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Centurion Journal of Multidisciplinary Research

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About the Journal

Centurion Journal of Multi-disciplinary Research

Centurion Journal of Multi-disciplinary Research is a refereed journal, which serves as a platform for exploring the current issues, challenges and linkages in the broad areas of development, technology, engineering and management. There is a special focus on skill development and education, its recognition and promotion in the country, especially with the 'Make in India' initiative by the government of India. The objective of the journal is to facilitate bringing together research based contributions in science, technology, management and skills that has direct implication for the development of under-privileged communities and empowering them. The journal links theory and practice in the above areas so as to have policy and programme implications, particularly in under-developed contexts. In addition to articles from individuals or collectives, the journal publishes book reviews.

Aims and Scope of CJMR

CJMR is a multi-disciplinary, refereed journal serving as a forum for exploring theoretical and empirical understanding in the broad areas of development, management, science and technology. Perspective building in the area of skill development and education is another area which the journal would like to promote.

Centurion Journal of Multi-disciplinary Research aims at:

- Providing a platform for debate and dissemination of research findings, conceptual developments and new research areas and techniques that promise to change analyses and perspectives on science and technology, development, management, skill in developing societies;
- Disseminating and promoting research, good practice and innovation in all aspects of science, technology, management and skill development to its main audiences, including educators, researchers, graduate students, policy makers, and practitioners; and
- Encouraging multi-disciplinary cooperation and understanding, and enhancing quality research.

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Editorial

Centurion Journal of Multidisciplinary Research has connected bioscience, technology and machine learning in this issue.

Bioscience:

Different medicinal plants available in Bhubaneswar have been described. About 30 plant species belonging to 15 different families have been reported in Bhubaneswar. The medicinal applications of the plants were described. These plants are often considered as home remedies (SDG 3) in different parts of India. Medicinal plants are used in traditional medicine and ethnomedicine worldwide. With industrialization and other environmental factors the floral diversity is getting affected. There is a strong need to conserve the plants and save the life on earth (SDG 15).

The food pattern of Asian Elephants has been analyzed and documented. It has been identified that Asian Elephants prefer to have 52 plant species. It was reported that trees and grasses are the major food of Asian elephants. The study described the importance of preserving different plant species to conserve the elephants. The unplanned destruction of the plants is causing conflict between the elephant s and humans. Thus, to save life on earth (SDG 15) it is important to preserve different species of plants.

The effects of organic manures on the growth and yield of mung beans and their nutrient content have been reported. It was

observed that vermicompost can improve the stem length, root length and health of leaves without hampering the soil quality. This study will help understand the use of vermicompost as a part of organic farming (SDG 12). Mung bean also improves soil fertility by the process of nitrogen fixation (SDG 15).

Technology:

The electromagnetic braking system is one of the recent technologies (SDG 9). It uses magnetic force to activate the brake and transmit the power required for braking. The eddy current developed causes retardation of rotating wheels while brakes are applied. The design and application of electromagnetic brakes in motorcycle has been described. They can be used in automobiles as an emergency braking device.

The design of electronic control unit for speed control of three-phase brushless DC (BLDC) motor of an electric vehicle has been described. The BLDC motor showed an efficiency of 90%. A higher speed and torque can be obtained with modification of differential gear settings. This study will help design an electric vehicle. Electric vehicles are important for reducing environmental pollution (SDG 13, SDG 15).

A review has been presented to understand the effect of different parameters on wood cutting. The study described the tool wear, cutting power and force, surface quality, sawing quality, and dust emission during sawing operation. The review will help understand the wood cutting operations.

The energy and exergy levels have been analyzed in a direct injection compression ignition engine using thermodynamics. The engine

performance was tested using diesel and biogas in a dual fuel mode of operation. The dual mode operation was optimized using Taguchi method. The study will help understand analysis of duel fuel mode operation.

Machine Learning:

Application of Artificial Neural Networks (ANN), Decision Trees (DT), Support Vector Machines (SVM), and Logistic Regression Models (LRM) to classify the health insurance dataset has been described. The same techniques can be used as predictive tools in other areas. Machine learning has gained lot of interest nowadays. It can be used to understand the effect of a single independent parameter on the output. It helps understand complex systems.

The basic science leads to knowledge generation and in turn, can be transformed into technology and innovation. This issue highlights science, technology and computational tools used in the areas of science and technology.

Dipankar Bhattacharyay

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Articles

Some Important Medicinal Tree Species of the Temple City, Bhubaneswar, Odisha

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Subhadarshini Satapathy[1], Rakhee Dimri[2] and Sanjeet Kumar[1]

Abstract

Odisha is a state with tremendous floral diversity. One-third of the state is covered with forests, mostly, the southern and western Odisha. These forests have a variety of plants. some of which local people use as a medicine as a primary source of their healthcare. Hence, a study was carried out in Bhubaneswar to document the medicinal tree species. Data was collected by repeated field studies and questioning local people. Plants were identified by the author and their uses were recorded. About 30 plant species are identified belonging to 15 different families. Moraceae is the dominant family followed by Fabaceae and Combretaceae. Each plant has its different mode of use for different ailments. So, more studies need to be done to document the local flora which might be the basis for future scientific validation.

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Introduction

The plant which can cure certain types of diseases in human beings is known as medicinal plants (Palombo 2006). From ancient times to date people depends on the plant as the primary source of medicine to treat many ailments (Satapathy and Kumar 2017). Out of 4,20,000 plants, about 50,000 flowering plants are used in the traditional system of medicine (Schippmann et al., 2002; Satapathy et al., 2019). According to World Health Organisation, about 80% of the total population depends on the plant product for their healthcare (WHO 2002; Rao et al., 2004). Mostly, Ayurveda, Siddha and Unani are the major part of indigenous medicine. The traditional knowledge on the uses of plant medicine spreads verbally from one generation to another (Bhatia et al., 2014; Kalaivanni and Mathew 2010). Most of the people in developed and developing countries preferred plant-derived medicine for their health care as they do not have any side effects, are not expensive and easily available. People believed that plants are God-gifted (Praveen et al., 2007). Due to overexploitation, climate change and human activities most of the plants are going to extinct level the traditional modes of use also decrease day by day. As there is less report on medicinal plants in Bhubaneswar, a major step was taken to study the medicinal tree species available in Bhubaneswar and conserve them.

Methodology

Study area

Bhubaneswar is the capital of Odisha situated in the Khordha district and otherwise known as the temple city of India. It is about 65 km away from the Bay of Bengal latitude 25° 15' North and longitude 85° 52' West (Satapathy and Kumar 2017).

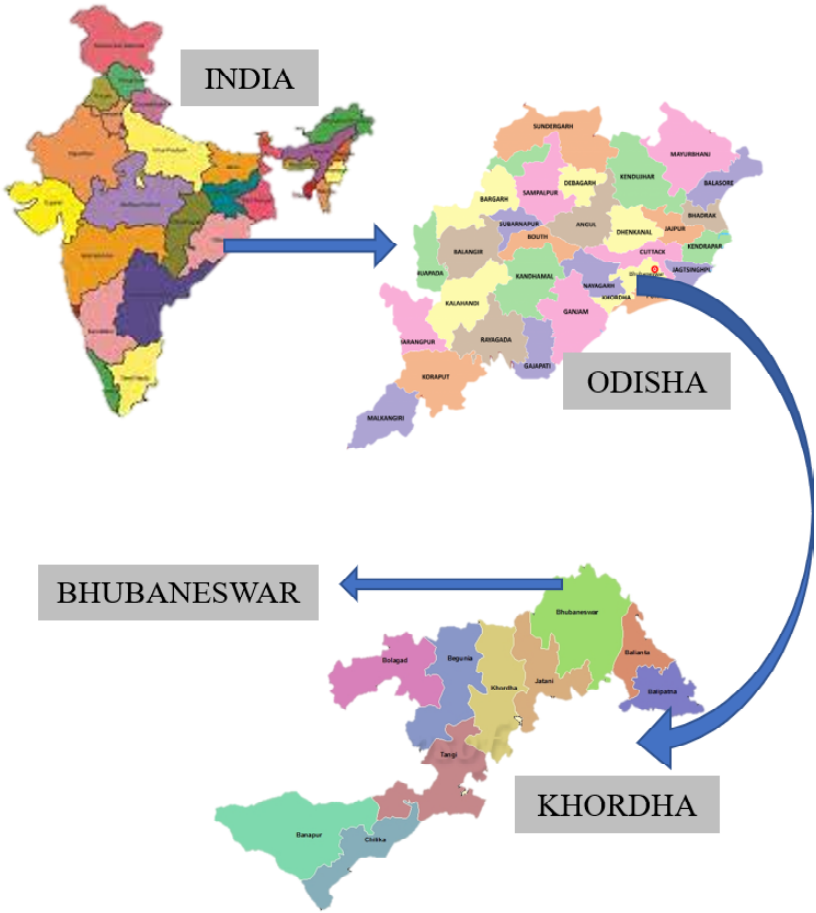

Figure 1: Study area

Field survey and data collection

Field surveys were carried out to the resourceful areas in and around Bhubaneswar. The plant having the medicinal values were collected and

by questioning with local people the therapeutic uses were noted. On that spot the collected plants were identified by the author following "Flora of Odisha" and "The Botany of Orissa and Bihar" and the botanical name, common name, family and medicinal uses were noted (Saxena and Brahmam 1995; Haines 1921-1925)

Results and discussion

After intensive and extensive field studies, questionary with local people and flora identification in and around Bhubaneswar about 30 common medicinal tree species (Figure 3 and 3.1) belonging to 15 different families have been identified (Table 1). Here, Moraceae is the dominant family followed by Fabaceae and Combretaceae (Figure 2). Each plant has different uses and also people use different parts of the tree to treat diseases. Mostly, local people use medicinal trees to treat common diseases like skin infections, vomiting, diabetes etc.

