवैज्ञानिक अंतःसंघर्ष-

मृदुला गर्ग की कहानियाँ अक्सर पात्रों के मानसिक उलझावों में प्रवेश करती हैं। उनकी कथा-तकनीक आंतरिक स्वगत और मनोविश्लेषणात्मक शैली पर आधारित है।

उदाहरण के लिए, “मैं और वे” कहानी में नायिका अपने परिवार और सामाजिक परिधि में रहते हुए अपनी पहचान खोजती है। वह अपने भीतर दो व्यक्तित्वों को महसूस करती है—एक जो समाज को खुश करता है, और दूसरा जो भीतर से विद्रोह करता है। यह द्वंद्व आधुनिक मनोविज्ञान की फ्रॉयडियन और युंगियन अवधारणाओं से मेल खाता है।

3. व्यंग्य और भाषा की विशिष्टता-

मृदुला गर्ग की भाषा सरल होने के बावजूद अर्थों में बहुस्तरीय है। वे सामाजिक पाखंड पर तीखा व्यंग्य करती हैं, लेकिन भाषा में कटुता नहीं लातीं। उनकी कहानियों में व्यंग्य, व्यंजना, और सांस्कृतिक संकेतों का प्रयोग आधुनिक हिंदी कथा को विशिष्ट बनाता है। “अनित्य” और “सज़ा” जैसी कहानियाँ सामाजिक मान्यताओं पर व्यंग्य करती हैं—जहाँ मानवीय संबंधों की नश्वरता और नैतिकता की कृत्रिमता दोनों को उजागर किया गया है।

4. आधुनिक जीवन और अस्तित्ववादी संकट-

अस्तित्ववादी चिंता—“मैं कौन हूँ?”—उनकी कई कहानियों का प्रमुख केंद्र है। आधुनिक समाज में व्यक्ति अकेलेपन, असंतोष और पहचान-संघर्ष से गुजरता है। “विपर्यय” और “तीसरी संभावना” जैसी कहानियाँ मनुष्य के भीतर की गहरी खालीपन और रिश्तों की अस्थिरता को सामने लाती हैं। यह आधुनिक अस्तित्ववाद की अवधारणाओं से जुड़ा है—विश्वास का टूटना, रिश्तों का बोझ, अस्तित्व की अनिश्चितता।

5. सामाजिक विसंगतियों का चित्रण-

मध्यवर्गीय समाज की रोजमर्रा की समस्याएँ दिखावा, नैतिक दबाव, सामाजिक प्रतिष्ठा—उनकी कहानियों में बार-बार उभरती हैं। वे यह दिखाती हैं कि यह वर्ग नैतिकता का मुखौटा पहनकर जीता है, लेकिन भीतर से भय और असुरक्षा से भरा है।

“दस्तक” में यह स्पष्ट दिखता है कि कैसे सामाजिक व्यवस्था स्त्री को स्वायत्त निर्णय लेने से रोकती है। कहानी आधुनिक नैतिकताओं पर गंभीर प्रश्न उठाती है।

निष्कर्ष-

आधुनिक हिंदी कहानी में मृदुला गर्ग की भूमिका अत्यंत महत्वपूर्ण है। उन्होंने स्त्री-लेखन को नई दिशा दी—जहाँ स्त्री केवल ‘विषय नहीं, बल्कि ‘लेखक और ‘विचारक’ के रूप में उभरती है। उनकी कहानियाँ समाज के पाखंड, नैतिक विसंगतियों और आधुनिक मनुष्य के अस्तित्ववादी संकटों को अत्यंत सजीव चित्रित करती हैं।

आधुनिक दृष्टि से देखने पर उनकी रचनाएँ केवल नारीवाद का दस्तावेज़ नहीं, बल्कि मनुष्य के संपूर्ण अस्तित्व का विश्लेषण प्रतीत होती हैं। यही कारण है कि मृदुला गर्ग का कहानी-साहित्य आज भी प्रासंगिक है, चुनौतीपूर्ण है और चिंतन को प्रेरित करता है।

संदर्भ-

१. मृदुला गर्ग व्यक्तित्व और कृतित्व, सम्पूर्ण कहानियाँ, मृदुला गर्ग पृष्ठ-१
२. मृदुला गर्ग कहानियाँ – मृदुला गर्ग. राजकमल प्रकाशन, नई दिल्ली।
३. मृदुला गर्ग कितने नैराश्य. राजकमल प्रकाशन।
४. मृदुला गर्ग दस्तक (कहानी-संग्रह)।
५. गिरिजा नंदा, समकालीन भारतीय नारी-लेखन. वाणी प्रकाशन।
६. विजय मिश्र, आधुनिक हिंदी कहानी का विकास. साहित्य भवन।
७. कुसुम शर्मा, हिंदी में नारीवादी कथा-धारा. भारतीय ज्ञानपीठ।
८. सुधा तिवारी, समकालीन कथा-साहित्य में स्त्री-अनुभव.
९. निर्मला चौधरी, हिंदी कहानी की नारी-चेतना.

“ राम वनगमन ” – एक आध्यात्मिक चिंतन

डॉ चित्रा मिलिंद गोस्वामी

प्रोफेसर, हिंदी विभाग

गोगटे जोगळेकर महाविद्यालय, स्वायत्त, रत्नागिरी

प्रस्तावना-

भारतीय संस्कृति में रामायण केवल एक धार्मिक ग्रंथ या पौराणिक कथा नहीं है, बल्कि यह भारतीय समाज की आत्मा है, जो धर्म, मर्यादा, कर्तव्य और आदर्शों का जीवंत प्रतीक है। मर्यादा पुरुषोत्तम श्रीराम का जीवन प्रत्येक युग में आदर्श पुरुषार्थ का मार्गदर्शन देता आया है।

राम के जीवन की सबसे महत्वपूर्ण घटनाओं में से एक है — वनगमन। यह प्रसंग केवल अयोध्या के एक राजकुमार के वन जाने की कथा नहीं है। यह त्याग, धर्मपालन, वचननिष्ठा और आत्मशुद्धि की एक गहन आध्यात्मिक यात्रा का प्रतीक है।

राम का वनगमन उनके जीवन के उस मोड़ को दर्शाता है जहाँ उन्होंने सत्ता, सुखसुविधा और राजवैभव का - परित्याग कर, कठिन जीवन को धर्म के लिए चुना। उन्होंने यह वनवास पिता की आज्ञा और धर्म की मर्यादा को निभाने हेतु स्वीकार किया। यह प्रसंग सिखाता है कि सच्चा धर्म केवल पूजा या अनुष्ठान नहीं, बल्कि अपने कर्तव्य और सत्य के प्रति पूर्ण निष्ठा है।

रामायण का यह प्रसंग केवल ऐतिहासिक दृष्टि से ही नहीं, मनोवैज्ञानिक और आध्यात्मिक दृष्टि से भी अत्यंत महत्वपूर्ण है। यह बताता है कि जीवन में जब विपरीत परिस्थितियाँ आती हैं, तो व्यक्ति को आत्मसंयम, समत्व और विश्वास के साथ आगे बढ़ना चाहिए।

उद्देश्य-

1 राम वनगमन. प्रसंग के आध्यात्मिक और प्रतीकात्मक अर्थ का विश्लेषण करना।

2. इस प्रसंग में छिपे धर्म, त्याग और साधना के तत्वों को पहचानना।
3. राम वनगमन केवल बाह्य घटना नहीं, बल्कि आंतरिक आत्मिक यात्रा का प्रतीक है यह समझना।
4. आधुनिक जीवन में इस प्रसंग की प्रासंगिकता को स्पष्ट करना।
5. राम के वनगमन का दर्शन मनुष्य को जीवन के संघर्षों में मार्गदर्शन देता है यह अध्ययन करना।

1. आध्यात्मिक दृष्टि से विश्लेषण-

(क) धर्म और मर्यादा की सर्वोच्चता-

राम का वनगमन धर्म और मर्यादा की रक्षा का सबसे उज्ज्वल उदाहरण है। जब कैकेयी ने राजा दशरथ से दो वरदान माँगे और परिणामस्वरूप राम को चौदह वर्ष के लिए वनवास जाना पड़ा, तब भी राम ने पिता के वचन को सर्वोच्च माना। उन्होंने न क्रोध किया, न विरोध। यह दर्शाता है कि सच्चा धर्म वह है जो कठिनाई में भी अपने कर्तव्य से विमुख न हो। वाल्मीकि रामायण में राम कहते हैं –

“पितु वचनं सत्यं कर्तव्यं मम नान्यथा।”¹ (वाल्मीकि रामायण, अयोध्या काण्ड)

यह वचन धर्मपालन की उस भावना को प्रकट करता है, जो व्यक्ति को आत्मबल और शांति प्रदान करती है।

(ख) त्याग और समत्व की भावना-

वनगमन केवल भौतिक सुखों का त्याग नहीं, बल्कि मानसिक समत्व का प्रतीक है। राम ने राजसुख, सिंहासन, और राज्याभिषेक के अवसर पर बिना क्लेश के वन को स्वीकार किया। उनका यह समत्व भाव गीता के कर्मयोग की व्याख्या करता है — निष्काम कर्म के माध्यम से आत्मशुद्धि। आध्यात्मिक रूप से यह बताता है कि जब मनुष्य अपने सुख दुःख के भावों को समान दृष्टि-से देखने लगता है, तभी वह सच्चे अर्थों में साधक कहलाता है।

(ग) वन का प्रतीकात्मक अर्थ – आत्मिक साधना का मार्ग-

‘वन’ केवल पेड़पौधों का स्थान नहीं, बल्कि मन का प्रतीक है — जहाँ मोह, माया, राग, द्वेष, अहंकार जैसे विकार निवास करते हैं। राम का वनगमन इन विकारों पर विजय पाने की यात्रा है।

वन का जीवन त्याग, तपस्या, संयम और प्रकृति के सान्निध्य में आत्मसाक्षात्कार की भूमि है। अतः जब हम “राम वनगमन” कहते हैं, तो वह आत्मा की संस्कार यात्रा का प्रतीक है, जिसमें व्यक्ति बाहरी ऐश्वर्य को त्यागकर आंतरिक शांति की खोज करता है।

(घ) सीता और लक्ष्मण का साथ – भक्ति और विवेक का संतुलन-

राम के साथ वनगमन में सीता और लक्ष्मण का साथ आध्यात्मिक दृष्टि से अत्यंत गूढ़ प्रतीक है। सीता भक्ति का प्रतीक हैं — प्रेम और समर्पण की मूर्ति। लक्ष्मण विवेक का प्रतीक हैं — ज्ञान और कर्तव्यनिष्ठा का आधार। राम के साथ जीवनयात्रा करते हैं (लक्ष्मण) और विवेक (सीता) जब भक्ति (परमात्मा), तब ही पूर्णता प्राप्त होती है। यह संकेत करता है कि आध्यात्मिक जीवन में भक्ति और विवेक दोनों का संतुलन आवश्यक है।

(ङ) वनगमन का आध्यात्मिक परिणाम – लोककल्याण-

राम के वनवास का अंत केवल उनके लौटने या रावणवध से नहीं होता, बल्कि अधर्म पर धर्म की विजय के माध्यम से लोककल्याण की स्थापना होती है। यह प्रसंग इस बात का प्रतीक है कि जो व्यक्ति आत्मसंयम, सत्य और धर्म के मार्ग पर चलता है, वह अंततः समाज में समरसता, न्याय और कल्याण की स्थापना करता है। राम का वनवास इस बात की प्रेरणा देता है कि त्याग और तपस्या केवल व्यक्तिगत नहीं, बल्कि सामाजिक और विश्वकल्याण की दिशा में भी आवश्यक हैं।

2. उदाहरण और व्याख्या-

(1) वाल्मीकि रामायण में वनगमन की महत्ता-

वाल्मीकि जी ने लिखा —

“न चास्य वचनं कर्तुं क्षमोऽहं पुरुषर्षभा”²

राम पिता के वचन से विचलित नहीं होते, क्योंकि उनके लिए सत्य सर्वोच्च है। यह दिखाता है कि धर्म का पालन किसी भी परिस्थिति में सर्वोपरि रहना चाहिए।

(2) तुलसीदास का दृष्टिकोण (रामचरित्र मानस, अयोध्या कांड)

“राजधर्म पालन हितु प्रभु बन जाइ।

परिहरि मृदुल सुभाय सिय संग लखि सखि जाइ॥”³

यह पंक्ति बताती है कि राम ने राज्य त्यागकर धर्म पालन हेतु वन को अपनाया। सीता का साथ इस त्याग को और पवित्र बनाता है।

