PROSPECTS OF INLAND WATERWAYS IN URBAN PUBLIC TRANSPORT OF KOCHI CITY KERALA

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Abstract

Cities, water, and transport are all fundamental elements in human society and associations between them are inevitably numerous. With the increasing cost of transportation over land, the high capital cost of developing roads and railway lines and the non-availability of land for this purpose, the relevance of inland water transportation is being increasingly emphasized. Kochi is one of the fast-growing urban centres in Kerala as well as in South India. Waterways constituted the main means of transportation even from historical times. The development of Kochi has been mainly on account of the political, administrative and commercial importance it has enjoyed over the centuries. Kochi is abundantly blessed with waterways with over 1100 kms of waterways available Out of this about 40 km of rivers and canals are navigable by motorized crafts. The waterways in Kochi also have a predominantly grid iron pattern. Proper maintenance of these waterways could help develop most of the available areas into waterway-accessible areas and thus develop an alternative mass rapid transit system for the city, thereby taking some load off the already congested roads. This paper attempts to explore the role of inland waterways as a mode of transportation both passenger and freight in Kochi city and how it serves for the functioning of Kochi harbour. The paper also discusses some neglected areas of investigation and to suggest possible method of advance.

Keywords: Inland Waterways, Passenger movement, Freight traffic, Urban water transport.

1. INTRODUCTION

Waterways constituted the main means of transportation even from historical times. It provides a strong potential for developing river and sea shuttle services by making use of the geographic features of the area. By enabling direct routes to be taken for crossings, waterways provide time savings as compared with the same journey made using land-based transportation and make the shuttle service attractive. However, improving the accessibility of urban areas or neighbourhoods is not only a question of transport policy but is even more so one of urban development. A river and sea shuttle project developed as part of a comprehensive transport policy often accompanies Urban area projects. The implementation of such a project may be facilitated if infrastructure (docks, jetties, platform,

etc.) already exists. Shuttles dedicated to urban transport in fact share waterways with other users (ships, cargo ships, cruisers, recreational boaters, fishermen, etc.)In addition, transportation by water has the special feature of being highly attractive for tourists and or for leisure activities. This dual use - urban daily transport and tourist transport - may impact the sizing of the urban shuttle service

Coastal cities around the world have played a pivotal role in the history of civilisation, as centres of global trade and commerce, of cultural exchanges, of vibrant local economies and of rapid growth and transformation. Like many of its counterparts around the world, the city of Kochi, located along India's Western coast, enjoys a strategic location, and has always been sought-after by nations looking to dominate in the area. Through the numerous waves of colonisation, the city flourished as a port, gaining in both economic prowess and population (Zeba Aziz and et.al, 2018). The entire development in the low lying coastal areas of Kochi

has been dependent on canal systems integrated by backwaters, lagoons and estuary and was instrumental for trade and commercial activities.

The paper addresses the feasibility of inland waterways in both passenger and freight movement in Kochi city and also how it supports the operation of Kochi port. It also attempts to focus on current developments and upcoming progress in water transportation in Kochi city.

2. STUDY AREA

Kochi is one of the fast growing urban centres in Kerala as well as in South India. Kochi has a coastline that stretches up to a length of about 48 kilometres (Fig.1). Average altitude ranges from 7.5m to 1m above MSL from east to west.The characteristic physical feature of Kochi is the expanse of backwaters and low lying wet lands.A number of main and secondary canals criss-cross the area. It is a coastal settlementinterspersed with backwater system and fringed on the eastern side by laterite capped low hills from which anumber of streams originate and drain into the backwater system. The area abounds in plains,rivers, estuaries, sea coast, islands and other types of natural features.Some are used for

transportation *Fig 1: National waterway3* while others are subjected to environmental degradation due to waste dumping. Kochi city shows a poly centred urban systemaround the Kochi port. The city of Kochi is the second largest city in Kerala and, is also a part of an extended metropolitan area, which is the largest urban agglomeration in the State. Kochi city is classified as a B-1 grade city by the Government of India and the city also ranks first in terms of the arrival of the international and domestic tourists in Kerala. Urban development has been more rapid in the city and its immediate suburbs. Five municipal towns actually small urban enclaves surround the Kochi city. They are linked to city through transportation corridors. (Jayalakshmy and Mereena, 2016)
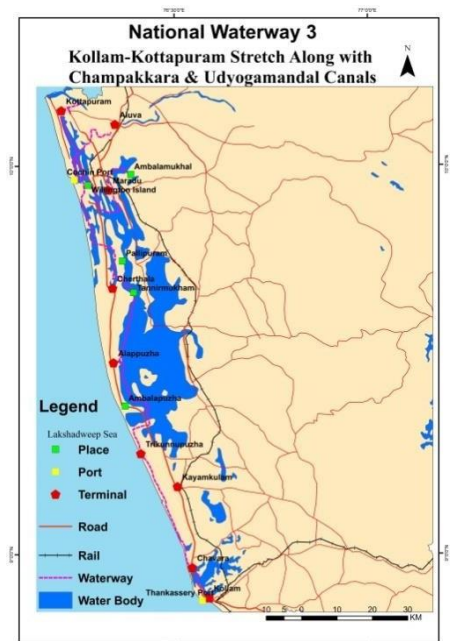
RESULTS AND DISCUSSIONS
DEVELOPMENT OF INLAND WATER TRANSPORT INKOCHI

Waterways of Kochiconstituted the main means of transportation even from historical times.The first mention of Kochi is made sixty years after the formation of the harbour(A.D

1341) by Ma Huan, a Chinese Mohammedan, and later by the Italian traveller Nicolo Conti (A.D 1440). When analysing the time line, the development of trade along the Vembanadu lake region has undergone a continues drift from Muziris(Pattanam) to Kodungallure.A sudden declination can be seen in the trade from Kodungallure during the 14th century A.D.And at the same time the Kochi has developed in to a port and the trade activities happened in the Kodungallure port shifted further south,toKochi.The port city of Kochi had become highly developed during the time of the British rule in India. Subsequently in 1840 AD Kochi rulers shifted to Ernakulam due to the congestion at Mattancherry. Ernakulam Market and associated settlements flourished during this period. The development of the town then shifted to the main land. By 1840-1870- The Karanchira-Trichur canal was constructed and Edathuruthi canal was deepened to provide through traffic between Ernakulam and Thrissur. Thevara to Kudannur canal was taken up to connect Ernakulam and Tripunnithura. By,1870s Munayam-Thiruvanchikulam canal was constructed. Edapalli and Parur canals were constructed by Tholan the Namboodiri Chieftain to provide waterways to Thiruvanchikulam for workship at the temple.

The opening of Suez Canal in A.D 1869 emphasized the importance of Kochi Port as a coaling station. The trade flourished after that and the Kochi port became the major port along the Kerala coast, suppressing the other major ports like Kollam and Calicut. This development leads to the formation of Kochi P.W.D. After the formation of P.W.D, a plan for dredging the sea and directing the ships to the inner lake shore was suggested. Then the main land and the islands in the Vembanad lake were connected with the water transportation system, in accordance with the shifting of capital and the growth of port after the Suez canal built. The WilingtonIsland became the port, were big, modern vessels can anchor. After the Willington Island built, the port developed drastically, and by the end of the British period it became one of the major port in Indian subcontinent**.**

In 1920 Sir Robert Bristow, the British harbour engineer created a new port, with jetties, railway line, ship yards, roads connecting bridges etc, which gavea new face for the Kochi port. Indian naval command had set up their southern naval base in Willington Island. The sudden growth helped the old trading centre - peninsular Kochi. Soon after the independence, the Kochi port has been announced as one of the major port in the Indian subcontinent, by the Government of India. The Kochi ship yard was set up here in 1976, and Kochi became known for the ship building also**.**Fig.2 portrays the trends in the development of transport in Kochi.
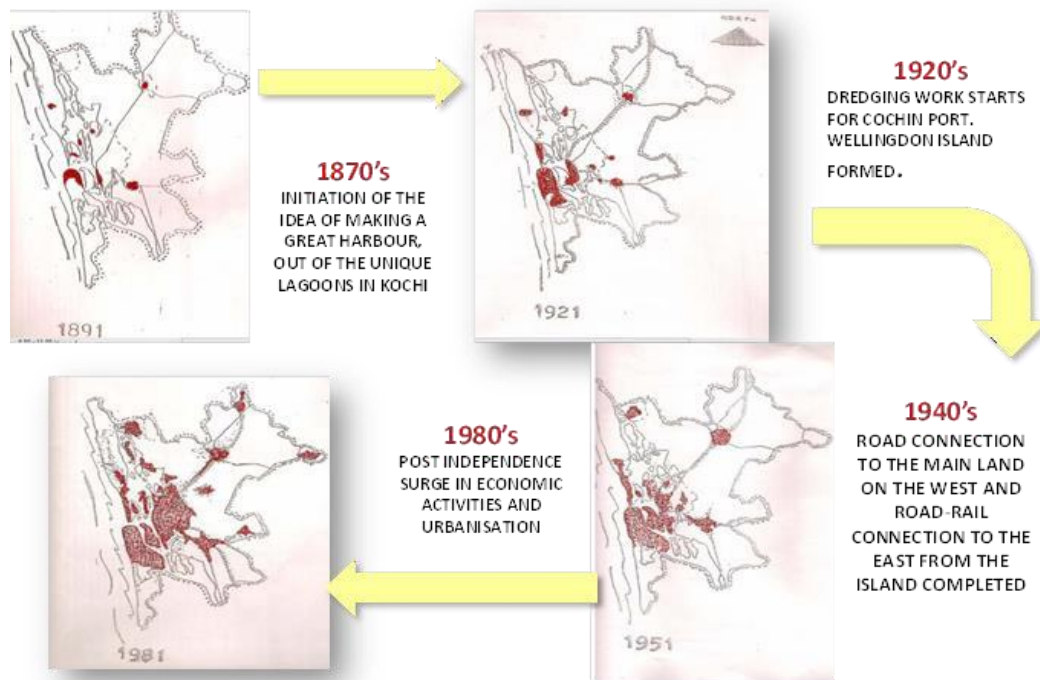
Fig 2: Development stages of Kochi city with regard to transportation facilities

Source: CDP, Kochi

Kochi is one of the few cites of India with connection to other parts by all major modes of Transportlike road, rail, air and water. NH 17, NH 47 and NH 49; National waterways 3, etc (Fig.3).International airport and Kochi port located on strategic international route are the major intercity linkages.Majority of road traffic are concentrated along two east-west corridors of the city. The major public transport modes in Kochi are city buses, auto rickshaws and ferry boats operated mainly by privateoperators. The Inland Water Transport System is comprised of ferries operating from 10 major terminals. The ferries operated by Pvt. Operators as well as KINCO; act as the principal link between the mainland and islands.
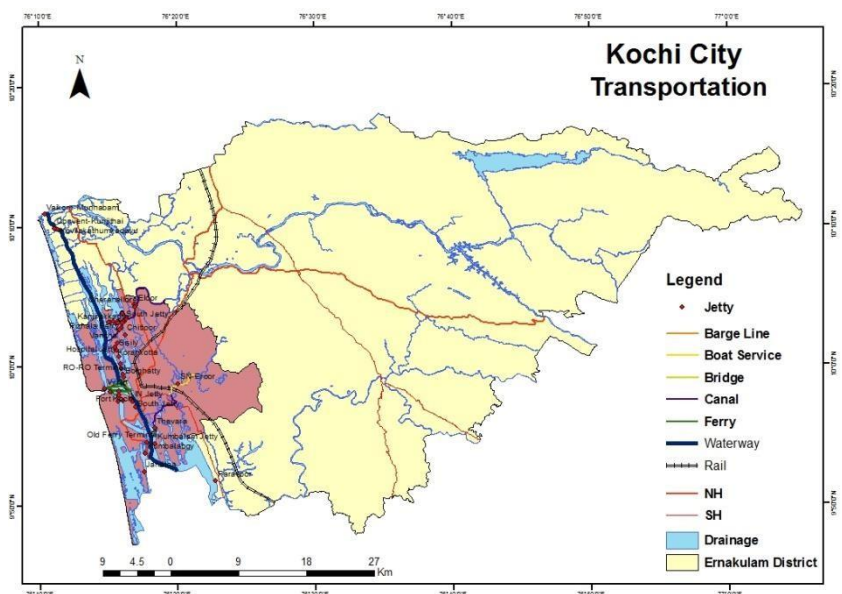
Fig: 3: Kochi city: current transportation

The ferry service between Fort Kochi and Vypinhas a ridership of 12,000 passengers daily. The waterway route connecting Fort Kochi – Vypin carries the maximum daily vehicle traffic of 1225. Water transport is also being used as a major transport for carrying freight. A total number of 45 boat jetties are located within the Kochi city region. Out of which major ferry routes includesErnakulam (Main Jetty) to Embarkation (Willingdon Island)/ Fort Kochi, Ernakulam (Main Jetty) –Vypin, Ernakulam (Main Jetty) –Mattancherry, Ernakulam (Main Jetty) –Varapuzha, Ernakulam (High Court Jetty) - Bolghatty Island and Fort Kochi–Vypin.

ECONOMIC FEASIBILITY OF INLAND WATERWAYS

Water based transport is effective as generally speaking, operating costs of fuel are low and environmental pollution is lower than for corresponding volumes of movement by road, rail or air. A major advantage is that the main infrastructure – the waterway – is often naturally available, which then has to be "trained", maintained and upgraded. Transport over waterways is especially effective when the source and/or destination are waterfront locations. (G.Raghuram,2006).

Route	Roadways			Waterways		
	Distance(KM)	Time (minutes)	Fare (rupees)	Distance(KM)	Time (minutes)	Fare (rupees)
Ernakulam-Vypin	22.4	39	20	16	20	12
Fort Kochi-Vypin	20.2	36	18	2	12	3
Ernakulam-Mattancherry	12	40	14	4	15	7
Ernakulam-Willington Island	12	40	14	3	8	4

Table 1: Travel distance between various nodes by road and waterway

Source: Primary Survey June 2017

Comparative analyses have been made in water ways and road ways with respect to distance, travel time and fares for selected transport routes in Kochi City Region. It is observed that, water ways is cheaper and faster as compared with the road ways. The details are shown in table1.It is found that Water based transport is effective as generally speaking, operating costs of fuel are low and environmental pollution is lower than for corresponding volumes of movement by road, rail or air. A major advantage is that the main infrastructure - the waterway - is often naturally available. (Rangaraj Narayan, 2006). In the given Table 1the travel distances between various important nodes are far lesser via waterways than roadways. For example the distance between Ernakulam and Willington Island is about four times more by road than by waterways. This inherent advantage of waterways over road transport can be used to attract the road users to use waterways for mobility and transportation of goods

TRENDS IN PASSENGER MOVEMENT

The passenger transport in Kochi inland waterways is provided by Kerala State Water Transport Department. Kochi city has two main boat-jetties. One is close to Subhash Park and the other is adjacent to the High Court. Hundreds of passengers including foreign tourists make use of the two Jetties for travel to Fort Kochi, Mattancherry, Vypin, Bolgatty Palace, Mulavukadu, and Vallarpadam.
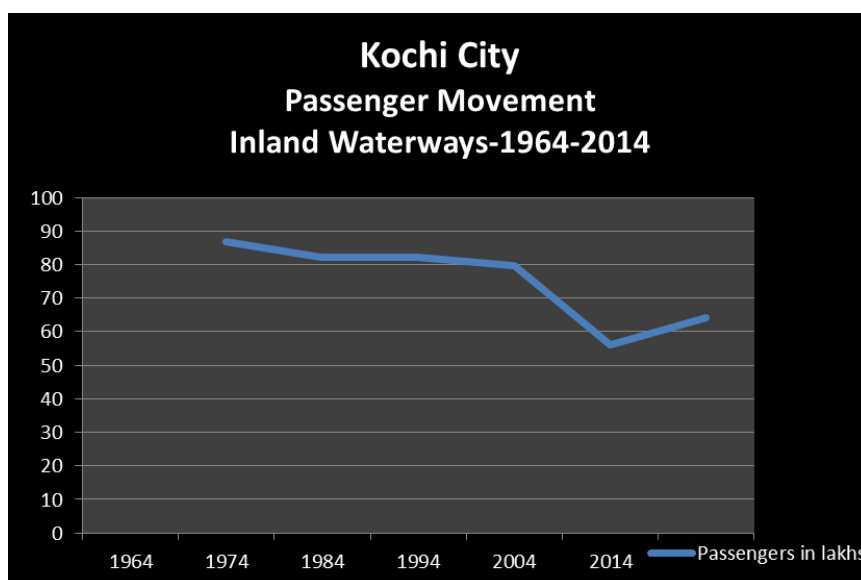

Fig 4: Kochi city passenger movement: 1964-2014

Source: Compiled by author, data collected from Economic review, Kerala State

The given figure 4 shows the inland passenger trend of Kochi city from 1964 to 2014. The inland passenger movement showed a declining trend since 1964.The modal share of Inland

Water Transport has gradually declined due to poor maintenance, lack of dredging, terminal facilities and improved road network resulting in fierce competition from road transport. Water transport in Kochi city region has also declined due to the construction of bridges connecting islands on the western part of the city (Prageeja K., 2011). But after 2010 it shows an increasing trend.Unregulated increase in the number of vehicles on the roads, traffic congestion, road accident growth, increased road transportation cost etc led to the increased dependency of waterways by the public during this period. This shows the growing demand of Pubic Inland waterways in the city region. Currently the modal share of Inland Water Transport in Kerala is higher than the national average.

TRENDS IN FREIGHT MOVEMENT

Freight movement has started in the Kochi city region only from 1994. Inland Water Authority of India has installed night navigation facilities, throughout the National Waterway 3 from Kottapuram to Kollam. This has led to reduction in turnaround time and increased number of cycles for vessels, particularly for movement of cargo in FACT.
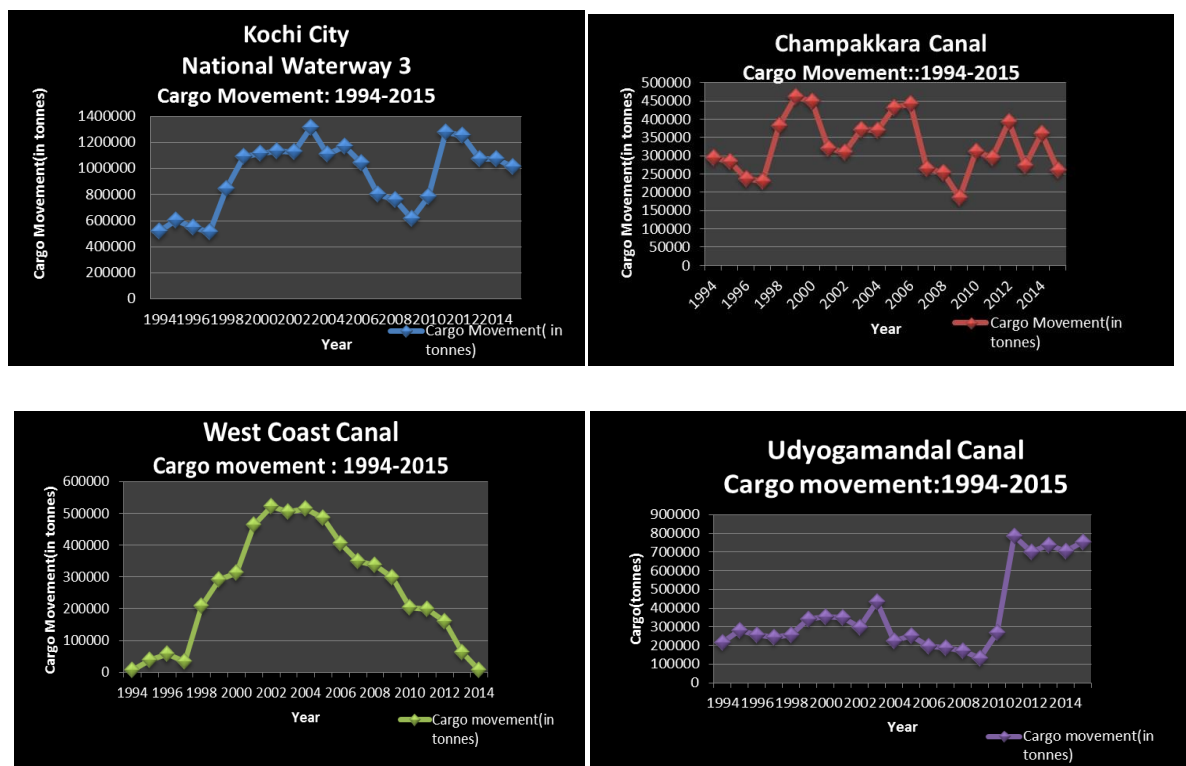

Fig 5: Freight Movement Trend,

Source: Primary data collected from IWAI,Maradu

However, only Champakkara and Udyogamandal Canals are being utilized for cargo transportation on the waterway, with rest of the waterway yet to see cargo movement. There

are public as well private sector companies providing transportation facilities on NW 3. These companies are mainly operating on charter basis and are involved in mainly the transportation of bulk cargo. Some of the companies include Kerala Shipping and Inland Navigation Corporation (KSINC), Lots Shipping Choice Shipping among others .Figure 5 shows the cargo traffic handled by the three canals in National waterway 3 from 1994-2014. The Udyogamandal Canalhas shown the highest growth in cargo movement over the last twenty years. During 2007-08 its shows a slight decline, after that it shows an increasing trendand the movement reached its maximum during 2011-12. Since 2012 it shows a uniform trend. Champakkara canal shows a fluctuation trend in freight movement with a maximum of 4.61 lakh tonnes during 1999-2000 and minimum of 1.81 lakh tonnes during 2009-10. In the recent years it shows an increasing trend. West coast canal shows a uniform trend of declining from 2004-2014. During 2004-05 it has the maximum freight movement of 5.24 lakh tonnes, while during 2014-15 it declined to the minimum value of 0.04 lakh tonnes. As a total National Waterway shows a declining trend from 2004-2007 and again shows a fluctuation trend between 2007-2009 and it shows an increasing trend from 2010-2011 and reaches its peak in 2012 with a maximum of 234 lakh tonnes.

3.4 KOCHI PORT AND INLAND WATERWAYS

Kochi Port is a major port on the Indian Ocean s and is one of the largest ports in India. The port lies on two islands in the Lake of Kochi: Willingdon Island and Vallarpadam, towards the Fort Kochi river mouth opening onto the Laccadive Sea. The International Container Transshipment Terminal (ICTT), part of the Kochi Port, is the largest container transshipment facility in India.The entrance to the Port of Kochi is through the Kochi Gut between the peninsular headland Vypin and Fort Kochi. The port limits extend up to the entire backwaters and the connecting creeks and channels.

National Waterway 3 (NW3) currently provides inland water connectivity from Kollam to Kottapuram. through the West coast Canal together with the Champakkara and Ugyogmandal branch Canals aggregating to a length of 205 Kms. The present traffic in the water way includes movement of fertilizer raw-materials, bulk commodities drinking water, POL and passenger movements.

The waterway is maintained at a draft of 2.5 to 3 meters. To establish a linkage of the inland terminals in the NW3 from Kollam to Kottappuram to the logistic chain of Kochi Port, the jetty infrastructure capable to unload containers from barges have been constructed at

Willingdon Island and Bolghatty by IWAI. The jetty infrastructure has been designed to meet the heaviest container load that may be imported or exported. Kochi port is connected to Kerala's hinterland through inland waterways which run virtually parallel to the Arabian Sea and link major trading centres.It is therefore, an industrial belt connecting the port through the inland waterway system for transportation of both raw materials and finished products to and from the industrial units to be located in the belt.