Botanical name	Common name	Family	Plant part use	Medicinal use
Aegle marmelos	Bel	Rutaceae	Leaves/ Fruit	Gastric
Alangium salvifolium	Ankula	Cornaceae	Bark	Vomiting
Anacardium occidentale	Kaju	Anacardiaceae	Leaves/Bark	Toothache and soar throat
Artocarpus heterophyllus	Panasa	Moraceae	Root	Skin diseases
Azadirachta indica	Neem	Meliaceae	Whole plant	Skin diseases
Bombax ceiba	Simili	Bombacaceae	Young roots	Cough and cholera
Butea monosperma	Palasa	Fabaceae	Flower	Liver disorder
Cassia fistula	Sunahari	Caesalpiniaceae	Leaves/ Bark	Skin diseases
Dalbergia sisso	Sisu	Fabaceae	Bark	Skin diseases
Diospyros melanoxylon	Kendu	Ebenaceae	Flower	Skin disorder
Ficus benghalensis	Bara	Moraceae	Fruits	Diarrhoea and dysentery
Ficus elastica	Rubber	Moraceae	Bark/ Leaves	Toothache and bone fracture
Ficus hispida	Bai dimiri	Moraceae	Leaves/ Bark	Jaundice and diabetes

Botanical name	Common name	Family	Plant part use	Medicinal use
Ficus racemosa	Panidimiri	Moraceae	Bark	Diabetes and liver disorder
Ficus religiosa	Aswastha	Moraceae	Bark/Leaves	Dysentery
Ficus semicordata	Bhuindimiri	Moraceae	Root	Headache
Ficus tinctoria	Kashkhijiri	Moraceae	Leaves	Bone fracture
Gmelina arborea	Gamhari	Lamiaceae	Flower	Leprosy and blood diseases
Mimusops elengi	Boula	Sapotaceae	Leaves	Toothache and headache
Phyllanthus emblica	Amla	Euphorbiaceae	Fruit	Digestion
Pongamia pinnata	Karanja	Fabaceae	Leaves	Rheumatics
Pterocarpus marsupium	Piasal	Fabaceae	Bark	Diarrhoea
Saraca asoca	Ashoka	Fabaceae	Seeds	Urinary disorder
Syzygium cumuni	Jamun	Myrtaceae	Fruits/ Leaves	Diabetes and dysentery
Terminalia arjuna	Arjuna	Combretaceae	Leaves	Earache
Terminalia bellirica	Bahada	Combretaceae	Fruits	Constipation
Terminalia catapa	Desi badam	Combretaceae	Bark	Stomach-ache
Terminalia chebula	Harida	Combretaceae	Fruits	Constipation and dysentery
Xylia xylocarpa	Kangada	Fabaceae	Bark	Body worm

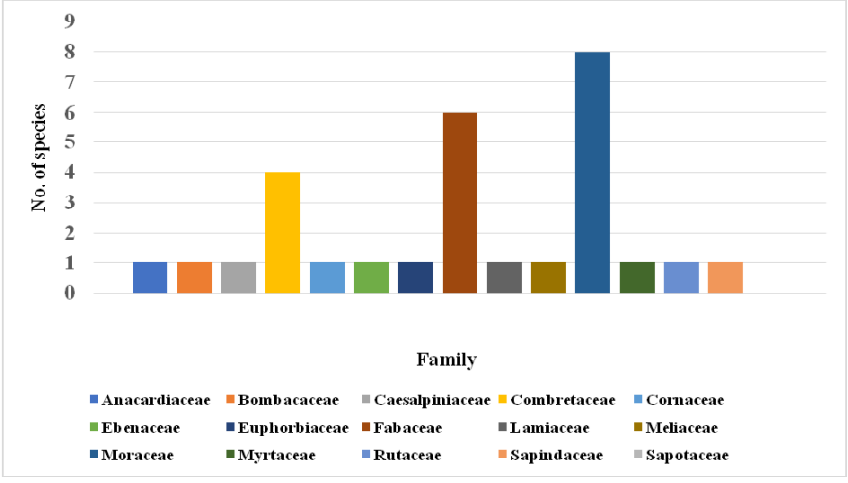

Figure 2: Total number of species present in the corresponding family

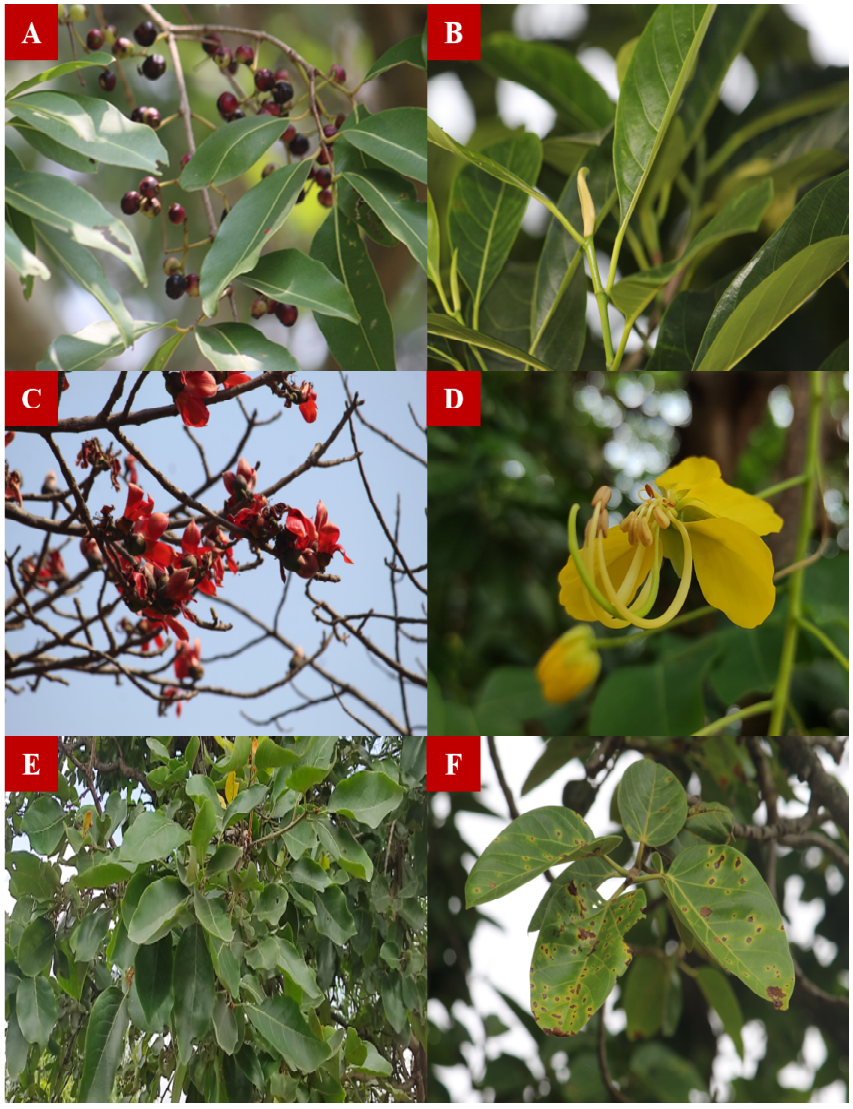

Figure 3: Some important medicinal trees of Bhubaneswar

A) Syzigium cumini, B) *Artocarpus heterophyllus*, C) *Bombax ceiba*, D) *Cassia fistula*, E) *Diospyrus melanoxylon,* F) *Ficus benghalensis*

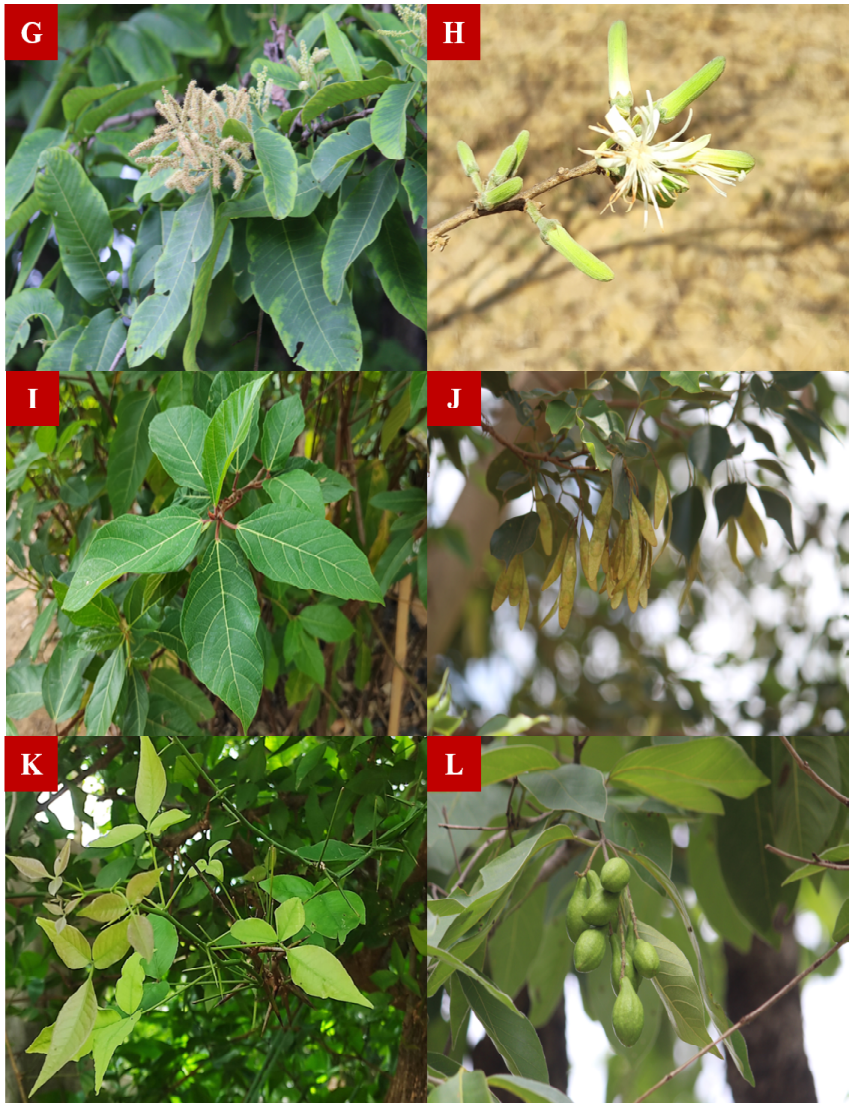

Figure 3.1: Some important medicinal trees of Bhubaneswar

G) *Terminalia alata*, H) *Alangium salvifolium*, I) *Ficus racemosa*, J) *Terminalia* alata, K) *Aegle marmelos*, L) *Terminalia chebula*

Conclusion

The result of the present study demonstrates the importance of traditional and folk knowledge about the medicinal plants which are used in the treatment of many human diseases as well as animals in Bhubaneswar. Due to human civilization, industrialization and other environmental factors the area is going to lose its diversity. Their medicinal uses also decrease day by day due to the chemical drug. So, it is necessary to conserve the plant and collect the therapeutic data available in the local area for future scientific validation.