(3) महात्मा गांधी का कथन-

महात्मा गांधी ने कहा था –

“राम का वनवास हमें यह सिखाता है कि सत्य और वचनपालन के लिए सबसे बड़ा त्याग भी तुच्छ है।”⁴

उनके लिए ‘रामराज्य’ एक आध्यात्मिक राज्य था, जहाँ शासन धर्म और न्याय पर आधारित हो।

(4) आधुनिक जीवन में प्रासंगिकता-

आज के युग में जब व्यक्ति सुविधा, भोग और भौतिकता में उलझा है, राम वनगमन हमें सिखाता है कि जीवन का सच्चा सुख बाहरी वैभव में नहीं, बल्कि अंतर्मन की शांति और कर्तव्यपालन में है। राम का वनगमन यह बताता है कि विपरीत परिस्थितियों में भी संयम, धैर्य और सत्य पर अडिग रहना ही आत्मिक विजय है।

3. आधुनिक सन्दर्भ में ‘राम वनगमन’ का सन्देश-

राम वनगमन केवल अतीत की कथा नहीं, बल्कि आधुनिक मानव जीवन का दर्पण है।

जब व्यक्ति भौतिक सुखों से विरक्त होकर आत्मज्ञान की खोज करता है, वह अपना ‘वनगमन’ आरंभ करता है।

जब वह झूठ, अन्याय, क्रोध और लोभ से दूर होकर आत्मसंयम में प्रवेश करता है, तब वह अपने भीतर के 'वन' को जीतता है।

जब वह दूसरों के कल्याण हेतु अपने स्वार्थ का त्याग करता है, वह राम के समान 'मर्यादा पुरुषोत्तम' बनता है।

राम वनगमन का आध्यात्मिक संदेश यही है —

“धर्म के मार्ग पर चलो, भले ही वह मार्ग कठिन क्यों न हो। क्योंकि अंततः धर्म ही विजय दिलाता है।”⁵

निष्कर्ष

राम वनगमन का प्रसंग भारतीय आध्यात्मिक परंपरा का अत्यंत गहन प्रतीक है। यह केवल एक ऐतिहासिक या पौराणिक घटना नहीं, बल्कि यह आत्मसंयम, तपस्या, और धर्मपालन की जीती-जागती परिभाषा है। राम का वनगमन हमें यह सिखाता है कि जीवन में जब संकट आएँ, तब भी सत्य और धर्म से विचलित न हों। यह प्रसंग आत्मा की उस यात्रा का प्रतीक है, जिसमें व्यक्ति मोहमाया से मुक्त होकर सत्य के - प्रकाश की ओर अग्रसर होता है।

आध्यात्मिक दृष्टि से राम का वनगमन मानव जीवन के तीन चरणों को दर्शाता है —

त्याग— राजमहल का परित्याग।

साधना— वनवास में तप और आत्मशुद्धि।

प्राप्ति— रावणवध के रूप में अधर्म का नाश और सत्य की विजय।

इस प्रकार, राम वनगमन केवल धर्मपालन नहीं, बल्कि आत्मविजय का मार्ग है।

यह प्रसंग प्रत्येक मनुष्य को प्रेरित करता है कि वह अपने जीवन के वनवासों को आत्मबल (संघर्षों), सत्य और विवेक के साथ स्वीकार करे।

“राम का वनगमन हमें यह सिखाता है कि कठिनाइयों से भागना नहीं, बल्कि उन्हें साधना के अवसर के रूप में स्वीकार करना ही सच्चा धर्म है।”⁶

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2. वाल्मीकि रामायण, अयोध्या काण्ड-गीता प्रेस, गोरखपुर।
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An Investigation of Nucleation and Growth of Magnesium Thin Films Prepared by Vacuum Deposition Technique.

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Abstract:

Magnesium thin films have been deposited on glass and Al₂O₃ substrates by vacuum evaporation technique. The films were characterized by x-Ray diffraction technique and scanning electron microscopy measurements. The effect of deposition rate on growth of the magnesium film was studied, the film deposited at deposition rate 20 Å/sec on glass substrate yields c-axis oriented magnesium films, which shows single peak of (002) for the film grown at 20 Å/sec. However, the film grown at the deposition rate other than 20 Å/sec show minor peak of (101) plane. The film grown on Al₂O₃ substrates yields films with higher crystallinity which was confirmed by XRD and SEM studies. The optimized deposition rate for growth of magnesium films on Al₂O₃ substrates is 10 Å/s. The improved crystallinity of the film on Al₂O₃ substrates is due to crystallinity of Al₂O₃ substrates compared to amorphous glass substrate.

Keywords: Magnesium thin films, vacuum evaporation technique

1.1 Introduction:

The featured properties of superconducting MgB₂ have created tremendous interest in its thin film synthesis for device applications such as Josephson three terminal electronic devices. Though this intermetallic seems simple binary compound, its synthesis has many hurdles especially in thin film form due to difference in melting point of its components. As an alternative to this, Pawar et.al have synthesized MgB₂ on conducting (silver) substrate by electrochemical co-deposition at ambient temperature and pressure. However, for electronic application one requires films deposited on non-conducting substrate unlike for high current conductor applications; where one needs conducting substrates. In this situation soft

electrochemical process involving deposition of precursor magnesium film on non-conducting substrates like glass, alumina etc. and its subsequent conversion into MgB₂ by boron intercalation was expected to give success in growing MgB₂ films on non-conducting substrate. In this paper deposition of precursor magnesium films by vacuum evaporation technique and its optimization to get good quality pinhole free films is discussed along with nucleation and growth process in vacuum deposition.

1.2 Nucleation and growth of the film from vapour phase:

Solid material vaporizes when heated to sufficiently high temperatures. The condensation of the vapour onto a cooler substrate yields thin solid films. The deposition by the thermal evaporation method is simple, convenient and is at present the most widely used.

Because of collision with ambient gas atoms, a fraction of the vapour atoms proportional to $\exp(-d/l)$ will be scattered and hence randomized in direction in a distance 'd' during their transfer through gas. Here 'l' is the mean free path (mfp) of gas atoms, which for air molecules at 25 °C and pressure 10⁻⁴ and 10⁻⁶ Torr respectively, is about 45 and 4500 cm. Thus pressure lower than 10⁻⁵ Torr is necessary to ensure a straight line path for most of the emitted vapour atoms in a vacuum evaporator for substrate to source distance of ~10 to 50 cm. The rate of free evaporation (m_e) of vapour atoms from a clean surface of a unit area in vacuum is given by Langmuir expression,

$$m_e = 5.83 \times 10^{-2} \rho_e (M/T)^{1/2} \text{ gm/cm}^2.\text{sec} \quad \dots\dots\dots (1.1)$$

Where, $\rho_e (<10^{-2})$ is the equilibrium vapour pressure (Torr) of evaporant under saturated vapour condition at temperature 'T' and 'M' is the molecular weight of the vapour species. Alternatively, this can be modified to write the evaporation rate as

$$N_e = 3.513 \times 10^{22} \rho_e (1/MT)^{1/2} \text{ molecules/(cm)}^2(\text{sec}). \quad \dots\dots (1.2)$$

However the rate of deposition of the vapour on substrate depends on the source geometry, its position relative to the substrate, and the condensation coefficient. For the ideal case of deposition from a clean uniformly emitting point source on to a plane receiver, the rate of deposition varies as $\cos\theta/r^2$ (Knudsen cosine law); where r is the radial distance of the receiver from source and θ is the angle between the radial vector and normal to the receiver direction.

Thermal evaporation can be achieved directly or indirectly by variety of physical methods. One of the simplest methods is resistive heating. The material is evaporated with a resistively

heated filament or boat generally made of refractory metals such as W, Mo, Ta and Nb with or without ceramic coatings. Crucibles of quartz, graphite, alumina, beryllia and zirconia are used with indirect heating. The choice of support material is primarily, determined by evaporation technique and resistance to alloying and / or chemical reaction with evaporant. With the exceptions of highly reactive materials such as Si, Al, Co, Fe and Ni most materials present no problem with evaporation from suitable support [1].

Once the material of interest is vaporized from source with the particular evaporation technique, the condensation of atoms from vapor phase onto a cooler substrate yields thin solid film. Generally there are three steps involved in the film deposition, *viz* Condensation, Nucleation and Growth. Atomic condensation takes place in the form of three dimensional nuclei which then grow to form continuous film by diffusion control process [2,3,4]. The condensation process involves the interaction between vapor atom and the impinging surface. The vapor atom is attracted by the substrate surface by the instantaneous dipole and quadrupole moments of the surface atoms. As a result the atom loses its velocity component normal to the surface in a short time. The vapour atom is then physically adsorbed, termed as adatom. It may move over the surface by jumping from one potential well to the other because of the thermal activation from surface and or its own kinetic energy parallel to surface. The adatom has finite residence time on the substrate surface during which it may interact with other adatom to form stable cluster and chemisorbed or incorporated into surface with release of heat of condensation. If not adsorbed the adatom evaporates into vapor phase [1]. The probability that an impinging atom will be incorporated into the substrate is called the condensation or sticking coefficient. According to famous Langmuir-Frenkel theory of condensation [5,6], the adsorbed atoms move over the surface during their lifetime to form pairs which intern acts as condensation centers for the other atoms. This cluster or subcritical nuclei are formed by collisions of adatoms on the substrate surface [7-11] and in vapor phase if supersaturation is sufficiently high, they continue to grow with increase in free energy until critical size is reached above which growth continues with a decrease in free energy. The Gibbs free energy for the formation of spherical cluster of radius 'r' is given by sum of surface energy to create the surface & volume energy of condensation,

$$\Delta G_0 = 4\pi r^2 \sigma_{cv} + 4/3\pi r^3 \Delta G_v \quad \dots\dots (1.3)$$

Where σ_{cv} is the condensate vapor interfacial free energy & $\Delta G_v = (kT/V)$ is the Gibbs free energy difference per unit volume of the phase of molecular volume V condensed from the supersaturated vapor of pressure 'P' to the equilibrium pressure P_e ($P/P_e = S$ is

supersaturation). The radius of the critical nucleus (r^*) which has maximum Gibbs free energy is given by

$$r^* = 2\sigma_{cv}/\Delta G_v = 2\Delta G_v V / (kT \ln(P/P_e)) \dots (1.4)$$

and corresponding Gibbs free energy (ΔG^*) in terms of various surface energies is given by

$$\Delta G^* = 16/3\pi\sigma_{cv}/\Delta G_v\phi(\theta) \dots (1.5)$$

Where $\phi(\theta) = 1/4 (2-3\cos\theta + \cos^3\theta)$

θ is contact angle in a condensate(c)-vapor(v)-substrate(s) system[12].

The nucleation rate I is proportional to the product of the concentration

$N^* = N_0 \exp(\Delta G^* / kT)$ of the critical nuclei and the rate Γ at which molecules join the critical nuclei by diffusion process.

$$I = Z(2\pi r^* \sin\theta)\Gamma N^* \dots (1.6)$$

Z is Zeldovich correction factor.

Thus one can control the nucleation rate by controlling the deposition parameters such as temperature and deposition rate i.e impingement of flux which intern controls the morphology and growth of the film.

Once the randomly distributed, three dimensional nuclei are formed, rapidly approaches a saturation density with small amount of deposit. These nuclei then grow to form island whose shapes are determined by interfacial energies and deposition condition. The growth is diffusion controlled [13-15]. As an island increase their size by further deposition and come close to each other, the larger ones appear to grow by coalescence of the smaller ones. Island density decreases continuously and its rate is determined by deposition conditions. The coalescence phenomena have a profound effect on structure and properties of resultant film since recrystallization, grain growth, orientation changes, incorporation and removal of defects take place as a consequences of coalescence.

2.1 Experimental:

The magnesium films were deposited using Hind HIVAC 12A 4D vacuum deposition system by resistive evaporation technique. To deposit the magnesium film, the magnesium powder (99% Pure, Merck) was placed in a molybdenum boat. The powder was then evaporated by

resistive heating of the boat. During evaporation the pressure inside the chamber was maintained below 10^{-5} mbar. Glass and Al_2O_3 (alumina) substrates were used for deposition. The films with different thickness were deposited. i.e. 100, 200, 300 and 400 nm. However 300 nm thick films were chosen for further experimental work. The deposition rates and thicknesses of the films were measured and controlled using digital quartz crystal deposition rate controller and monitor (DTM 101 operated at 6 MHz).