A number of industrial plants on the banks of Udyogamandal Canal, where the public sector FACT and Travancore Kochi Chemicals (TCC) were located, is benefited as they were able to transport imported raw materials from the port through the waterways. Some private firms are also engaged in transporting raw materials from the port through the inland water transport system. The Mumbai-based Ardeshir B. Cursetjee and Sons Ltd was among those engaged in transporting imported liquefied ammonia gas to FACT. The other cargoes transported through the inland water route include sulphur and furnace oil.TheKochi Port Trust and the Inland Waterway Authority of India in a joint venture introduced Ro-Ro/ Lo-Lo Barge connectivity to the new International Transhipment Terminal at Vallarpadam. To facilitate the inland waterway connectivity for containerized cargo, new Terminal Jetties have completed at Willingdon Island and Bolghatty. Fig 6shows the share of commodities transported from Kochi port through National Waterway 3.Mainly chemical, petroleum products,steel, water and container cargo is being transported.
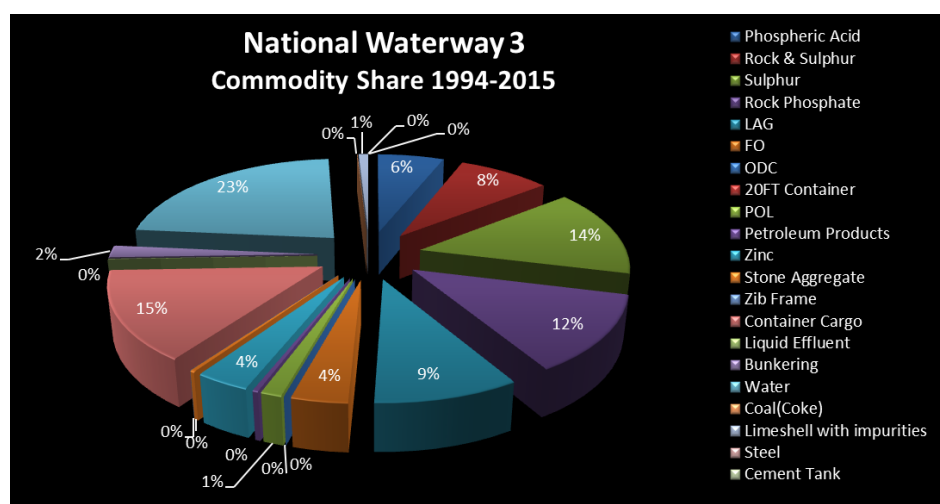

*Fig 6: Commodity share NW3: Source: IWAI(figure compiled by authors)*

In addition to reducing road congestion and pollution throughout the South Kerala and Kochi roads, the water corridor also helps Kochi city and port by following usages.

a) Cost effective transit for containers from the cashew export belt of Kollam and coir export belt of Alappuzha and vice-versa by using container barges.

b) The mobilization of empty containers for export by using LO-LO barges in larger numbers as its carriage should be at minimum cost.

c) The containers from land locked sources and transiting through NH 49 (Madurai-Kochi) and through NH 47 (from South Kerala) can move to W/Island and transit across to the Vallarpadam making use of the NW3 channel through RO-RO/barges using facilities are created in W/Island and Bolghatty. This mode of water bridging avoids a road transit of 35 Kms through the very congested Kochi City roads to Vallarpadam.

d) The sea food processing plants in Aroor can make a straight water corridor to the Kochi port.

e) The existing CFS with 10000 Sq. mtr covered area in the Willingdon Island can support cargo consolidation and the hinterland cargo can make use of the facility through the NW3. New CFS would also come up in the W/Island with the establishment of the terminals.

f)The shore area of the NW3 becomes more valuable as more ancilliary activities can come up in the area. ICD/CFS business is a very potential area of development in this regard.The traffic in the water way is estimated to increase from the present level of 0.7 million to 2.6 million tonnes in the initial years itself.

An economy has little chance of flourishing if it lacks certain basic conditions like efficient transport. But mounting volumes of traffic take a heavy toll on the environment. Traffic congestion and pollution lead us to seek out modes of transport that are less environmentally harmful. This is why Inland water Transport has tremendous potential, in terms of both capacity and logistics. From a supply chain perspective, the main reason for using inland waterways as a mode of transport is the fact that it decreases the total cost, when used as part of the end to end logistical requirement of cargo movement

4. FUTURE VISIONS

- The growth in National Waterway 3 shall be closely related to the growth of International Container Transhipment Terminal (ICTT).

National Waterway 3
Freight Movement-Projection
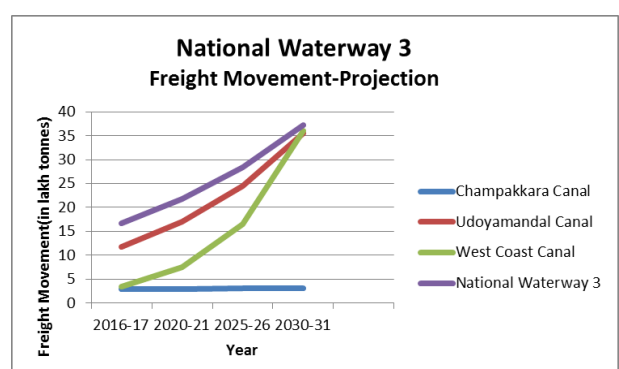
The current transit hub for containers to India is in Colombo which adds to the transit time. Once Kochi has adequate draft and the large box ships start visiting Kochi,the transit hub will entirely shift to ICTT Kochi. National Council of Applied Economic Research (NCAER) projects a growth of 37 lakh tonnes by 2030(Fig: 7).

Fig 7: Freight movement projection NW3: Source: NCAER

- Kochi Water Metro is an integrated water transport project in Greater Kochi region proposed by Kochi Metro Rail Limited. It will be developed as a feeder service to the Kochi Metro rail. The project envisages the development of 16 identified routes, connecting 10 islands along a network of routes that span 76 km. The project intends to bring in a fleet of 78 fast, fuel-efficient, air-conditioned ferries plying to 38 jetties, 18 of which will be developed as main boat hubs, while the remaining 20 will be minor jetties for transit services. More than 100,000 islanders are expected to benefit from the Water Metro, complete with modern watercrafts.

- Inland Water transportation in Kochi city region is in a new development path. Kochi Unified Metropolitan Transport Authority has planned to integrate all modes of transport under a single authority and making its fare uniform .This will be a great boom to inland transportation in future.
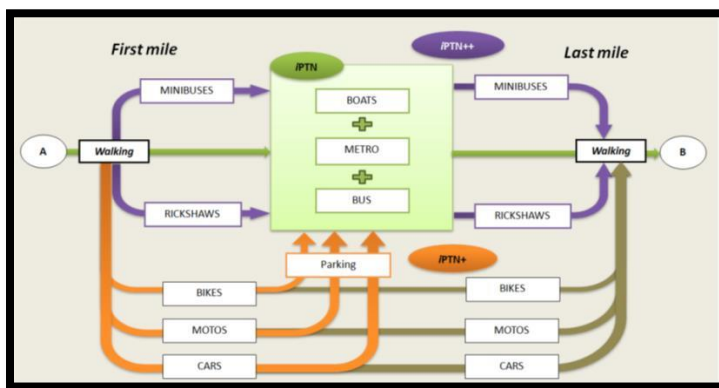

Fig 8: Plan of Kochi Unified Metropolitan Transport Authority

- Another major vision is the Market based distribution using inland water transport in Kochi city region. It is a concept of "Metro Aqua" in which inland waterways is integrated with Low Emission Vehicles to transport commodities. The wards of Kochi city will be divided into various market clusters and new market jetties will be developed. The concept aims to reduce CO_2 emission by 73%.
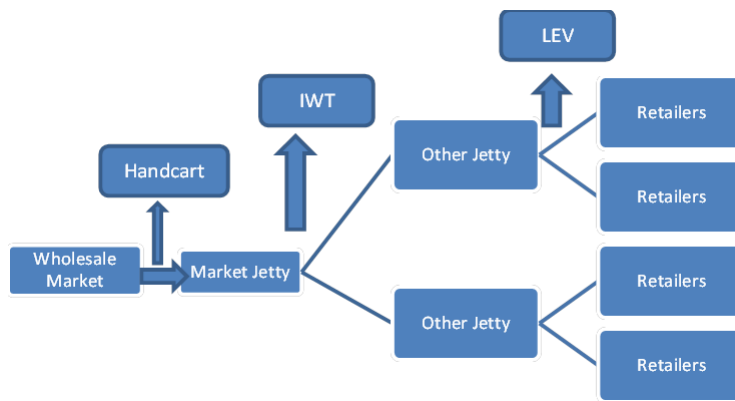
Fig 9: Distribution via LEVs (Low Emission Vehicles) from jetty toother zones.
Source:Urban Moblility India

5. CONCLUSION

The Inland Canals play an important role in the economy of the Kochi city as they interconnect places of commercial and industrial importance and also give a connection from interior places to the West Coast Canal System and their development is still taking place on a piecemeal basis. Inland waterways can have a major role to play in the integrated passenger transport in the urban area.IWT is an option that cannot be ignored in the future growth of the city and calls for integrated investments to increase complementarity with other modes of transport. The city of Kochi has much to gain from the development of waterways. A sustainable water transport system will invariably mean the revival of natural water channels in the city and the creation of climate- proof infrastructure; the twin benefits would be an efficient transport system and increased resilience.IWT and coastal shipping are complementary in nature to each other for providing hinterland-port-port connectivity. The operational and regulatory paths are already paved for integrating IWT with coastal shipping. In addition, the viability of using the inland waters for movement of cargo toward the nearest port also has to be considered.Conclusively, the outlook of inland navigation looks promising, wherein issues on infrastructural gaps and institutional support are addressed suitably.

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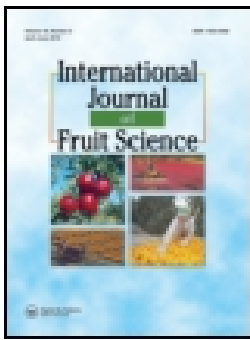
Enhanced Secondary Somatic Embryogenesis in Suspension Culture of Four Diploid Banana Cultivars from Kerala

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Enhanced Secondary Somatic Embryogenesis in Suspension Culture of Four Diploid Banana Cultivars from Kerala

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ABSTRACT

Secondary somatic embryogenesis was observed in the suspension culture of bract-derived banana calli in the presence of liquid Murashige and Skoog medium with additives such as glutamine (0.68–34.21 µM), biotin (0.40–20.46 µM), or ascorbic acid (0.56–28.38 µM) along with malt extract (100 mg/l). After the initiation of homogenous cell suspension, fully developed somatic embryos were observed after fifth subculture in the four cultivars. Somatic embryos were successfully regenerated in basal MS medium and were transplanted after fifth week. After fifth subculture, the frequency of somatic embryos increased in each culture flask. Maximum number of somatic embryos were observed in cv. Sannachenkadali (46.12 ± 0.85[a]) when cultured in liquid MS medium supplemented with biotin (8.18 µM) along with malt extract (100 mg/l), in followed by cv. Matti (44.75 ± 1.19[a]) having (AA) genome. SEM analysis revealed the presence of secondary somatic embryos on the surface of primary somatic embryos in each culture and it attributed a high frequency of somatic embryogenesis. The addition of biotin along with malt extract increased the frequency of secondary somatic embryogenesis in the diploid banana cultivars.

Introduction

Banana is one of the most important tropical fruits in the world trade. India has been the largest producer of banana worldwide since the past one decade (FAO, 2010). It is largely cultivated in India accounting for about 33.4% of the total fruit production. India ranks first both in terms of area and production of banana in the world contributing around 15% of the total global area under banana and about 29% of the total world's production (Nayak and Singh, 2018). In India, banana is the second most important fruit crop and has dominated the fruit industry contributing the highest GDP of 1.99% to agricultural sector. Though India is a leading country in global banana production, the total production is largely consumed domestically

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and provides only a negligible share in the global trade. In Kerala, the cultivation for local consumption is based on a large number of cultivars adapted to domestic cultivation as well as the varied use and taste of local consumers (Aravindakshan and Pushkaran, 1996). In Kerala cv. viz., Njalipooovan, Matti, Sannachenkadali, Palayamcodan, and Nendran are widely cultivated. Most of the edible bananas are sterile polyploids and must be propagated vegetatively. The materials used for conventional propagation include corms, large and small suckers, and sword suckers and are not the ideal propagule, because they carry weevils, fungal pathogens, nematodes, and viruses (Arias, 1992) and also suffer from slow multiplication, bulkiness, and poor phytosanitary quality and genetic improvement of this plant through cross breeding is a difficult task. *In vitro* culture of banana has been extensively used to quickly propagate vegetative clones of many genotypes. Somatic embryogenesis, the process whereby a single somatic cell developed into somatic embryos is widely applicable in case of banana.

Somatic embryogenesis and plant regeneration in suspension culture of dessert banana (AA and AAA) and cooking (ABB) bananas (*Musa* sp.) were reported by Novak et al. (1989). Grapin et al. (2000) established embryogenic callus initiation and regeneration of embryogenic cell suspensions from female and male immature flowers of *Musa* (AAB). Cote et al. (2000) studied the field performance of embryogenic cell suspension – derived banana plants (*Musa* AAA, cv. Grand Naine) and reported two types of variants with 'variegated or deformed leaves' and 'fascinated-leafed plants.' Regeneration of banana (*Musa* spp. AAB cv. Dwarf Brazilian) via secondary somatic embryogenesis was reported by Khalil et al. (2002) In their study primary somatic embryos were produced from explants of immature male flower buds and morphologically normal plants developed from all of the regenerated plantlets. Kosky et al. (2002) initiated cell suspensions of the hybrid cultivar FHIA-18 (AAAB) which were established from sections of embryogenic tissue derived from male flowers. Xu et al. (2005) established embryogenic cell suspensions and plant regeneration of the dessert banana 'Williams' (*Musa* AAA, group). Morias - Lino et al. (2008) reported cell suspension culture and plant regeneration of a Brazilian plantain, cultivar 'Terra' from immature male flowers, and secondary somatic embryos were reported from the suspension culture. Molecular genetics studies have also shown that ectopic expression of a specific embryo – and meristem-expressed transcription factors or loss of certain chromatin-modifying proteins induces spontaneous somatic embryogenesis (Horstman et al., 2017). The literature review revealed that there are many reports on somatic embryogenesis in triploid bananas since most of the commercial cultivation belongs to triploid cultivars; however, in this study, we describe an efficient and reproducible protocol with high-frequency regeneration of secondary somatic embryogenesis in four diploid banana cultivars viz, *Musa acuminata* cv. Matti (AA),

Sannachenkadali (AA), Chingan (AB), and Njalipoovan (AB). These cultivars are common in Kerala under domestic cultivation and may have the potential for nonconventional banana breeding programs.

Materials and Methods

Male flower bunches obtained from adult field – grown banana maintained at garden, Department of Botany, University of Kerala, Kariavattom. Male flowers of four cultivars were collected at the end of the emergence of the last batch of fruits after sixth week. The bracts with associated hands of male flowers were removed in a step-wise manner until they become too small to be removed by hand. The remaining portion having an approximate size of 4–5 cm length was immersed in 1% (v/v) Labolene® for 6 min and kept under running tap water for 30 min. The explants were surface sterilized in 0.1% (w/v) mercuric chloride for 4 min followed by three rinses in autoclaved double-distilled water, 5 min for each rinse. Two or three outer protective bracts and corresponding groups of male flowers were sequentially discarded. Here, ~1 cm square pieces from the basal region of inner bracts were excised, removed the male flowers with a single cut and the bract was inoculated on Murashige and Skoog medium supplemented with Thidiazuron (0.045–9.00 μM), 30 gl^{-1} sucrose, 0.7 gl^{-1} agar and the pH of the media was adjusted to 5.8 before autoclaving at 120°C for 18 min. The cultures were maintained at a temperature of 25 ± 2°C with a photoperiod of 16 h/day under 50 μmol m^{-2}s^{-1} light intensity provided by fluorescent lamps. Primary explants were transferred to fresh media every 3 weeks. The darkened tissue was removed and the remaining tissue was transferred to fresh medium containing the same hormonal concentrations. After sixth week, embryogenic calli were initiated and cell suspension cultures were initiated by placing 100 mg fresh weight of embryogenic callus into 20 ml of MS liquid medium with additives such as glutamine (0.68–34.21 μM), biotin (0.40–20.46 μM) or ascorbic acid (0.56–28.38 μM) along with malt extract (100 mg/l) and were dispensed in 100 ml Erlenmeyer flasks. The cultures were maintained at 80 rpm. Subculturing was done at the end of every third week. The cultures were maintained at 25 ± 2°C temperature with a photoperiod of 16 h/day under 50 μM m^{-2} s^{-1} light intensity provided by fluorescent lamps. Fully developed embryos were isolated by sieving through a stainless steel filter (450 μM) and placed in liquid MS basal or half basal medium for germination. Germinated somatic embryos were transferred to the MS basal or half basal medium for rooting. Rooted plantlets were transferred to greenhouse condition for 2 weeks for acclimatization and were successfully transferred to field conditions. Secondary somatic embryos were more frequently observed after fifth subculture. The presence of secondary somatic embryos was studied under scanning electron microscope (SEM; JEOL JSM). Samples were dehydrated in ethanol series (30–100% v/v) and dehydrated tissues were then critical point dried, mounted on metal blocks, and sputter coated with gold (JOEL JFC 1200 Fine

coater). The gold coated samples were observed and photographed under SEM operating at 10 kv.

Statistical Analysis

Statistical analysis was performed with the software SPSS/PC Version 4.0 (SPSS Inc., Chicago, USA). Mean and SE were calculated and differences between means were tested using Duncan's Multiple Range Test at the level of $P < .05$.

Results

Friable embryogenic calli initiated from bract explants inoculated on MS medium supplemented with TDZ (4.5 µM) were selected for the initiation of embryogenic cell suspension (Figure 1a). MS medium supplemented with (0. 45 µM) TDZ produced off-white friable calli while (3.6 µM) and (9.00 µM) TDZ initiated yellow compact calli. Influence of TDZ on callus induction from bract explants of diploid banana cultivars and frequency of somatic embryo formation after second subculture were summarized in Table 1. After synchronization of suspension cultures by filtration over the course of more than 4 months, stable and homogenous embryogenic cell suspension cultures were established. Round or oval-shaped viable single cells were observed during the initial stages of cell suspension (Figure 1b). Embryogenic cells and embryos of different stages were also observed during the period of the first subculture (Figure 1c). After 4–5 months, embryogenic cell suspension reached the phase of synchronized growth in the medium supplemented with additives. Further subculture in the same hormonal concentration enhanced the development of heterogeneous embryo culture with various developmental stages (Figure 1d). Cell suspensions were sieved and washed thoroughly and plated on petri plate containing basal MS medium and were incubated in dark for 1 week. Somatic embryos were germinated within 2–3 weeks and basal MS medium showed better growth of somatic embryos in all four cultivars. Synchronous development of root and shoot observed in basal medium. Full strength MS basal medium found to be effective for cv. Matti and cv. Sannachenkadali and was germinated after 2 weeks while somatic embryos of cv. Chingan and cv. Njalipoovan germinated after third week. Then, the cultures were transferred to a 16-h photoperiod in the culture room and green shoots were developed (Figure 1e). Globular embryos were transferred individually or in small groups to 100 ml Erlenmeyer flask containing basal MS medium or one-half basal MS medium also showed shoot regeneration. In suspension culture development of clusters of somatic embryos from the existing embryos was frequently observed after fifth subculture. For SEM analysis, secondary somatic embryos were observed on the surface of primary embryos. Frequency of somatic
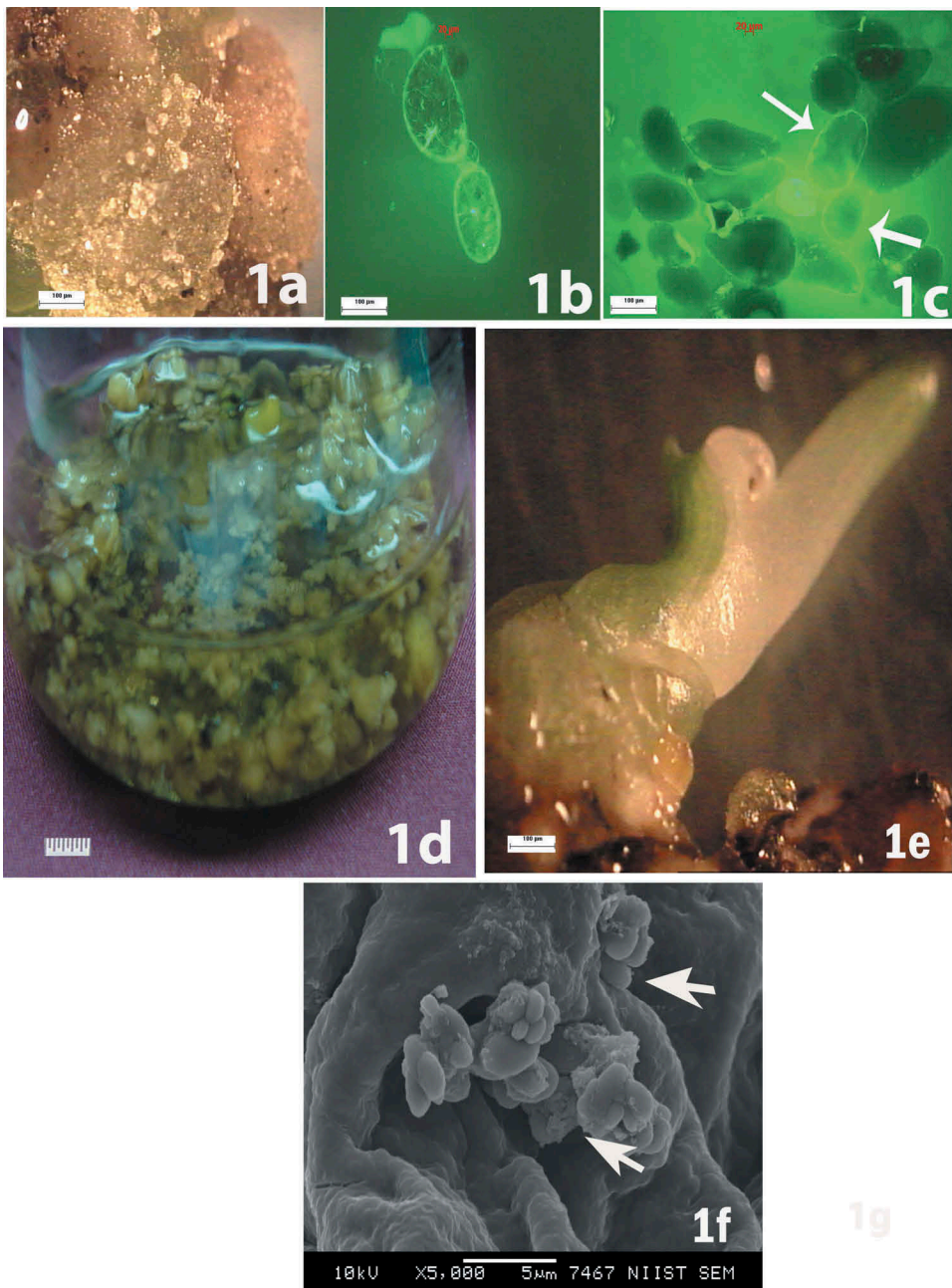
Figure 1. (a) Calli forming from male immature banana flowers. (b) Round or oval-shaped viable single cells observed during the initial stages of cell suspension. (c) Formation of somatic embryos at various stages of development. (d) Culture in liquid medium containing globular somatic embryos. € Green shoot development from the embryo. (f) Secondary somatic embryos appearing as small protuberances on the surface of primary somatic embryos.

embryos bearing secondary somatic embryos after fifth subculture was summarized in Table 2. The maximum frequency of secondary somatic embryos was observed in the presence of 8.18 μM biotin along with malt extract

Table 1. Influence of TDZ on embryogenic induction from bract explants of diploid banana cultivars.

		Hormone concentration (μM)		Average number of embryos formed after second subculture	
		Matti	Sannachenkadali	Chingan	Njalipoovan
		(AA)	(AA)	(AB)	(AB)
TDZ	0.045	6.75 ± 0.36f	5.29 ± 0.18f	7.25 ± 0.52d	7.25 ± 0.52c
	0.135	7.13 ± 0.51f	4.89 ± 0.30f	10.50 ± 0.62b	6.00 ± 0.53c
	0.225	8.63 ± 0.26e	8.14 ± 0.26c	12.50 ± 1.11b	6.75 ± 0.59c
	0.36	11.00 ± 0.37d	7.44 ± 0.24d	12.75 ± 1.19b	8.50 ± 0.32c
	0.45	12.38 ± 0.18c	7.63 ± 0.18e	14.25 ± 1.12a	5.00 ± 0.75c
	1.35	12.38 ± 0.26c	7.75 ± 0.31de	13.75 ± 0.70a	8.50 ± 0.62b
	2.25	11.38 ± 0.26d	8.88 ± 0.12d	10.75 ± 0.36b	9.50 ± 1.05b
	3.6	14.75 ± 0.46b	12.25 ± 0.36b	8.50 ± 0.62c	11.25 ± 0.25a
	4.5	18.38 ± 0.18a	13.88 ± 0.35a	14.75 ± 1.19a	12.75 ± 0.64a
	9	7.13 ± 0.12f	8.50 ± 0.18d	7.25 ± 0.36c	8.50 ± 0.82b

Significance was determined by ANOVA: significant at $P < .05$.
SE = standard error; Data represent the mean of eight replication.

(100 mg/l) in cv. Matti (44.75 ± 1.19[a]) and cv. Sannachenkadali (46.12 ± 0.85[a]). While 16.37 μM biotin along with malt extract (100 mg/l) results in maximum frequency of secondary somatic embryos in cv. Chingan (34.62 ± 0.77[a]) and cv. Njalipoovan (33.50 ± 0.96[a]) Glutamine (6.84 μM) along with malt extract (100 mg/l) produced a maximum number of secondary somatic embryos from cv. Sannachenkadali (38.12 ± 0.63[a]) while ascorbic acid (11.35 μM) along with malt extract (100 mg/l) produced a maximum number of somatic embryos in cv. Matti (27.00 ± 0.65[a]). Secondary somatic embryos typically entered the globular stage directly from primary somatic embryos and occurred in clusters, initially appearing as small protuberances on the surface of primary somatic embryos (Figure 1f). SEM analysis revealed the initial development of somatic embryos and clusters of secondary embryo, on higher magnification tertiary somatic embryos were also observed. In the clusters of somatic embryos, several developmental stages were observed, revealing non-synchronized development and the somatic embryos had a broad basal area fused to the maternal tissue. Once somatic embryogenesis was triggered, continual development of somatic embryos was again observed, resulting in the development of clusters of secondary and tertiary somatic embryos.