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Some important food plants of Asian Elephant: A conservation approach

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Sanjeet Kumar[1*] and Rakhee Dimri[2]

Abstract

Each living organism has a different mode of feeding process and preference for food. The Asian elephant is an important wildlife and essential for our forest. Asian elephants consume specific plant species as per behavior and they migrate in search of those food species. Keeping this in view, an attempt has been made to document the food species of Asian elephants in Rairangpur areas of Odisha through field works. The study reveals that about 52 plant species are found to be the preferred food for elephants belonging to 20 different families. The dominant family was Poaceae followed by Fabaceae and Moraceae. It was noted that leaves are the most preferred plant part. The present study highlights the importance of food plants in the conservation of Asian elephants.

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Keywords: Asian Elephant, Mega fauna, Food plants

Introduction

Due to habitat destruction and fragmentation resulting from human land practices the habitat of Asian elephants (*Elephas maximus*) has been decreasing. Elephants are known to be elongated large mammals (Sukumar 1990). There are about 35,000 to 55,000 around the world (Wang 1998). Each animal has a specific feature to survive in a particular area. *Elephas maximus* is the only living species of genus *Elephas* which is distributed throughout the Indian Sub-continent and Southeast Asia, from India in the west, Nepal in the north, Sumatra in the south and Borneo in the east (Samson et al., 2018). The bodyweight of an Asian Elephant is about 2,000 to 5,500 kg. The male has up to 3.2 m height of shoulder and female have up to 2.24 m. The trunk is a combination of an elongated nose and upper lip (Pradhan et al., 2015). They can consume up to 150 kg of plant matter per day. They can consume herbs, shrubs, trees, legumes, sedges and true grasses. They brow more in the dry season. They drink once a day and like to stay near freshwater bodies (Behera et al., 2020). Elephant plays an important role to protect the ecosystem. They indirectly provide food and water to other small animals. In summer, with the help of their tusk, they dig holes for water which is a source for other animals also. Elephants are herbivores and their dunk is full of seeds of other plants which will reform to trees and bushes which grow and provide food to other animals and a healthy ecosystem (Gunaryadi and Hedges 2017; Prajapati 2008). As the elephants are big, they need a large area to move but due to some manmade factors like industrialization, civilization and many more, the habitat of the Asian elephant is decreasing which create conflict, loss of agriculture, loss of lives and injuries (Chen et al., 2016). People use the forest products, cut down trees for their daily needs which push elephants to rush towards the villages for searching food resulting in

conflict (Shaffer et al., 2019). Several studies have been made on the food plant of Asian elephants too (Koirala et al., 2016; Baskaran et al., 2010; Pradhan et al., 2008). The present study aims to document the food plants of Asian elephants in Rairangpur, Mayurbhanj, Odisha.

Methodology

The study was carried out from August 2020 to July 2021 (Figure 1). During the study, the food and feeding behavior of Asian elephants was observed and also discussed with local people and forest officers. The food plants of Asian elephants were enumerated and identified by Dr. Sanjeet Kumar followed by literature (Hains 1921-1925; Saxena and Brahmam 1995).

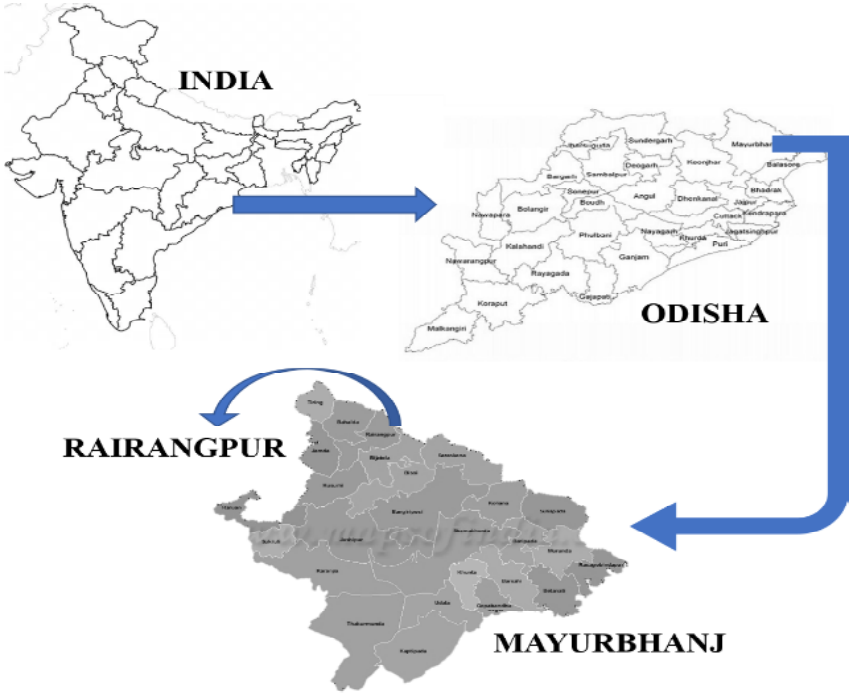

Figure 1: Geographical location of study areas

Results and discussion

In the present study food plants of Asian elephants were observed by visiting the habitat of the elephant. Many plant species were found which are consumed by the elephant. About 52 plants (Table 1; Figure 2-5) were found to be the food for Asian elephants belonging to 20 different families. Among all the families Poaceae is dominated followed by Fabaceae and Moraceae (Figure 2). It was observed that mainly, trees and grasses are the major food of Asian elephants. The study shows that elephants prefer leaves to other plant parts (Figure 3).

Table 1: Common food plants of the Asian elephant

Botanical name	Common name	Family	Habit	Plant parts
Abutilon indicum	Pedipedica	Malvaceae	Shrub	Leaves and stem
Acacia leucophloea	Gohera	Fabaceae	Tree	Leaves
Acacia pennata	Dontari	Fabaceae	Tree	Whole plant
Aegle marmelos	Bela	Rutaceae	Tree	Leaves and fruit
Alangium salvifolium	Ankula	Fabaceae	Tree	Leaves and fruit
Albizia lebbeck	Dhala siris	Fabaceae	Tree	Leaves
Albizia procera	Siris	Fabaceae	Tree	Leaves
Anacardium occidentale	Kaju	Anacardiaceae	Tree	Fruits
Artocarpus heterophyllus	Panasa	Moraceae	Tree	Fruit and leaves
Asparagus racemosus	Satabari	Asparagaceae	Climber	Root and leaves
Bambusa arundinacea	Kanta baunsa	Poaceae	Bamboo	Leaves
Bauhinia vahlii	Siali	Fabaceae	Climber	Leaves and bark
Bombax ceiba	Simili	Malvaceaae	Tree	Leaves
Bothriochloa pertusa	Gonad bena, Basana	Poaceae	Grass	Whole plant
Buchanania cochinchinensis	Chara	Anacardiaceae	Tree	Leaves and fruit
Cassia fistula	Sunari	Fabaceae	Tree	Leaves
Chloris barbata	Jargi ghasa	Poaceae	Herb	Whole plant
Cymbopogon martini	Magarlata	Poaceae	Herb	Whole plant

Botanical name	Common name	Family	Habit	Plant parts
Cynodon dactylon	Duba	Poaceae	Herb	Whole plant
Dalbergia latifolia	Sissu	Fabaceae	Tree	Leaves
Dillenia pentagyna	Rai	Dilleniaceae	Tree	Leaves
Dioscorea alata	Khamba alu	Dioscoreaceae	Climber	Whole plant
Dioscorea bulbifera	Pita alu	Dioscoreaceae	Climber	Whole plant
Dioscorea hamiltonii	Suta alu	Dioscoreaceae	Climber	Whole plant
Dioscorea oppositifolia	Pani alu	Dioscoreaceae	Climber	Whole plant
Diospyros melanoxylon	Kendu	Ebenaceae	Tree	Leaves and fruit
Eragrostis japonica	Pani ghasa	Poaceae	Grass	Whole plant
Ficus benghalensis	Bara	Moraceae	Tree	Leaves
Ficus racemosa	Dimiri	Moraceae	Tree	Leaves and fruit
Ficus religiosa	Aswastha	Moraceae	Tree	Leaves
Gmelina arborea	Gambhari	Lamiaceae	Tree	Stem
Heteropogon contortus	Dauria	Poaceae	Grass	Whole plant
Imperata cylindrica	Chhana ghas	Poaceae	Grass	Whole plant
Madhuca longifolia	Mahula	Sapotaceae	Tree	Flower and leaves
Mangifera indica	Amba	Anacardiaceae	Tree	Fruits
Oryza sativa	Dhana	Poaceae	Herb	Whole plant
Phyllanthus emblica	Amla	Phyllanthaceae	Tree	Leaves
Saccharum officinarum	Akhu	Poaceae	Herb	Whole plant
Saccharum spontaneum	Kasatandi	Poaceae	Herb	Whole plant
Schleichera oleosa	Kusuma	Sapindaceae	Tree	Leaves
Senna tora	Sana Chakunda	Fabaceae	Shrub	Leaves
Shorea robusta	Sal	Dipterocarpaceae	Tree	Leaves
Smilax zeylanica	Muturi	Smilacaceae	Climber	Leaves
Streblus asper	Sahada	Moraceae	Tree	Leaves
Syzygium cumini	Jamun	Myrtaceae	Tree	Leaves and fruit
Terminalia alata	Asana	Combretaceae	Tree	Leaves
Terminalia bellirica	Bahada	Combretaceae	Tree	Leaves and fruit
Terminalia chebula	Harida	Combretaceae	Tree	Leaves and fruits
Themeda triandra	Pedda ghasa	Poaceae	Herb	Whole plant
Tinospora cordifolia	Guduchi	Menispermaceae	Climber	Leaves
Zea mays	Maka	Poaceae	Herb	Whole plant
Zizipus mauritiana	Bara koli	Rhamnaceae	Shrub	Leaves