2.1 Substrate Cleaning

Glass and Al_2O_3 substrates must be thoroughly cleaned before deposition and a variety of procedures exist for this purpose. The following procedure is used for cleaning of the substrates. The contaminants are first removed by lukewarm, ultrasonically agitated, ionic detergent. The substrates are rinsed thoroughly several times in de-ionized water and latter subjected to a vapour digresser using pure alcohols. The cleaned substrates are stored/ immersed in pure alcohol and occasionally agited ultrasonically before use.

3. Results and discussion:

3.1 Growth of magnesium thin films on glass substrate:

The influence of the deposition parameters on film growth may be understood in terms of their effects on sticking coefficient, the nucleation density and surface mobility of adatoms. We have studied the effect of deposition rate on the growth of the magnesium film. As required the thickness of the magnesium films was kept constant (300 nm) for each deposition and vacuum of 10^{-5} mbar was kept inside the chamber. The deposition of magnesium film was carried at various deposition rates such as $10\text{\AA}/\text{sec}$, $20\text{\AA}/\text{sec}$, $35\text{\AA}/\text{sec}$ and $50\text{\AA}/\text{sec}$ on glass substrates. These films are then characterized by x-Ray diffraction technique. Fig. 3.2 (a-d) shows the XRD pattern of the films deposited at the deposition rates $10\text{\AA}/\text{sec}$, $20\text{\AA}/\text{sec}$, $35\text{\AA}/\text{sec}$ and $50\text{\AA}/\text{sec}$. The well agreement of observed 'd' values of these films with JCPDS data (Card No.35-0821) confirms its hexagonal structure. From figure, it is clear that all the films show reflection along (002) plane revealing its c-axis orientation. However, films deposited at deposition rate $10\text{\AA}/\text{sec}$, $20\text{\AA}/\text{sec}$, $35\text{\AA}/\text{sec}$ and $50\text{\AA}/\text{sec}$ show minor reflections along (101) plane. The maximum crystallinity and maximum crystallite size of 132 nm was found for the film deposited at the deposition rate $20\text{\AA}/\text{sec}$. The obtained films were pinhole free and well adherent to substrate. Hence the deposition rate of $20\text{\AA}/\text{sec}$ was found to be optimum for the nucleation of magnesium vapor atoms or cluster and its subsequent growth

into continuous magnesium film. Films deposited at the deposition rate lower than 20Å/sec shows pinholes due to insufficient impingement of flux of vapor atoms to form required supersaturation to have required nucleation density to form a cluster for its further growth. Also deposition rate higher than 20Å/sec yields films, which are nonadherent to the substrate. At higher deposition rate, the rate of impingement of vapor atoms is higher than adatom diffusion rate which disturbs the equilibrium resulting in poor quality film. Further increase in deposition rate than 35Å/sec produces the films, which are nonadherent as well as with pinholes.

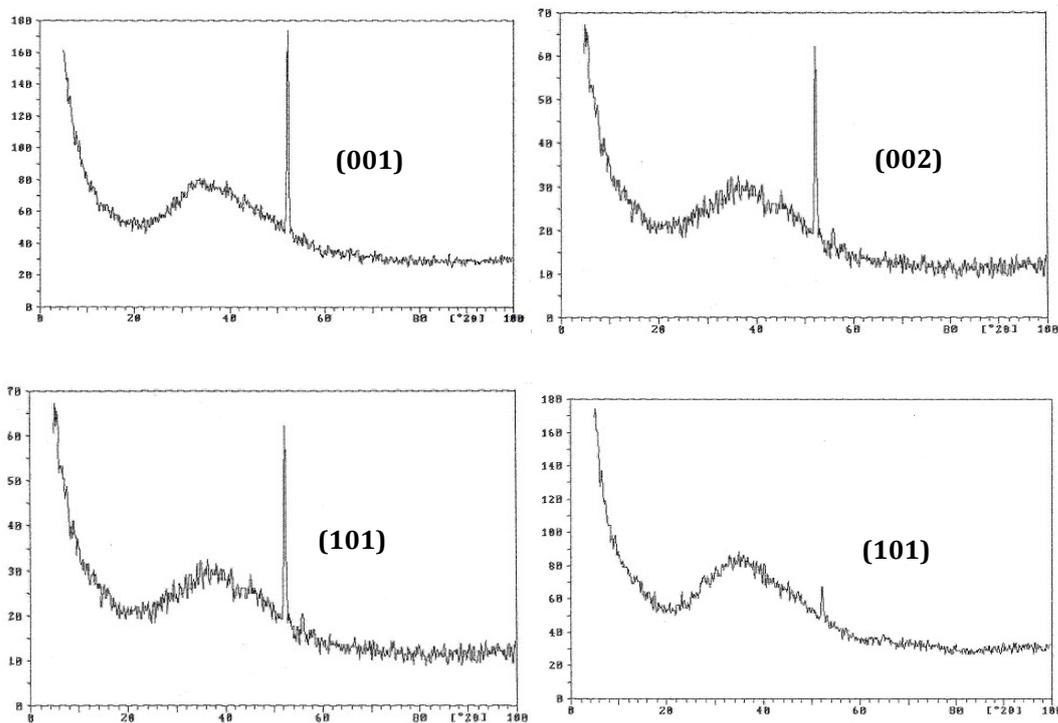


Fig. 3.2 XRD Pattern of vacuum deposited magnesium film on glass substrate with denosition rate 10 Å/sec. 20Å/sec. 35Å/sec and 50Å/sec.

Further the crystallite size was calculated using Debye Scherrer's formula for crystallite size [16]

$$t = \frac{0.9\lambda}{\beta \cos \theta_B} \quad \dots (3.7)$$

Where, t = particle size, θ_B = diffraction angle, λ = wavelength of x-rays and β is line broadening at Full Width at Half Maxima (FWHM). Crystallite size of a vapor deposited polycrystalline magnesium films increases with increase in deposition rate. This increase in crystallite size is not indefinite but after a saturation value of deposition rate the crystallite

size begins to decrease rapidly. The effect of deposition rate on the film growth is tabulated in table 3.1

Deposition rate Å /sec	Crystallite size nm	Adherenceto substrate	Quality of film
10	65±3	Adherent	Pinholes
20	132±5	Adherent	Pinhole free
35	73±2	Non adherent	Pinhole free
50	54±2	Non adherent	Pinholes

Table.3.1 Effect of deposition rate on the film growth

The deposition rate of 20 Å/sec yields good quality, well adherent and pinhole free films. Here film adherence is concerned with the ability of the film to remain intact during soft electrochemical synthesis of MgB₂ from non-aqueous bath, DMSO and pinholes are observed through Metzer optical microscope and Scanning electron Microscope (JEOL 6360).

Parameter	Optimized value
Deposition rate	20 Å/sec
Pressure	10 ⁻⁵ mbar
Thickness	300 nm
Growth temperature	Room Temperature

Table.3.2 Optimized deposition parameters for the deposition of magnesium films on glass substrates.

The morphological studies of the vacuum deposited magnesium films were carried out by using Scanning Electron Microscope (SEM). Fig. 3.3 shows SEM images of magnesium films grown on glass substrate by vacuum evaporation technique at the deposition rate of (a & b) 10 Å /sec, (c & d) 20 Å /sec, (e & f) 35Å /sec. The film deposited at deposition rate 20 Å /sec shows smooth pinhole free surface. However, the films deposited at the deposition rate 35 Å /sec show pinholes.

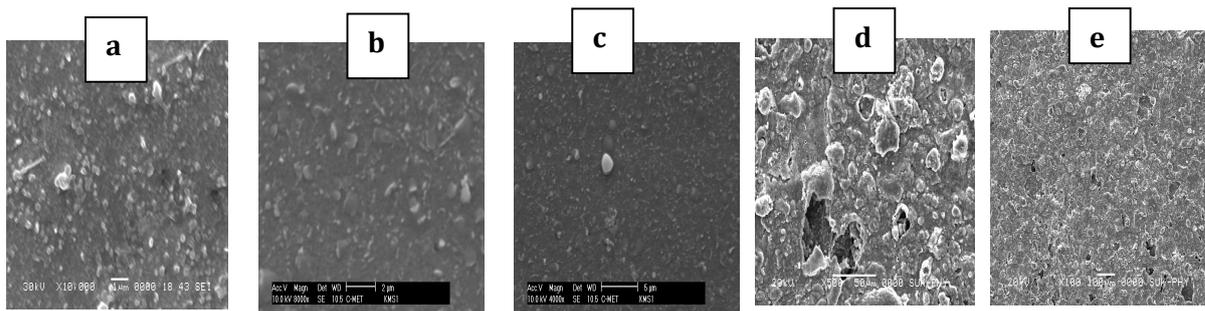


Fig. 3.3 SEM image of vacuum deposited magnesium films on glass substrate with deposition rate of (a & b) 10 Å/sec, (c & d) 20 Å/sec, (e & f) 35 Å/sec.

3.3 Conclusions

The magnesium films were grown on glass and Al₂O₃ substrates by vacuum evaporation technique. The effect of deposition rate on growth of the magnesium film was studied and found that the film deposited at deposition rate 20 Å/sec on glass substrate yields c-axis oriented magnesium films. This is confirmed by XRD studies which shows single peak of (002) for the film grown at 20 Å/sec. However, the film grown at the deposition rate other than 20 Å/sec show minor peak of (101) plane.

The film grown on Al₂O₃ substrates yields films with higher crystallinity which was confirmed by XRD and SEM studies. The optimized deposition rate for growth of magnesium films on Al₂O₃ substrates is 10 Å/s. The improved crystallinity of the film on Al₂O₃ substrates is due to crystallinity of Al₂O₃ substrates compared to amorphous glass substrate.

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NCC: A PATH TOWARDS MEANINGFUL CAREER.

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Abstract

" Discipline today builds leaders for tomorrow's world ."

The youth of a nation are the backbone and most powerful force within the nation. They are the hope of the future and can shape the destiny of a country. History shows that countries subjected to alien rule have without exception sought the help of youth in times of crisis. They have always been in the forefront in the building of political social and economic orders of a society. They play a positive role for the cause of a nation and national integration. The youth are the pulse and strength of nation and with their alertness and their balanced approach can help in bringing stability the nation.

India has already started National Cadet Corps (NCC), National Social Service (NSS), National Service Volunteer Scheme (NSVS) and other similar organization, which are an asset of our nation. Youth to train themselves effectively both in institutional and adventure activities as such activities imbibe self-confidence, harmony and patriotism NCC is one of the biggest youth organizations in India. It is well organized youth force which not only maintains the self-discipline but also create the space for youth in Arm Forces. NCC was found in 1948 with the laudable aim of providing an opportunity to youth of the country to build character and develop leadership qualities. Students of our institute have tremendous potential. We must provide them the best training so that they can excel as NCC cadets. An ANO forms a critical link between the NCC as an organization and the cadets. Institutionalized NCC training lays down a strong foundation for a cadet and accordingly, should be given almost importance.

NCC Training is increasingly linked to career opportunity which with a focus on developing soft skills leadership and discipline that are valuable in both defence and civil civilian sectors the NCC special entry schemes offers Direct entry into the Indian armed forces for C certificate holder bypassing return exam.

Key Words: Motivation, Development, Career, Personality,

Introduction:

This is the era of development it is seen that in practice development means material advancement all the great thoughts about developing the finger aspect of human being do not get translated into reality they remain in the books even if it was indented no one would non how to go about it therefore a prick particular situation prevails while human beings scan boost of tremendous material development the same cannot be said about their own quality they remain same they remain same while they are expected to help in establishing a just order for the same reason the matter of establishing a just order cannot be left to culture or tradition as the context as considerably changed both traditional thought and modern experience will have to be focused on human development the national cadet corps NCC that grooms youngster into discipline and patriotic citizens has now decided to introduce personality development lesson for its cadets the NCC has choked out syllabus that has already been approved by its advisory committee the new course will be focus on improving personality of the cadets .

The NCC is undergoing a major expansion plan with an addition additional 3,00,000 cadets' vacancies approved recently coming for a total sanctioned strength of 20,00,000 cadets to meet growing demands from education and institutions This increase was a significant goal for 2025 up from a previous strength of 17,00,000 cadet. There has been a significant rise in female part participation with girls now making up approximately 40% of the total cadets

Objectives:

1. To identify the conceptual background
2. To study aims and objectives of NCC
3. How NCC uplifting Willingness students towards their meaningful career

Methodology:

This paper is based on secondary and primary data. Secondary data has collected for this purpose various books journals have been used as it is a conceptual paper and it is also based observations and work experience of researcher working as an associate NCC officer.