Discussion

The phenomenon of somatic embryogenesis was exploited to regenerate whole plants of agronomically and horticulturally important species, since the discovery of this process for the first time by Steward et al. (1958) in callus cultures of carrot. Horticulture industry realized the utility of this process for studying early events regulating embryogenesis, in large-scale production of propagules, respectively, with low labor inputs by combining somatic embryogenesis with mechanized

Table 2. Influence of additives with malt extract on the production of secondary somatic embryos in diploid *Musa acuminata* cultivars.

MS medium with	Concentration (µM) MA	Number of primary somatic embryos bearing secondary SK	Additives CH		Somatic embryos after fifth subculture NJ
Biotin ME (100 mg/l)	0.4	22.25 ± 0.59[e]	24.00 ± 0.53[d]	18.37 ± 0.90[d]	18.00 ± 0.32[e]
	1. 22	26.25 ± 0.59[d]	25.25 ± 0.75[c]	20.00 ± 1.01[c]	20.12 ± 0.51[c]
	2. 04	28.00 ± 0.75[b]	25.25 ± 1.46[c]	19.12 ± 1.17[cd]	19.87 ± 0.66[d]
	3. 27	27.25 ± 0.64[c]	25.75 ± 0.70[c]	20.00 ± 1.30[c]	21.12 ± 0.89[bc]
	4.09	44.25 ± 0.95[a]	41.25 ± 0.99[b]	22.75 ± 0.97[a]	23.87 ± 1.07[b]
	8.18	44.75 ± 1.19[a]	46.12 ± 0.85[a]	22.37 ± 0.73[b]	25.00 ± 0.65[b]
	12.27	38.50 ± 0.98[b]	39.50 ± 0.50[b]	25.37 ± 1.63[bc]	31.12 ± 1.67[b]
	16.37	30.75 ± 1.06[c]	29.75 ± 0.59[c]	34.62 ± 0.77[a]	33.50 ± 0.96[a]
	20.46	29.50 ± 1.11[cd]	31.25 ± 0.64[c]	26.62 ± 0.67[b]	27.12 ± 1.43[b]
Ascorbic acid ME (100 mg/l)	2.83	20.75 ± 0.45[cd]	14.62 ± 0.73[c]	16.50 ± 1.41[bc]	10.87 ± 0.93[d]
	4.54	24.00 ± 0.92[b]	24.50 ± 0.37[a]	17.00 ± 0.32[b]	10.62 ± 0.86[d]
	5.67	20.75 ± 1.98[cde]	18.75 ± 0.52[b]	19.12 ± 0.29[a]	18.06 ± 1.05[a]
	11.35	27.00 ± 0.65[a]	15.25 ± 0.64[c]	15.50 ± 0.26[bc]	12.50 ± 0.37[bcd]
	17.03	23.37 ± 0.46[c]	15.37 ± 0.77[c]	15.50 ± 0.73[bc]	12.12 ± 0.74[bcd]
	22.71	19.12 ± 0.47[e]	14.62 ± 0.80[c]	13.37 ± 0.32[d]	11.37 ± 0.92[cd]
	28.38	21.87 ± 0.22[cd]	15.25 ± 0.67[c]	14.00 ± 0.70[cd]	13.02 ± 0.56[b]
Glutamine ME (100 mg/l)	0.68	20.62 ± 0.92[de]	18.12 ± 0.91[e]	21.87 ± 0.58[cd]	17.25 ± 0.94[d]
	2. 05	22.75 ± 0.36[cd]	18.25 ± 0.94[e]	20.00 ± 1.06[d]	18.87 ± 1.25[bcd]
	3.42	23.12 ± 0.69[c]	19.50± 0.94[de]	19.75 ± 0.59[d]	16.50 ± 0.94[d]
	5.47	33.37 ± 0.49[a]	24.37 ± 1.05[c]	22.12 ± 0.35[cd]	20.75 ± 0.75[bc]
	6.84	27.37 ± 0.67[b]	38.12 ± 0.63[a]	25.75 ± 0.67[b]	16.37 ± 0.41[d]
	13.68	20.00 ± 0.65[e]	29.50 ± 0.86[b]	33.37 ± 0.41[a]	21.87 ± 1.05[ab]
	20.52	19.75 ± 1.27[e]	21.12 ± 0.39[d]	23.62 ± 2.05[bc]	24.56 ± 0.53[a]
	27.36	23.25 ± 0.36[c]	19.50 ± 0.77[de]	21.00 ± 1.30[cd]	18.87 ± 1.20[bcd]
	34.21	18.62 ± 1.17[e]	21.12 ± 0.76[d]	19.75 ± 1.04[d]	18.37 ± 1.40[cd]

Significance was determined by ANOVA: significant at $P < .05$.
SE = standard error; Data represent the mean of eight replication.
MA – Marti, SK – Sannachenkadali, CH – Chingan, NJ – Njalipoova, ME – malt extract.

automated culture systems. Embryogenic culture system with reliable regeneration efficiency from important varieties of banana is a prerequisite for realizing the potential of cellular and molecular tools of crop improvement. Toward this goal, studies were made to develop protocols for somatic embryogenesis and plant regeneration from different banana cultivars. In banana, the limited choice of explants, lengthy preparation phase, low and variable embryogenic response have been reported from various studies of somatic embryogenesis (Khalil, 2002). The capacity for totipotent growth reaches its maximum potential during *in vitro* tissue culture, where an even wider range of explants can be induced to undergo embryogenesis, including haploid cells of the male and female gametophyte (Soriano et al., 2013) and vegetative cells of the sporophyte (Elhiti et al., 2013).

In the present study friable embryogenic calli obtained from bract explants was the potential source for secondary embryogenesis. Grapin et al. (2000) reported that the embryogenic and regenerative capacity of suspension cultures of banana cultivars Currare and Currare Enano retained for 18 months. The cell

suspensions with high regeneration capacity were commonly used for mass clonal propagation and these cells were also the only source to regenerate plant materials for inducing mutations and genetic engineering (Strosse et al., 2006). In situ gene expression analysis resolved the contradictory relationship between expression of developmental marker genes and cell fate in different culture systems (Miguel and Marum, 2011) and provided a more exact description of when and how embryogenic cells are formed in culture (Soriano et al., 2014). In the present investigation, secondary somatic embryos were observed during SEM studies of embryogenic callus. A much higher efficiency of secondary somatic embryos over primary somatic embryos has been reported in many plant species (Raemakers et al., 1995). Khalil et al. (2002) reported regeneration of banana via secondary somatic embryogenesis in Musa spp. AAB cv. Dwarf Brazilian. In their reports primary somatic embryos were produced when explants of immature male flower buds were cultured on Murashige and Skoog medium plus 1 mg/l biotin, 100 mg/l malt extract, 100 mg/l glutamine, 4 mg/l 2,4-dichlorophenoxyacetic acid, 1 mg/l indole-3-acetic acid, 1 mg/l α-naphthaleneacetic acid, 30 g/l sucrose, and 2.6 g/l phytagel and then transferred to m1 medium plus 200 mg/l casein hydrolyzate and 2 mg/l proline. Subsequent transfer to MS supplemented with 10% coconut water produced rapidly proliferating embryogenic callus that developed into secondary somatic embryos. Some cultures were able to retain their competence for secondary somatic embryogenesis for many years and thus provide useful material for various studies, as described for *Vitis ruperis* (Martinelli et al., 2001). Secondary embryo development frequently occurred in embryogenic cultures at the late stages of embryogenesis. Possibly somatic embryos that failed to convert into plantlets were inclined to produce secondary embryos (Ammirato, 1987). The occurrence of secondary somatic embryos in primary culture condition was observed in many other monocot species including *Hemerocallis* sp, *Dactylis glomerata*, *Oryza sativa, Panicum maximum, Pennisetum americanum, Triticum aestivum, and Zea mays* (Martinelli et al., 2001; Raemakers et al., 1995).

Somatic embryos are used for studying the regulation of embryo development, but also as a tool for large-scale vegetative propagation. In some cases, somatic embryogenesis is favored over other methods of vegetative propagation because of the possibility to scale up the propagation by using bioreactors (Zhong et al., 2017). The embryogenic-callus-induced rate of the immature male florescence cultured on the media containing the recombinant protein Arg9-NLSWIND1 was significantly higher than that of the immature male florescence cultured on the control media. (Chang et al., 2018). Genetic analysis showed that AIL proteins interact with auxin pathways throughout plant development (Horstman et al., 2014) and BBM (BABY BOOM) binds to auxin biosynthesis genes (TAA1, YUC3, and YUC8) in somatic embryo tissue (Horstman et al., 2018). SE-inducing *AIL* gene has been investigated in the Arabidopsis (Su et al., 2015). Differential expression pattern of SE related genes in different developmental stages of cell suspensions

(ECS and NECS) suggested that *MaPIN1* played a crucial role in the initiation and maintenance of embryogenic capacity of ECS in banana (Shivani et al., 2018). In the present study, the biotin requirement for somatic embryogenesis was different with respect to their genomes. The maximum frequency of secondary somatic embryos was observed in the presence of 8.18 μM biotin along with malt extract in cv. Matti (AA) and cv. Sannachenkadali (AA), while 16.37 μM biotin along with malt extract (100 mg/l) produced a maximum frequency of secondary somatic embryos in cv. Chingan (AB) and cv. Njalipoovan (AB). This indicates the potential of these cultivars for further studies in genome analysis and the protocol developed in the present study may be used for plant propagation and genetic transformation studies.

As somatic embryos arise from single cells seems to produce fewer rates of somaclonal variations and due to the cellular totipotency somatic cells under appropriate conditions are able to develop a complete functional embryo. When integrated with conventional breeding programs and molecular and cell biological techniques, somatic embryogenesis provides a valuable tool to enhance the pace of genetic improvement of commercial crop species.

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A LOGISTIC REGRESSION BASED HYBRID MODEL FOR BREAST CANCER CLASSIFICATION

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Abstract - Data mining techniques are being used for breast cancer classification and good performance accuracy has been obtained while using the techniques individually or as ensembles. A notable problem is the skewed nature of the data which leads to imbalance among the output classes. The minority class being the negative class usually are smaller in number than the positive majority class. This usually leads to a moderate accuracy value for the classifier. The correct classification of minority cases is a significant problem. All classes need to be given equal importance during classification. In this study a hybrid model based on Logistic Regression is implemented with class balancing and ant search techniques and the performance is evaluated on the two class Wisconsin breast cancer dataset. A performance accuracy of 99.4% was obtained.

Keywords: Synthetic Minority Over-sampling Technique (SMOTE), Oversampling (OS), Random Undersampling (US), Neural Networks (NN), Random Forest (RF), Logistic Regression (LR), Support Vector Machines (SVM), Naïve Bayes (NB), Ant Search (AS)

1. Introduction

Breast Cancer is the most common and frequently diagnosed cancer in women worldwide and is the leading cause of death in women. Early detection is the key to survival and better breast outcome. Machine Learning techniques are widely used for disease diagnosis and outcome prediction [Durga *et al*., (2020), Kotsantis, (2007), Arafat *et al*.,(2012), Sivapriya e*t al*,.(2015), Mathew, (2019a), Mathew, (2019c)]. Classification is a machine learning technique that is used for producing class labels. In disease diagnosis, classifiers categorize the solution into respective classes based on the features space provided. In the training process, using the samples provided the classifier trains itself to produce the most optimal result. Once the model is constructed any new instance provided is expected to produce the finest result. The problem with the feature space in most cases is its large dimensionality. High number of attributes and large dimension of the feature space leads to the curse of dimensionality [Li *et al*., (2017)]. Feature selection, extraction and feature reduction helps to overcome this problem. It helps in identifying and extracting the most relevant information without loss of necessary information. Hence the primary goal of feature Search is to help in selecting relevant attributes [Rahman and Muniyandi, (2020), Rania and Ramyachitra, (2018), Jabbar, (2019), Sadhegipour *et al.,* (2015)] Reduction of attributes and dimension helps in reducing the cost and improving accuracy by eliminating redundant or irrelevant information [Durga *et al*., (2020)]. Besides this, Feature search methods can also be used as classifiers for disease diagnosis [Rajguru and Prabhakar, (2018)]. Swarm search or Meta heuristic methods have shown better results than conventional search methods [Singhal, (2016), Fong *et al*., (2018), Fang *et al*., (2018), Yahiya, (2018), Ramasamy and Rani, (2018)]. A major problem with disease datasets is the class imbalance present in them, Class imbalance occurs when the classes of the datasets are not equally represented. In a majority of cases the positive class which represents abnormality will be the minority class and the negative class which represents normal cases will be the majority class. When classifiers are used with these datasets since the majority is the negative class the classifiers produce a moderate accuracy and the accuracy of the positive class gets overlooked in the process. This issue can be overcome by using class balancing techniques where samples can be reduced (undersampling) or samples can be increased (oversampling) or by using a combination of both [Chawla *et al*., (2002)]. Another issue is the misclassification of samples and it can lead to serious consequences. The performance of the classifiers can be evaluated by not only Accuracy, but with other measures such as Kappa values, Sensitivity, FPR, ROC, time to build the model and F-measure. The performance of the feature search methods vary depending on the data subsets

selected so evaluation metrics are essential in estimating whether the selected features are optimal [Li *et al*., (2017)].

The aim of the study is to classify breast cancer tumors as malignant or benign using the Logistic regression model integrated with a feature search technique ant search and class balancing. The first objective of this work is to reduce the number of features in the cancer dataset using ant search, and the second objective is to classify the cancer as benign or malignant using Logistic Regression and evaluate the classifier using various performance measures. To compare the performance of the proposed model, it is evaluated against four other classification techniques Naïve Bayes, Neural Networks, Random Forest, and Support Vector Machines.

The rest of this paper is organized as follows. In Section 2, the related work on the classification of diseases using various Meta heuristic algorithms is reviewed. In Section 3, the implementation of our feature selection strategy with class balancing techniques is described. The evaluation of the proposed method is discussed and analyzed in Section 4. Section 5 makes a conclusion of the study done.

2. Related Works

To improve classification of incomplete data Tran *et al.*, (2017) proposed a combination of bagging and feature selection methods. The C4.5 and REPTree classifiers were used with Particle Swam Optimization as the search technique for feature selection and achieved an accuracy of 96.19% and 96.03% respectively for the breast cancer dataset. Rajendran *et al.*, (2020) in their work using the combination of SMOTE and spreadsubsample with Naïve Bayes, Bayesian Networks, Random Forest and Decision tree C 4.5 classifier and they compared performance of the classifiers. Bayesian network was seen to provide an overall better performance with an ROC of 0.937. Reddy and Khare, (2017) introduced the FFBAT-ANN prediction algorithm for Diabetes disease classification and the results outperformed conventional methods. Mazen *et al.,* (2016) proposed Genetic Algorithm based Firefly Algorithm approach to classify Breast cancer and it was capable of achieving the lowest mean squared error of 0.0014. Emami and Pakzad, (2019) proposed an approach, of two phases. In the first phase, the Affinity Propagation (AP) clustering method was used for instance reduction, by finding noisy instances and eliminating them. In the second phase, feature selection and classification was conducted by using the Adaptive Modified Binary Firefly Algorithm using SVM. A classification accuracy of 98.606% was obtained. Nadira and Rustam, (2017) proposed a Global Artificial Bee Colony - Support Vector Machine for classification of various cancers. The results showed classification accuracy on breast cancer dataset of 96.4286 %. Saoud *et al.,* (2019) proposed an LR model with Best First search algorithm for Breast cancer classification and obtained an accuracy of 96.70%.Dhahri *et al*., (2020) proposed an LR model with Tabu Search and obtained an accuracy of 98% on the WDBC dataset. Mathew, (2019b) in her work used Logistic regression with a greedy feature seelction algorithm RFE to select relevant features to classify Breast Cancer. The model gave an accuracy of 95.98%.

3. Methodology and Techniques

The methodology involves selection of the dataset, preprocessing it by initially removing instances with missing values and then transforming it into nominal values. This data is fed to the machine learning techniques and performance is evaluated. Feature selection is done and few attributes are selected and this refined dataset is also run on each classifier to see the results. On the training dataset, balancing techniques are applied. The dataset is then fed to, the Logistic regression classifier and the performance of is evaluated using various evaluation measures. On the balanced dataset feature selection is applied and then this is passed to the classifier and performance is evaluated. The search algorithms reduced the number of attributes by avoiding irrelevant features. The performance measures used are Accuracy, ROC, FPR, Recall, F measure. 10 fold cross validation is done. Fig 1 shows the working of the proposed model.
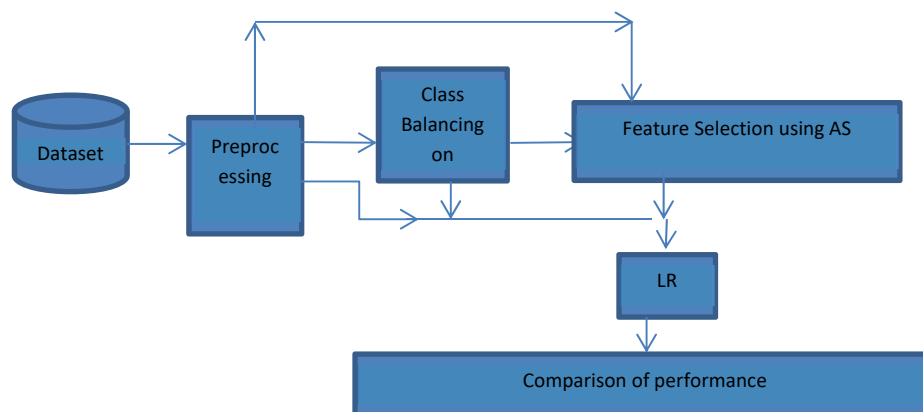

Fig 1: Working of the model

3.1. Data Mining Techniques Used

3.1.1 Logistic Regression

Logistic Regression is a supervised classifier that models data using a sigmoid function. The advantage of using LR is that it maximizes the quality of output on a training set and makes no assumptions on the distribution of classes in the feature space. A major problem with the classifier is that it is insensitive to imbalanced data and outliers. The model provides the relationship between one dependent binary variable and the many independent variables. The probability that a data point belongs to a specific class is given by the Logistic model. For a dataset with n features and p instances the feature matric $X = \begin{bmatrix} 1 & x11 & x12 & \cdots & x1n \\ & \vdots & & \ddots & \vdots \\ 1 & xp1 & xp2 & \cdots & xpn \end{bmatrix}$, where x_{ij} represent the jth feature of the ith instance.

The sigmoid function is used as objective function and the aim is to minimize it. The logistic function "Eq.(1)" is given as

$$\emptyset(z) = \frac{1}{1 - e^{-z}} \tag{1}$$

$\emptyset(z)$ is always bounded within (0,1). The net input function, z, is a dot product of the input features and the respective regression coefficients and is denoted "Eq. (2)" as

$$z = x_0 w_o + x_1 w_1 + \dots . x_n w_n = \sum_{j=1}^{n} wjxj \quad = wTx \tag{2}$$

$$z \text{ can also be represented as } logit(p(y=1|x)), \tag{3}$$

Where p(y=1|x) is the conditional probability that data point belongs to class 1 given its features x. This is inverse to the logistic function and once model fitting is done, the conditional probability p(y=1|x) is transformed to a binary class label thru g(z), a threshold function "Eq.(4)" and

$$g(z) = 1 \text{ if } \emptyset(z) \geq 0.5 \tag{4}$$
$$= 0 \text{ else}$$

To minimize the logistic function the Maximum likelihood function is used. The log likelihood function is maximized or alternatively a cost function can be defined to be minimized. This cost function "Eq. (5)" can be defined as

$$H(w) = - log(\emptyset(z)) \text{ if } y = 1$$
$$= -log(1 - \emptyset(z)) \text{ if } y = 0 \tag{5}$$

To prevent overfitting L2 parameter regularization is done. Large weight values are penalized to reduce the model complexity. The regularization term is added to the cost function. The L2 parameter "Eq. (6)" is given as

$$L2 = \frac{\lambda}{2} \sum w_j 2, \text{ j} = 1 \dots .\text{n} \tag{6}$$

3.2 Class Balancing Techniques

3.2.1 Oversampling using SMOTE (OS)

Synthetic minority oversampling technique (SMOTE) is an oversampling method used for class imbalance problems. In SMOTE minority class examples are randomly increased by replicating them. To be precise, new minority instances are synthesized between the existing minority instances. The synthetic records are generated by the random selection of k nearest neighbours of the instances in the minority class.

3.2.2 Undersampling using Random Subsampling (US)

Random Undersampling involves randomly selecting examples from the majority class to be removed from the training dataset. To be specific, a sample down procedure is done on the majority class data until it occurs with the same frequency as the minority class The major limitation of Undersampling is that instances from the majority class that are deleted may be useful important information or even perhaps critical to fitting a robust decision boundary and this can influence the performance of the model.

3.2.3 Combination of Oversampling and Undersampling (OS+US)

A moderate increase in minority class instances and moderate reduction in majority class instances help in improving and reducing the bias involved in the two situations. First the difference between the majority and minority class samples are calculated. Then the number of samples to be removed from the majority class and number of samples to be increased for the minority class are determined. Then, the majority class samples are reduced and the minority class samples are increased accordingly.

3.3 Feature Search Techniques

3.3.1 Ant Search (AntSrch/AS)

Ant Search is based on the Ant Colony optimization technique proposed by Marco Dorigo and colleagues in 1990s. It is a population based metaheuristic technique. It is inspired by the foraging behavior of ants seeking an optimal path from the food source to their colony. Ants live and work in colonies and as a group exhibit highly organized capabilities. They travel the shortest path between their food sources and nest. They communicate with each other through pheromones as they have low visibility. Pheromones are chemical substances released while an ant travels on the ground. These mark trails on the ground and other ants follow this path. The collective behavior of ants is used as an optimization tool. Initially ants move in random searching for food. Hence multiple paths are created. A portion of food is carried back to the nest if the quantity and quality are right, and they leave pheromone trails on the way back. This acts as a guide to other ants. Pheromone evaporation is also to be taken into account. On the less travelled trail the pheromones evaporate and hence the most frequently travelled path will have a high intensity of pheromones. The intensity of pheromones on the travelled path increases as each ant traversing it deposits pheromones on it. There are various variants to the original ACO algorithm. Elitist ant systems, Ant colony system, Max- Min ant system, rank based ant systems, and continuous orthogonal ant systems,

The algorithm for ant search is given as

Procedure AntSearch( )

Initialize pheromone trails and parameters.- population size n, maximum iterations, pheromone value, fitness value, pheromone evaporation rate T,

While (not terminated)

> *Generate ant population*
>
> *Calculate fitness value for each ant*
>
> *Find best solution through roulette wheel selection criteria*
>
> *Update pheromone trail.*

End while

Display best ant(solution), best fitness value

End

3.4. Data Used

The benchmark Breast Cancer datasets of the Wisconsin Hospitals from the UCI repository is being used. This breast cancer databases was obtained from the University of Wisconsin Hospitals, Madison from Dr. William H. Wolberg. The Breast Cancer Wisconsin Original data Set has 699 instances, 11 attributes and 13 missing instances with 458 benign (65.5%) and 241 (34.5%) malignant cases. The data features are computed from the digitized image of a fine needle aspirate (FNA) of a breast mass and describe characteristics of the cell nuclei present in the image. The attributes are shown in Table 1. Id Number, since it has no relevance in the classification process is discarded from the set of attributes.

TABLE 1 Attributes

Number	Attribute Name	Values	Comparison of malignant and benign cells	
			Malignant	Benign
1	Clump_thickness	1-10	Seen in Multilayers	Seen in monolayers
2	Size_uniformity	1-10	Size differs	Unifrom size
3	Shape_uniformity	1-10	Shape differs	Unifrom Shape
4	Marginal_adhesion	1-10	Cells don not stick together	Cells stick together
5	Epithelial_size	1-10	Enlarged	Small
6	Bare_nucleoli	1-10	Have bare Nucleoli	No Bare Nucleoli
7	Bland_chromatin	1-10	Coarse in texture	Uniform texture
8	Normal_nucleoli	1-10	Nucleus is bigger	Nucleus is small
9	Mitosis	1-10	More Mitosis	Not so
10	Class	2-Benign 4-Malignant		

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3.5 Evaluation Metrics used

Various metrics are available for evaluation of models. The metrics used for evaluation of the model in this study are accuracy, ROC, Mathews Correlation Coefficient (MCC), Kappa Statistic, Precision and Recall.