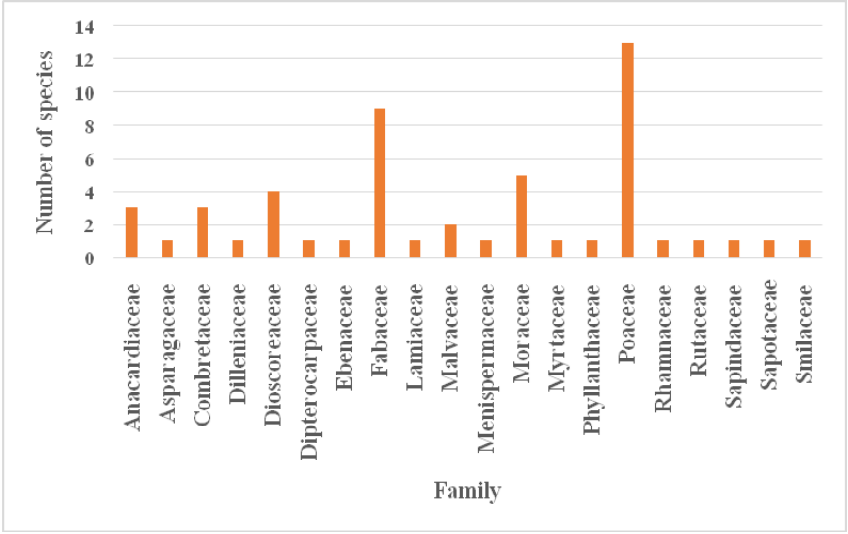

Figure 2: Total number of species present in the corresponding family

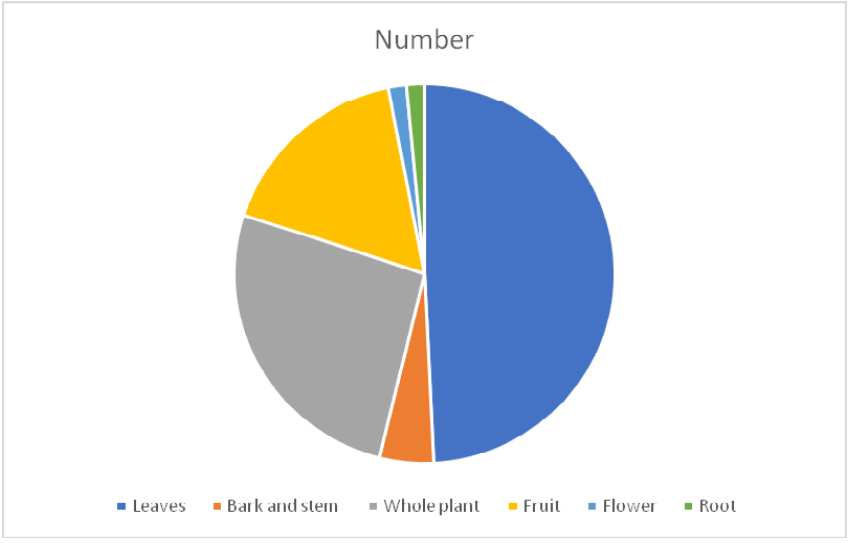

Figure 3: Plant parts used by Asian elephants in study areas

Figure 4: Some important food plants of the Asian elephant, A) *Terminalia bellirica*, B) *Oryza sativa*, C) *Chloris barbata*, D) *Artocarpus heterophyllus*, E) *Bombax ceiba*, F) *Asparagus racemosus*

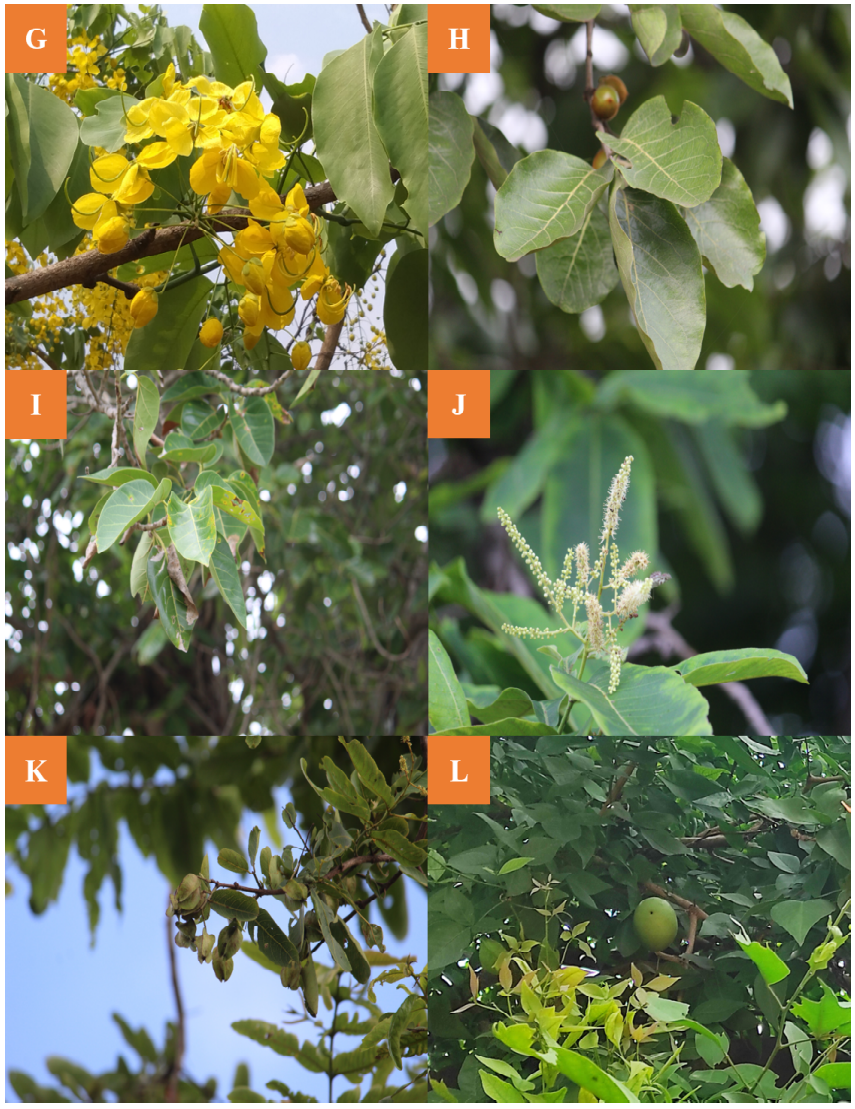

Figure 5: Some important food plants of the Asian elephant, G) *Cassia fistula*, H) *Diospyrus melanoxylon*, I) *Ficus benghalensis*, J) *Terminalia alata*, K) *Terminalia arjuna*, L) *Aegle marmelos*

Conclusion

The above study concluded that Asian elephants consume a wide variety of plants like grasses, herbs, shrubs, trees and climbers. Anthropogenic activities and forest fragmentation are the major cause of the reduction of food plants in their habitat. Hence, the present study highlights the importance of food plants and recommends documenting them as per landscapes for fast restoration.

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Design and Development of Electromagnetic Brake

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Abstract

Brake is an important component of an automobile. There are advancements in brake technology from time to time. There is a wastage of energy during the application of the brake. To overcome this problem, several technologies and methods have been invented by different researchers. The electromagnetic braking system is one of the recent technologies being adopted in recent time. It uses magnetic force to activate the brake, but manually transmits the power needed for braking. The disk is attached to a shaft and the electromagnet is placed on the base. Due to the current flowing through the coil as electricity is applied to the coil, a magnetic field forms around the coil which causes the development of eddy current. The developed eddy current flows in a direction opposite to that of the rotating wheel direction. This causes

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retardation of rotating wheels and the vehicle stops ultimately. The outcome of using the electromagnetic braking system along with the conventional friction brake in a motorcycle is studied in this work.

Keywords: Design, Electromagnetic, Brake, Torque

1. Introduction

Brake is one of the main controlling devices of any automobile without which it cannot be used for transporting passengers and cargo (Totala et al. 2015). Several essential features of a brake must be met during the design of the brake system. Several research works are being carried out for optimizing the design and brake force requirements. A brake should not be too heavy, which helps to slow the vehicle down and it should not be too expensive (Routh et al. 2019). On the other hand, if a braking system is too low, the stop distance will increase and can result in accidents as a consequence. The method of braking is closely related to Newton's laws of motion.

A lot of new developments are emerging in the world with technological change, especially in the automobile sector (Sudarshan et al. 2018). Drum and disk brakes are the widely used friction brakes in automobiles. But there are advancements in brake technologies occurring in recent times (Barnes et al. 1993). In this work, we intend to incorporate electromagnetic braking into a two-wheeler with minor vehicle modifications.

2. Product Concept

As the name suggests, the working of the electromagnetic braking system is based on the creation of a magnetic field within a metal disc that rotates in between two poles of an electromagnet (Sharma et al. 2015). The electromagnet induces a second magnetic field in the aluminium braking disc. This secondary magnetic field opposes the motion and

helps develop a braking torque that slows down the wheel. Initially, it was proposed to surround the whole disc with a semi-circular electromagnet. But soon it was found not enough space for the desired shape of electromagnet installation. Then a magnet was fabricated with a rectangular cross-sectional pole to hover over the disc to induce the secondary magnetic field.

2.1 Principle of Electromagnetic Braking System

Electromagnetic brakes operate electrically, but mechanically transfer the torque. Therefore they used to be called electro-mechanical brakes. Over the years, the electro-mechanical brakes, known as electromagnetic, refer to their form of actuation (Sarath et al. 2018). The number of applications and brake designs has significantly expanded but the basic procedure remains the same. Single-face electromagnetic brakes make up around 80 per cent of all brake applications applied in strength.