The nature of NCC now a days is changing very drastically. This organization has become society-oriented workforce. It also tries to provide the accountable youth force to nation. The NCC training schedule invaluablely gets diluted by increasing competition academic load on students, inevitable disruption in academics and NCC training curriculum. ANO's must plan the yearly training schedule in soon manner that disruption is overcome, with flexibility, so that cadets derive maximum benefits of training. The last Sunday of November is celebrated as the NCC day the major object of this day is to motivate the youth towards the NCC.

Concepts:

Ability to work and willingness to work is peculiarity of human being. Ability gets by training and education and willingness by motivation and high morale.

- Willingness – The quality of state of being prepared to do something; readiness, cheerfully agreeing or enthusiastic about doing something.
- Personality – It has varied dimensions it includes style of interacting with environment etc.
- Motivation- Concern with the conditions responsible for variation in intensity, quality and direction of ongoing behaviour.

- Development- It refers to growth, stage of inducement or progress. This progress or growth is gradual and has sequential phases. Always there is an increasing differentiation. It also refers to the overall movement towards greater efficiency.

Educational Value of NCC:

Education is basically a sort of training that imparts knowledge and skills by which one stands on his or her own feet. It is a light that show mankind the direction to move in night. The purpose of education is to integrate people in the society through there fold functions of teaching, preparing and quantifying them for valuing the morale of the society. There are two types of activities co-curricular activities and extra-curricular activities.

- Co-Curricular Activities: Refers to those activities which complement learning experience of the students in the college. These activities are connected with academic and are organized or designed to help the students to have a better understanding to their courses e.g. Research, Essay Competition, and Seminars.
- Extra-Curricular Activities: Refers to those activities which are to maintain their physical balance. Extra-curricular activities are ones that happen outside of the colleges, however necessary they may be. e.g. singing, all sports activities, swimming etc.

The normal education given in our schools and colleges seeks to transform those young men and women, bubbling with life and gaiety into mere inactive receivers of information. It provides no scope for their initiative, creativity and ingenuity. The result is the disaffection and frustration which is seen among the students and is so often reflected in student strikes and other disturbing activities. NCC seeks to fulfil this great demand of the youth by organization varies activities which provides sample opportunities for initiative and leadership.

Organisational Structure of NCC

The NCC functions under the overall supervision of the Central Advisory Committee. Raksha Rajya Mantri is the chairman. The committee meets once in the two years. The organization of the committee is as follows.

- RRM (Raksha Rajya Mantri) – Chairman
- Defence Secretary- Ex Office – member
- Secretary of education – Ex office- member
- Three Service Chiefs – Ex office – member
- Two MPS of Lok Sabha
- One MP of Rajya Sabha
- Five non official members nominated by the central Govt.

Motto of NCC (Unity And Discipline)

- NCC has 17 directorates under the three wings and three divisions as under Army Wing.
- Air Wing – raised in 1950
- Naval Wing – raised in 1952

Divisions: - There are three divisions

- a) Senior Division- Recruitment to which shall be from amongst the student of the male sex of any university, age group is 19-26 years.
- b) Junior Division- Recruitment to which shall be from amongst the student of the male sex of any school, age group is 13-18 years.
- c) Girls Division- Recruitment to which shall be from amongst the student of the female sex of one's university or school.
 - NCC Day- NCC day is celebrated on 4th Sunday of November every year.
 - VISION- Empower volunteer youth to become potential leaders and responsible citizens of the country.

- **MISSION-** To develop leadership and character qualities would discipline and nurture social integration and cohesion through multi-faceted programme conducting in a Military Environment.

AIMS: -

- 1) Develop character, commandership (brotherhood), discipline and secularism (respect of every religion), spirit of adventure.
- 2) Create a human resource of organized turned and motivated youth to provide leadership in all works of life.
- 3) Provide suitable environment to motivate youth to take up a career in the Armed Force.

How To Create Willingness:

The NCC Training of aims at channelizing the vast potentiality of the youth of the country into constructive channels. The students are vast reservoirs of energy which requires to be exploited into healthy disciplined and gainful activities. It starts with the selection of willing full students and orientation of students. At the time of new admission, we organize the exhibition of ships models, showing adventure documentary films, display of flex in the college campus. Notices regarding NCC admission.

- 1) ANO's and senior cadets' visits the classes to give information regarding NCC and NCC activities.
- 2) Organizing principal's as well as Commanding Officer's address for the first-year students.
- 3) As per the criteria given by NCC we arrange various test. E.g. Physical, Interview, Swimming.

..... TO CREAT WILLINGNESS.

Enrollment:

- a) A student desirous to being enrolled in the senior division or senior wing shall apply to the Officer commanding the unit.

- b) The Officer to whom an application under sub rule. (1) Has been made shall cause the applicant to fill up and sign in his presence a statement in form I.
- c) The Head of institution to whom an application under sub- rule. (2) Has been made should cause the applicant to fill up and sign in his presence a statement in form II.

If the commanding officer or the Head of institution is satisfied with the applicant, he shall sign a certificate to that effect on the said form and the applicant shall thereupon be deemed to have been enrolled.

VIII) Importance of NCC Activities:

A) Institutional Activities

To empower voluntary youth to become potent leaders is the ultimate dream of NCC. The dream will be in reality when we develop character qualities in our cadets like:

Quality	Activities
Self-Awareness	SOWT analysis of each cadet
For development of positive attitude	Yoga Practice
Visit to motivation hall	Principal and co address to cadets.
Knowledge of Language	
To deals with presence	Compulsion to speak into national language at the time of parade. Submission of any activity will be in Hindi or English. Arrangement of spoken English classes. Study material in simple English language.
Spirit an Adventure	Organization of expeditions Stamina building, Show adventure Movies.

Knowledge of team spirit

Organization of trekking.

Time management

Interaction with Ex cadets.

Skill Development

Team spirit, endurance

Organization of guest lectures
Communication skills
Soft skills
Practice during vacations
Vocational training
with prior permission of authorities'
parents e.g. best putting, ship
modelling, firing

Sense of patriotism

Organization of various camps create
awareness regarding one's nature
Interaction sessions with NCC
dignitaries.

B) Training Activities:

The training activities of NCC nurture core values, enhance awareness skills and give exposure to basic military skills, The training activities of NCC can be classified as under.

1) Camp Training:

NCC camps motivates every youngster to do something good for the nation – Prime minister of India.

Every cadet in the NCC is expected to attend at least two camps during one's tenure to complete the training syllabus.

- Annual Training Camp (ATC) - These are held within the state under respective NCC directorates.

- Centrally Organized Camps (COC) -These are of an all-India nature and planned by H.Q DG NCC in consultation with the directorates, selected cadets a per vacancy allotted to each directorate.

Filling types of camps

- Leadership camps.
- Thal Sainik Camp (TSC) for Army Cadets.
- Vayu Sainik Camp (VSC) for Air Force Cadets.
- Nau Sainik Camp (NSC) for Naval Cadet.
- National Integration Camp (NIC)

The camps are conducted all over India basis and it helps to bridge the cultural gap among varies state.

- **Republic Day Camp (RDC)** - It is a prestigious camp inaugurated by Vice President of India and visited by the Raksha Mantri. The camp culminates in the Prime Minister Rally on 27 January every year which showcases all the activities of NCC.
 - **Attachment Training:** NCC Army Wing Cadets are given an opportunity to live and work in regular service units in the form of attachment training. Every year selected SD/SW cadets are given attachment training with IMA and OTA respectively.
 - **Naval Wing Activities:** Naval Wing syllabus is common for SD and SW. During sea training Navel subjects like Seamanship, Navigation, Communication, Gunnery, Damage Control and Ship Safety are taught to cadets. Swimming, Scuba Diving and Wind surfing are other activities.
 - **Air Wing Activities:** Gliding, Microlite, Flying and attachment training with Air Force stations are main activities.
- 2) **Social Service And Community Development:** NCC has adopted community development activities with the aim, of NCC cadets imbibing selfless service to the community dignity of labour, importance of self-help, need to protect environment and to assist weaker sections of society to in their upliftment. E.g. Tree plantation, Blood donation, adult education, Community work, Disaster relief, AIDS awareness etc.

- 3) **Youth Exchange Programme (YEP):** The aim of YEP is a country-to-country exchange of cadets belonging to NCC or govt. organizations of friendly countries and participation in NCC activities of the host country to create an increased awareness among participants and appreciation of each other's cultural realities.
- 4) **Adventure Activities:** Adventure training forms an integrate part of NCC training, it not only breaks the monotony of training but also provides an opportunity for cadets to develop leadership qualities.

Incentives For Ncc Cadets:

a) Concession in Employment:

- 1) Vacancies reserved for commission in Defence Force for NCC 'C' certificate.
- 2) Para Military Forces- 2 to 10 % bonus marks awarded for recruitment.
- 3) Department of the Tele-communication – Bonus marks awarded for recruitment.
- 4) National Cadet Corps - Civilian Gliding Instructor, Girls Cadet Instructor, ANO's.
- 5) Industry – some industries give preference to NCC 'c' certificate holders for various jobs.

b) Financial Benefits:

The expenditure incurred on NCC is borne by the government. A cadet does not have to pay for uniform, casuals, parade, adventure, sports, transportation.

c) Financial Assistance:

The society is growing financial assistance and relief to cadets who sustain injury or death during NCC related activity.

NCC related Activities	Death cases	Permanent Disability	Temporary Disability
High risk	Rs. 2,00,000/-	up to 2,00,000/-	up to 1,00,000
Other activities	Rs. 1,50,000/-	up to 1,50,000/-	up to 1,00,000/-

- d) **Scholarships:** A scholarship scheme was introduced in 1991, where 250 scholarships of Rs. 25,000/- each were awarded to academically brilliant NCC cadets.

Motivation To Join Armed Forces:

Defence service offers one of the most challenging and yet a meaningful career. A soldier is a respected citizen of any country, because he lives for the virtues of sacrifice, commitment and selfless devotion.

Towards Meaningful Career...

- a) **Indian Army:** 50 vacancies in all regular forces of IMA are reserved for NCC 'B' Grade holders of 'C' certificate with a minimum of two academic years in the senior division of NCC. Who have passed UPSC exam and have also been declared successfully by the Service Selection Board.

1) Short Service Commission (Non-Technical) OTA Chennai – graduates with 50 % marks NCC 'C' certificate with 'B' grade and serving for 2 years from the receipt of application can appear directly for SSB interview. For SSB at OTS, Chennai on selection cadets undergo monthly training at OTA after which they are granted commission the rank of LT.

b) Indian Navy:

In the 21st century, the Indian Navy has played a vital role in maintaining peace for India on the maritime front, in spite of the state of torment in its neighbourhood. 6 vacancies for per course for grant of commission in the Navy are reserved for selection of NCC cadets as special Entry cadets, provided they are in possession of 'C' certificate of Navel Wing and are declared fit by the Navel Selection Board. Such cadets are exempted from appearing in the UPSC exam.

c) Air Force:

The Indian Air Force is divided into five operational and two functional commands each command is headed by an Air officer commanding. In chief with the rank of Air Marshal. 10 vacancies per course are reserved for NCC Air wing cadets holding NCC 'C' certificate of Air Wing. Two courses are held every year. The cadets for pre-flying course do not have to undergo UPSC exam.

Conclusion:

The purpose of NCC training is to bring about systematic change in the knowledge, skills and attitude. As a number of young boys and girls, individuals with various potentials and talents come to prominence and take lead. Such number excel all others in endurance and automatically take the place of leader to contribute to the improvement of the quality of the life of the community. A person has to work in harmony and develop human understanding and tolerance. A cadet will have to develop the qualities which enable him to play a useful role in the society and a meaningful career.

As per the aims we encourage them to serve our golden sparrow. The journey is long the road is hard. Yet it is rightly said by Swami Vivekananda. **"Stand up, be bold, be strong take the whole responsibility on your shoulders and know that you are the creator of your own destiny."**

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Fruit Detection System using Ultrasonic and Colour Sensor

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Abstract

The main focus of the research work is to study the detection of fruits using IoT sensors such as TCS3200 colour sensor and the Ultrasonic sensor. The five fruits are concentrated: apple, banana, papaya, pomegranate, and chikoo. The result prediction uses three classifiers: Random Forest, Decision Tree, and K nearest neighbor machine learning algorithms. The fruit detection is judged on three features: height, width, and color. The Random Forest Classifier gives a more accurate result in the detection of the fruits. The accuracy of Random Forest, Decision Tree, and K nearest neighbor is 99.39%, 99.59%, and 97.98% respectively. The detection of fruits is accurate in the Random Forest classifier. From the observation, the Random Forest Classifier will be the most suitable model for fruit detection.