3.5.1 Accuracy

Accuracy is the number of correct classifications made by the model. It is evaluated as

$$\text{Accuracy} = \frac{TP+TN}{TP+TN+FP+FN} \, x \, 100 \tag{7}$$

TP, TN, FP, FN being the True Positives, True Negative, False Positives and False Negatives obtained from the confusion matrix.

3.5.2 Mathews Correlation Coefficient

$$\text{MCC} = \frac{=TPxTN-FPxFN}{\sqrt{(TP+FP)(TP+FN)(TN+FP)(TN+FN)}} \tag{8}$$

3.5.3 F Score

F score is the harmonic mean of Precision and Recall

$$\text{F score} = \frac{2TP}{2TP+FP+FN} \tag{9}$$

3.5.4 Kappa Statistic

It compares the expected and observed outcome and is given by

$$\text{Kappa} = \frac{total\ accuracy - random\ accuracy}{1 - random\ accuracy} \tag{10}$$

And random accuracy $= \frac{(TN+FP)(TN+FN)+(FN+TP)(FP+TP)}{total\ x\ total}$

And total accuracy = Accuracy

3.5.5 Recall

Recall is also known as sensitivity gives the number of correctly classified true positives.

$$\text{Recall} = \frac{TP}{TP+FN} \tag{11}$$

3.5.6 Precision

Precision gives the number of true positives against the number of positives identified.

$$\text{Precision} = \frac{TP}{TP+FP} \tag{12}$$

4. Results and Discussion

The performance of the hybrid model obtained is shown in Table 2. Accuracy "Eq. (7)" of 99.4 % was attained by the proposed model. MCC "Eq. (8) is a reliable score which produces a good result only if a good prediction score is arrived for the four categories of the confusion matrix. It shows how well the classifier performs and the proposed model displayed it at 0.988. Table 2 gives the comparison of the various cases of accuracy of the classifier. ROC, Fig 2 depicts the tradeoff between TPR and FPR. The ROC value of 0.998 was obtained and in figure 2 it can be seen along the y axis at leftmost edge of the graph. The Confusion matrix presents the correctly classified and misclassified instances of the two classes. The hybrid model was seen to classify the positive classes correctly except for one instance and 3 wrongly classified instance for the negative class. The kappa statistic "Eq. (10)" measures the interrater reliability viz. expected and observed outcomes. A value of 1 shows perfect agreement. The proposed model achieved a good value of 0.9883. The F measure "Eq.(9)" is obtained as the harmonic mean of precision and recall. Recall "Eq. (11)" gives the ratio of correctly predicted positive observations to the all observations in actual class. The proposed model achieved a recall, precision "Eq. (12)" and F measure of 0.994 each.

The proposed model is compared with the conventional Logistic Regression classifier, the LR classifier with Oversampling alone performed, LR classifier with Undersampling alone done and with feature search performed with the LR classifier. The proposed model outperformed them in all the cases. Oversampling improved the accuracy measure considerably when compared with the technique with no class balancing. This is due to the increase in samples of the minority class. The performance of Undersampling was reduced and seen as the least efficient among the class balancing methods applied in the models. This is due to the loss of useful information when samples are reduced from the majority class. The combination of Undersampling and Oversampling produced the best results with the Logistic Regression classifier. This was similar with the four other classifiers used for comparison, (Table 3). Table 2 shows the various performance metrics used. In every case the proposed hybrid model performed comparatively better than them all.

Table 2 Performance Metrics

Classifiers	Accuracy	Kappa	ROC	FPR	F-Measure	MCC	Recall	Precision	Time taken to build model (secs)	Confusion Matrix
LR	92.53	0.8321	0.928	0.112	0.924	0.835	0.925	0.926	0.06	430 14 37 202
LR+OS	96.42	0.9284	0.988	0.035	0.964	0.929	0.964	0.965	0.28	433 11 22 456
LR+US	92.25	0.8452	0.958	0.077	0.923	0.846	0.923	0.924	0.16	
LR+(OS+US)	99.1	0.9824	0.999	0.009	0.991	0.982	0.991	0.991	0.05	339 2 4 337
LR+Ant Search	91.9	0.8311	0.920	0.116	0.921	0.832	0.921	0.921	0.06	418 26 29 210
Proposed Hybrid Model-LR+OS+US+AntSrch	99.4	0.9883	0.998	0.006	0.994	0.988	0.994	0.994	0.03	338 3 1 340
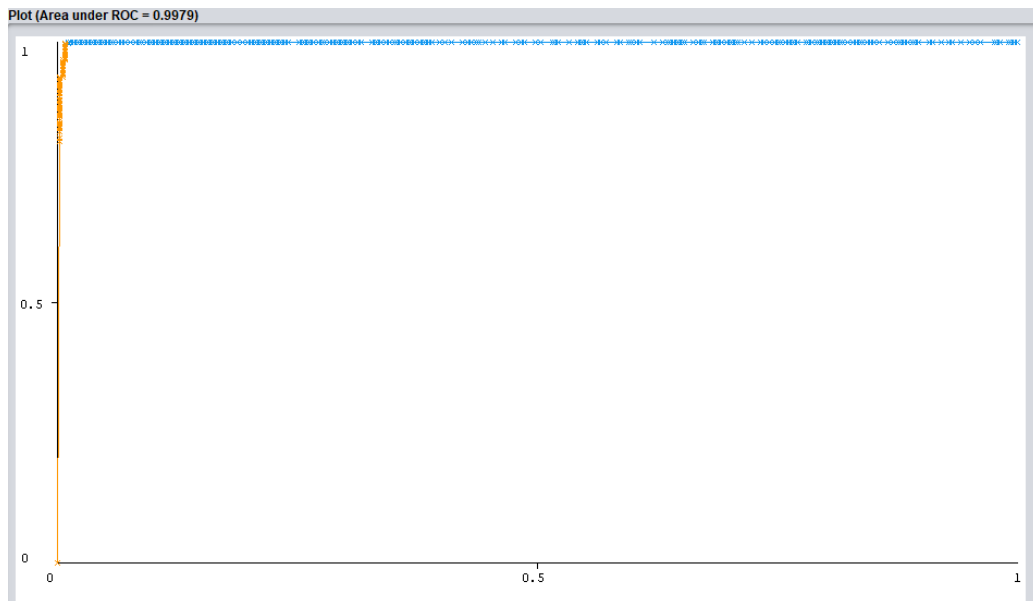
Figure 2 ROC

The performance of the proposed model is evaluated other four other classifiers- Support Vector Machines, Neural Networks and Naïve Bayes is shown in Table 3. The accuracy obtained for each classifier is displayed. SVM obtained an accuracy of 98.87%, Neural Network 98.97%, Naïve Bayes 98.3% and Random Forest 98.82%. The results show that the proposed model outperformed them all with an accuracy of 99.4%.

Table 3 Comparison with other classifiers

Classifier	Accuracy%	Confusion Matrix
SVM	98.97	338 3 4 337
Neural Networks	98.97	338 3 4 337
Naïve Bayes	98.3	332 9 2 339
Random Forest	98.82	337 4 4 337
Proposed Model	99.4	338 3 1 340

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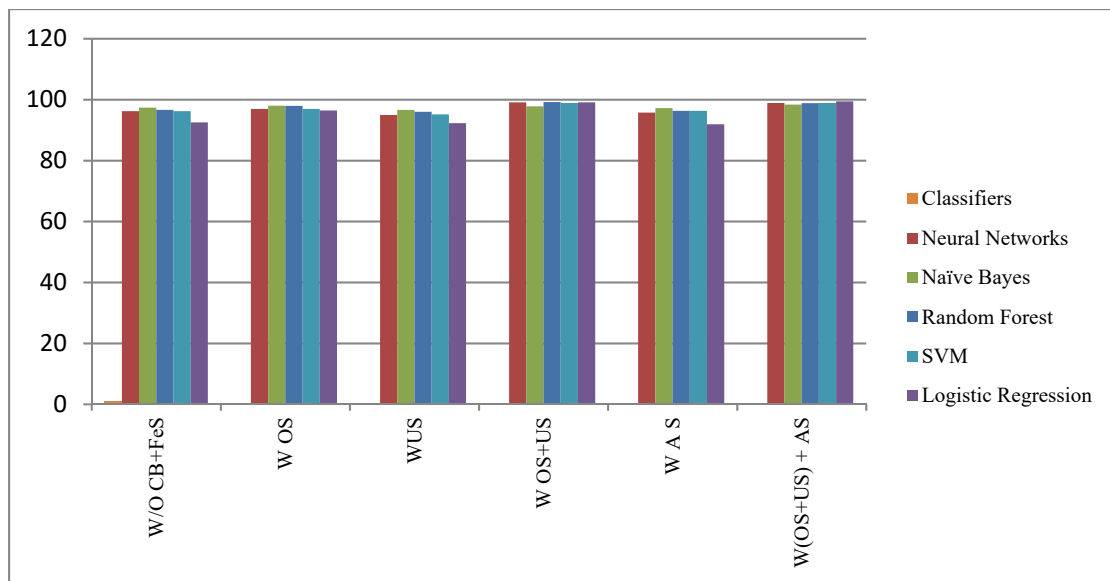

Fig 3 Comparison of Models against accuracy

In Fig 3, the performance of Logistic Regression models is presented alongwith that of the other four classifiers. The models using the classifiers alone performed comparatively lesser. The best accuracy among them was given by Naïve Bayes. With Oversampling alone Random Forest and Naïve Bayes models produced the best result. With Undersampling alone Naïve Bayes was the best classifier. With the combination of Oversampling and Undersampling performance of Logistic Regression improved considerably. Similar was the case with Random Forest, NN, and SVM, while Naïve Bayes showed a moderate performance. The best performance was by the proposed Logistic Regression and Ant search model. With Class balancing the results of all the classifiers increased considerably. With Ant search alone the best result was given by Naïve Bayes and the combination of OS+US increased the performance of all the classifiers significantly. Logistic regression improved with the combination class balancing methods and ant search techniques. Logistic regression classifier is sensitive to class imbalance. Hence applying a combination of oversampling and undersampling brought a significant accuracy increase. Combining ant search with this further increased the performance of the model. The proposed models are compared with a few other works that used swarm intelligence methods with classification techniques in Table 4

Table 4 Comparisons with other Related Works using various Search Techniques

Literature	Search Technique	Data Mining technique	Accuracy %
Saoud *et al*. (2019) [25]	Best First	LR	96.7096
Dhahri *et al*. (2020) [3]	Tabu Search	LR	98
Mathew (2019)[13]	RFE	LR	95.98
Proposed work	Ant search	LR	99.4

The proposed model is compared against related works in Logistic Regression with various feature selection methods. The proposed model outperformed all in terms of accuracy.

5. Conclusion

The paper produced a hybrid model for breast Cancer classification using Logistic Regression on the WBCD dataset using ant search and class balancing techniques. The model was compared against four other Meta heuristic methods for attribute selection and reduction and four other classifiers alongwith three class balancing methods. Among the balancing methods used combination of Undersampling and Oversampling was seen most effective in Logistic Regression. Feature selection using Ant Search, when applied on the model made improvement to the various performance measures. The best accuracy measure was obtained by the hybrid Logistic Regression model using the combination of class balancing and Ant Search methods with a value of 99.4%. Ensemble methods can be devised so as to improve the performance of other feature selection methods with logistic Regression for classification in two class problems. Modification of the cost function and application of optimization techniques for improving the Logistic regression model can also be explored

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Acknowledgments

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Removal of lead (II) ions from water using copper ferrite nanoparticles synthesized by green method

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ABSTRACT

The present work reports the removal of heavy metal ion, Pb^{2+} by adsorption on Copper Ferrite nanoparticles synthesised by the green method. The green method is a low cost, a non-toxic and environmentally friendly method using plant parts. In this work, we use phytochemicals from Simarouba glauca leaf extract as the reducing and capping agent. The product obtained was characterised by XRD, FT-IR, UV, XPS, SEM and TEM. The results revealed a sphere-like morphology for the synthesised nano copper ferrite with an average particle size 9 nm. Batch adsorption experiment shows that it is a good adsorbent for removing Pb (II) ions from aqueous solutions. Adsorbent could be easily separated from the reaction mixture and reused several times.

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1. Main text

Water pollution by heavy metals becomes a serious environmental problem. Existence of heavy metals like lead in the aquatic environment causes many health issues to human beings and animals. The removal of heavy metals is very important due to their recalcitrance and persistence in the environment. Of the many heavy metals, lead toxicity is a major problem in developing countries. Major sources of lead poisoning are different kinds of human-related activities such as lead paint, smoking, leaded petrol, contaminated food, smelting and industries. Excessive intake of lead in human body results in the disturbance of body functions such as neurological, cardiovascular, hematologic and reproductive systems [1,2].

Among various other methods like filtration, electrodialysis, ion exchange, colloidal precipitation etc., adsorption is the most effective and low-cost method for discarding toxic components. Among various adsorbents nano metal oxides having large surface area and small diffusion resistance are attractive. These properties make them potential adsorbents. The metal oxide nanoparticles are generally prepared by different chemical methods like sol–gel, hydrothermal, co-precipitation, sonochemical and microwave method many of which are time-consuming, expensive and use toxic chemicals as a solvent, precipitating agent or stabilising agent

[3]. Metal oxides with magnetic properties are attractive since they can be recovered easily and reused [4].

Copper ferrite nanoparticles are magnetic spinel particles very effective in removing heavy metal ions from water. The spinel structure is highly flexible compared to other structures. The alteration of properties of these spinels is due to the tendency to occupy the divalent and trivalent cations in both tetrahedral and octahedral voids [5]. It can be easily separated from the reaction mixture and reused [6]. $CuFe_2O_4$ nanoparticles have been prepared by methods like sol–gel, co-precipitation, ball milling, hydrothermal [7] etc. But the green method is a low cost, non-toxic, less time consuming and environment-friendly method [8]. Thus we select a green method for preparing nano $CuFe_2O_4$ using aqueous leaf extract *Simarouba glouca* plant. It is a medicinally important plant. The metabolites such as terpenoids, tannins, alkaloids, steroids, saponins, polyphenols, alkaloids, phenolic acids, and proteins present in the leaf extract can act as bio reducing agent and also as a capping agent for synthesising nano $CuFe_2O_4$.

The present work aimed at preparing copper ferrite nanoparticle using minimum energy consumption, least amount of chemicals and final sintering of produced solid. Thus we can maximise the amount of copper ferrite having a high surface to volume ratio, high adsorption ability for heavy metal and easy recovery by applying a magnetic field.

2. Materials and methods

2.1. Materials

Ferrous sulphate ($FeSO_4 \cdot 7H_2O$) and Copper acetate (Cu (CH_3-COO)$_2 \cdot H_2O$) were obtained from BDH and used as such.

2.2. Synthesis of $CuFe_2O_4$ nanoparticles

Aqueous leaf extract of Simarouba glauca was prepared by heating 20 g dried leaves powder with 300 ml distilled water. A mixture of 50 ml 0.1 M $FeSO_4$ and 50 ml 0.05 M $CuSO_4$ solutions was treated with 160 ml of the prepared leaf extract, stirred well and sonicated for 30 min. The product obtained was filtered, washed, dried and heated in a muffle furnace at 500 °C for 2hrs.

2.3. Characterisation techniques

The characterisation techniques employed in the present study are XRD, FT-IR, UV–Visible, XPS, SEM and TEM. The crystallographic identity and phase purity of the prepared material were evaluated by powder X-ray diffraction technique (XRD) by using a Bruker AXS D8 Advance model with Cu Kα radiation. The functional groups were identified using Fourier transform infrared (FT-IR) of Thermo Nicolet, Avatar 370 model by converting it into pellet using KBr. The absorption spectrum of the powdered sample was recorded at room temperature using UV– Visible spectrophotometer of model Cary 5000. The surface elemental composition of the product was evaluated by using X-ray Photoelectron Spectroscopy(XPS) of Thermo Scientific ESCALAB 250Xi model XPS spectrometer. Surface morphology of the sample was analyzed by Scanning electron microscope (SEM) of JEOL model JSM-6390LV. The particle size and shape was obtained using a Transmission electron microscope (TEM) of model JEOL/ JEM 2100.

2.4. Adsorption study on nano $CuFe_2O_4$

Adsorption studies were performed by the Batch method. A known weight(0.1 g) of $CuFe_2O_4$ and 100 ml 10 mgL^{-1} Pb (II) solution in a stoppered conical flask and placed on a mechanical shaker at 160 revolutions per minute. The rate of adsorption of lead on $CuFe_2O_4$ nanoparticles after desired time intervals [30, 60, 90, 120,150 min. etc], was determined by measuring absorbance using atomic absorption spectrometer of model iCE 3000. The experiments were repeated for the different dosage of adsorbent, concentration and pH for heavy metal ion solutions. The adsorption efficiency (q) and removal percentage are determined as follows:

$$q = \frac{[C_0 - C_e]V}{W} \tag{1}$$

$$\text{Removal percentage} = \frac{(C_0 - C_e)100}{C_0} \tag{2}$$

where q is adsorption efficiency of the adsorbent [mg.g^{-1}], W is weight of adsorbent [g], V is volume of solution [L], C_o [mgL^{-1}] and C_e [mgL^{-1}] are initial and equilibrium concentration of adsorbate in the solution respectively.

3. Results and discussion

3.1. Colour and appearance

Nanoparticles of $CuFe_2O_4$ were obtained as a dark brown coloured fine powder.

3.2. XRD analysis

The phase purity and crystallographic identity of the prepared product was verified by XRD. In the XRD of $CuFe_2O_4$ nanoparticle (Fig. 1), the observed peaks of the nanostructures match well with standard JCPDS File No. 77–0010 and no other crystalline phases (eg.Fe_2O_3, CuO) were detected. The average crystallite size was calculated using Debye-Scherer equation. The diffraction peaks were assigned to the cubic spinel structure. The major peaks with 2θ values and Miller indices (*hkl*) values which correspond to the standard data are 30 (2 2 0), 35 (3 1 1) and 62 (4 4 0). The maximum intense peak appearing at 2θ = 35 is specific for ferrite materials [9]. Similar results were reported by other researchers in the hydrothermal method at varying temperatures and different sintering temperatures[10,15]. But in the present work, the average crystallite size of $CuFe_2O_4$ is 9 nm according to Scherer equation. The decrease in particle size is due to the presence of reaction takes place at room temperature and the phytochemicals in the leaf extract act as capping agent.

3.3. FTIR spectral analysis

The FTIR spectrum for nano $CuFe_2O_4$ is shown in Fig. 2. The broad absorption band at 3440 cm^{-1}is attributed to OH stretching vibrations of H_2O molecule. The band at 1630 cm^{-1} is due to the bending vibrations of absorbed molecular water [11]. The IR spectrum shows two principle absorption bands at 570 cm^{-1} and 401 cm^{-1}. These two vibration bands in $CuFe_2O_4$ nanoparticles corresponds to the intrinsic lattice vibrations of Cu–O stretching bonds in tetrahedral sites and Fe-O stretching bonds in octahedral sites respectively [12,13,14,15].

3.4. UV– Visible spectral analysis

UV–Visible spectroscopy is a wildly used technique to study the optical properties of nanomaterials. Fig. 3 represents the absorption spectrum of nano $CuFe_2O_4$ recorded in the UV range. The band at 350 nm represents the fundamental absorption corresponding to the electron excitation from the O – 2p level into Fe 3d level for the spinel-type $CuFe_2O_4$ [16].

3.5. XPS analysis

XPS spectra were analysed to explain whether the Ferric ions existed on the surface of $CuFe_2O_4$ nanostructures. Fig. 4 shows the XPS spectrum in a wide energy range up to 1400 eVand Cu 2p and Fe 3p core-level regions in Fig. 4a and Fig. 4b [17]. The Cu 2p scan has four peaks at 932,942,953 and 965 eV9 Fig. 4a). Fe 2p scan has two major peaks at 712 and 725 eV which can be

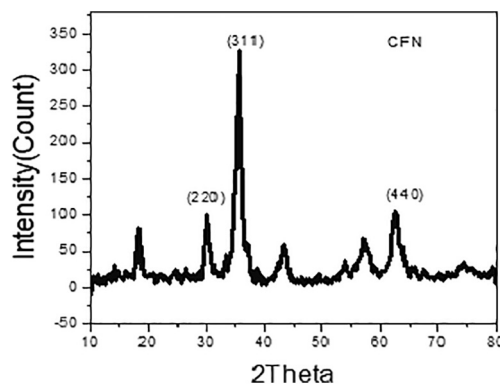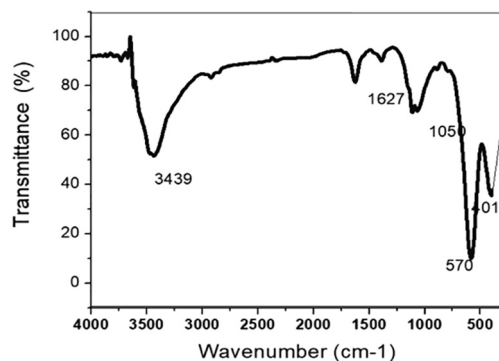**Fig. 1.** XRD spectrum of $CuFe_2O_4$ nanoparticle.

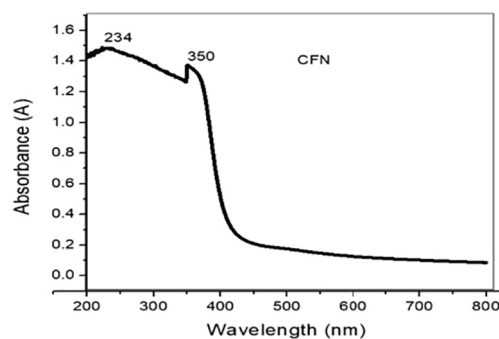**Fig. 2.** FTIR spectrum of CuFe$_2$O$_4$ nanostructure.

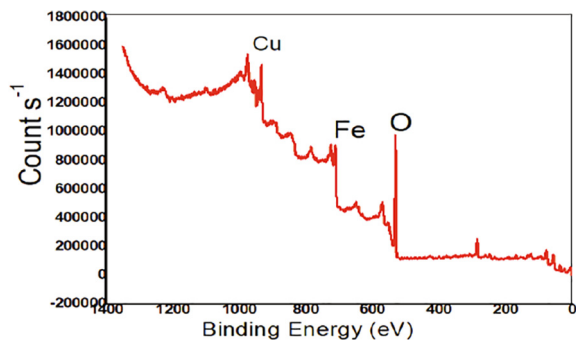**Fig. 3.** UV– Visible spectrum of nano CuFe$_2$O$_4$.

Fig. 4. XPS spectrum of the prepared CuFe$_2$O$_4$ nanoparticles.

assigned to Fe^{3+}ion and no Fe^{2+} peaks were observed(Fig. 4b). The lines at 531 and 535 eV corresponds to oxygen. The extra lines present apart from those of Cu, Fe and O are due to carbon from XPS [18].

The BET surface area of CuFe$_2$O$_4$ was found to be 130 m^{2}g^{-1}.

3.6. SEM analysis

The surface morphology of CuFe$_2$O$_4$ nanoparticle was investigated by SEM. Fig. 5 shows the SEM image of CuFe$_2$O$_4$ nanoparticles which shows agglomeration of very small particles.

3.7. TEM analysis

TEM techniques are usually used to examine the nanostructure formation in the heterostructure in a detailed manner. The TEM image in Fig. 6a indicates sphere-like morphology for the prepared nanoparticles. The particle size obtained from TEM also coincides
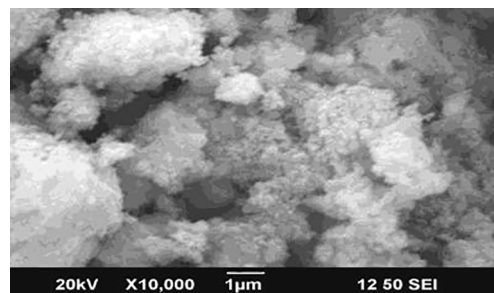

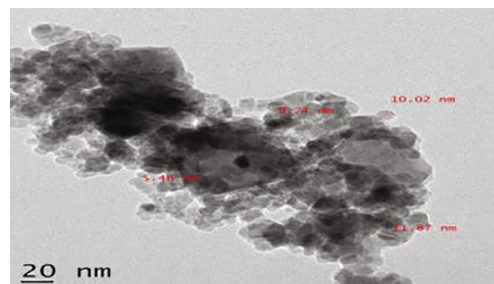**Fig. 5.** SEM Image of CuFe$_2$O$_4$.

Fig. 6a. TEM image.

with the result from XRD (9 nm). SAED pattern supports the crystalline nature due to the presence of concentric rings in Fig. 6b.

Both SEM and TEM images revealed the sphere-like morphology for the synthesised CuFe$_2$O$_4$ nanoparticles.