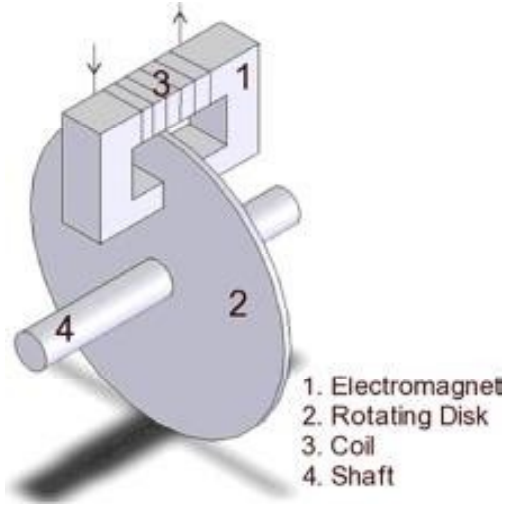

Figure 1: Electromagnetic braking system

2.2 Calculation of Braking Torque

A drag force exists in the disc during the application of brake and due to this, the disc may deform. Therefore, assuming the maximum speed of the vehicle to be 80 kmph (23 m/s), the total weight with passengers be 200 kg. By conservation of energy,

Work done = change in kinetic energy

Initial kinetic energy = (1/2) mv^2

Final kinetic energy = 0

Therefore, work done = Braking Force (F_b) × displacement (s) = (1/2) ×200 × 23^2 = 52900 J

Assuming the braking distance to be 30 m, the braking force can be calculated as 1763N. Let the front and rear wheel take equal braking force, the braking force in the rear is 800 N. Since the electromagnetic braking system is integrated with friction brake in the rear, assuming half braking force taken by an electromagnet, electromagnetic braking force required is 400 N. Let the radius of the wheel = 230 mm, Hence braking torque required is, F_b × S = 400 × 0.23 = 92 Nm.

2.3 Design of Product

The electromagnetic brake was fitted with a 2 mm air gap to the aluminium brake disc. The aluminium brake disc is fitted to the sprocket of the vehicle. The modelling of the wheel and sprocket is done using CATIA V5 as presented in Figures 2 and 3.

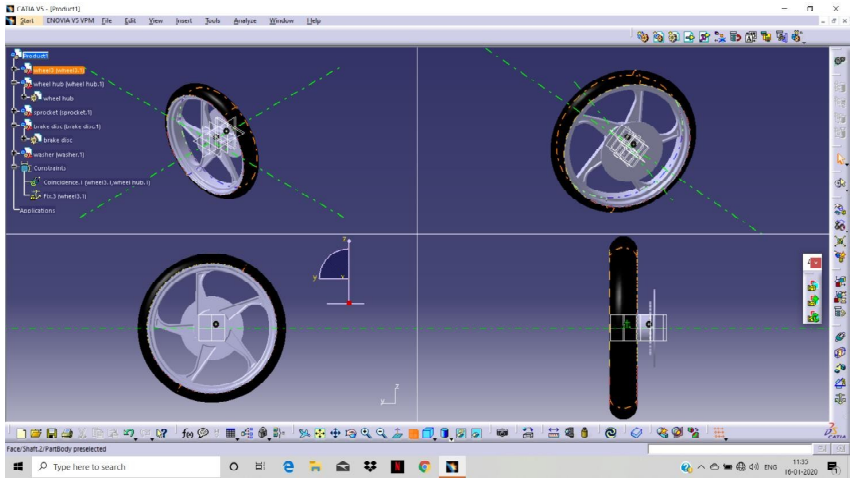

Figure 2: CATIA designs of wheel

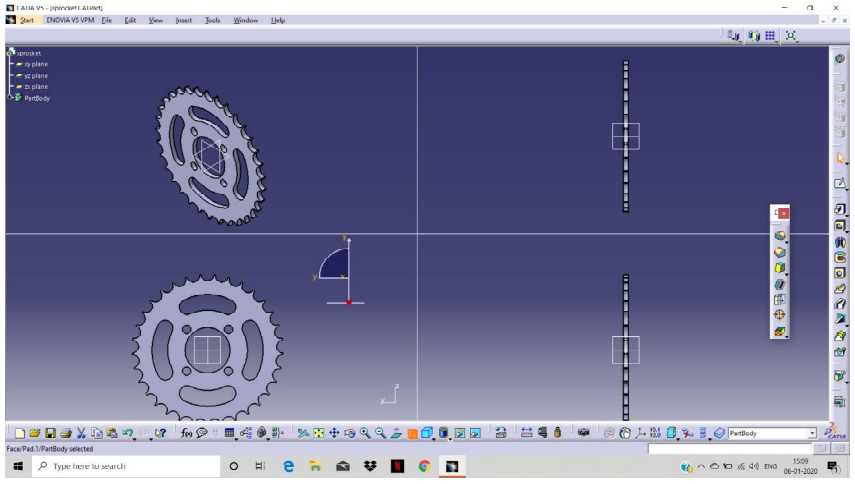

Figure 3: CATIA design of sprocket

2.4 Specification of Components

The specification of different parts used in the electromagnetic braking system is displayed in Table 1.

Table 1: Specification of different parts of the electromagnetic braking system

S.N.	Part name	Description	Quantity
1	Electromagnet	Made from transformer core 12V DC	1
2	Battery	Exide 12V 40 Ah	2
3	Bike	Bajaj XCD 125 DTS-SI	1
4	Disc material	Aluminium	1
5	Mass of disc	12 kg	-
6	Diameter of wheel	0.276 m	-
7	Nuts and bolts	Mild steel	8
8	Electricals	Wires, switches, connectors	-

3. Results and Discussion

The motorcycle was tested after incorporating the electromagnetic brake. The stopping times were recorded at different speeds with the application of friction brake and both friction and electromagnetic brake as presented in Table 2. It was found that with the application of both friction and electromagnetic brake, there were reductions in stopping times as shown in Figure 4.

Table 2: Comparison of stopping time during two types of braking

Speed (kmph)	Friction brake stopping time (s)	(Friction + electromagnetic) brake stopping time (s)
30	6.75	5.25
35	8	6
40	8.5	6.75
45	8.75	7
50	9.25	7.25
55	9.5	7.5
60	10	7.75

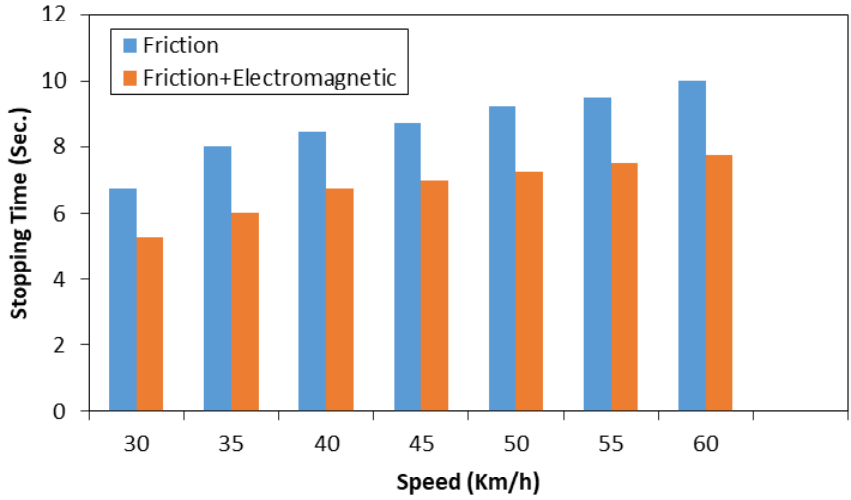

Figure 4: Stopping time vs. Speed

4. Conclusions

From the experimental measurement of braking force generated, it is observed that the brake force for a combination of electromagnetic and disc brakes is less than disk brakes. Therefore, it can be used in automobiles as a secondary or emergency braking device. It can be

concluded after the test that the electromagnet mounted on the motorcycle adds braking power to stop it and is efficient for use. Despite this advantage of electromagnetic braking over friction brakes, they can be extensively used on heavy vehicles where the problem of 'brake fading' is present.The same principle to apply to lighter vehicles is being developed. The idea conceived in this work is just a prototype and needs to be built further. If these brakes are combined, this improves brake life and thus is very useful.

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Powertrain Modelling for Electric Vehicle for 1 kW BLDC Motor and STM Controller

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Sudhansu Kumar Samal[1]

Abstract

This paper deals with the design of electronic control unit (ECU) speed control of three-phase brushless DC (BLDC) motor with STM32 NICLEO Board and STM CUBE IDE. The practical application is tested under a 48V, 50A Lead Acid battery connected with E-Rickshaw. Different loading condition and up to 500kG payload is used to test the capacity of the drive system. A detailed analysis and comparison study for passenger and loader is being done and lodging capacity is also discussed. The test is also being done with different controller and driver circuits design with MOSFET. The required PWM signal is obtained with 500Hz and the duty cycle is being maintained at a different level to get the driving forces.

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***Keywords**: STM32, STM32 Cube MX, BLDC Sensor Motor, Arduino IDE.*

Introduction

BLDC (Brushless Direct Current) motor It has been widely used in household appliances, automobiles, medical treatment, industrial equipment and other fields. Three-phase brushless DC motors are more mainstream products. Figure 1 is a schematic diagram of the driving part of a three-phase brushless DC motor, which mainly includes the collection of Hall information and the corresponding modulation of the three-phase inverter according to the Hall signal. The switching sequence of the three-phase inverter PWM has been PWM (Hubik *et al*., 2008). The duty cycle is the main content of modulation. Different modulation methods have a great impact on the performance of BLDC. In recent years, as the motor control system has become more and more refined, based on the original common square wave 120-degree pulse width modulation, the sine Pulse Width Modulation (SPWM) and Space Vector Pulse Width Modulation (SVPWM) appear to reduce the motor pulsation and current waveform distortion, but the algorithm of the latter two is more complicated (Huazhang, 2012). This article will introduce the characteristics of the three modulation methods one by one. Principles and calculation details. ON Semiconductor's LC08000M chip integrates these three modulation methods and is suitable for BLDC drive (Janpan *et al*., 2012).