Keywords

IoT sensors, Random Forest, Decision Tree, K Nearest Neighbour

Introduction

Fruits are an essential part of the human diet and natural sources of minerals and vitamins. Nowadays, the commercial industry is working along with the agriculture sector to grow the economy. A quality product needs to be packaged for export. The packaging requires human intervention, which is time-consuming. Also, human errors can significantly impact businesses, leading to financial losses.

Research is in progress to reduce such losses. Researchers are trying to train machines to detect fruits, classify fruits, recognize ripeness levels, identify diseases present among the fruits, and more. In addition to direct consumption, fruits are used as raw materials to prepare healthy food and also as commercial products for the global market.[1]

Fellow researchers are working to identify fruits using different deep-learning techniques and IoT mechanisms. Identification and quality identification are also recognized with the help of the different deep learning algorithms. The image processing techniques are also used to pre-process the images. Images are used in research to gather information and predict the result. Also, Different IoT sensors are also used to extract the features of real-world objects directly and to process it. SHT40 temperature and humidity sensor, and SGP30 gas sensor are used to check the ripeness level of the fruits in the real world. [2]

The key of the current research is to develop a system based on IR sensor(Ultrasonic sensor) and color sensor(TCS3200) which help to identify fruits by using features such as height, width, and color. We propose to build an IoT-based model that can be used to identify the fruits along with the ripeness level in the fruits using machine learning classification models such as Random Forest, Decision Tree, and K Nearest Neighbourhood.

Each classifier delivers its importance. K Nearest Neighbourhood is simple to implement and achieves good results.[8] The decision tree is glass box modelling which learns rules by decision tree based on data structure. Random Forest classifier comprises multiple decision trees which form more complex structures but provide good results. [8]

The current research is focused on five fruits: apple, banana, pomegranate, chikoo, and papaya. The height, width, and RGB colours of the fruit are determined with the help of sensors. The inputted data is checked with a preformed dataset using classifiers such as random forest, decision trees, and K nearest neighbor algorithm.

Literature Review

As fruits play a vital role in the human diet it is necessary to identify quality fruits. To reduce human error in the identification of the fruits, researchers are taking a step to train the model that can deal directly with real-world fruits.

The researchers R. M and P. Voola developed a system with an ESP32 microcontroller, SHT40 temperature and humidity sensor, and SGP30 gas sensor. [2] The ESP32 microcontroller works as a central unit with wireless data transmission. The SHT40 Temperature & Humidity Sensor is used to measure the temperature and humidity observed in the ripeness stage of the fruits. The SGP30 gas sensors are used to detect Ethanol, H₂, CO₂, and TVOC.[2] It is observed that the level of the gases increased or decreased at different stages of the ripeness level. This helps to predict the ripeness level of fruits.

The rotten fruits are methane and ethylene. The MQ-4 methane gas detector is used to detect the level of methane gas being produced by fruits. Also, the DHT-11 sensor is used to capture temperature and humidity. The experiment on the banana shows that the methane level increases as per the ripeness level. [3]

To train the machine, deep learning algorithms with computer vision are used. R. Kumar Agarwal *et al* also used a DHT- 11 sensor to sense the humidity and temperature of the fruits. The input from the center is used to classify the images and then a Convolutional Neural Network (CNN) is used to identify the quality of the fruits.[4] When working with the CNN model it is needed to capture the images and process the images carefully. Images are acquired with a Raspberry Pi Camera. These images are pre-processed to form the dataset.[6]

The researchers M. Rizzo, M. Marcuzzo, A. Zangari, A. Gasparetto, and A. Albarelli stated the use of machine learning methods, such as Support Vector Machines, decision trees, and K- Nearest Neighbor algorithms, in fruit ripeness classification problems, noting their successful application in the literature.[5]

A review taken on the use of IoT in agricultural products, various IoT sensors are used in agriculture to improve the system. The sensors such as soil sensors, meteorological sensors, water sensors, and plant sensors. A wide application was created and connected through WIFI. The created data is saved on the cloud server.[9]

The article based on smart agriculture states the advantage of using IoT sensors can help in the gain from farming and also agriculture can grow in the advanced development to grow the production. [10]

The color sensor is used to detect the ripeness of the palm oil. The red, green, and blue colour values for each stage of the ripeness of the palm oil are detected. The range is preserved to check the ripeness level. The data is used for further processing. [11]

Methods and Materials

The current research is focused on fruit identification. The project is based on five fruits: apple, banana, chikoo, papaya, and pomegranate. The IoT model and machine learning algorithms are combined in the research work to predict the fruits. The working model is developed starting with dataset preparation, model building based on IoT sensors and machine learning, and analyzing and predicting results.

Dataset Preparation:

The data is crucial in any project. The dataset is prepared in the CSV file. This CSV file is prepared based on the online dataset Fruit 360 present on the Kaggle site. The dataset contains more than 40,000 images. In the project, five fruits are observed: Apple, Papaya, Banana, Chikoo, and Pomegranate. The images of size 100 x 100 are picked from the dataset. The features such as height, width, dominant red color, dominant green colour, and dominant blue colour are extracted from the image and along with the label as the name of the fruit is stored in the CSV file format. The dataset is prepared with 3609 entries for all the values.

IoT model setup and machine learning model:

Arduino UNO is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. The Ultrasonic sensor transmits and captures the reflected waves from an obstacle or object. Two ultrasonic sensors were used to measure the height and width of the fruits based on the distance captured by the sensors. The TCS3200 colour sensor can detect a wide variety of colours based on their wavelength. It uses a TAOS TCS3200 RGB sensor chip to detect colour. The TCS3200 has an array of photodiodes with 4 different filters. The intensity of the colour in red, green, and blue format is measured by choosing the photodiode filter's reading.

There are some very expensive colour sensors used in industries and there are some inexpensive ones, TCS230 (TCS3200) being one of the inexpensive ones. As it is inexpensive it has some disadvantages. Factors such as lighting conditions, sensor variation, and surface properties can lead to incorrect readings. So calibration is performed. When we connect the sensor to the Arduino using s0, s1, s2, s3, and sensor out pins, s0 and s1 pins are used for pulse width scaling, and s2 and s3 are used to filter the incoming colour light. After setting it up we keep a white coloured surface in front of the sensor and calculate the pulse width reading from the sensor. We note down the lowest possible values recorded by the sensor for all three R, G, and B. Then we keep a black

colored surface in front of the sensor and again calculate the pulse width reading from the sensor. Now we note down the highest possible values recorded by the sensor for R, G, and B. We use minimum value from white and maximum value from black because the brighter the light detected by the sensor less the pulse width. So by using these minimum and maximum values, we set up a baseline for the sensor for minimum intensity colour black (0, 0, 0) and maximum intensity colour white (255, 255, 255). These values are then used in another program as baseline values and then the actual RGB value detection is done. [12] The IoT setup is defined in the figure 1.

Supervised Machine Learning algorithms are used in classification problems. [6] Random forest classifier, Decision Tree classifier, and K Nearest Neighbour algorithms are used to classify the images. The data is divided into three parts: training, validation, and testing. The division is 80 % data for training and 20% data is used for validation. Out of 80% data from the training, 20% data is used for validation. As per the analysis of S. Espinoza, C. Aguilera, L. Rojas, and P. G. Campos, confusion metrics are the most popular methodology to compare the results. The metrics accuracy is used to judge and compare the result of all three classifiers. [7]

As shown in Figure 1, two Ultrasonic sensors are used to measure the distance between the sensor and the fruit. One of the sensors is used to calculate height and another sensor is used to calculate the width.

Height = Total distance from Ultrasonic sensor to the boundary of the box – Distance from Ultrasonic sensor to fruits.

The same formula is depicted for the calculation of the width. As the fruits are irregular in shape. Hence this arrangement gives a more accurate result. The colour sensor senses the colour in red, green, and blue format. These five parameters are passed to the Random Forest classifier, Decision Tree classifier, and K Nearest Neighbourhood Classifier to check the accuracy.

Results

Different colours that are observed from colour sensors are described in Table 2. Table 2 states that the highest value of red colour in Apple and Pomegranate whereas in Banana more red and green colours values are observed. The highest red colour is observed in papaya. This sensed range is matched with a prepared dataset. The summary of the result is given in Table 4.

The Random Forest Classifier with random state 50 is used from sklearn. The Decision tree with random state 50 is used The K Nearest Neighbourhood with a K value of 5 is used for accuracy detection.

Accuracy is a common performance evaluation metric for analyzing results. The accuracy of training, testing, and validation data is checked. The testing accuracy is 99.39% in Random Forest which is more compared to the rest of the two classifiers. Decision Trees testing accuracy is more than that of Random Forest but in some cases, it is unable to identify the correct fruit which can be analyzed through Table 3. The summary of the accuracy is given in Table 1.

The accuracy remains the same even if the random state is either increased or decreased. The same observation for the decision tree. If the K value of the KNN classifier is increased then the accuracy is decreased. Table 3 summarizes the changes in the accuracy for each classifier if the checkpoint is changed.

Conclusion

The main aim of the research work is to justify the detection of fruits using only features such as height, width and colour. Due to the variations in the size and shape of the object the dataset is prepared and tested with different classifiers. From the work it is being observed that among the three classifiers, Random Forest classifier gives the better accuracy 99.39% in the detection of fruits. The observation suggests that Random Forest machine learning algorithms can be most suitable for predicting fruits. Due to similar feature values of colours and size, classifiers find it difficult to detect the fruits. More features can be added to get more accurate results. The work can be extended to get the ripeness level of the fruits.

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Figures and Tables

Table 1: Accuracy obtained for three classifiers

Machine Classifier	Learning Accuracy	Training Accuracy	Validation Accuracy	Testing Accuracy
Random Forest		100%	99.59%	99.39%
Decision Tree		100%	99.59%	99.59%
K Nearest Neighbourhood		99.73%	99.79%	98.99%

Table 2: Testing Accuracy obtained for each fruit against the classifier

Colour range	Apple	Banana	Chikoo	Pomegranate	Papaya
Red	118 - 233	143 - 247	149-174	196 - 228	219 - 239
Green	0 - 185	95 - 233	110-128	44 - 157	156 - 190
Blue	0 - 140	42 - 199	167-93	56 - 145	99 - 142

Table 3: Reflection of changes in accuracy

Machine learning classifier	Changes	Training accuracy	Validation accuracy	Testing accuracy
Random forest	Random state=30	100%	99.59%	99.39%
	Random state=80	100%	99.59%	99.39%

Decision Tree	Random state=30	100%	99.59%	99.59%
	Random state=80	100%	99.59%	99.59%
K Nearest Neighbourhood	K=10	99.46%	99.59%	98.39%
	K=30	98.25%	98.99%	97.98%

Table 4: Obtained result

Machine learning classifier	Apple	Banana	Chikoo	Pomegranate	Papaya
Random Forest classifier	Detected	Detected	Detected	Detected as Apple	Detected
Decision Tree	Detected as Orange	Detected as Papaya	Detected	Detected as Apple	Detected
K nearest Neighbourhood	Detected	Detected	Detected	Detected as Apple	Detected

Figure 1: Experimental setup



Gewald reaction using Banana peel ash-fly ash composite as a low-cost and reusable catalyst

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Abstract

A novel composite catalyst Banana peel ash-fly ash, completely based on waste materials, was developed in this study. Its application was investigated in the Gewald synthesis of 2-aminothiophene derivatives. The effect of parameters such as solvent, temperature, and catalyst amount on the synthesis was investigated. Recycling studies indicated that the catalyst could be effectively reused for up to five cycles without significant loss of activity. This novel, inexpensive catalyst derived from waste materials unfolds attractive applications in multicomponent reactions.