3.8. Adsorption efficiency of nano CuFe$_4$ for lead (II) ions

The adsorption efficiency of the obtained CuFe$_2$O$_4$ nanoparticles was evaluated for Pb (II) ions. Batch adsorption experiments were performed by varying the reaction conditions like adsorbent dose (0.025 g to 0.1 g), pH (4 to 8) and Pb (II) ion concentrations (10 to 40 mg/L). In a typical experiment, the 10 mg/L Pb (II) solution was treated with 0.05 g of CuFe$_2$O$_4$ nanoparticle in a mechanical shaker for 150 min. 1 ml solution of the reaction mixture was withdrawn at every 30 min interval and absorbance was measured using AAS. It was found that absorbance of the solution decreased with increasing time interval.

3.8.1. (a) Effect of pH

The solution pH in adsorption experiments is one of the important parameters in solution chemistry and adsorption mechanism. The removal efficiency increases with increase in pH reach a maximum at pH 6 and then decreases(Fig. 7(a)). This can be explained
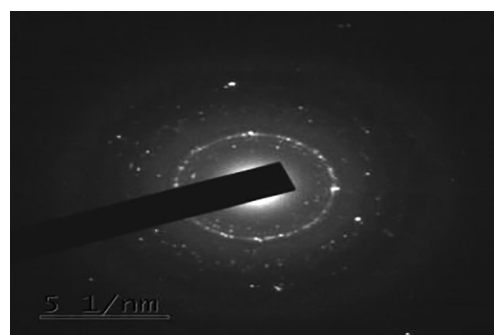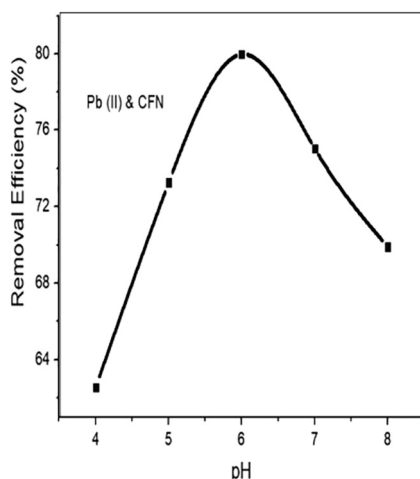

Fig.6b. SAED pattern.

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Fig. 7a. Effect of pH on adsorption of CuFe$_2$O$_4$.

Fig. 7c. Effect of initial metal ion concentration.

based on surface complex formation theory. According to this theory increase in pH decreases the competition between metal ions and protons and enhances the metal ion adsorption. At pH values higher than 6, removal efficiency decreases due to precipitation of Pb(II) in the form of Pb(OH)$_2$[19].

3.8.2. (b) Effect of amount of adsorbent

The effect of the number of nano CuFe$_2$O$_4$ on the rate of adsorption was examined by varying its amount from 0.025 g to 0.1 g/100 ml in 10 mg/L Lead solution (Fig. 7(b)). The rate of adsorption increases with the amount of adsorbent up to 0.05 g and then it decreases. The increase in dosage beyond a certain level results in no further increase in adsorption which may be because the amount of ions bound to the adsorbent and the number of free ions in the solution remains constant [20].

3.8.3. (c) Effect of initial concentration

The effect of initial solution concentration on the adsorption of Pb (II) on to nano CuFe2O4 was studied by varying the initial concentration of Pb (II) solution from 10mgL^{-1} to 40mgL^{-1} by fixing other parameters at optimum conditions. As shown in Fig. 7(c), the removal efficiency increases with increase in initial concentration up to 20mgL^{-1} and then decreases. At low concentration, the ratio between active sites on the surface and the total metal ions
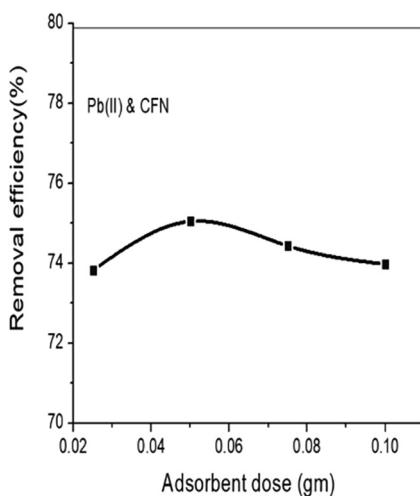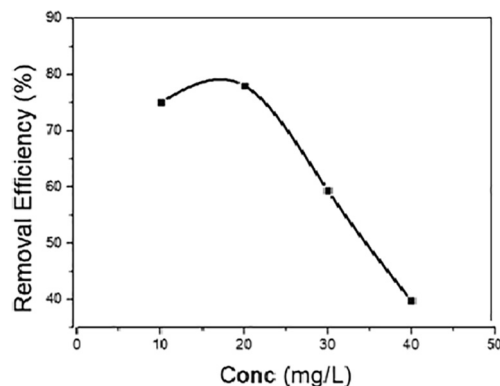
in solution was very high. While all the metal ions could interact with the adsorbent and result in high adsorption efficiency [20].

Table 1 showed the adsorption efficiencies of different types of ferrite and their surface modification towards Pb(II) ion from wastewater. Adsorption efficiency is improved by surface modification in the ferrite structure. However, it is very important in the role of decreased particle size and increased surface area of copper ferrite in the presence of phytochemicals from plant extract in enhancing the adsorption efficiency.

3.8.4. (d) Adsorption kinetics

Kinetics of adsorption plays an important role in designing and modelling the adsorption process Figs. 8a and 8b(b) shows the plot for pseudo-first-order and pseudo-second-order kinetics. The plots were prepared for the initial concentration from 10 to 40mgL^{-1}. From the kinetic variables obtained, it is clear that the correlation coefficient (R^2) is close to unity for the second-order kinetic model which indicate strong applicability of this model over the pseudo-first-order kinetic model.

Table 1
Comparison of adsorption Efficiencies of various adsorbents towards Pb(II) ion from water.

Nanoadsorbent	pH	% Removal	Reference
γ-Fe$_2$O$_3$	6	50	6
CuFe$_2$O$_4$/DC	6	84	21
CoFe$_2$O$_4$/RS	6	80	22
Mg$_{1-x}$Ni$_x$Fe$_2$O$_4$	–	35	23
CuFe$_2$O$_4$	6	80	This study

Fig. 7b. Effect of adsorbent dose.
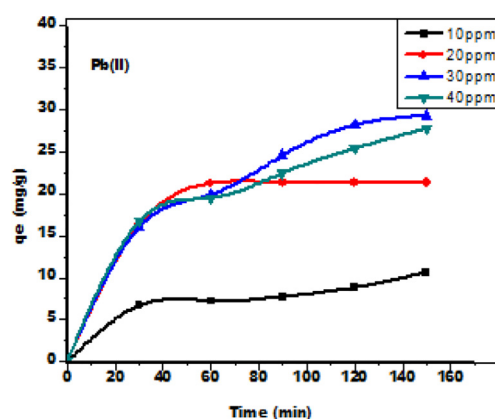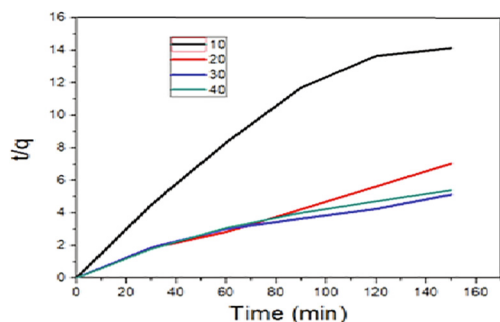

Fig. 8a. Pseudo first order reaction.

Fig. 8b. Pseudo second-order reaction.

3.9. Recycling

$CuFe_2O_4$ could be easily removed from the reactive mixture and reused three times without any loss of efficiency.

4. Conclusion

$CuFe_2O_4$ nanoparticles could be successfully prepared by using *Simarouba glauca* aqueous leaf extract. This is an easy, low cost, non-toxic and environment-friendly method. The phytochemicals present in the leaf extract act as a reducing/oxidising agent and stabilising agent. The obtained $CuFe_2O_4$ particles were characterised by XRD, FT-IR, UV–Visible, XPS, SEM and TEM. The results reveal that $CuFe_2O_4$ spinel nanoparticles are spherical with particle size 9 nm and having cubic geometry. The obtained magnetic spinels are effective in removing Pb (II) ions from aqueous solution. The $CuFe_2O_4$ could be easily separated from the reaction mixture and reused 3 times without any loss of efficiency. Applicability of $CuFe_2O_4$ as adsorbent is enhanced by the low-cost of preparation, non-toxicity, ease of separation, reusable and easily recyclable. $CuFe_2O_4$ could be used for the removal of other heavy metal ions from water. The removal efficiency of this nanoparticle will be increased by surface modification with functional groups or polymers. In future, surface modification this material with biopolymers helps to remove organic, inorganic and microbial contaminants from water. $CuFe_2O_4$ sheets are used as a filter for wastewater treatment due to its non-toxic, antimicrobial and adsorbing properties.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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THE LINKAGE BETWEEN PHYSICAL GEOGRAPHICAL CONDITIONS AND MODE OF TRANSPORTATION; A CASE STUDY FROM ALAPPUZHA AND KOTTAYAM DISTRICTS, KERALA

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The impact of the physical environment on land use is well-known, as is the relationship between topography and transport use. The paper concentrates on the role of topography in the spatial aspects of network planning and mode of transport selection. Analysis of the case study of Alappuzha and Kottayam district in Kerala, shows how implementing mode of transportation is influenced by the natural environment.
Key words: Physiography, Mode of transportation Transport, Inland Waterways, Road, Railway.

1. INTRODUCTION

Transport routes and the physiography of a region are correlated. Land transport infrastructures are usually built where there are the least physical impediments, such as on plains, along valleys, through mountain passes, or when necessary, through the digging of tunnels. Water transport is influenced by water depths. Topography can complicate, postpone, or prevent transport activities and investment. Physical constraints fundamentally act as absolute and relative barriers to movements. An absolute barrier is a geographical feature that entirely prevents a movement, while relative barriers impose additional costs and delays. Land transportation networks are notably influenced by the topography. (Paul Rodrigue,2020). An ecological view in the study of transportation stress the ways in which transport is related to the physical environment. The key feature of area study tradition is it views Geography as a synthesizing or integrative discipline. (Taffe,1996). Here an attempt is made to understand mode of transportation development strictly based on environmental factors. The paper is structured as follows: First, the physiography and present mode of transportation of both Alappuzha and Kottayam is discussed. The second section discusses and identifies better the impact of topography in public transport network planning and selection of mode of transportation

2. STUDY AREA

Alappuzha (Alleppey) is one of the well-developed coastal districts in southern part of Kerala State

STUDY AREA

covering an area of 1,414 sq.km and is the smallest district accounting 3.64% of the area of the State. It is the only district in the State where there are no reserved forests. Kuttanad, also known as the "rice bowl of Kerala" has a predominant position in the production of rice. Alappuzha is well known for its coir industry with innumerable outlets for various finished coir products. The district lies between North latitudes 9° 05' and 9° 54' and East longitude 76° 17' and 76° 36' and is surrounded by Lakshadweep sea on the west, Kottayam and Pathanamthitta districts in the east, Kollam district in the south and Ernakulam district in the north
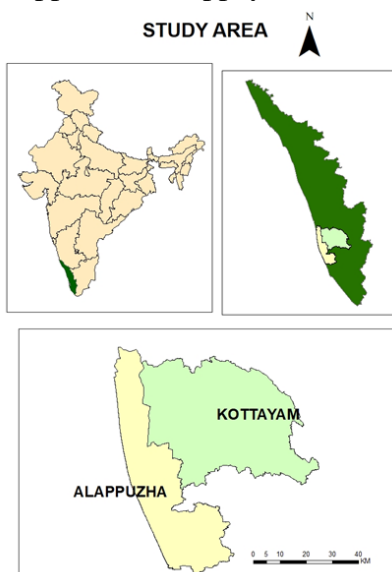
Fig: 1: Location map

Kottayam district is located in central Kerala, consisting of 2208 sq.km and stands 10th in area in the State among districts. Kottayam is also called as "Akshara Nagari" which means the city of letters considering its contribution to print media and literature.

District is located in central Kerala and divided into four submicroregions. District lies between 9^0 15' and 10^0 21' North Latitude and 76^0 22' and 77^0 25' East Longitude.

3.RESULTS AND DISCUSSION

3.1 Physiography of Alappuzha and Kottayam

Alappuzha is a sandy strip of land intercepted by lagoons, rivers and canals. There are no mountains or hills in the district but for the scattered hillocks lying between Bharanikkavu and Chengannur block panchayats in the eastern tracts of the district. The taluks of Cherthala, Ambalapuzha, Kuttanad and Karthikappally lie fully in the lowland region. 80% of the district area lies in low land region and midland occupies the remaining area. Alappuzha is the only district in the State with no high land or forest land. Water bodies spread over 10% of the geographical area of the district. Kuttanad area is described to be located below sea level. The Vembanad Lake borders the district on the north east portion. The regional divisions of Alappuzha consists of three sub micro regions-viz.,(i) Alappuzha Coast, (ii) Kuttanadu low lying plains and (iii)Chengannur rolling plains.

Kottayam district can be divided into three regions based on physical features, they are the lowland, midland and highland. Kanjirappally taluk and portion of the Meenachil taluk is the highland region, western portion of the Meenachil taluk and the eastern parts of Kottayam, Changanassery and Vaikom taluk falls in the midland region and the western portion of Kottayam, Changanassery and Vaikom taluks falls in the lowland region. The lowland lies on the border of the Vembanad lake. The highland lies on the extreme east covered by forests. It comprises of mountain ranges, valleys and the lower ground from which the mountains arise. These hills and the lower ground from which they arise together constitute the high ranges. There is forest area in Kanjirappally taluk. Low lying plain region comprises of parts of Vaikom, Kottayam and Changanassery taluks and lies as a narrow strip over the Western portion of the district and makes its boundaries with Kottayam rolling plain in the north and the east, Kuttanad low lying plain in the south and the Vembanad lake in the west Rolling plain region comprises of parts of Vaikom, Meenachil, Kottayam and Changanassery taluks and lies over the central part of the district and bounded by Periyar-Muvattupuzha rolling plain in the north, Meenachil-Kanjirappally upland in the east, Chengannur rolling plain in the south and Kumarakam low lying plain in the west. Upland region comprises parts of Meenachil, Kottayam, Kanjirappally and Changanassery taluks and lies in the eastern part of the district and makes its boundaries with the Periyar river basin in the north, Thekkedy forested hills and Ranni forested hills in the east, Mallappally taluk and part of Ranni taluk and Alappuzha rolling plain in the south and Kottayam rolling plain in the west. This region slopes towards the west.

3.2 Drainage of Alappuzha and Kottayam

Alappuzha district is drained mainly by Pamba River and its tributaries viz. Achankovil and Manimala Rivers. The Pamba River drains an area of 804 sq.km of the district and form a deltaic region skirting the south eastern, southern and south western fringes of Vembanad Lake. The Manimala River enters the Kuttanad area at Thondara and confluences with Pamba River at Neerettupuram. Achancovil Ar enters Kuttanad at Pandalam and joins Pamba River at Veeyapuram. Vembanad Lake, the largest back water in the State lies on the north eastern part of the district separating Alappuzha from Kottayam district

The important rivers of the Kottayam district are the Meenachil River, the Muvattupuzha River and the Manimala River. The 78 km. long Meenachil River flows through the Taluks of Meenachil, Vaikom and Kottayam. It has a catchment area of 1272 km2 and utilizable water resource of 1110 mm3. The River is formed by several streams originating from the Western Ghats in Idukki district. At Erattupetta, Poonjar River also joins it, takes a sharp turn and flows towards the west. At Kondur, it is joined by the Chittar and at Lalam it receives the Payapparathodu and flows in a south-west direction till it reaches Kottayam. Here it branches into several streams before emptying into the Vembanad Lake. The important towns in the basin are Pala, Poonjar, Ettumanoor and Kottayam. Meenachil Medium Irrigation project is having a net ayacut of 9960 hectares, 155 sq.km. catchment area and a water spread area of 228 hectares.The Muvattupuzha River originates from Idukki district, flows through Vaikom Taluk and empties into the Vembanad Lake. The most important town in the basin is Vaikom, the famous pilgrim centre.The Manimala River flows through Kanjirappally and Changanassery Taluks. The Chittar joins it on its course further down the west as it flows to Alappuzha district. The important town in the basin is Mundakkayam.

3.3 Mode of Transportation
3.3.1 Road transportation in Alappuzha and Kottayam district
In Alappuzha district the road transportation system is fairly well developed with a rather good network of roads. The eight State Highways and the National Highway passing through the district ensures sufficient linkage with other areas. The district is connected with adjoining Ernakulam and Kollam districts by National Highway NH 47 and Kottayam and Pathanamthitta districts by State Highways. The district is aligned on NH 47 and MC Road, the major corridors of transportation.

In Kottayam district M.C. road is the busiest road. National Highway 183 passes through Kottayam district. A number of State Highways serve the district. SH 9, SH 11, SH 14, SH 15, SH 32, SH 40, SH 42 and SH 44 passes through Kottayam.

3.3.2 Rail transportation in Alappuzha and Kottayam district
Alappuzha is linked by rail to cities like Thiruvananthapuram, Kochi, and Kozhikode etc and Mumbai, Bokaro, Chennai, Bangalore, Kolkatta, New Delhi etc outside the state. The two railway lines in the district. Kayamkulam-Ernakulam (via Chengannur) of length 115 km and Kayamkulam-Ernakulam (via Alappuzha)-coastal railway of length 101 km provide sufficient accessibility by rail to the rest of the country. Alappuzha, Kayamkulam, Chengannur, Cherthala, Mavelikara and Haripad are the major railway stations.

Rail network in Kottayam district comprises of 49 km of rail tracks. Changanasseri , Ettumanur, Kottayam,Piravam and Vaikom are the railway stations available in the district Kottayam.

3.3.3 Canals in Alappuzha and Kottayam district
Waterways play an important role in the transportation system of the district. In certain water locked areas of the district, transportation of goods and passengers is possible only through boats and ferry services. The Kochi-Alappuzha section consisting of Vembanadu Lake extending from Kochi to Alappuzha along Cherthala and Ambalapuzha Taluks is the most important stretch of West Coast Canal System. The Kochi-Alappuzha section of the Canal system lies in Ambalapuzha and Karthikappally Taluks. Alappuzha was proposed to be connected with Changanassery by a canal along AC Road through Kuttanad.. This district has a network of canals included in the west coast canal system which are used for navigationThe important canals in Alappuzha Town are Vadai Canal and Commercial Canal and the link canals between these two canals. Apart from these, there are many inland canals like Alappuzha – Ambalapuzha, Alappuzha–Changanassery, Alappuzha-Kottayam, Alppuzha-Thalavady, Alappuzha-West junction, Ambalapuzha-Purakkad, Kakkazham-Kayamkulam salt shell, Muhamma-Poochakkal canal etc. which are mainly used for passenger navigation and commercial purpose

The Canals in Kottayam district are Kottayam-Vaikom canal, Alappuzha-Kottayam-Athirampuzha canal and AC Canal. The Kottayam-Vaikom canal passing through the Vembanad Lake is 28 km long. Starting from Kodimatha in the heart of Kottayam town, it touches Kanjiram, Illikkal, Thazhathangadi, Moolakatukunnu, Thiruvaataa, Kallumada, Pulikkuttisseri, Maniyamparambu and Cheepungal to enter Vembanad Lake. It reaches the final destination in Vaikom after crossing the Thannirmukkam Bund. Alappuzha-Kottayam-Athirampuzha canal route consists of Kodimatha, Kanjiram, Illikkal, Thiruvaataa, Kallumada, Pulikkuttisseri,Pennarthodu, Mannanam and Athirampuzha Chavara Pilgrim Centre. It connects Mannanam and Kainikkara. Mannanam and Athirampuzha have boat jetties. Boat services were available until 10 years ago on Cheepunkal-Mannanam route. A Kainakkara-Mannanam boat service is also in the pipeline. AC canal starts at Manakkachira in Changanassery and stretches 16 km to end at Onnamkara in in Kuttanad. The stretch from Onnamkara to Pallathuruthi in Alappuzha is in ruins now. Boat service from Manakkachira to Kavalam or Alappuzha through Kidangara is a possibility. This will help frequent flooding in Kuttanad and provide better paddy cultivation. These areas were deepened and banks fortified under the Kuttanad Package. The canal from Onnamkara to Pallathuruthi has to be renovated and encroached area regained. Small bridges from Changanassery to Alappuzha should be reconstructed for smooth boat service.

3.3.4 Waterways in Alappuzha and Kottayam district

Alappuzha district can boast of a good network of canals, rivers and backwaters. Many of these water bodies are perennial and navigable during all seasons. Passenger and goods traffic depended on water during the past. Alappuzha is linked by boat service through the backwater, rivers and canals to Kollam, Changanacherry, Kottayam, Kochi, Kumarakom, Kavalam, Chengannur etc. State Water Transport Department (SWTD) has the monopoly over passenger transportation by water. Alappuzha is the headquarters of SWTD

3.4 LINKAGE BETWEEN PHYSICAL GEOGRAPHICAL CONDITIONS AND MODE OF TRANSPORTATION

The physical attributes of space, such as the topography, influence the route selection process since they impose a variable friction on movements. (Rodrigue ,2020). In practice, network planning principles are heavily constrained by the natural environment and topography in both the initial development and growth of a network. Topography has affected both the historical

development of modes and public transport networks as well as the restructuring of current networks and expansion and growth of network. Topography can influence all modes of public transport through its impacts on planning, network expansion, operations, and public transport use. These factors are clearly inter-related and can have a cumulative influence. (Rhonda Daniels,2012)

3.4.1 Case Study: Alappuzha and Kottayam districts

Alappuzha is a land marked between the broad Arabian Sea and a network of rivers flowing into it. Most of the land area of Alappuzha lies below the mean sea level. In terms of Physiography Alappuzha is divided into three features- Coastal plain. Flood plain and Plateau. (Fig 2) Major portion of Alappuzha is covered by flood plain, followed by coastal plain and a minor portion by Plateaus on the south eastern end. Kottayam on the other hand has five topographical features- Coastal plain, Denudational hills complex, Flood plain, Islands and Plateau, (Fig 3). The major segment of the district is covered by Plateaus followed by denudational hill complex as well as coastal plain.

Topography has influenced on the network and route planning as well as the selection of mode of transportation in both the districts. Road, Railway and Water transportation has been developed in both the districts. In case of Alappuzha road transportation has very much developed in almost all parts except a few portions on Central part where flood plain is dominated. The road network in Alappuzha district follows a grid iron pattern. Railways run across the plateau and coastal plains. The biggest share of National Waterway 3 runs through Alappuzha district. More over a greater concentration of ferries are also seen. (Fig 3)
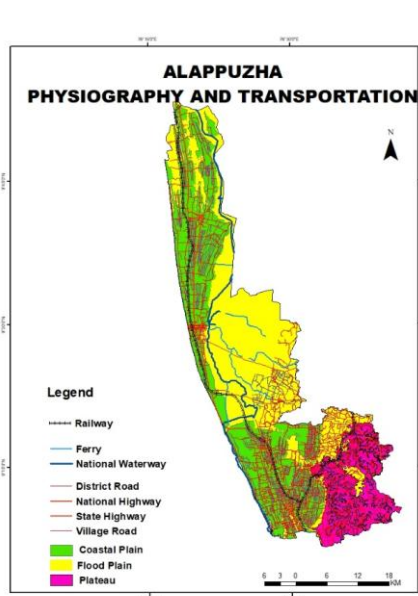

Fig: 2 Alappuzha physiography and transportation   Fig: 3 Kottayam physiography and transportation
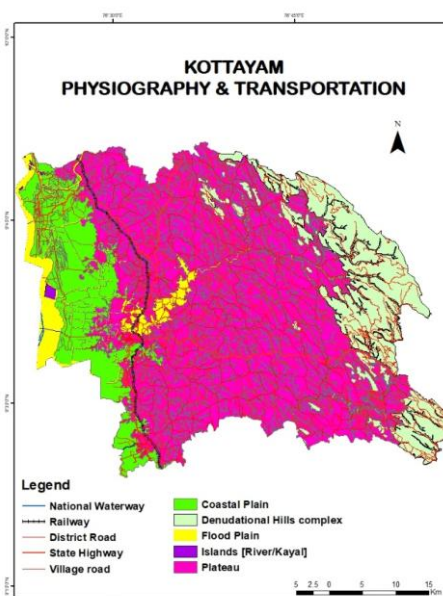
Kottayam district ranks first in terms of state highways and other roads.The road here follows a mixed or organic pattern. Roads are well distributed all over the plateau region.Road concentration is comparatively less in denudational hill complex and in coastal plains.The road transportation distributiom is neligible in flood plains.Railway mainly passes though the plateau region. The distribution of waterways and ferries is limited in Kottayam as it shares only a small portion of flood plain.(Fig 3 & 5).