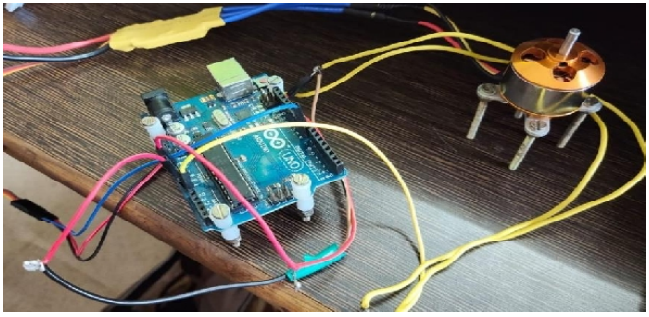

Figure 1: Arduino based Sensor less BLDC motor control

Problem Formulation

BLDC motor speed computing" has shown how to calculate the BLDC motor (with HALL sensor) actual speed use hall sensor to calculate the motor speed, and interrupt events, with one pair of pole BLDC motor for example (Salah *et al*., 2011), the revolution of the motor will generate six HALL states, each state machine of a mechanical angle of 60 degrees, if a HALL sensor interface STM32 timer function can be directly calculated in the interrupt timer in the motor rotation speed = 60/360 / t (revolutions per second), T is the interval of time between two interrupts, can be obtained simply by the timer, the speed can be obtained after closed-loop control of the motor speed, based on this section NUCLEO-64-F410RB and X-NUCLEO-IHM07M1 3SH achieve BLDC motor speed control loop (Paul and George, 2011).

As used in this section motor operating voltage 48V, the maximum speed of 3000rpm Brushless motor, the motor has two sets of lines (three-phase motor and a Hall sensor line):

Ready to operate

X-NUCLEO-IHM07M1 3SH is dedicated to the PMSM (permanent magnet synchronous) or the BLDC motor drive plate (brushless DC), the plate driving motor driver chip model L6230 (detailed data sheet may official website to download st), this section required to IN1, IN2, IN3 and OUT1, OUT2, OUT3, HALL sensor signal interface H1, H2, H3 single resistor and a current sampling interface PC1 (Zhen, 2014).

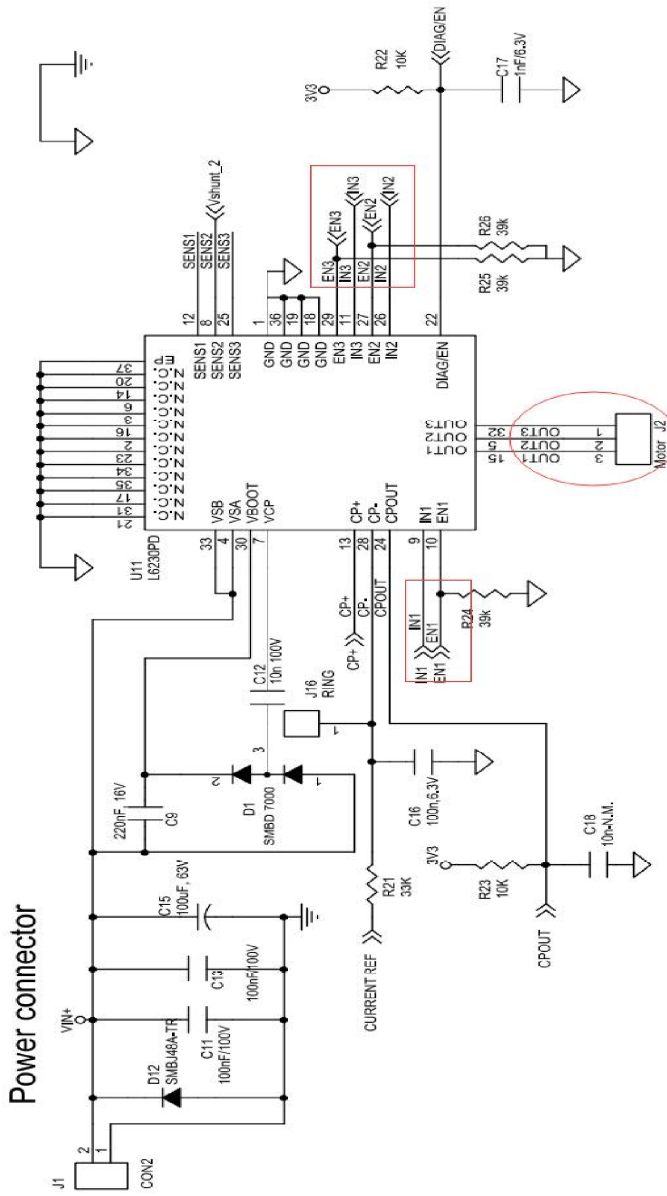

Figure 2: GATE Driving Circuit for MOSFET

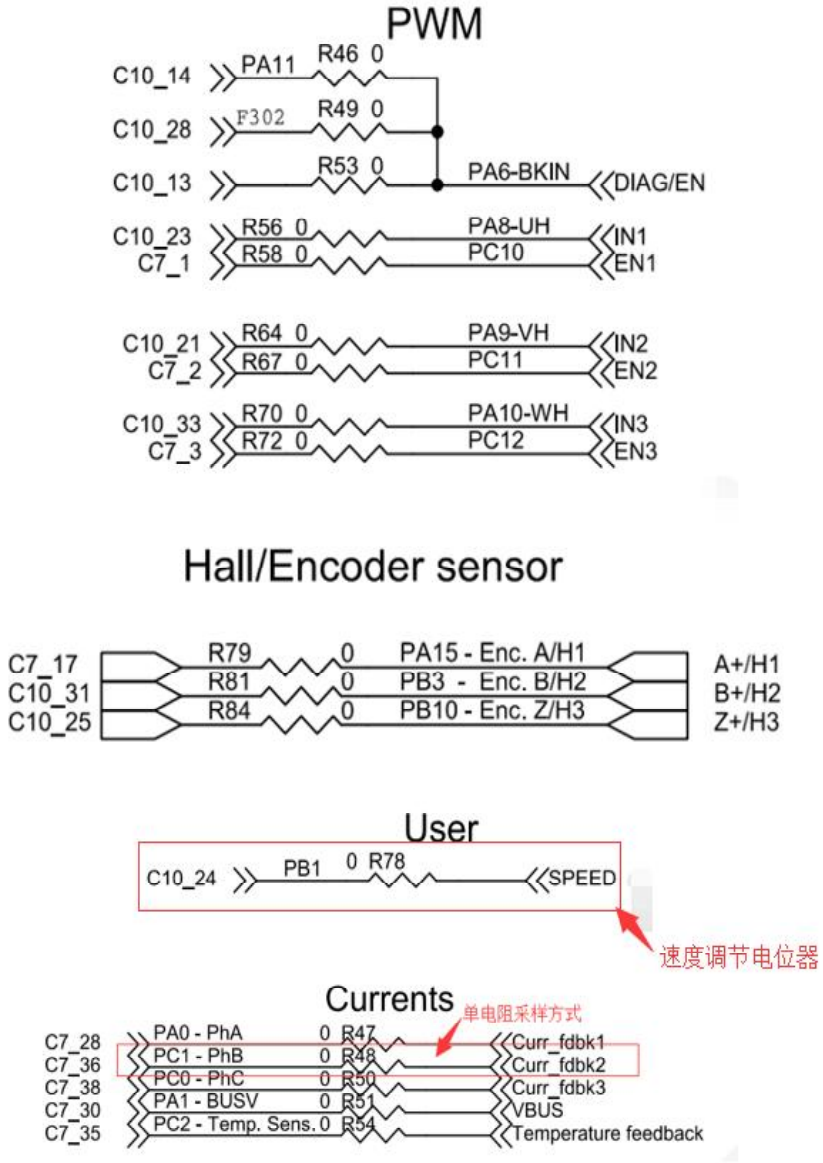
PWM
C10_14
PA11
R46 0
C10_28
F302
R49 0
C10_13
R53 0
PA6-BKIN
DIAG/EN
C10_23
C7_1
R56 0
R58 0
PA8-UH
PC10
IN1
EN1
C10_21
C7_2
R64 0
R67 0
PA9-VH
PC11
IN2
EN2
C10_33
C7_3
R70 0
R72 0
PA10-WH
PC12
IN3
EN3
Hall/Encoder sensor
C7_17
C10_31
C10_25
R79 0
R81 0
R84 0
PA15 - Enc. A/H1
PB3 - Enc. B/H2
PB10 - Enc. Z/H3
A+/H1
B+/H2
Z+/H3
User
C10_24
PB1
0 R78
SPEED
速度调节电位器
Currents
单电阻采样方式
C7_28
C7_36
C7_38
C7_30
C7_35
PA0 - PhA
PC1 - PhB
PC0 - PhC
PA1 - BUSV
PC2 - Temp. Sens.
0 R47
0 R48
0 R50
0 R51
0 R54
Curr_fdbk1
Curr_fdbk2
Curr_fdbk3
VBUS
Temperature feedback

TABLE 1: Signal Pin of MCU

Need to use the signal	**The corresponding MCU pin**
EN1	PC10
IN1	PA8
EN2	PC11
IN2	PA9
EN3	PC12
IN3	PA10
H1	PA15
H2	PB3
H3	PB10
Speed parameter saving positioner	PB1
Current sampling interface	PC1

This section is used directly STM32 TIM1 generating three PWM wave signals corresponding to IN1, IN2, IN3, motor speed control is achieved by adjusting the duty cycle of PWM wave; and EN1, EN2, EN3 IO port configured to output normal output mode, H1, H2, H3 configured hall sensor mode TIM2 and open capture T1 interrupt, the interrupt trigger mode bilateral trigger mode (actual TRC signal), the interrupt service routine real reason is a more accelerated commutation of the motor with a phase (6-step commutation step) operation, PB1, PC1 configured AD samples pin, wherein PB1 is the speed reference potential input pin, pin PC1 is sampled motor current, this section mining machine 64 in a plurality of the second PWM period to which 64-point average as an average current of the motor (Parka *et al*., 2016).