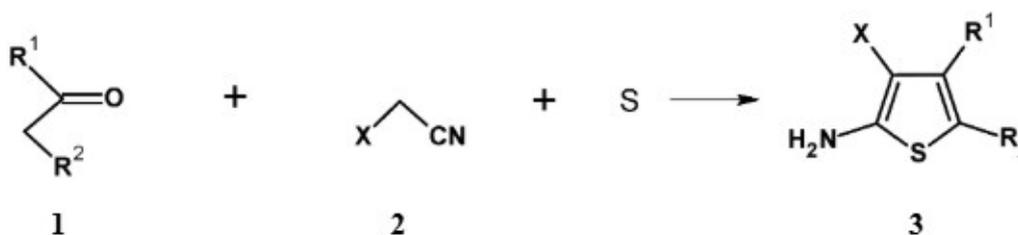
Keywords: Gewald reaction, multicomponent, fly ash, banana peel ash, antibacterial activity

1. Introduction

Heterocycles represent a highly significant class of compounds, frequently serving as key structural motifs in dyestuffs, synthetic pharmaceuticals, and agrochemicals. They also find widespread applications in materials science including fluorescent sensors, information storage, as well as in supramolecular and polymer chemistry (Eftekhari-Sis et al 2013). Five-membered heterocycles containing a single heteroatom are widely found in nature and possess diverse biological activities; notably, pyrroles, furans, and thiophenes serve as key pharmacophores and valuable precursors in the synthesis of various natural products (Jiang et al 2010). Thiophene and its substituted derivatives have sparked

significant attention in both industry and academia due to their broad therapeutic potential and diverse applications in medicinal chemistry and materials science. These compounds exhibit remarkable biological and physiological activities, including antimicrobial, antioxidant, anti-inflammatory, antianxiety, antifungal, antimitotic, antitubercular and anticancer properties (Shah et al 2018; Kunda et al 2013). Various synthetic procedures have been developed to obtain differently substituted thiophenes. Among the well-known methods are the Paal–Knorr thiophene synthesis, Fiesselmann thiophene synthesis, Gewald aminothiophene synthesis, and Hinsberg synthesis (Puterová et al 2010).

Among these methods, the Gewald reaction (scheme1) has attracted significant attention due to its versatility, mild reaction conditions, and ability to construct polysubstituted 2-aminothiophenes (3). It involves multicomponent reaction between elemental sulphur, an α -methylene carbonyl compound (1) and an activated nitrile (2). Multicomponent reactions (MCRs) are convergent reactions, in which three or more compounds react to form a product, where most of the atoms of the reactants are incorporated in the newly formed product (Kiss et al 2016). They are inherently aligned with green chemistry principles such as high atom economy and reduced number of steps.



scheme1 : Gewald 2-aminothiophene synthesis

Catalysts play a pivotal role in enhancing the efficiency and sustainability of MCRs. The use of heterogeneous and bio-derived as well as waste-derived catalysts has gained significant attention in recent years, as they offer reusability, ease of separation, and reduced environmental impact. Among various biogenic waste-derived materials, banana peel ash has emerged as an inexpensive and eco-friendly catalyst. It is rich in metal oxides

and carbonates like those of potassium, calcium, and magnesium. These components impart strong basic character to banana peels making it a promising candidate for promoting key steps involved in MCRs, such as enolate formation and condensation reactions (Rajkumari et al 2019). Another industrial waste fly ash (FA) is generated in thermal power plants during coal combustion. Its disposal is a major challenge as it is generated in vast quantities. Chemically, fly ash consist of silica, alumina, and iron oxides, which makes it a potential catalyst support or even a catalyst in various organic reactions. Fly ash has been reported to efficiently catalyse reactions like Knoevenagel condensation, Biginelli reaction, Beckmann rearrangement etc. (Yao et al 2015; Asl et al 2018; Gopalakrishnan et al 2006) Incorporating such waste materials in catalysis supports the development of low-cost, eco-friendly, and sustainable strategies for the multicomponent reactions.

Previous investigations into the Gewald reaction have employed catalysts such as secondary amines, DABCO, and bovine serum albumin etc. (Shearouse et al 2014; Kathiravan et al 2007; Abaee et al 2014; Zhao et al 2013). Additionally, several studies have utilized microwave or ultrasound irradiation (Zargari et al. 2024; Akbarzadeh et al. 2017), solvents like DMF (Rezaei-Seresht et al. 2021), and polymer-supported reagents (Castanedo et al 2001; Zhang et al 2004). However, these methods suffer from disadvantages such as lack of catalyst reusability, expensive catalyst, high boiling solvents, requirement of special instruments or additional steps for synthesis. Therefore, a low cost and eco-friendly alternative to Gewald synthesis needs to be developed. In this study, we prepared a novel reusable catalyst completely based on waste materials in fewer steps for the synthesis of 2-aminothiophene via Gewald reaction.

2. Materials and methods

1. Catalyst preparation

Banana peels were first thoroughly washed with distilled water to remove any adhering impurities. The cleaned peels were cut into pieces, then dried completely in a hot air oven at 100°C to eliminate moisture content. Once dried, the peels were manually crushed using a mortar and pestle to obtain a powder. This powdered material was subsequently subjected to calcination at 400°C for 4 hours in a muffle furnace, resulting in the formation of banana

peel ash (BPA). Calculated amounts of BPA (2 parts) and FA (1 part) were mixed in presence of 15 ml distilled water at room temperature for 4 hours. This resulted in desired composite catalyst banana peel ash-fly ash in 2:1 proportion respectively (2:1 BPAFA).

2. Synthesis of 2-aminothiophene derivatives

1 mmol ketone, 1 mmol active methylene compound and 1 mmol sulphur were reacted in presence of catalyst, 3 ml solvent at 40°C and 500 rpm for appropriate time. The reaction was monitored using TLC (90:10 Pet ether: Ethyl acetate). After the reaction, the crude product was extracted in dichloromethane (DCM). Crude product when purified using column chromatography afforded pure 2-aminothiophene product. The product structures were confirmed from their melting points, IR, ^1H NMR, ^{13}C NMR spectral data.

3. Results and Discussion

1. Characterization of BPAFA catalyst

1. FT-IR analysis

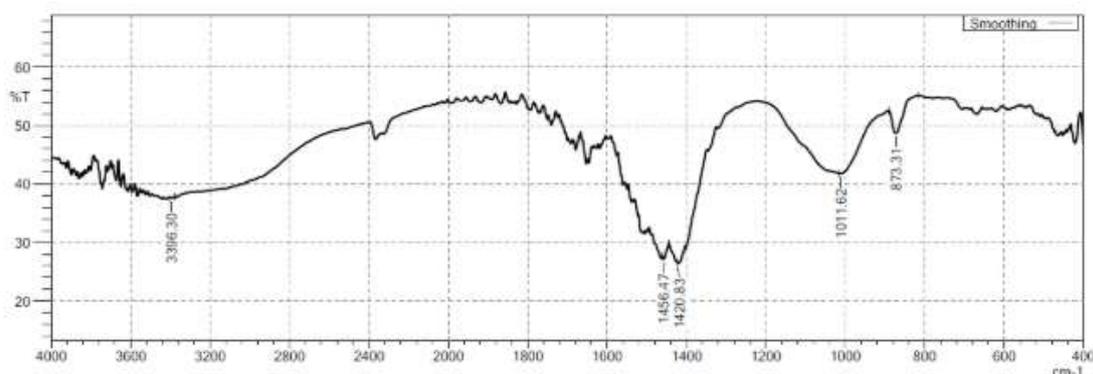


Fig.1. FT-IR spectrum of BPAFA catalyst

Fig.1. represents FT-IR spectrum of the catalyst. The band at 3396 cm^{-1} can be assigned to O–H stretching vibrations due to the adsorbed moisture or hydroxyl groups on the catalyst surface. The peak at 1456 cm^{-1} indicates the presence of K_2CO_3 from banana peel ash. The peak at 1420 cm^{-1} is due to C–O stretching and bending vibrations due to the presence of metal carbonates in the catalyst. The peak at 1011 cm^{-1} is attributed to the

asymmetric stretching vibrations of Si–O–Si linkages. The peak at 873 cm^{-1} corresponds to T-O-Si (T=Si /Al) bond which suggests successful impregnation of fly ash in catalyst.

2. XRD analysis

Fig.2. represents the XRD spectrum of the catalyst. It shows crystalline nature of the catalyst. The peak at 37° and 37.62° correspond to CaCO_3 and CaO whereas the peak at 34.9° & 56° belong to SiO_2 . Presence of K_2O and K_2CO_3 can be observed from the peaks at 29.42° , 30.89° and 39.43° . The peak at 42.96° is related to oxides such as MgO and P_2O_5 . These findings are consistent with those reported in the literature.

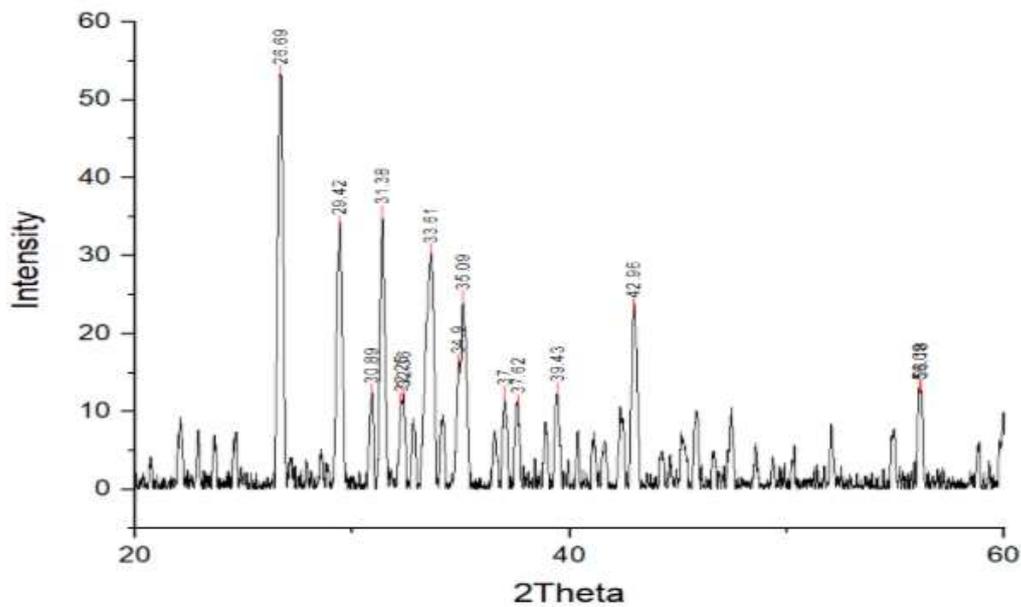


Fig.2. XRD spectrum of BPAFA catalyst

3. SEM-EDX analysis

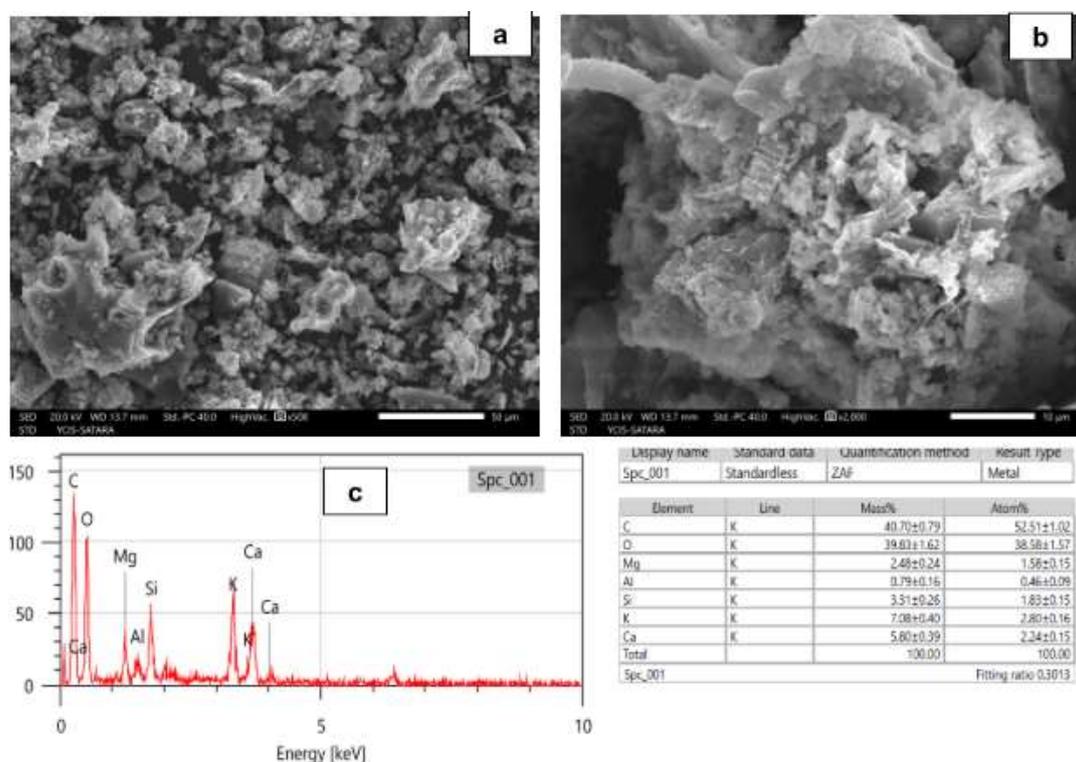


Fig.3(a-b) SEM analysis (c) EDX analysis of BPAFA catalyst

The surface morphology of the BPAFA catalyst was examined by SEM analysis (Fig. 3a–b). The images reveal a highly irregular and porous surface with many cavities. This provides a larger surface area and more active sites available to the reactants. The non-uniform distribution might be attributed to the merging effect of the two materials during synthesis. The EDX spectrum (Fig. 3c) further confirms the elemental composition of the catalyst. The high carbon content indicate that calcination of BPA was incomplete (Rosa et al 2019). Strong peaks corresponding to C, O, Mg, Si, Ca, K, and Al were observed, consistent with the mineral constituents typically present in banana peel ash and fly ash (Pathak et al 2018; Dias et al 2024; Wang, 2008). The alkaline earth metals such as Ca, K, and Mg contribute to the basicity of the material. The synergistic effect of these oxides is expected to enhance the activity of the composite catalyst.