Topography constraints and topographic features has impacts on the development of mode of transportation and its networks in Alappuzha and Kottayam. In case of road it can be developed in most unaccessible terrain too.That's why road transportation is found in almost all geomorphic features in both districts.Road transportation is best developed in plain and plateau region where there are the least physical impediments .Hence the major portion of Kottayam district is covered by plateau Kottayam stands first in terms of road density network in Kerala state. The road width also depends on topography of the land. Alappuzha is mostly covered by flood plain.Therfore the road width is comparatively less than other parts of the state.

The pattern of Indian railway network has been influenced by geographical factors. The presence of large rivers as well as backwaters makes it necessary to construct bridges which involve heavy expenditure.If we examine the railway line Alappuzha and Kottayam railway is constructed over plateau and coastal plains. (Fig 2 & 3). Railways are completely absent in hilly region where construction is a tedious task

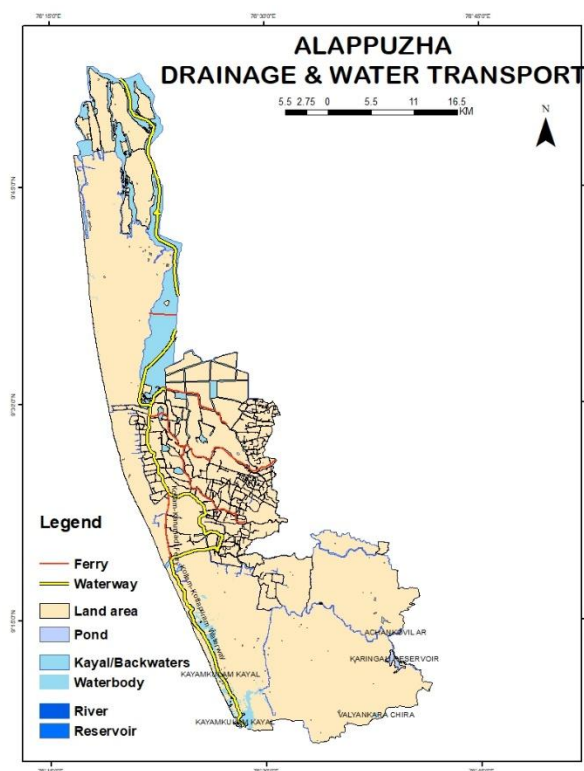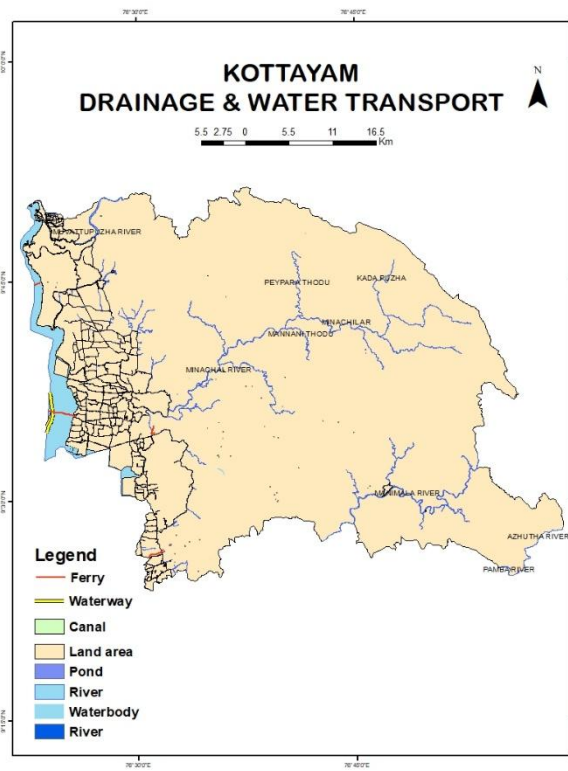
Fig 3.Alappuzha drainage & water transportation   Fig 4: Kottayam drainage & water transportation

The development of inland waterways also depends upon many geographical conditions. The rivers and canals should have a regular flow of sufficient water. The river should be silt fee as silting may cause the reduction of water depth. There should be sufficient demand for waterways to make it an economically viable mode of transportation. The diversion of river water for irrigation canals make rivers unsuitable for navigation. Figure 3 & 4 represents the drainage and water transportation in Alappuzha and Kottayam districts. Alappuzha district is covered by estuaries and backwaters namely Vettakkalachal, Vembanad, Poomeen, Vadakkal, Chethi, Arthungal , Pozhichal and a portion of Kayamkulam lake.Vembanad lake is the main backwater in Kottayam district. Vembanad Lake is the most important waterbody of the West Coast Canal System. It is the largest waterbody in the state. It spreads over a vast area stretching from Alappuzha to Kochi. Five rivers originating in the Western

Ghats, Pampa, Achankovil, Manimala, Meenachil and Moovattupuzha rivers drain into this waterbody in addition to the numerous canals and river branches draining to this. The wetland is fed by the rivers flowing into it, adding up to a vast and extensive drainage area. It is a complex aquatic system of 96 km long coastal backwaters, lagoons, marshes, mangroves and reclaimed lands, with intricate networks of natural channels and man-made canals. Therefore, inland waterways are well developed in Alappuzha with a large number of ferries, jetties, boat schedules etc. Moreover, the better part of National Waterway 3 passes through Alappuzha district.

Kottayam has network of rivers and canals, which empty into the great expanse of water called the Vembanad Lake. But it is comparatively lesser than that of Alappuzha district. Even though Meenachil Ar, Manimala river, Moovattupuzha river,a portion of Pampa river flows through Kottayam district especially in its plateau region, they are not used for navigation as navigable length is comparatively shorter as well as the due to the wide network of road transportation. A portion of National Waterway 3 passes through the flood plain region of Kottayam and there are only limited number of ferries

The case study of Alappuzha and Kottayam, with its combination of topographical features, highlights the two-way process of the relevance of taking topography into account in the planning of mode of transportation and its network distribution. The presence of topographical constraints like denudational hills and flood plain means that extending of road and rail transport system is expensive in both capital and operational terms, with trade-offs between the areas to serve becoming necessary in a budgetary and evaluation constrained environment

4.CONCLUSION

Topography can complicate, postpone, or prevent transport activities and investment. Physical constraints fundamentally act as absolute and relative barriers to movements. An absolute barrier is a geographical feature that entirely prevents a movement, while relative barriers impose additional costs and delays. Land transportation networks are notably influenced by the topography, as highways and railways tend to be impeded by grades higher than 3% and 1%, respectively. Under such circumstances, land transportation tends to be of higher density in areas of limited topography. (Rodrigue (2020). Likewise, inland water transportation also can be developed and maintained if physiography and drainage conditions are favourable. Since transportation involves a set of technologies designed to overcome the constraints of space, physical constraints are the most fundamental to consider. Even if technological improvements have made the physical constraints of space less acute, they still play a considerable role in the location, path, and operational conditions of transportation systems

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ENVIRONMENTAL PERCEPTION INTO DEVELOPMENTAL PLANNING: KERALA PERSPECTIVES

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Abstract

Geography deals with the man-environment relationship in spatial context, concerned with the surface of the earth and its natural environment and also the human intervention. These type of frequent intervention has changed the physical and cultural landscape over years. Kerala state is continuously degraded based on environmental dimension. A close analytical scrutiny of the various facets of state is needed up. State Kerala is sufficient with its resources for life on earth and directs, determines the existence, growth and development of mankind and all activities. Even then man did not concern himself with conservation method, does not favor our nature than take maximum utilization and profit. It is essential to realize the necessity for conservation. Remember that nature has been increasingly damaged, restorative capabilities have progressively weakened, and human intervention is deteriorating day by day to the point of quality life and existence of life. At thos point, we should realize the potentialities and capabilities of our environment to maintain the ecological equilibrium.

Key terms: Environment, Spatial context, Human intervention, Landscape, Degradation, Conservation, Deterioration, Ecological Equilibrium.

Introduction

Kerala lies between 8°.17'.30" N and 12°. 47'.40" N and east longitudes 74°.27'.47" E and 77°.37'.12"E. Kerala's climate is mainly wet and maritime tropical, heavily influenced by the seasonal heavy rains brought up by the South west monsoon and the North east monsoon. The State is located in the tropical region of Indian Peninsula and extends to an area of about 38863 km^2, which accounts for about 1.18 per cent of the total geographical area of the country. Kerala state is often subjected to natural hazards like landslides, flooding, lightning, drought, coastal erosion, earthquakes, Tsunami etc. The highlands of Kerala experience several types of landslides. The west facing Western Ghats scarps is the most prone physiographic part for landslides. These areas are characterized by thin soil cover modified heavily by human activity. Such frequent landslides were accelerated by anthropogenic disturbances mainly deforestation lead to steep slopes.

Floods in the State is becoming more frequent and severe. The latest among them was the 2018 and 2019 Kerala floods. Continuous occurrence of high intensity rainfall, wrong land use practices and mismanagement of the water resources and forests etc are the major reason for such severe impacts. It is accounted that about 26% of the total geographical area accommodating about 18% of the total population of the State is prone to floods. Draught in Kerala state is mainly due to changes in land use pattern, conventional agricultural practices, misleading life style of the people etc. rapid rate of population increase and industrial explosion also become responsible for such large scale draught.

The most outstanding tsunami occurred in the Kerala coast on December 26th 2004. The maximum aggression was reported in the low coastal land of Kollam, Alappuzha and Ernakulum districts, causes life and property lost. Geographically, Kerala roughly divides into three, the eastern highlands, the central midlands, and the western lowlands. Kerala state becomes role model in the world in many dimensions not only because of socio, cultural and life expectancy but of the natural resource endowment covering land, water and biomass and the physiographic structure. In recent years, deterioration of the natural resource causes unexpected consequences to people, flora and fauna community. People stick on monoculture practices and embedded with profit consumerism lead to minimum level of self-existence in the environment. Many of our perennial drainage system lowered into non perennial or drying periodically. Our rural cool and calm atmosphere condition become negatively reacted as a result of doubling of industries and urbanization without judicial concerns. It does not mean we all are living only in the agrarian economy but can afford urban life touch as green city aspect.

It is noted that frequent Sand mining, clay mining affects hydrological regime of the river. Huge Construction of dams in the upper reaches of the river restricts regular flow and also sediment movement. This situation also fears we people in connection with our sustainability. Sand occupying from our coastal areas lea to deep cutting and regressive to marine aquatic. One of the vital factor regarding our wetland system right time remained only in the name of convention not in action of conservation.

Study area
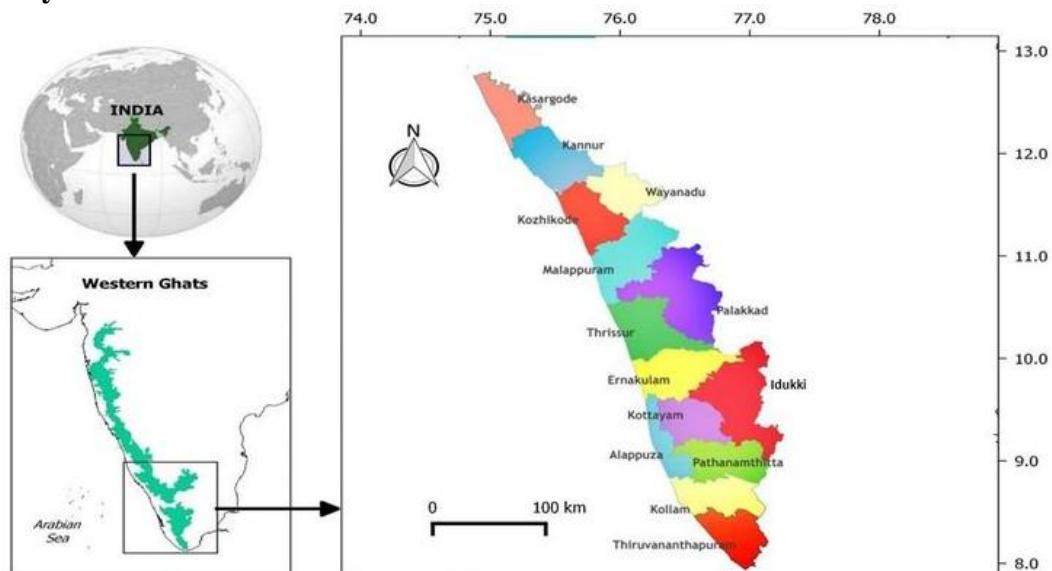
Major objective
To develop the concept of biodiversity is life and is our future existence.

Methodology in brief
The Survey cum direct experiential method is used for the present study. Normative Survey method was adopted in the present study to find out the extent of awareness on environmental aspects. Major tools are the following;

1. Environmental awareness test for local people. (Developed and Standardized by Dr. Nishad Nazeer (2019)
2. Environmental Ethics Scale (Prepared and Standardized by Dr. Nishad Nazeer and Dr. Sindhya v (2019)

We all know that our bio system is in a dangerous condition and facing frequent destruction by natural as well as human induced action. 1992 Rio Dee Jeneero earth summit take important steps against bio destruction. Every year since 1992 we celebrate bio diversity day without any lag but unfortunately right now the situation become pathetic regarding protection and conservation of habitat in one way or another. The aforesaid destruction mainly happened due to the greedy interference of human beings. He continuously encroach environment without judicial steps for his own profit only. Carving out hills by using sophisticated devices, filling wetlands for various dimension purposes. Hierarchical hunting subjected to endangered situation forever. It is revealed from the Red data books that10000 flora and 1000 more fauna were facing its last survival. Our multiplying private vehicle usage causes diurnal temperature increase and lead to destruction of many species forever. Uncontrolled fishing, explosive sea pollution often responsible for marine life lost.

India has 78% of global flora bio habitat. Based on bio system India is divided into mainly 10 bio geographical regions.

1. Tibetan Himalayan region
2. Himalayan Mountain system
3. Indian Desert region
4. Western Ghat region
5. Semi-Arid region

6. North Eastern region
7. Deccan trap region
8. Gangetic plain region
9. Coastal region
10. Island group (Andaman and Nicobar group of islands)

India is embedded with a rich and highly endemic biota, but the burgeoning human population has massively changed Indian bio physiography into mere physiographic structure. Widespread human presence do not compromises the existence of Indian biotas.

BIO GEOGRAPHICAL REGIONS.OFINDIA
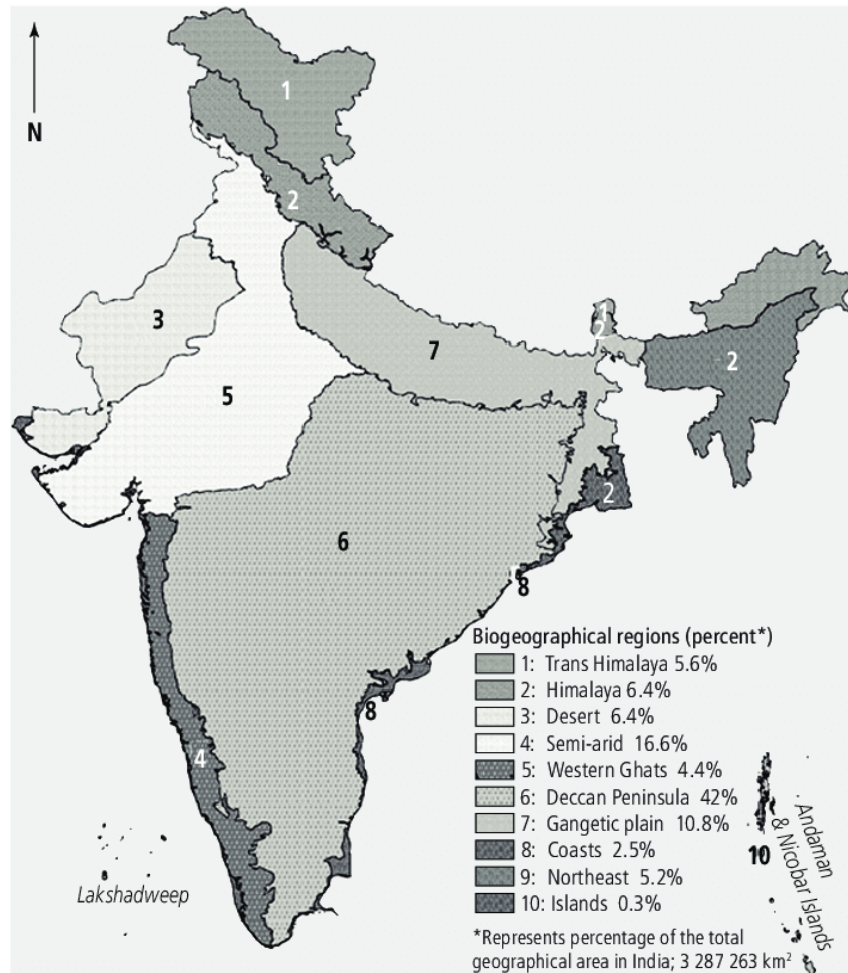
Kerala is one of the most appropriate places for developing a network on sustainable development and trying to keep the resources for the future survival of our generation. In that aspect Kerala state hold the concept of sustainability, equity, empowerment etc.   Kerala state is well specific for having a cleaner environment than the other states of India. The present study mainly focusses on geographical perspectives for selected environmental issues. All rivers which is flowing in Kerala state specially facing pollution aspect mainly due to dumping of solid waste, bathing and discharge of effluents from domestic as well as from industries. Population pressure, unemployment and state policies in Kerala have encouraged large scale internal migration which has resulted rapid deforestation and finally causes environmental degradation. Large-scale deforestation in the Western Ghats and implementation of monoculture for profit making resulted in surface soil erosion and environmental quality lost, causing serious ecological and environmental problem.

The backwaters are polluted in many ways. Agricultural pollution and allied regression may occurred in this sphere Decline of the backup capability of soils, soil erosion, lack of water and natural vagaries are some of the prime physical factors responsible for this condition. In this context it is now increasingly felt that a strategy for sustainable land management in order to save our ecosystem forever. It is now important to briefly deal with the concept of sustainable development approach.

Geography is a dynamic and all-encompassing subject. It is a distinct and dynamic science of social science discipline that deals with the study of man and his physical environment. Geography is the branch of knowledge that studies the land features, the inhabitants, and the phenomena of the Earth. It is the scientific study of the location and spatial variation in flora, fauna and human phenomena on earth. Geography learning prepares the students to see and overcome various problems related to sustainable living. If a student is familiar with the natural conditions of a region, its climate, vegetation, natural resources, mineral wealth, it becomes easier for him to plan for the future.

Geography is the most scientific and practical oriented subject which often become difficult to grasp in its reliable and meaningful way with the help of common strategies. So many researches are going on to find out new approaches to help students to understand these concepts more easily. Geography is a part of composite science dealing with the human world and central purpose is to study the structure and behavior of human society in relation to geographical factors. The facts and concepts in Geography has scientific as well as humanistic base. With innovative thought, people instantly search information and understand Geography concept in a lucid and meaningful way and interesting without worrying boredom.

The study of environment in one way or the other has always been recurring theme in geography. A variety of instructional approaches provide opportunities to transfer skills and ideas from one situation to another, meaningful connections between skills and ideas and real life situations, opportunities to be independent and show what they know, encouragement to self – monitor and self-correct tools. Eco psychology an emerging area of study maintains the inseparable relation between the perceptual system of human beings and the physical world in which they evolved. Eco psychology laid strong foundation between man and environment. This discipline provide way of developing affection towards nature. This field bring a form of human shape with natural structure. Eco psychology supports deterministic approach, the conventional view of environmental role. The central premise of this field is to improve interpersonal relationships and emotional well beings allied with environment. Eco psychology reduce stress among people, natural restoration and environmental awareness among human beings. It improves self-efficacy beyond age through domestic gardening and planting shelter trees etc. Eco psychology can sharpen the inborn skill to sustainable culture. It develop the sensation of harmonious development of man's innate power combined with nature. Yet today, our culture is not completely incorporated with nature stability. Eco psychology is described as a love of nature and an earth touched feelings from our every way of life. People know our present life is not at all fit to our environment and follow technological comfort by destructing our divine nature. This type of non-human attitude must be eliminated from our privileged culture. It is necessary to promote a feeling of inclusive community and a thirst feeling of moral obligation to nature. Geographers, urban planners, architects and environmentalist strongly support green city concept through eco-friendly life style. Our mannerism should go with nature stability and bond with inner sense of belonging and earth friendly behavior.

Geography is a discipline that seeks to integrate and synthesize environmental knowledge. Geography represents impact of human presence on the environment. Geography studies the relationships between people, places and planet. The teaching geography pay attention to designing and adhering to the appropriate strategies throughout for improving the quality of teaching environmental geography. The strategies and its need for teaching geography may differ from fact to fact or from concepts to concepts. Well planned and organized teaching strategy for imparting present day relevance of environmental awareness is not yet properly applied. Yet the basic approach towards teaching geography remains the same. Keeping all this in view, the present study has been done with clear objectives, to enable geography teachers, irrespective of mere a branch, in developing the most appropriate strategies for their subject completely, both theoretical and practical context and to make them familiar with new instructional strategies for developing geographical knowledge.

The present study mainly focuses on development of eco psychological approach. The primary function is to develop and enhancing peoples environmental ethics. This situation highlights the interest and positive attitude towards our environment to great extent. Recently, human beings interfere to environment and destruct nature for their mere satisfaction. He does not treat nature as divine. He only consumes environmental resources for his own satisfaction proving towards an

undesirable attitudes. So a good psychological attitude is needed to protect the destructing environment, which can be practicable through geographical study and towards environmental protection and related aspects. From what has been stated above, we can say that new methods and strategies are needed to promote environmental habit. If such a development does not happen, the child will grow as a self-centered individual and may become a maladjusted person. Every child wants to experience the thrill of success. The need for success has close relationship with the application of good aptitude that have multiple integration. Unfortunately our educational system particularly geography discipline is not favorable to the satisfaction of this need. The existing approach of teaching are adjusted to the average child. Hence, the child who is below and above average does not have the feeling of success. It is believed that with the introduction of new methods and approaches, geography teachers, experts and scientist can equip pupils towards sustainable living practices in harmony with living and nonliving things, and more generally with nature as a single unit. Moreover, it is needed to promote interest in geography learning through systematic application of divergent process. Mechanical ways of teaching do nothing creative among students. It is very late to awaken the ability to tap into new way of ecological addressing. Nature – based cultures catalyze, focus and harness are to be synthesized for sustainable life practice. Every geographers, allied planners and experts must promote the idea that the earth also has life and all facets of life on it are sacred. It is very urgent in the due process of evolving; everyone in the planet develops his or her unique style of protection of our surroundings in a judicial way.

Several research studies are undertaken and accomplished year after year. But in most cases very little attention is paid to an important dimension relating to geography. In the contemporary scenario of education all over the world the scope of new and creative idea and ideologies are very wide and is found to be increasing day by day. These kind of knowledge has a very significant role to play in all aspects of education related to the behavior modification and development of the population.

Conclusion

The present study aims to develop the concept of biodiversity is life and is our future existence based on Eco Psychological approach in Kerala context. It is commonly stated that people do not have good attitude to save our resources scientifically. Even though they are aware about environmental destruction, not ready to promote conserving habits. Our teachers purely emphasizes on the content prescribed in the curriculum rather than the further output regarding environmental aspects among students. But not at all facilitate them to create psychological fitness in them. The researcher reviewed the present geography teaching learning and read literature in the concerned area of research. Then the investigator collected information regarding the development of new approaches for environmental consideration, especially environmental Geography for making appropriate environmental management.

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A MODIFIED- WEIGHTED- K - NEAREST NEIGHBOUR AND CUCKOO SEARCH HYBRID MODEL FOR BREAST CANCER CLASSIFICATION

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Abstract

One of the leading death-causing cancers in women is Breast Cancer. Accurate, precise, and early diagnosis is a crucial solution to survival. Data mining techniques have proved to produce good results in disease diagnosis. Feature search techniques are useful in identifying the relevant features for classification thus reducing time and effort. Class inequality is a significant challenge and one of the methods to overcome it is class balancing. In certain cases, the negative class is the majority class. To be specific; the negative class has a more number of instances than the positive class, so the overall classifier performance may be high; consequently, the classifier performance in accurately identifying positive instances gets overlooked. In this paper, a combination of two class balancing approaches is applied. It is used to balance the number of instances in each of the target classes. *k*-Nearest Neighbour classifier is a simple, easy to implement, and robust classifier with few parameters needed to be tuned. In this paper, we propose a *k*- Nearest Neighbour Classifier model implemented with feature search using Cuckoo search and Class balancing to classify Breast Cancer. The proposed model produced an accuracy of 99.41 %., ROC of 0.999, and MCC of 0.988.