Program Implementation

In STM32CubeMX/STM32CUBEIDE 1.6.1, there are special NUCLEO-64-F410RB project templates, create a new Cube engineering, chip model:STM32F410RBTX:

Produces a simple project template to achieve the RCC, SYS, USART2 configuration interface, while still achieving the (LED) configuration pins LD2. Next, each functional module configured manually, first TIM1, configured to output a three-way PWM mode, PWM carrier frequency is 20Khz = 72M / (2 + 1) / (1199 + 1), each channel 500 is the initial wave PWM (Tadrist and Zeroug, 2014):

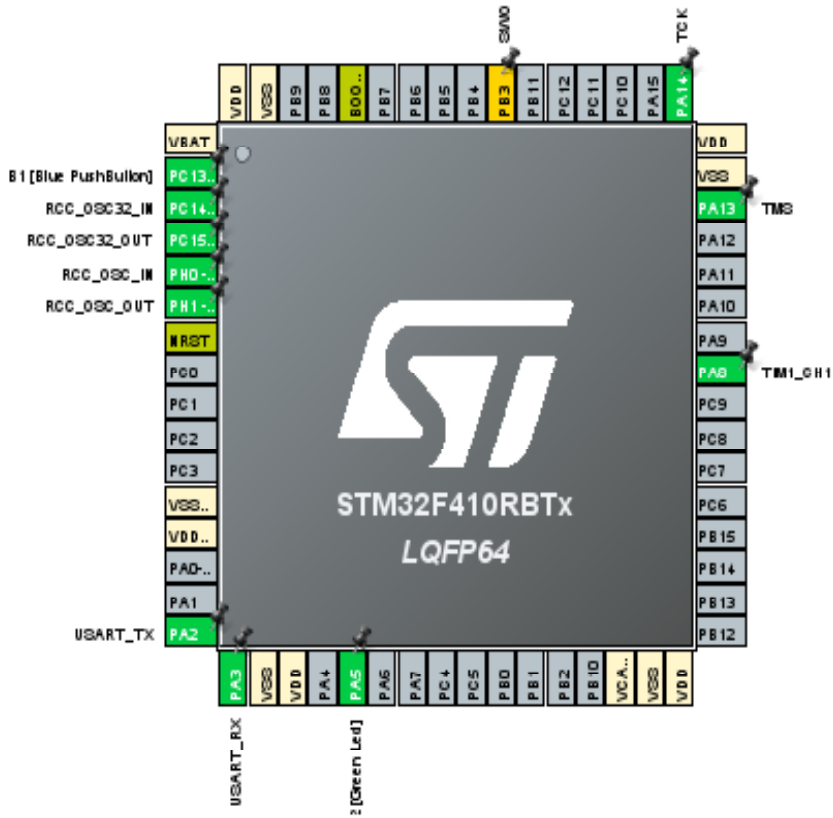

Figure 3: Pin Configuration of STMF410RBTx for BLDC Motor Drive

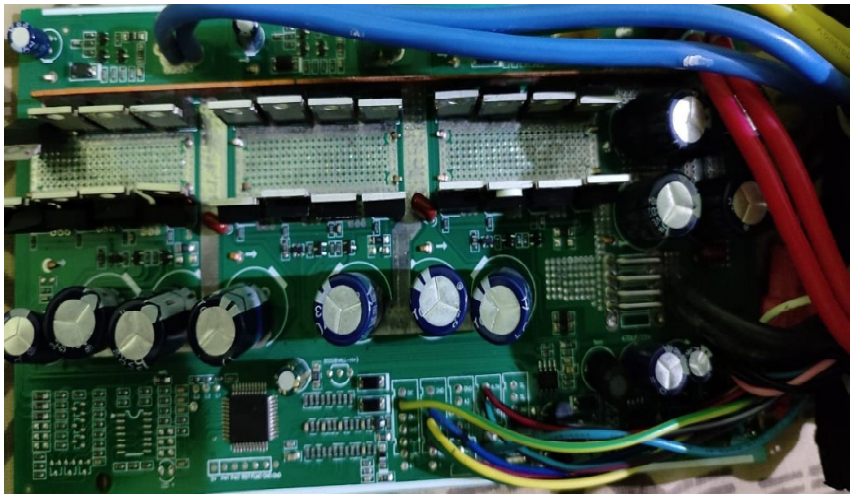

Figure 4: MOSFET-based Driver For 3-Phase BLDC motor Drive

Enable TIM1 of UPDATA interruptions, the current operation and PID control in the interrupt service routine:

Next is TIM2 configuration, open three-way input capture function, enabling XOR function, turn the timer interrupt:

The figure above the desired TIM2 directly HALL sensor function, only CUBE is not arranged in point problem for the following reasons, when configuring the input capture channels, many models are not available (Paul and George, 2011; Hemanand and Rajesh, 2006):

However, to achieve STM32 timer HALL sensor interface function, in addition, to open XOR functions (can be checked directly in CUBE):

TI1F_ED (direct bilateral edge detection) signal, and, ultimately the TRC signal. CC1I interrupt, a complete signal flow diagram below:

ADC of the present embodiment adopted the motor current sampling resistor in single mode, as shown above, the relationship between the

motor current and the current ADC sampling (JP1, JP2 not answer): V = 3 * 0.33 * I, where 0.33 is the sampling resistor the resistance, I is the motor current, V is the motor current amplified 3 times (Milivojevic *et al*., 2010; Tashakori and Ektesabi, 2012).

Enable the ADC DMA functions

Configuration ADC2

Next, the PC10, PC11, PC12 Common IO function configuration, GPIO_output mode, the default output is low (Subramanian et al., 2021):

Finally, interrupt priority level configuration:

Generating projects:

1. Open the project, add the prepared bldc.c, pid.c, visualscope.c and bldc.h, pid.h, visualscope.h (.c .h in the src folder in the INC folder) file:

At the same time add the following code tim.c stm32f1xx_it.c and in which (Mishra *et al*., 2021):

Export variables and function names in adc.h in:

Finally, add the following code in main.c:

The Main code is automatically generated using STM32 CUBE IDE as flows (Hameed, 2018):

```
/* Initialize all configured peripherals */
  MX_GPIO_Init();
  MX_USART2_UART_Init();
  MX_TIM1_Init();
  HAL_TIM_PWM_Start(&htim1, TIM_CHANNEL_1);
```

```
/* USER CODE BEGIN 2 */
/* USER CODE END 2 */
/* Infinite loop */
/* USER CODE BEGIN WHILE */
while (1)
 {
        while (CH1_DC < 65535)
         {
                TIM1->CCR1 = CH1_DC;
                CH1_DC += 70;
                HAL_Delay(100);
         }
        while (CH1_DC > 0)
         {
                TIM1->CCR1 = CH1_DC;
                CH1_DC -= 70;
                HAL_Delay(100);
         }
 }
```

The above code provides the increase of PWM signal to fixed Timer value and vice versa. The duty cycle for the motor is changed accordingly and we can control the basic speed of the motor (Costa *et al*., 201). Compiled code, debugging the code, BLDC motor speed calculation" achieved based on the motor current can be seen (red) serial port on the oscilloscope, the target speed (yellow) and the actual speed (blue) waveform, the rotary potentiometer can be seen that the effect of the closed-loop control of motor speed (yellow, blue substantially coincide) (Poovizhi *et al*., 2017):

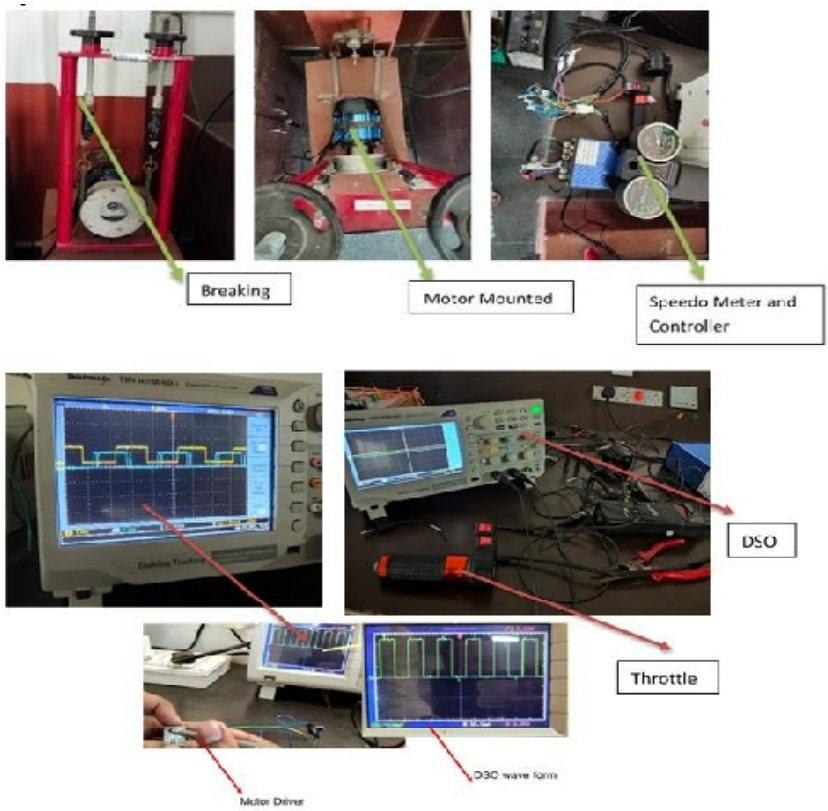

Figure 5: EV Experimental Setup

Data analysis and interpretation

Table II describes the driving test for different vehicles (i.e., passenger and loader) under no-load and loaded conditions. The test results give us the detailed current drawn and voltage drop during load and no-load conditions.