2. Optimization of reaction conditions

1. Screening of different solvents

Initially, various solvents were tested for the model reaction between 1 mmol cyclohexanone, 1 mmol malononitrile, and 1 mmol elemental sulphur. The reaction mixture was magnetically stirred by adding 3 ml of solvent and 50 mg of 2:1 BPAFA catalyst for 3 hours. The temperature was kept constant at 40°C.

Table 1 indicates the solvent optimization. When water was used as the solvent (entry 1), the yield was limited to 32% may be due to sparingly water-soluble elemental sulphur [55]. A moderate improvement was observed with acetonitrile, which gave a 48% yield (entry 2). This can be attributed to better dispersion of sulphur in organic solvents. Significantly better results were achieved with methanol and ethanol (entry 3&4) producing 65% and 73% yield respectively. However, when ethanol:water was used as a mixed solvent system in a 1:1 ratio (entry 5), the yield dropped to 41%, indicating that the presence of water adversely affects the reaction efficiency. Based on these results, ethanol was selected as the optimal solvent for further studies.

Table 1. Optimization of solvent

Entry	Solvent	% Yield
1	Water	32
2	Acetonitrile	48
3	Methanol	65
4	Ethanol	73
5	Water:ethanol (1:1)	41

2. Effect of temperature

Gewald reaction between 1 mmol cyclohexanone, 1 mmol malononitrile and 1 mmol sulphur was carried out in 3 ml ethanol and 50 mg catalyst at 40°C. This produced 73% of desired 2-aminothiophene product in 3 hours. However, when the same reaction was

performed at room temperature, it took 4 hours to produce 61% yield. Hence, for further investigation, reaction temperature was optimized as 40°C.

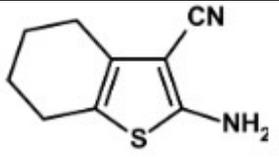
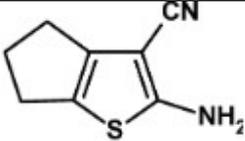
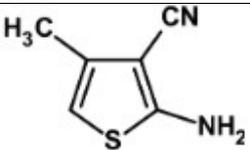
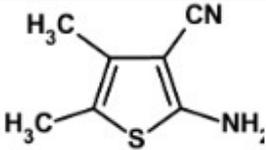
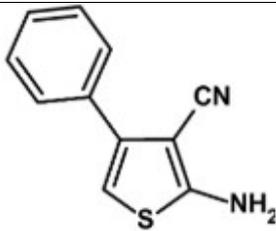
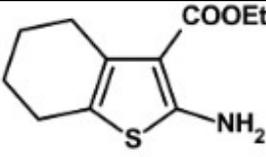
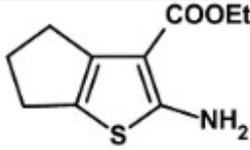
3. Optimization of catalyst amount

Three different catalyst loadings ranging from 50 to 150 mg were evaluated to optimize the yield of 2-aminothiophene. As shown in Fig.4, increase in catalyst amount led to enhanced reaction yield. However, no significant improvement was observed beyond 100 mg. Therefore, further experiments were conducted using 100 mg of catalyst as the optimal loading.

3. Substrate scope

The scope and efficiency of the process was explored under the optimized conditions. For this purpose, the present study was extended to various ketones and two variants of activated nitrile. The results are shown in Table 2. A comparison of two different activated nitrile compounds reveals that malononitrile exhibits significantly higher reactivity than ethyl cyanoacetate under the studied conditions (entries 1 and 6; entries 2 and 7). This is in accordance with the literature (Zhao et al 2013; Gavali et al 2023). Additionally, it was observed that cyclic ketones were more reactive than acyclic ketones (entries 1, 2, and 3). When acetone was chosen as a substrate, the reaction was performed in presence of 3 ml H₂O as a solvent since acetone-water forms a homogeneous mixture favourable for the reaction. (entry 3). Furthermore, it was found that butanone and acetophenone did not produce the desired 2-aminothiophene products (entries 4&5) when employed as substrates in the Gewald reaction under optimized conditions. This reaction failure may be attributed to competing side reactions such as self-aldol condensation, possibility of formation of mixture of products as well as steric hindrance that interferes with nucleophilic attack and sulphur incorporation leading to incomplete reactions.

Table 2. Synthesis of different 2-aminothiophene derivatives

Entry	Product code	Product	Time (hrs)	% yield	MP·C obs(lit)
1	3a		3	82	142 (139-147)
2	3b		4	69	148 (144-145)
3	3c		4	57 ^a	116 (118-119)
4	3d		4	NR	-
5	3e		4	NR	-
6	3f		6	36	118 (115-123)
7	3g		8	24	90 (92-102)

Reaction conditions: 1 mmol ketone, 1 mmol activated nitrile, and 1 mmol elemental sulphur, 3 ml ethanol, 100 mg 2:1 BPAFA catalyst, 40°C, 500 rpm.

^aWater was used as solvent. NR : No reaction.

4. Catalyst reusability study

Recyclability is a crucial parameter in assessing the practical applicability of heterogeneous catalysts. To check reusability of BPAFA catalyst, Gewald reaction was performed under the optimized conditions. The crude products were extracted in DCM and the catalyst was separated by centrifugation. The used catalyst was then washed with water followed by acetone, dried, and reused in subsequent runs. The effect of repeated use of catalyst on the reaction yield is illustrated in Fig.5. It indicates that the BPAFA catalyst retained its efficiency for up to five consecutive cycles.

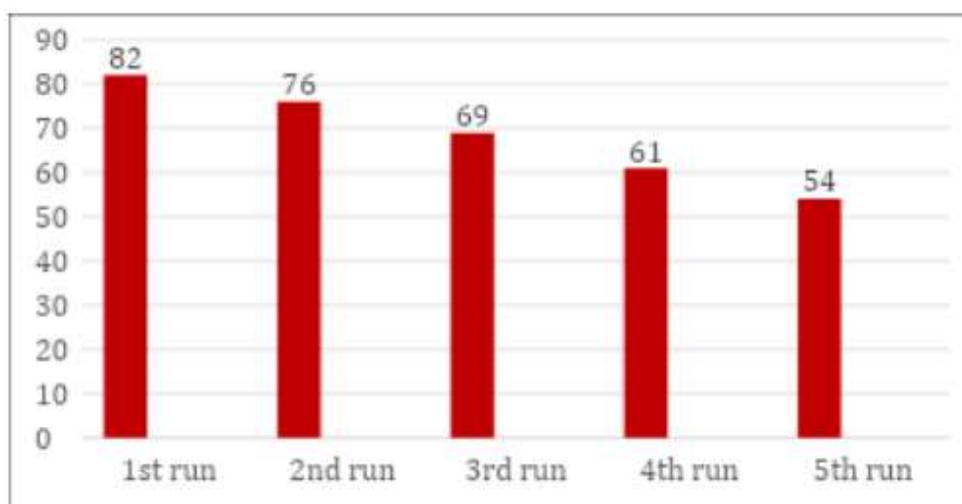


Fig.5. Catalyst reusability study

5. Antimicrobial properties

2-Aminothiophene and its derivatives show wide range of biological properties and broad spectrum of applications with remarkable potency. The antibacterial profile of the synthesized compound AT-1 (**3a**) was systematically evaluated against two representative bacterial strains, namely *S. aureus* and *E. coli* using the agar well diffusion method comparing with the standard Streptomycin (Fig.6). Samples were prepared in DMSO with the concentration of test solution as 1mg/ml.

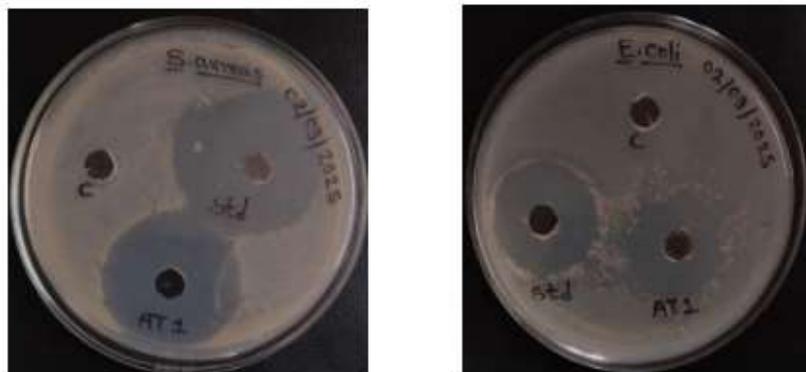


Fig.6. Antibacterial activity of synthesized compound AT-1 (3a)

These results revealed that AT-1 exhibited a good antibacterial effect, as evidenced by the clear and measurable zones of inhibition formed around the wells. When compared with the standard antibiotic streptomycin, the compound AT-1 demonstrated comparable inhibitory potential against the tested strains. These results highlight the therapeutic relevance of AT-1 as a potential antibacterial agent.

4. Conclusion

In this work, a novel banana peel ash–fly ash (BPAFA) composite catalyst, prepared entirely from waste materials, was successfully applied to the Gewald synthesis of 2-aminothiophenes. Reaction at moderate temperature using ethanol solvent underscores the sustainability of the process. The low cost and waste-derived origin of the catalyst ensure resource sustainability and its reusability up to five cycles highlights its practicality. The antimicrobial activity of synthesized compound demonstrates potential in pharmaceutical development. This study not only introduces an eco-friendly and inexpensive catalyst for Gewald synthesis but also opens avenues for its application in other multicomponent reactions.

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Ocean to Application: Bioactive Compounds of *Holothuria leucospilota* for Sustainable Health and Environmental Benefits

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Abstract

Sea cucumbers (Holothuroidea) are marine invertebrates widely recognised for their nutritional and medicinal value. They produce diverse bioactive compounds such as triterpene glycosides, sulphated polysaccharides, peptides, and sterols, which contribute to their ecological defence and pharmacological potential. Traditionally used in Asian medicine for wound healing and immune support, sea cucumbers are now gaining importance in biotechnology for their antioxidant and antimicrobial properties. In this study, *Holothuria leucospilota* was collected from the Ratnagiri coast, India, and subjected to solvent-guided extraction, phytochemical screening, and biochemical characterisation. Extracts revealed the presence of glycosides, saponins, phenolics, and proteins, supported by FTIR and GC–MS analyses that confirmed functional groups associated with active metabolites. Bioactivity assays showed strong antioxidant potential, with methanolic extracts displaying over 65% radical scavenging activity, and broad-spectrum antimicrobial activity against both Gram-positive and Gram-negative bacteria. These findings validate the traditional therapeutic relevance of sea cucumbers and highlight their potential in nutraceutical and pharmaceutical applications.

Keywords: Sea cucumbers, *Holothuria leucospilota*, bioactive compounds, antioxidant activity, nutraceuticals

1. Introduction

Marine ecosystems are among the most prolific sources of structurally unique bioactive compounds with significant pharmacological and ecological relevance (Blunt *et al.*, 2018). Among marine invertebrates, sea cucumbers (Class Holothuroidea) are recognised for their dual role in marine ecosystem functioning—through nutrient recycling and sediment bioturbation—and for their capacity to produce diverse secondary metabolites such as triterpene glycosides, sulphated polysaccharides, phenolics, peptides, and sterols (Purcell *et al.*, 2012). These compounds exhibit a wide spectrum of biological activities, including antioxidant, antimicrobial, anti-inflammatory, antitumor, and anticoagulant properties (Zhong *et al.*, 2019; Nigam *et al.*, 2020).

Traditionally, extracts from sea cucumbers have been used in Asian medicine for wound healing, immune enhancement, and the treatment of inflammation (Bordbar *et al.*, 2011). In recent years, modern investigations have scientifically validated these traditional claims, attributing their pharmacological properties to bioactive compounds such as triterpene glycosides, phenolics, peptides, and sulphated polysaccharides (Kariya *et al.*, 2010). Beyond their ecological role, sea cucumbers have thus gained prominence as promising sources of marine-derived therapeutics.