Keywords: *k*-Nearest neighbors (*k*-NN); Cuckoo Search (CS); Class Balancing (CB); Breast Cancer (BC), Metaheuristic Search

1. Introduction

Breast cancer is a leading cause of death in women worldwide [Paul et al. 2015, Sharma et al., (2010)]. Many methods are available for diagnosing Breast cancer, yet the disease is still on the rise and claiming the lives of thousands of women [Momenimovahed & Salehiniya, (2019)]. A key to survival is the early diagnosis of cancer. Medical diagnosis at times can be inconclusive, stressful, and painful to the patients. Applying data mining techniques for the diagnosis of the disease can provide added support to healthcare personnel in disease diagnosis. Many classification models and case studies are available with medical images [Enireddy & Kumar, (2015), Chakravarthy & Rajguru, (2019), Rajathi, (2020)]. Disease classification can be done as well using cytological feature analysis besides, image analysis [Arya & Tiwari, (2016), Daoudy & Maalmi, (2020), Mathew, (2019)]. Simple as well as ensemble machine learning models [Mathew, (2019)] are being to address the breast cancer classification problem. But developing models that are precise as well as accurate is a challenging task. Misclassification of the disease is one matter to be taken into account. In most cases, the positive class which indicates the existence of the disease is a minority and the negative class which indicates no disease is the majority class. So usually an overall moderate accuracy is received in classification when the various machine learning techniques are used and a major constraint is that the classification accuracy of the minority class is overlooked [Pelayo, (2012), Park & Park, (2020)]. Misdiagnosis of a positive class is a relatively serious issue than vice versa. So to provide equal importance to both the classes in the two-class problem of Breast cancer classification class balancing is used. Medical datasets usually have high dimensional datasets and hence suffer from the curse of dimensionality [Nabila, Boukadoum & Proulx, (2020)]. Feature selection has become a necessity in many applications [Saeys, Inza & Larrananga, (2007), Mathew, (2019)] Feature selection helps in reducing irrelevant features [Perelta et al., (2015)]. Many feature search algorithms are available in the literature. Nature-inspired, Metaheuristic, Swarm Intelligence algorithms have been seen to show better performance than conventional search methods [(Fong, Aghai, Milhalm, (2018), Mathew, AnilKumar, (2020)]. These algorithms have been used for various applications from disease diagnosis [Nagthane & Rajurkar, (2017)], drug design [Houssein et al.,

(2020)], Traffic engineering in Networks (Ammal, Sajimon & Vinodchandra, (2020)] to Big data cybersecurity problems [Mylavathi & Sreenivasan, (2019)] and many more. The combination of feature search algorithms can also be used to improve searching [Houssein et al, (2020)]. Cuckoo search has the advantage that it is easy to implement and it has been found capable of solving many combinatorial optimization problems. A significant number of studies have used Cuckoo search to analyze images for breast cancer classification [Michahial, (2019). Adam based Cuckoo search algorithm proposed by [Mohsin, Li & Abdalla, (2020)] used Deep Belief networks to classify various datasets and the method was found to improve performance. Cuckoo search optimization and SVM were used by [Prabhukumar, Agilandeeshwari & Ganesan, (2019)] to classify lung cancer and achieved an accuracy of 98.51%. In their proposed work [Jaddi, Abdullah & Malik, (2017)] used a modified cuckoo search with ANN to predict water quality prediction. They modified the CS algorithm so that the parameter P_a .takes a maximum value initially instead of the default value of one and reduced it during the search. [Peng et al., (2020)] proposed a composite firefly algorithm with k-NN and applied it on Breast cancer datasets. It was seen to improve the performance and an accuracy of 98% was obtained on the WBCD dataset. An enhanced cuckoo search with k-NN was proposed by [Sudha, & Selvarajan, (2016)]. The model achieved an accuracy of 98.75%. A new cuckoo search based extreme learning-based model was proposed by [Mohapatra, (2015)] and it was seen to outperform other compared models. The improved cuckoo search was used to pre-train the machine.

The objectives of the paper are
- To investigate whether class balancing and the combination with feature selection improves the classification of breast cancer.
- To investigate whether the modification to the k-NN algorithm improves breast cancer classification.
- To develop an effective data mining approach that helps the classification of Breast cancer as malignant or benign with minimal misclassification of the positive class.

The major contribution of the work is
- A hybrid model for the classification of breast cancer based on a modified weighted k-Nearest Neighbour using Class balancing and Cuckoo Search with minimal misclassification of the positive class.

The rest of this paper is structured as follows. The next section describes the materials and methods used. This is followed by the results obtained. The subsequent section is a discussion of the results, and finally, a conclusion of the study is provided.

2. Methodology and Techniques

2.1. *Dataset*
The Wisconsin Breast Cancer original dataset publicly available in the University of California, Irvine Machine Learning Repository created by Dr. William H Wolberg is used. The dataset has 699 instances, 11 attributes with 458 benign (65.5%) and 241 (34.5%) malignant cases. Since 13 instances have missing attribute values only 683 instances are used and the rest is discarded. The first attribute Id number is of no relevance in classification so it is also removed from the dataset. All the attribute values are in the range 1-10. And the class has two labels 2 for benign and 4 for malignant.

2.2. *Cuckoo Search (CS)*
Cuckoo search (CS) is a nature-inspired metaheuristic algorithm belonging to the family of swarm intelligence [.Meng et al. (2018)]. The propounders are Xin-She Yang and Suash Deb [Yang & Deb, (2009)]. Cuckoo Search is considered to be easier in tuning as it has a lesser number of parameters than other metaheuristic techniques. Cuckoo search is based on the principles of the brood parasitizing mechanism of some species of cuckoo birds and Levy Flight search. Some Cuckoo species lay their eggs in the nest of other birds. To increase the hatching probability of its eggs the cuckoos at times remove the host eggs and the host bird nurtures the eggs. Three types of brood parasitism can be adopted in the Cuckoo search- intraspecific brood parasitism, nest takeover, and cooperative breeding [Shehab, Khader & Al-Betar, (2017)]. If the host bird discovers that the eggs in the nest are not its own, it throws out unknown eggs or leaves the nest and builds a new nest elsewhere. Certain species of cuckoos are capable of mimicking egg colors and patterns of the host eggs, thus preventing their eggs from getting abandoned. Levy flight, a term coined by Benoit Mandelbrot, is a random walk with step size having a levy tailed probability distribution. Many species of birds and insects follow the Levy flight properties. Here steps are defined in terms of step length with a definite probability distribution and isotropic and random direction. In the cuckoo search algorithm, each egg in the nest represents a solution. The cuckoo eggs denote new solutions. The cuckoo search aims in replacing the solution in the nests (host eggs) with better solutions (cuckoo eggs). Three rules followed in cuckoo search are [Yang & Deb, (2009)]:

- A cuckoo places an egg one at a time in an arbitrarily selected nest.

- The next generation includes the nest with the best fitness namely, eggs

- The number of host nests is fixed and, the detection of the cuckoo egg by the host bird has a probability index ϵ (0, 1) [Kuldeep et al., (2014)].

The new solution (cuckoo egg) $x_i^{(t+i)}$ is generated by the Levy flight principle and is given as

$$x_i^{(t+i)} = x_i^{(t)} + a \oplus Levy(\lambda), \tag{1}$$

Where step size, a= 1, & $x_i^{(t)}$ is the current position.

$$Levy \sim u = t^{-\lambda}, (1 < \lambda <= 3) \tag{2}$$

λ is the infinite variance with infinite mean

The best fitness is denoted by x_{best} and the control parameters used are scale factor (β= 1.5) and probability index (p_a). Evolution of x_i is defined by v= x_i and

$$Stepsize = 0.01(u_i/v_i)^{1/\beta} . (v - x_{best}) \tag{3}$$

Many variants of the Cuckoo search are available in the literature [Yang, (2014)]. A few are

a) Gradient free Cuckoo Search which improves the convergence rate (Walton et al., 2011). Two modifications were made. The original CS algorithm uses a step size of value 1. In the gradient method, the value of step size, (a) is varied at each generation as (a / √G), where G is the generation number, instead of being assigned a constant value of 1. The second modification was that to speed convergence information is exchanged between eggs.

b) Improved Cuckoo search [Valian, Mohana &Tavakoli, (2011)] proposed a technique to vary the parameters p_a and a, which was assumed as constant in the original version. They are initially kept high and are decreased in the final generations for fine-tuning values.

c) Binary Cuckoo search [Rodrigues et al., (2013)] is another variant where the search space is represented as n-cube, n being the number of features. A set of binary coordinates are assigned to each nest. This is an indication of whether a feature belongs to the final set of features or not. The accuracy of the classifier is the objective function used. This is to be maximized [Rodrigues et al., (2013)].

2.3. Class balancing (CB)
Mostly class balancing is done either by reducing the majority class or increasing the minority class. Usually increasing minority classes is seen as more effective with classifiers than vice versa, since relevant information can get lost in the process of reducing instances [Sreejith, Nehemiah & Kannan, (2020)].   Class balancing of the datasets is seen to improve classification performance [Vasquez, (2020)]. A combination of both techniques has been seen to be effective [Chawla et al., (2002), Pradoa et al., (2020)]. Resampling is being used to implement the combination method.

2.4. k -Nearest Neighbour (k-NN)
k-NN, also known as a lazy learner is a non-parametric supervised method developed by Thomas Cover. It assumes the similarity between the new cases and existing cases. The similarity is measured using distance metrics. The conventional *k*-NN algorithm uses the Euclidian distance. The advantage of *k*-NN is that it is simple to implement. The working of *k*-NN is as below

- *Define the objective function*
- *Select the value for k*
- *For a new point, estimate the Euclidean distance of k number of neighbors from the new point*
- *Take the k nearest neighbors for the calculated Euclidean distance.*
- *Among these k neighbors, count the labels in each category.*
- *Assign the new label to that category for which the number of labels of the neighbors is the highest.*

2.5. Proposed model Modified -weighted k-NN (M_W-k-NN)
The distance metric used in the conventional *k*-NN is Euclidian distance. Many other distance metrics are available. The proposed algorithm uses the Manhattan distance which is calculated as the sum of the absolute differences of the Cartesian coordinates of two points. Equation 4 gives the formula for Manhattan distance. For two given points (x_1, y_1) and (x_2, y_2)

$$Manhattan\ distance = |x_1 - x_2| + |y_1 - y_2|. \tag{4}$$

The k-NN classifier assigns the k nearest neighbors a weight $(1/k)$ and all others a weight 0. The proposed model uses a weighting factor for the k nearest neighbors as shown in equation 5.

Weighting factor= (1/distance).   (5)

The Proposed M_W-k-NN Algorithm

- *Let m be the number of data samples. Let p be an unknown point.*

- *Read k*

- *Store the samples in an array of data points arr[]*

- *For j= 0 to k*

   o *Calculate d= Manhattandistance(arr[j], p)*

   o *Add d to set S = (k distances obtained from p)*

- *Return the majority label of S*

- *Manhattandistance (A(x_1,y_1), B(x_2,y_2))*

   o *d= |x_1 – x_2| + |y_1 – y_2|*

   o *Return d*

   o

Finding the value of k

- *The optimal value of k is obtained by using k fold validation*

- *Initialize neighbors N with values[0 or 1,50, 2]*

- *Initialize L_CV= empty list of cv scores*

- *Perform cv(for cv= 10)*

- *For each k in N*

   o *Find the cv_scores using accuracy,*

   o *Add mean of cv_scores to L_CV*

- *Plot accuracy vs. k*

2.6. *Methodology*

The working of the proposed model is in four stages – preprocessing, class balancing, feature selection, and classification.

- *Data preprocessing by removing instances with missing values*
- *Applying a Combination of Oversampling and Undersampling*
- *Cuckoo Search with Chaotic logistic map is applied*
- *Relevant features are identified*
- *Modified k-NN classifier with, k= 5, Manhattan distance metric and a weighting factor of (1/distance) is applied on the new set of feature vectors*
- *10 fold cross-validation to avoid overfitting.*
- *Evaluation of the classifier based on performance metrics –Accuracy, Receiver Operating Characteristics (ROC), False Positive Rate (FPR), Kappa Statistic, Matthews correlation coefficient (MCC), and Recall. To identify the performance of the classifier in identifying positive classes other performance metrics such as ROC, FPR, and MCC are used.*
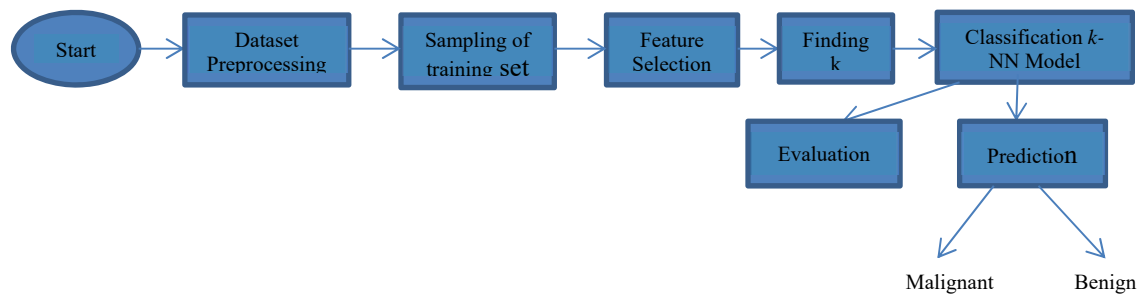
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Figure 1 Working of Proposed Model

3. Results and Discussion

Table 1 summarizes the results obtained by the various models. The comparison of the performance of the classifiers is done using the standard metrics Accuracy, ROC, Recall, MCC, Kappa statistic, and FPR. The proposed method presented an accuracy of 99.41% with a ROC value of 0.999, recall of 0.996, MCC value of 0.988, FPR value of 0.006, and Kappa statistic value of 0.9883. The conventional k-NN method without class balancing obtained an accuracy of 94.87%. With class balancing alone the conventional method achieved an accuracy of 97.50%. With feature selection using cuckoo search the accuracy slightly decreased to 97.21%. But with the proposed modification, the model with class balancing alone achieved an accuracy of 98.97% and 95.02% without class balancing. Accuracy improved to 99.4 with feature selection using cuckoo search.

Table 1 Results

Methods	Accuracy 1	ROC 2	Recall 3	MCC 4	FPR 5	Kappa 6
k-NN	94.8755	0.989	0.949	0.887	0.078	0.8855
k-NN + CB	97.5073	0.996	0.975	0.950	0.025	0.9501
k-NN+ CB + CS	97.2141	0.996	0.972	0.994	0.028	0.9443
M_W-k-NN	95.022	0.994	0.950	0.890	0.075	0.8889
M_W-k-NN + CB	98.97	0.999	0.990	0.979	0.010	0.9795
M_W-k-NN + CB+ CS	99.4135	0.999	0.994	0.988	0.006	0.9883

In the current study, we focused on improving breast cancer classification using the k-NN classifier and implemented class balancing to avoid the issues related to class imbalance along with feature selection using cuckoo search to reduce irrelevant features. The various metrics applied to the proposed model demonstrate better performance than the original k-NN model with class balancing and Cuckoo search. The proposed model is better in terms of Accuracy, Recall, MCC, FPR, ROC, and Kappa statistics. The confusion matrix (Table 2) presents the classification done by the model. The proposed model misclassified one instance of the positive class and three instances of the negative class while the conventional model, having a classification accuracy of 97.21%, even with class balancing and feature selection has thirteen and 6 misclassified cases in each class. When compared against the various models' classification of the positive classes as well as the negative class in the proposed model has improved significantly. A significant improvement was seen in classifying the positive class. Thus, proving the fact that classifier accuracy alone does not imply the best classification was done [Araya & Cipriano, (2007)]. The variance of performance between the simple k-NN and k-NN with class balancing shows the sensitiveness of the classifier to an imbalanced dataset. The conventional algorithm of k-NN uses majority voting of the labels of the nearest neighbors to classify a new instance. In cases when the probability distribution of the data is skewed the predictions of the majority class dominate and affect the accuracy. Providing weights to the distance measured from the new point to its neighbors by multiplying it with the weighting factor (1/distance) helps in overcoming this problem. Moreover, class balancing improves the performance significantly, by keeping a balance among class labels. Feature selection using Cuckoo search further enhanced the performance. By using Manhattan distance in the proposed model, it gives the advantage that the closest approximation of the real distance is taken, whereas Euclidean distance gives the shortest distance. The chaotic map variable used in the CS algorithm is seen to improve performance as it increases the speed of search and avoids local optima. Similar performance was seen with whale optimization methods [Houssein et al, (2020)] The k-NN classifier without CS and CB has low performance when compared to the proposed model. FPR rate is a mere value of 0.078 compared to 0.006 achieved by the proposed model.

The proposed model is compared with the Nearest Neighbour (NN) model which uses normalized Euclidean distance as the distance metric, Logistic Regression, and Multilayer Perceptron, Random Forest, Naïve Bayes, and SMO Models (Table III). The proposed method shows better performance among the 7 classifiers. The second-best model is the NN model with an accuracy of 98.82%. The Logistic Regression and Random Forest have an accuracy of 98.53% and 98.68% respectively. The lowest performance was demonstrated by the Naïve Bayes classifier. Besides accuracy, the kappa value of the proposed model is much better than that of other classifiers. Kappa statistics compare the observed accuracy with the expected accuracy. Accuracy, inaccuracy is plotted against the proposed model and various k-NN models (Fig 2).
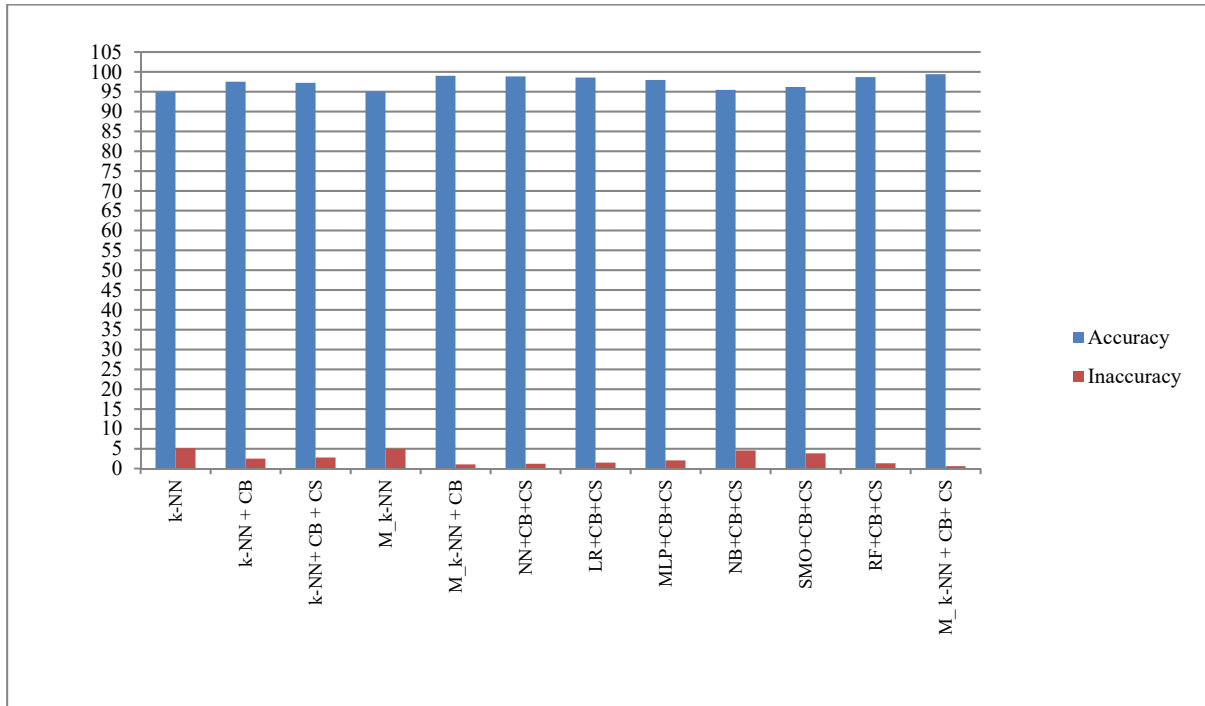
Figure 2: Methods vs Accuracy vs Inaccuracy

The ROC of the positive class, (Fig 3), with FPR, plotted on the x-axis and TPR on the y axis is shown. The ROC metric helps in discriminating between classes and is found effective for medical diagnostic evaluation (Swets, 1986, Tilaki, 2013).
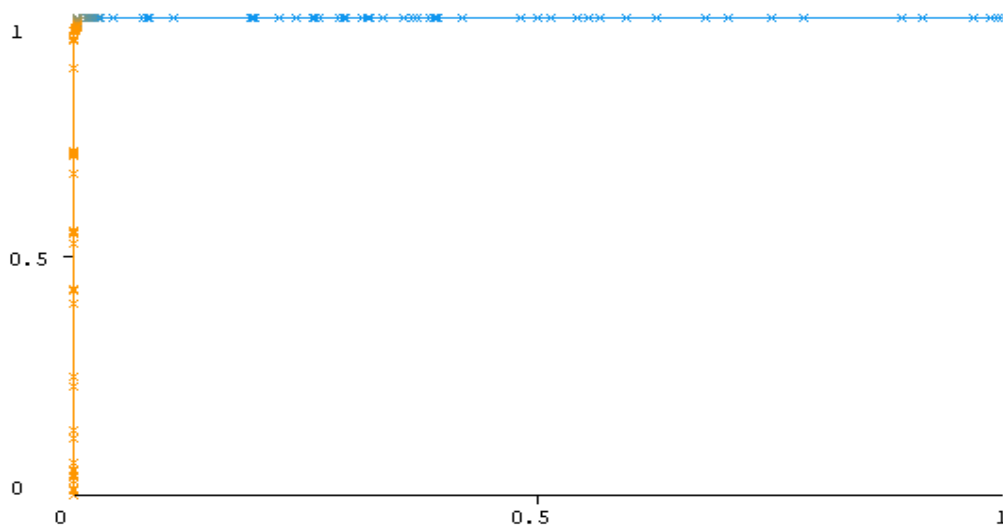
Figure 3 ROC curve:

Table 2 – Confusion Matrix

Metric used	*k*-NN 1	M_*k*-NN 2	*k*-NN+CB 3	M_*k*-NN+CB 4	*k*-NN+CB+CS 5	M_*k*-NN + CB+ CS (Proposed Model) 6
Confusion Matrix	a b 435 9 a= 2 26 213 b= 4 a- benign b- malignant	a b 435 9 a= 2 25 214 b= 4 a- benign b- malignant	a b 330 11 a= 2 6 335 b= 4 a- benign b- malignant	a b 338 3 a= 2 4 337 b= 4 a- benign b- malignant	a b 328 13 a= 2 6 335 b= 4 a- benign b- malignant	a b 338 3 a= 2 1 340 b= 4 a- benign b- malignant

The curve is seen at the upper leftmost corner near the y axis adjacent to one indicating a high ROC value and the discriminating power of the proposed model. The proposed model has a better value for MCC with a value of 0.988, FPR rate with 0.006, and recall of 0.994 when compared with other classifiers. A comparison of the FPR of the classifiers is illustrated (Fig 4). The least efficient result was shown by the Naïve Bayes classifier. The FPR indicates how much the model incorrectly predicts the positive class. Hence a lower value is preferred. The least FPR is shown by the proposed model. It indicates that the number of correctly classified
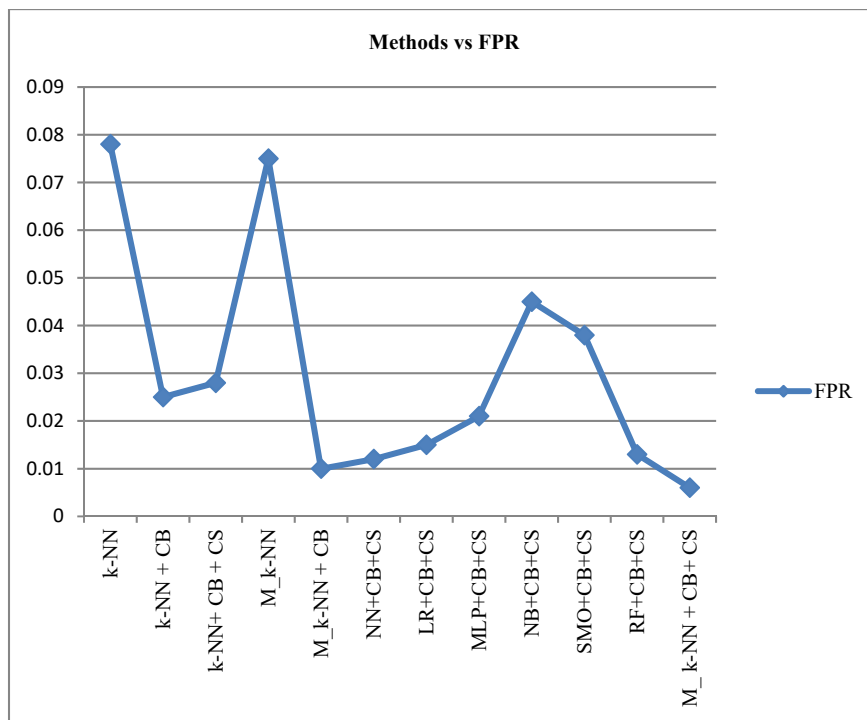
Figure 4 Methods vs FPR

positive instances are high and that with least misclassification was done by the proposed model. Figure 5 illustrates the MCC values plotted against the proposed model and various *k*-NN models. MCC gives a high score only if good prediction results are achieved in all four categories of the confusion matrix - (TP, TN, FP, FN). MCC is seen to be effective if the classes are balanced and deteriorate if they are unbalanced since it gets unevenly distributed [Zhu, (2020)]. Table 3 gives the comparison with other data mining methods.