Despite extensive studies in Southeast Asia and other Indo-Pacific regions, research on Indian sea cucumbers, particularly *Holothuria leucospilota* inhabiting the Maharashtra coast, remains limited. The Ratnagiri coast, characterised by variable salinity and nutrient-rich intertidal zones, provides an ideal environment for studying metabolic diversity in this species. Therefore, the present study was undertaken to investigate the biochemical, phytochemical, and bioactive potential of *Holothuria leucospilota* collected from two ecologically distinct intertidal sites along the Ratnagiri coast. The research integrates

solvent-guided extraction, phytochemical screening, and bioactivity assays to identify bioactive compounds contributing to sustainable health and environmental applications.

2. Materials and Methods

2.1 Study Area and Sample Collection

Specimens of *Holothuria leucospilota* were collected during low tide from Alawa (Mirya; 17.023° N, 73.276° E) and Kasop–Phansop (16.951° N, 73.286° E) beaches along the Ratnagiri coast. Samples were identified using FAO keys and authenticated by qualified taxonomists. Ethical clearance was obtained from the Research Advisory Committee and the Institutional Ethics Committee of Gogate Jogalekar College.

2.2 Sample preparation and extraction

The body wall, visceral mass, and Cuvierian tubules were separated, dried at 35 ± 2 °C, powdered, and stored at 4 °C. One gram of tissue powder was extracted in 10 mL of the respective solvent (methanol, ethanol, chloroform, petroleum ether, n-hexane, and water) for 24 h under agitation. Filtrates were concentrated and used for phytochemical and biological assays.

2.3 Phytochemical and biochemical analyses

Qualitative tests (Harborne, 1973) detected saponins, flavonoids, phenolics, glycosides, steroids, tannins, and alkaloids. Quantitative biochemical assays estimated total proteins (Lowry), carbohydrates (anthrone), and lipids (sulfophosphovanillin).

2.4 Antioxidant and antimicrobial assays

DPPH radical scavenging activity was measured spectrophotometrically at 517 nm (Brand-Williams *et al.*, 1995). Antimicrobial potential was evaluated via agar disc diffusion against *Staphylococcus aureus*, *Escherichia coli*, and *Candida albicans* (Bauer *et al.*, 1966).

2.5 Instrumental analyses

Methanol and n-hexane extracts (highest bioactivity) were analyzed using:

- FTIR (4000–400 cm^{-1}) for functional group identification.
- GC–MS (Agilent 7890B) for compound identification against NIST library standards.

3. Results and Discussion

3.1 Phytochemical composition

All tissue extracts contained a variety of secondary metabolites, varying with solvent polarity. Methanol and ethanol extracts yielded the broadest spectrum of phenolics, flavonoids, saponins, and glycosides, while petroleum ether and chloroform extracts revealed sterols and alkaloids. The Cuvierian tubules exhibited the highest metabolite diversity, suggesting an ecological defence role.

These findings concur with previous studies that correlate polar solvents with higher metabolite recovery (Sarker & Nahar, 2012; Wen *et al.*, 2021). The rich saponin and phenolic content underscores *Holothuria leucospilota*'s potential for antioxidant and immunomodulatory applications.

Table 1. Qualitative Phytochemical Screening of *Holothuria leucospilota* Extracts

Phytochemical Group	Methanol	Ethanol	Petroleum Ether	Chloroform	n-Hexane	Water
Phenolics	++	++	–	–	+	+
Flavonoids	++	+	–	–	–	+
Saponins	++	++	–	–	+	+
Glycosides	+	+	–	–	–	+

Tannins	+	+	–	–	–	+
Alkaloids	+	+	+	+	–	–
Steroids	+	+	+	+	++	–
Proteins	++	+	–	–	–	+

3.2 Biochemical composition

Tissue analyses revealed significant nutritional variation: proteins (body wall 46.65 ± 0.9 mg/g), lipids (visceral mass 4.70 ± 0.4 mg/g), and carbohydrates (Cuvierian tubules 45.88 ± 0.9 mg/g). High protein levels, mainly collagen, affirm the value of the body wall for nutraceutical and cosmetic formulations.

Table 2. Biochemical Composition of *Holothuria leucospilota* Tissues

Tissue Type	Protein (mg/g)	Lipids (mg/g)	Carbohydrates (mg/g)	Total Phenolic Content (mg GAE/g)
Body wall	46.65 ± 0.9	3.42 ± 0.3	40.12 ± 0.6	15.4 ± 0.7
Cuvierian tubules	42.35 ± 0.8	2.98 ± 0.2	45.88 ± 0.9	28.2 ± 0.9
Visceral mass	38.10 ± 0.6	4.70 ± 0.4	39.15 ± 0.8	9.8 ± 0.4

3.3 Antioxidant activity

Methanolic extracts demonstrated concentration-dependent DPPH scavenging, reaching 86.7 % inhibition at 125 $\mu\text{g/mL}$ (Cuvierian tubules). The corresponding IC_{50} values ranged 72.4–95.6 $\mu\text{g/mL}$, confirming strong antioxidant efficacy, although slightly below the ascorbic acid standard (91.8 %). Elevated activity corresponded with high total phenolic

content (28.2 ± 0.9 mg GAE/g), validating the contribution of phenolics and flavonoids to radical neutralisation (Bahrami & Franco, 2016).

Table 3. Antioxidant Activity (DPPH Radical Scavenging) of *Holothuria leucospilota* Extracts

Tissue Extract (Methanol)	Concentration ($\mu\text{g/mL}$)	% Scavenging Activity (Mean \pm SD)	IC ₅₀ ($\mu\text{g/mL}$)	Remarks
Body wall	125	65.2 ± 1.4	72.4	Strong antioxidant potential due to phenolics and flavonoids
Cuvierian tubules	125	86.7 ± 1.2	72.4	Highest radical scavenging activity among tissues
Visceral mass	125	58.4 ± 1.8	95.6	Moderate activity linked to lower phenolic content
Ascorbic acid (standard)	125	91.8 ± 0.9	52.0	Reference standard for comparison

3.4 Antimicrobial activity

Methanol extracts exhibited broad-spectrum inhibition against *S. aureus* (26.4 ± 1.3 mm), *E. coli* (28.3 ± 1.5 mm), and *C. albicans* (32.7 ± 1.5 mm), surpassing non-polar extracts. This potency is attributed to the synergistic action of saponins, sterols, and fatty acids (Zhong *et al.*, 2019). The observed effects paralleled standard antibiotics (streptomycin, fluconazole), indicating potential for natural antimicrobial formulations.

Table 4. Antimicrobial Activity of Methanolic Extracts of *Holothuria leucospilota*

Test Organism	Body Wall (mm)	Cuvierian Tubules (mm)	Visceral Mass (mm)	Standard Drug (mm)	Reference Drug
<i>Staphylococcus aureus</i>	23.8 ± 1.2	26.4 ± 1.3	22.5 ± 1.4	27.2	Streptomycin
<i>Escherichia coli</i>	25.5 ± 1.4	28.3 ± 1.5	23.9 ± 1.3	29.1	Streptomycin
<i>Candida albicans</i>	29.8 ± 1.3	32.7 ± 1.5	26.4 ± 1.2	33.5	Fluconazole

To further elucidate the chemical basis of these activities, the most active extracts were characterised using FTIR, HPLC, and GC–MS analyses.

3.5 FTIR, HPLC, and GC–MS analyses

FTIR spectra showed characteristic bands at 3280 cm⁻¹ (–OH stretch, phenolics), 2924 cm⁻¹ (C–H lipids), and 1634 cm⁻¹ (C=O amide, proteins), confirming complex biochemical architecture. HPLC peaks indicated phenolic acids such as gallic acid, quercetin, and catechin derivatives.

Table 5. Major FTIR Absorption Bands of Methanolic Extract of *Holothuria leucospilota*

Peak (cm⁻¹)	Functional Group	Vibration Type	Possible Compound Class	Interpretation / Remarks
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3280– 3300	–OH stretch	Hydrogen bonded	Phenols, alcohols	Hydroxyl groups of phenolic/flavonoid compounds
2924– 2854	C–H stretch	Asymmetric/symmetric	Alkanes, fatty acids	Characteristics of lipid and sterol chains
1740– 1720	C=O stretch	Carbonyl	Esters, aldehydes	Presence of fatty acid esters and triterpenoids
1654– 1634	C=O (amide I) / C=C	Stretch	Proteins, amides, aromatics	Proteinaceous and phenolic components
1542– 1535	N–H bend (amide II)	Bending vibration	Proteins, peptides	Peptide backbone structure
1456– 1415	C–H bending	Deformation	Lipids, sterols	Aliphatic groups of lipids
1380– 1365	C–N stretch / O– H bend	Mixed	Phenolic acids	Phenolic hydroxyl interactions
1245– 1220	S=O / C–O stretch	Stretch	Sulphates, esters	Sulphated polysaccharides
1150– 1080	C–O–C stretch	Stretch	Polysaccharides, glycosides	Glycosidic bonds
1030– 1020	C–O stretch	Stretch	Carbohydrates, saponins	Sugar and saponin components
875– 720	C–H bend	Bending	Sterols, triterpenes	Terpenoid skeletons

GC–MS profiling identified bioactives including palmitic acid, eicosapentaenoic acid (EPA), arachidonic acid, oleyl alcohol, and β -sitosterol. These compounds are known for antioxidant, antimicrobial, and anti-inflammatory functions (Mamelona *et al.*, 2007; Man *et al.*, 2023). The dominance of EPA and sterols highlights the nutritional and therapeutic value of the species.

Table 6. Major Bioactive Compounds Identified by GC–MS in Methanolic and n-Hexane Extracts of *Holothuria leucospilota*

Retention Time (min)	Compound Name	Molecular Formula	Compound Class	Reported Bioactivity	Reference
17.38	Palmitic acid	C ₁₆ H ₃₂ O ₂	Saturated fatty acid	Antioxidant, antimicrobial	Mamelona <i>et al.</i> , 2007
18.75	Eicosapentaenoic acid (EPA)	C ₂₀ H ₃₀ O ₂	ω -3 polyunsaturated fatty acid	Anti-inflammatory, cardioprotective	Wen <i>et al.</i> , 2021
19.62	Oleyl alcohol	C ₁₈ H ₃₈ O	Long-chain alcohol	Emollient, antimicrobial	Zhong <i>et al.</i> , 2019
20.32	Arachidonic acid	C ₂₀ H ₃₂ O ₂	Polyunsaturated fatty acid	Cell signalling, immune response	Man <i>et al.</i> , 2023
23.11	β -Sitosterol	C ₂₉ H ₅₀ O	Phytosterol	Anti-inflammatory, antioxidant	Bordbar <i>et al.</i> , 2011
27.24	Cyclodeca siloxane	C ₂₀ H ₆₀ O ₁₀ Si ₁₀	Siloxane derivative	Antioxidant stabilizer	Suleria <i>et al.</i> , 2015

4. Discussion

The findings demonstrate that *Holothuria leucospilota* collected from the Ratnagiri coast is a promising source of diverse bioactive metabolites. The high antioxidant and antimicrobial activities support its traditional use in coastal communities for wound healing and immune enhancement (Bordbar *et al.*, 2011).

The solvent-specific variations observed suggest that polarity strongly influences metabolite recovery. Methanol, a polar solvent, efficiently extracted phenolic and saponin compounds responsible for free radical scavenging (Sarker & Nahar, 2012). Non-polar extracts containing sterols and fatty acids contributed to antibacterial action, consistent with previous studies (Zhong *et al.*, 2019).

Moreover, the integration of FTIR, HPLC, and GC–MS provided a comprehensive chemical fingerprint, reinforcing the pharmaceutical relevance of *Holothuria leucospilota*. The presence of multifunctional metabolites highlights its potential in sustainable biotechnological applications including nutraceuticals, cosmetics, and environmental health formulations.

5. Conclusion

Holothuria leucospilota from the Ratnagiri coast exhibits remarkable biochemical diversity and biological activity. Polar solvent extracts, particularly methanol, yielded high levels of phenolics and saponins responsible for antioxidant and antimicrobial properties. FTIR and GC–MS confirmed functional groups and compounds of pharmaceutical significance, including EPA, oleyl alcohol, and palmitic acid.

These findings validate the traditional medicinal value of sea cucumbers and emphasize their promise in nutraceuticals, pharmaceuticals, and environmental health formulations. Future studies should focus on compound isolation, toxicity assessment, and sustainable cultivation for commercial application.

6. References

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