Table 3- Comparison with other classifiers

Methods	Accuracy 1	ROC 2	Recall 3	MCC 4	FPR 5	Kappa 6
NN+CB+CS	98.82	0.988	0.988	0.977	0.012	0.9765
LR+CB+CS	98.53	0.987	0.985	0.971	0.015	0.9707
MLP+CB+CS	97.94	0.989	0.979	0.959	0.021	0.9589
NB+CB+CS	95.45	0.991	0.955	0.909	0.045	0.9091
SMO+CB+CS	96.18	0.962	0.962	0.924	0.038	0.9238
RF+CB+CS	98.68	0.997	0.987	0.974	0.013	0.9736
Modified_ k-NN + CB+ CS	99.4135	0.999	0.994	0.988	0.006	0.9883
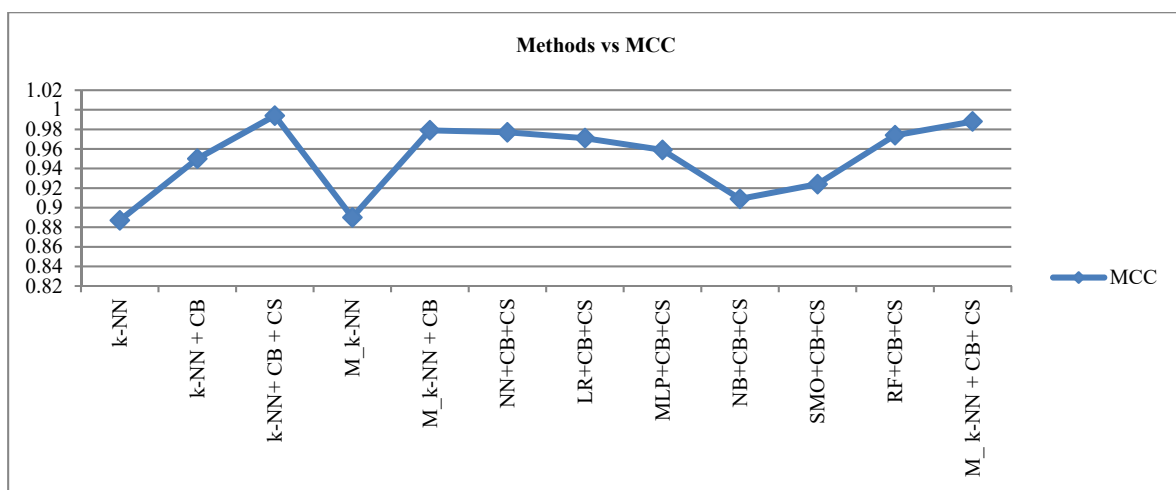
Figure 5 Methods vs MCC

The proposed model has the best MCC value among the models. The least efficient model is given by Naïve Bayes and k-NN classifiers. (Fig 6) illustrates the Precision-Recall curve for the positive class with the X-axis plotted with TPR values and Y-axis with Precision values. Recall is the ability of the classifier to correctly predict the positive samples. The P-R curve helps in visualizing classifier performance and threshold. Precision shows how closely the results agree with one another. The P-R curve is at the upper rightmost corner indicating the good performance of the classifier.
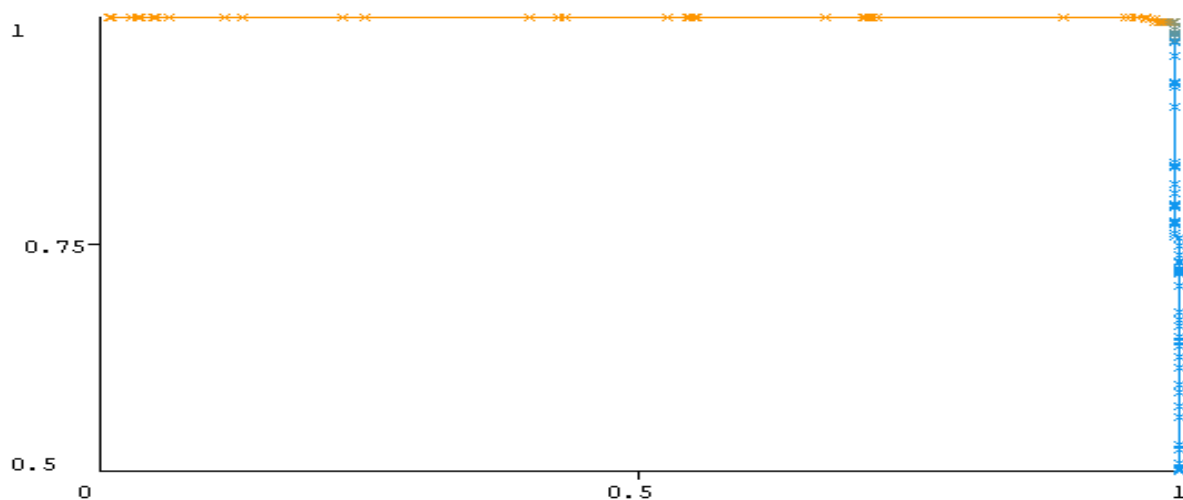
Figure 6: Precision-Recall Curve

K is chosen a value 5(Fig 7).A set of values from 1 to 50 were used for k, and k=5 was taken based on the cross validation scores obtained. Higher k leads to high bias and too low value for k leads to high variance. Hence to select a suitable k value the cv scores for different values of k is compared. A large k is also computationally costly, besides to avoid ties between classes that are chosen an odd value of k will be better.

Comparison of Modified- Weighted -k-NN+CS with a few other nature-inspired feature search methods: Firefly search (FFS), Bee search (BS), Flower search (FS), Elephant search (ES) is also shown (Table 4). The proposed model shows better results against k-NN with other search methods. In all the methods class balancing is used.

Table 4 Comparison with other search methods

Methods	Accuracy 1	ROC 2	Recall 3	MCC 4	FPR 5	Kappa 6
k-NN + CB+ BS	98.97	1	0.990	0.980	0.010	0.9795
k-NN + CB+ ES	98.8	1	0.988	0.977	0.012	0.9765
k-NN + CB+ FFS	98.68	0.999	0.987	0.974	0.013	0.9736
k-NN + CB+ FS	99.1	1	0.991	0.982	0.009	0.9824
M_k-NN + CB+ CS	99.4135	0.999	0.994	0.988	0.006	0.9883

Comparison with related existing works in literature with the proposed model in terms of accuracy is summarized (Table 5). The proposed model exhibited an improved performance when compared to other models. To observe the stability and performance of the model. It was evaluated on three other datasets from the UCI machine learning repository- the Cleveland heart dataset, Hepatitis Dataset, and Kidney dataset. (Table 6) presents the results obtained. The model was seen to produce better performance in all three cases.

Table 5 Comparison with literature

Previous Literature	Classifier used 1	Dataset used 2	Accuracy obtained 3
(Sudha & Selvarajan 2016)	k-NN+ECS	DDSM	99.13
(Prabhukumar, Agilandeeswari & Sangaiah, 2017)	SVM +CS	MIAS	96.72
(Chakravarthy & Rajguru, 2019)	ECS	MIAS	97.5
(Peng et al., 2020)	k-NN+ CoFF	WBCD	98
Proposed Model	M_k-NN + CS +CB	WBCD	99.41

Table 6 Comparison of the model with other datasets

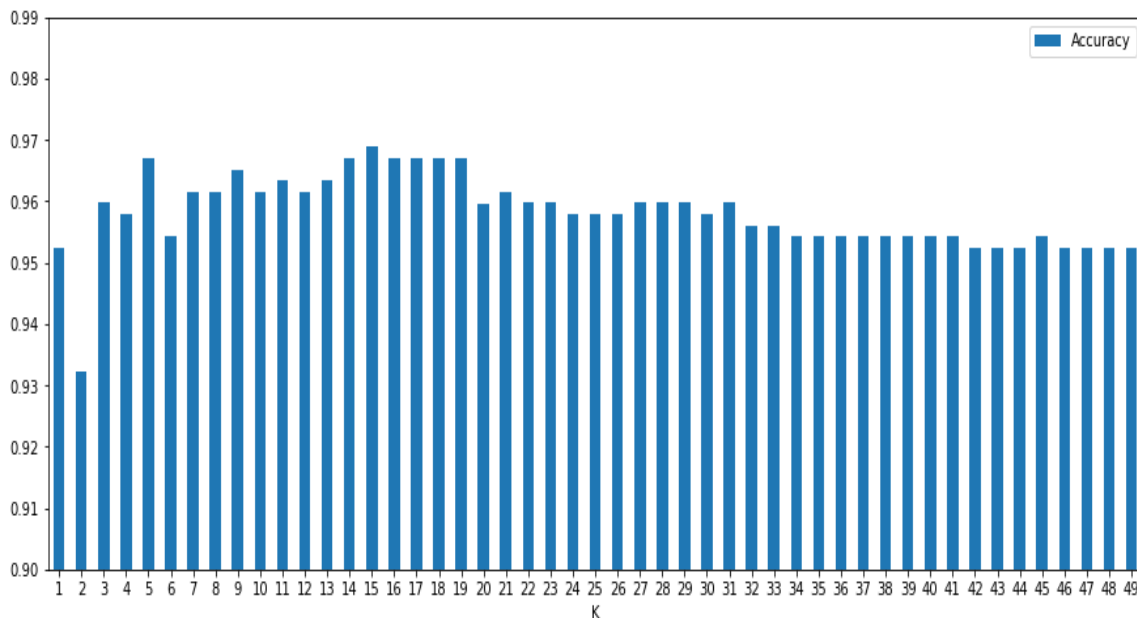| Dataset used	Accuracy of the *k*-NN method 1	Accuracy of the proposed Model 2
Cleveland Heart database	88.4106	98.0132
Hepatitis dataset	60.3196	82.4675
Kidney dataset	79.75	87.25

Figure 7: K vs CV Scores

4. Conclusion

The study proposed a model with the *k*-Nearest Neighbour classifier used in combination with the feature selection method of Cuckoo search and class balancing. It demonstrated good performance with an accuracy of 99.41% and MCC of 0.988 for Breast Cancer classification into Malignant or Benign Class. The proposed model was used on small datasets and its performance on large and high dimensional datasets is to be evaluated. Further work can be done to evaluate the performance and build ensemble classifiers with metaheuristic search techniques and also to use the combination of different feature search optimization methods to improve feature search thus aiding disease diagnosis. Moreover, Deep learning models can be implemented to provide better models for diagnosis and classification.

Acknowledgments

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Edible *Solanum trilobatum* chloroform extract modulates CCL$_4$ induced toxic changes in rat liver by enhancing the antioxidant activity

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Abstract: Liver diseases are one of the major causes of morbidity and mortality all over world. Environmental chemicals and pesticides are one of the most common causative factors for liver injury. Since there are no reliable hepatoprotective drugs available, many plant extracts are frequently utilized to treat liver disease. Therefore, searching for effective and safe plant based drugs for liver disorders is a matter of interest. In this study, hepatoprotective and antioxidant activity of the polyphenol rich chloroform extract of Solanum trilobatum (CST) was evaluated on CCl4 induced acute hepatotoxicity in Sprague Dawley rats. METHODS:Cytotoxic effect of CST on cancer cells as well as primary rat hepatocytes and proliferative effect on human peripheral blood lymphocyte (PBL) were evaluated in vitro. Animals were divided into 4 groups control group (received only normal saline), CCl4 group (received only CCl4 (2.0g/kg body weight), CST group (received 50 mg/kg and CCl4 (2.0g/kg body weight), CST group (received 100mg/kg and CCl4 (2.0g/kg body weight). After 14 consecutive days of treatment, the levels of hepatic biochemical markers, malondialdehyde (MDA) content, peroxidase and catalase activities were measured. The histopathological study of control and treated animals were also performed. RESULTS:Administration of CST prior to CCl4 was found to significantly inhibit the hepatotoxicity produced by CCl4 since CST restored the elevated activities of serum and liver marker enzymes and also enhanced the antioxidant enzyme levels. Histological changes caused by CCl4 were found to be significantly reversed by CST, which further confirms the dual effect of CST on CCl4-induced acute liver injury as a hepatoprotectant and antioxidant. CONCLUSIONS:The present study clearly demonstrates that CST contains therapeutic components which in combination/alone possess hepatoprotective and in vivo antioxidant effect.

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03

EFFECTS OF WALKING AND LOW IMPACT AEROBIC EXERCISE PROGRAMME ON BLOOD PRESSURE ON MILD HYPERTENSIVE MEN

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Dr. Rajeev Kumar .R
Mr Amjith S

Abstract

Introduction

Hypertension is one of the most important modifiable risk factors for cardiovascular diseases. Nearly 10.8% of all deaths in India are attributed to hypertension (Gupta and Yusuf 2014). Life style modification is recommended as an adjunct to medication in persons already on drug therapy and it is considered as initial therapy in pre-hypertension and in stage 1 hypertension. In a study conducted on 20-69 age group 20% prevalence of hypertension was reported in India (Kinra et al. 2010).

Purpose of study : The purpose of the study was to investigate the stage wise effect of six months aerobic exercise programme on blood pressure on mild hypertensive men.

Selection of the subjects

Sixty male mild hypertensive patients (SBP140-159 mmHg and/or 90-99 mmHg) from Thiruvananthapuram city, Kerala were selected as subjects for the study. Subjects were selected for the study through screening and was based on average of two or more readings taken on a mercury

Sphygmomanometer, in a seated position for a minimum 5 minutes, at each of two visits. Subjects were considered for this study only if they had resting systolic blood pressure ranged between 140-159 mmHg and/or diastolic blood pressure 90-99 mmHg). These values are considered as stage 1 hypertension (mild hypertension) according to Seventh Report of Joint National Committee on Prevention, Detection Evaluation and Treatment of High Blood Pressure (Chobanian et al. 2003) When systolic or diastolic falls in different categories, the higher category was selected to classify the individual's blood pressure status (Chobanian et al.2003).

Exclusion criteria

Those individuals who were undergoing any sort of structured physical training programmes or engaging in regular physical activity, and those subjects who were having history of uncontrolled diabetes, chest pain, coronary artery disease, asthma, severe arthritis of knee joints, recent surgery and hernia were excluded from the present study.

Initial characteristics of subjects

VARIABLE	ExperimentalGroup	ControlGroup
Age(years)	58.87±3.96	57.7±3.66
Height(cm)	165.9±5.7	167.17±6.8
Systolic blood pressure(mmHg)	149.1±10.03	148.4±8.14
Diastolic blood pressure(mmHg)	93.13±4.17	92.2±5.36
VO_{2max}(ml/kg/min)	31.82±3.91	32.13±3.02
Body weight(kg)	74.91±9.2	73.69±7.4
Body fat (%)	26.38±3.4	25.77±3.5
Resting heart rate	75.17±6.36	73.93±6.09

Selection of Variables: The variables selected for the study were Systolic and Diastolic blood pressure. Auscultation method using Mercury Sphygmomanometer was used to measure blood pressure.

Administration of Physical Activity Programme: Aerobic mode of training at Five days per week was given to the subjects. Walking for four days per week and Aerobic exercise to music programme was given one day per week. Intensity of walking programme was at 40% to 75% of Heart rate reserve.

Statistical techniques employed: The selected variables were analyzed for the experimental and control Group separately at 3 predetermined stages i.e. prior to the training programme to mid-test 1(stage 1), mid-test 2 (stage 2) and post- test (stage 3).To determine the difference between the pre-test and post-test results and to assess the changes that occurred during the different stages of the aerobic exercise training programme ANCOVA was computed for each of the selected variables. When significant differences were noticed in any of the selected variables Scheffe's Post Hoc test was computed to determine the mean difference. A calculated "P" value less than 0.05 was considered to be statistically significant at 95% level of confidence.

Analysis of data and results of the study: For determining the stage wise difference during training for the variable systolic blood pressure for the experimental and control group ANCOVA was computed. The details are shown in Table

Analysis of data and results of the study: For determining the stage wise difference during training for the variable systolic blood pressure for the experimental and control group ANCOVA was computed. The details are shown in Table

ANCOVA for stage wise difference of Systolic blood pressure for Experimental and Control group

| Group	Source	SS	df	MS	F	P
Experiment	Between	780.289	2	390.144	42.338	<0.01**
	Within	791.545	86	9.204		
	Total	1571.834	88			
Control	Between	12.689	2	6.344	0.956	0.388 ns
	Within	570.695	86	6.636		
	Total	583.384	88			

ns: not significant(P>0.05), **: significant at 1% level(P<0.0

Scheffe's post hoc comparisons of Systolic blood pressure (mm/Hg) during different stages in the Experimental and Control group

Group	Stage 1	Stage 2	Stage 3	MD	P
Experiment	144.533	138.667		5.866	<0.01**
	144.533		137.967	6.566	<0.01**
		138.667	137.967	0.700	0.339 ns
Control	147.9	148.6		-0.700	0.296 ns
	147.9		148.769	-0.869	0.196 ns
		148.6	148.769	-0.169	0.803 ns

ns: not significant(P>0.05), **: significant at 1% level(P<0.01)

Diagrammatic representation of comparisons of Systolic Blood Pressure (means in mm/Hg) during different stages in the Experimental and Control group
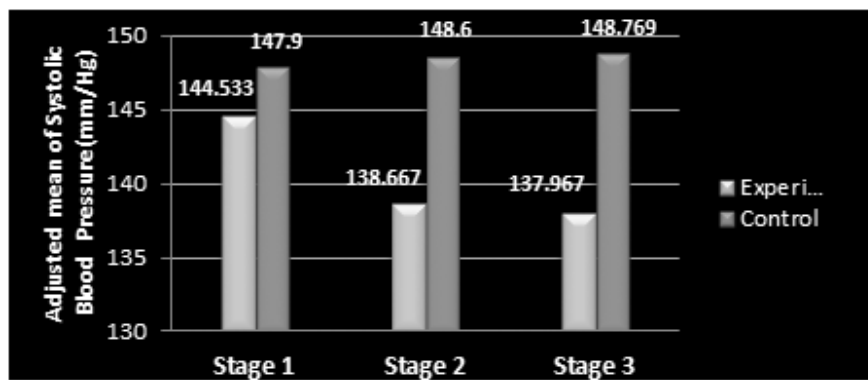
The data pertaining to diastolic blood pressure scores for the experimental and control groups were compared between different stages using ANCOVA.

ANCOVA for stage wise difference of Diastolic blood pressure for Experimental and Control group.

| Group	Source	SS	df	MS	F	P
Experiment	Between	373.4	2	186.7	40.522	<0.01**
	Within	396.236	86	4.607		
	Total	769.636	88			
Control	Between	10.689	2	5.344	0.676	0.512ns
	Within	680.355	86	7.911		
	Total	691.044	88			

ns: not significant(P>0.05), **: significant at 1% level(P<0.01)

Scheffe's post hoc comparisons of Diastolic Blood Pressure (means in mmHg) during different stages in the Experimental and Control groups

Group	Stage 1	Stage 2	Stage 3	MD	P
Experiment	90.4	86.6		3.8	<0.01**
	90.4		85.7	4.7	<0.01**
		86.6	85.7	0.9	0.111ns
Control	92.333	91.5		0.833	0.250ns
	92.333		91.8	0.533	0.461ns
		91.5	91.8	0.3	0.678ns

ns: not significant(P>0.05), **: significant at 1% level(P<0.01)

Diagrammatic representation of comparisons of Diastolic Blood pressure (mmHg) during different stages in the Experimental and Control group
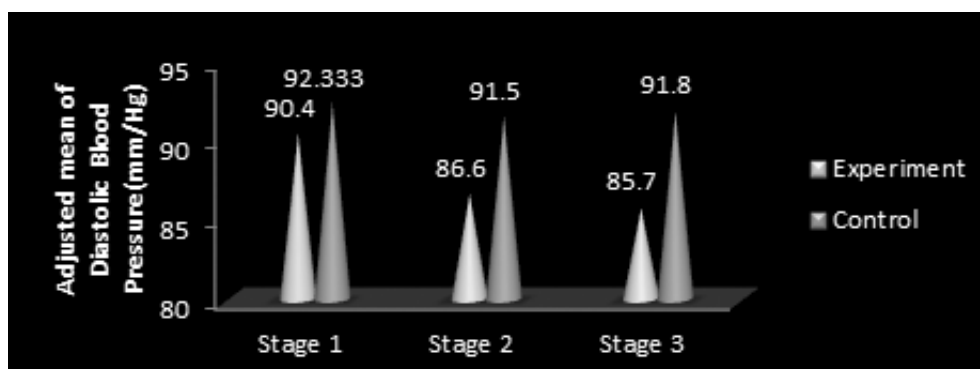
Discussion of results

Significant reduction in systolic blood pressure was seen in the experimental group following the training programme. In the experimental group, Stage 3 reported lower adjusted mean (137.967) followed by stage 2 (138.667) and Stage 1 (144.533). Scheffe's post hoc comparisons revealed that Systolic blood pressure scores differed significantly between stage 1 and stage 2 and stage 1 and stage 3 in the experimental group(P<0.01). But no differences were seen in the adjusted means of systolic blood pressure between stage 2 and stage 3.

Significant reduction in diastolic blood pressure was also seen in the experimental group following 6 months of training programme. In the experimental group, Stage 3 reported lower adjusted mean (85.7) followed by stage 2 (86.6) and Stage1 (90.4). Scheffe's post hoc comparisons showed that Diastolic blood pressure scores differed significantly between stage 1 and stage 2 and stage 1 and stage 3 in the experimental group(P<0.01). But no differences were seen in the adjusted means of diastolic blood pressure between stage 2 and stage 3.

Hypertension is multifactorial in nature, recent findings from animal studies suggest aerobic exercise may prevent increases in BP through beneficial alterations in insulin sensitivity and autonomic nervous system function. Blood pressure is the force exerted by the blood against the walls of the arteries and is the product of cardiac output and total peripheral resistance. Blood pressure lowering and cardio protective effects of regular exercise are based on neurohormonal and structural adaptations in muscle, vessels, and adipocytes. The primary mechanisms influencing the reduction of resting blood pressure following aerobic activity is due to reduction in total peripheral resistance **(Blumenthal, et. al., 2000)**. The reduction of blood pressure following in mild hypertensive

men might be probably due to improved endothelial function in hypertensive men. This improved endothelial function is due to improved endothelial Nitric oxide release and this leads to vasodilatation. The vasodilation results in reduction of peripheral resistance **(Westhoff et al., 2007)**.

Hyperinsulinemia has been postulated to raise blood pressure via renal sodium retention, sympathetic nervous activation, and induction of vascular smooth muscle hypertrophy. Even single bout of exercise has well-known insulin like effect and dramatically increases skeletal muscle glucose transport. Exercise training increases insulin sensitivity which results in decrease serum insulin and reduce sodium retention ultimately results in blood pressure reduction in hypertensive patients. The findings of Chen et al., (2010) confirmed the blood pressure lowering effect of aerobic type swimming training in hypertensive patients which was associated with improvement in insulin sensitivity.

Aerobic mode of activity results in reduction of circulating noradrenaline and its receptors and angiotensin ll. Aerobic exercise also increases nitric oxide bioavailability **(Yung et al. 2009)**. Angiotensin ll is a potent vasoconstrictor, which promotes an increase in systemic blood pressure. Reduction in angiotensin ll reduces the stimulation of adrenal cortex to release aldosterone (hormone that enhances the renal reabsorption of sodium). Reduction of aldosterone hormone results in reduced sodium retention. This would be yet another possible adaptation leading to reduction of blood pressure following aerobic training programme in the present study.

Another mechanisms by which aerobic exercise lower blood pressure partly involve the effects of two hormones, epinephrine and norepinephrine, on blood flow in the arteries. Both of these hormones are vasoconstrictors,

Studies shown that aerobic exercise reduces blood level norepinephrine. The kidneys also play an important role in blood pressure regulation. Regular aerobic exercise improves renal function in patients with essential hypertension and cause favorable changes in arterial structure (Williams 1998). This favorable changes in arterial structure presumably reduce peripheral vascular resistance. Regular physical activity also cause vascular remodeling of existing arteries and new vessel growth which result in reduction of peripheral resistance.

Studies shows aerobic exercise training increases serum taurine concentrations (Taurine is an aminoacid that has antihypertensive properties) with accompanying reductions in plasma levels of norepinephrine and results in blood pressure reduction.

Conclusion: Participation in six months of aerobic exercise programme resulted in reduction of Systolic blood pressure and diastolic blood pressure in mild hypertensive men. Significant reduction in systolic and diastolic blood pressure was seen in first four months of the training programme and four to six months there was no significant improvement.

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