Table II: No-load and Load test of EV

Type Of vehichle	
Non passenger vehichle-Loader	**Passanger vehichle**
No-Load	**No-Load**
Voltage = 47.2 v current= 4.7 amp	Voltage = 47v-48v **current= 3.7 amp**
Condition tested in 3phase	Condition tested in 3phase
Loading Conditions	
With Load (Motor input (3ph),5 person,450 kg)	**With Load (Motor input (3ph),5 person,450 kg)**
Normal Running Current = 22 Amp-27 Amp	Normal Running Current = 22 Amp-27 Amp
Maximum = 48Amp	**Maximum = 48Amp**
Minimum = 21Amp	Minimum = 21Amp
With Load (2 person, 300kg)	**With load (2 person, 275kg)**
Normal Running Current = 15 Amp-18 Amp	Batter current = 11.5amp, Motor current = 19 amp(5km/h)
Maximum = 20Amp	Battery current = 14.5amp, Motor current = 22amp(10km/h)
Minimum = 12Amp	**Battery current = 22.1 amp, Motor current = 25.8 amp (15km/h)**

With Load (1 person, 250kg)	With Load (3passanger,350kg)
Normal Running Current = 12 Amp-16Amp	Battery current = 12 amp, Motor Current = 25 amp(5km/h)
Maximum = 17Amp	Battery current = 22 amp, Motor Current = 29.2 amp(10km/h)
Minimum = 8.7Amp	Battery current = 26amp, Motor current = 34 Amp(14rkm/h)

With Load (1 person, 250kg)	With Load (3passanger,375kg) starting
Battery Side	Battery current = 8.3 Amp, Motor Current = 18 Amp(5km/h)
Normal Running Current = 12 Amp-16Amp	Battery current = 16.3 Amp, Motor Current = 22 Amp(10km/h)
Maximum = 17Amp	Battery current = 24Amp, Motor current = 32.3 Amp(14km/h)
Minimum = 8.7Amp	
starting current = 52 Amp	

Conclusion

The current test is completed with a conclusion of implementation of current loop introduce closed-loop speed embedded. The speed we get up to 35km/hr. with higher PWM frequency and current consumption of 25Amp to 27Amp at steady drive. The transient drive is of 125Amp while breaking and starting. The Battery lasts about 50km

drive with a single charge. The BLDC motor shows an efficiency of 90% with this experiment. We can achieve a larger speed and torque with modification of differential gear settings.

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Wood Sawing Process: A Review

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Abstract

Machining is used in almost every step of the timber conversion process. Wood is frequently shaped, sized, and has a poor surface quality after machining. There are two types of woodworking: cutting with and without cutting. Sawing is the machining process of cutting a thin saw kerf to separate wood and wood-based components. The purpose of this study is to examine how various factors influence it. The impact of numerous elements and process characterization are the topics of this paper. It also demonstrates how the above-mentioned factors are linked to surface finish, tool wear, dimensional accuracy, cutting force and power.

***Keywords**: Tool wear; surface roughness; cutting power*

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1. Introduction

Cutting is caused by the interaction of timber and tool in machining. The interaction is determined by the physical and mechanical qualities of the wood, the tool geometry, and the operating factors. The fundamental goals of contemporary machining are to control the sawing process to achieve improved surface quality and cost-effective machining. Breaking logs into boards or bigger dimension lumber is done with a number of saws. Circular saws and bandsaws, on the other hand, are highly prevalent and advanced. Ripping is a phrase used to describe cutting along the grain. Cross-cutting is a word used to describe cutting across the grain. The worker must take into account the following key interactions like blade material, speed, various angles, sharpness or tooth angle, feed, and speed. The purpose of this review is to compile information on how cutting factors affect tool wear, surface quality, and others.

Tooth design, speed, feed rates, lubrication, machine capacity and condition, and the material are all elements that affect sawing efficiency. Under a microscope, you can see the tooth tip of a blade pierces the work and pushes, or shears, to form chips. The "shear plane angle" refers to the angle at which the material shears off. This is, without a doubt, the single most significant component in increasing cutting efficiency. The lower the shear plane angle is for a particular depth of penetration, the thicker the chip grows and the worse the cutting effectiveness. The higher the shear plane angle, the more efficient the process is, resulting in thinner chips.

1.1 Wood Type

Wood is a biologically complicated substance. Tool wear, cutting power, and surface are all affected by the wood types (Goli et al. 2010). The effect of specific gravity on the circular sawing of wood-based panels was demonstrated while machining with a circular saw (Barros et al.

2012). It was discovered that higher density wood-based panels have better surface characteristics. European oak has a rougher surface than European beech because of its anatomical peculiarities (Barcik et al. 2010).

The fact that vessel sizes in European beech (a diffuse porous wood species) growth rings are uniform helped to lessen the impact on surface quality. Moisture in wood affects the specific gravity and mechanical properties of wood and hence affects the ease of machining (Axelsson et al. 1993).

1.2 *Tooth geometry*

Several parameters influence tooth geometry. The pitch is increased to increase the bite/tooth and the saw's power requirement. Increased gullet capacity would allow for quicker feed speeds, but increased tooth length puts more strain on the tooth and increases the chance of gullet breaking. Increasing the rake angle lessens the tooth's sharpness, reduces power consumption, and promotes faster tool wear. A positive clearance angle prevents the saw from rubbing against the machined surface. The bite per tooth should be half the width of the kerf. Too small bite overheats the blade. It produces sawdust (fine) which blocks the clearance between the blade's face and the wood.

Another component that affects cutting efficiency is gullet capacity. The gullet is the area between the tooth tip and the blade's inner surface. During a cut, the chip curls up into this location as the tooth scrapes away the substance. The chip will coil up uniformly and fall away from the gullet if the blade has enough clearance for the cut. The chip will jam into the gullet area if too much material is scraped away, generating additional resistance. This slows down the machine, consumes energy, and puts the blade at risk of damage.

Wood types, cutting speed, feed and tooth geometry must all be considered when determining the best rake angle (Davim 2013).

Selection of improper rake angle and input cutting parameters cause surface flaws such as ripped and coarse grain. Adopting a rake angle (20°- 40°) for circular saw to reduce energy usage and tool wear with good surface quality (Koch et al. 1964). When sawing hard and red maple wood with a band-saw, a 35° rake angle resulted in minimal cutting forces and high surface quality (Eyma et al. 2005). The diameter of the saw increases the cutting speed linearly. It has an inverse relationship with the feed per tooth and can have a considerable impact on cutting performance.

1.3 *Saw Materials*

Saw blades are made of the highest-grade steel that induces durability, wear and fatigue resistance and resistance to distortion. High carbon steels and alloy steels with manganese or nickel are used for blades. Steel bandsaw blades are durable, tough and easy to sharpen. Blades are frequently tempered and plastic-worked. These cause phase changes in the steel and the formation of dislocation networks, as well as hardening the blade (Atkins 2003).

1.4 *Type of Saws*

Circular saws are generally not recommended for processing large diameter wood or thick timbers for avoiding wider kerf and a large quantity of sawdust. Because saw kerfs are often twice as thick as the steel saw blades, it is better to keep the diameter of the saw as small as possible. Circular saw blades with smaller diameters offer significant advantages. The more the flexibility and movement, the further the saw tip is from the arbor. To compensate, a thicker saw gauge must be utilized to preserve stability. Because the cut depth is not very large (usually 25-100 mm), circular saws are preferred because the kerf may be maintained minimal (2-4 mm). For deep cuts with a narrow kerf, bandsaws are ideal. They meant for the long run and fine cutting.

1.5 *Feed Speed*

The depth of penetration of the tooth into the material being cut is referred to as feed. For cost-effective cutting, use the highest feed rate/ pressure so that the machine can rapidly remove much material. However, the machinability of the material and the blade life expectancy will limit feed. Feed speed is determined by the cutting depth, wood's hardness, and the saw's size. In a high-volume softwood mill, it is typically 1-1.25 m/s. It is possible that the return speed will be twice as quick.

2. Process Analysis

2.1 *Blade wear*

Blade or tool wear causes cutting edge blunt affecting the cutting angles as a result of which temperature is increased due to friction. Scars from burns, increased surface roughness, and sawing deviation can all occur as a result of lowering the surface standard (Cool et al. 2011). Cutting force and accompanying power consumption are also affected by tool wear. As a result, any research that improves our understanding of tool wear mechanisms and the implications of different cutting parameters on blade wear behavior will have a direct impact on power efficiency and surface quality.

When the number of teeth on a circular saw is reduced, tool wear will be increased (Fujimoto et al. 2011; Eyma et al. 2005). An increase in the number of teeth increases the risk of burn marks. Saw blade wear is also influenced by the tooling material (Kvietková et al. 2015). Soft carbide grades are tougher but wear faster, whereas harder carbide grades are brittle but more resistant to wear. The tooling material selection depends upon the wood types, moisture level, and temperature and alters the mechanical properties of the wood. Wood with minerals in tropical rain forests increases abrasive wear (Amos et al. 1952). The specific gravity of the tool has a considerable impact on

its wear rate (Bahr et al. 1997). More is the specific gravity; more is the wear.

2.2 *Surface finish and dimensional accuracy*

Surface roughness is the micro irregularities, while other irregularities like waviness, scratches are macro irregularities or defects. Surface quality has been assessed using a variety of approaches. Until recently, the stylus technique was the most used tool for objectively assessing surface roughness (Chuchala et al. 2014; Delio et al. 1992).

2.3 *Types of wood or workpiece*

Cost reductions and increased production would result from an optimal mix of wood, feed, and cutting-edge factors. The impact of workpiece variables has been extensively researched in the literature, as wood anatomy and mechanical qualities have a significant impact on surface quality (Fahrussiam et al. 2016; Aguilera et al. 2000; Goli et al. 2001). Each wood species has its specific gravity and anatomical components, which have a major impact on surface quality (Cool et al. 2015). Wood with a greater specific gravity has better surface quality (Dzurenda et al. 2011). This includes the fact that hardwoods have a better finish than softwoods. Within hardwoods, diffuse porous wood species are frequently linked with a higher surface finish than circular porous wood (Bohadana et al. 2000). Temperature and moisture content in wood are crucial, especially in basic wood processing applications. However, the impact of moisture content variations and subzero temperatures on surface quality and sawing accuracy has received little attention. On the one hand, the moisture level of the wood has a major impact on the quality of the machined surfaces (Aslan et al. 2008).

Surface quality has increased due to continual chip generation while band sawing dry and green maple wood perpendicular to the grain (Eyma et al. 2005). Extreme cold conditions increase the brittleness of

wood and also improve surface quality (Barcenas et al. 2005; Gašparík et al. 2014; Bariska et al. 2015). Furthermore, cold conditions limit the friction coefficient between the wood and the tool lowering the blade heating and reducing dimensional accuracy (Bayoumi et al. 1983).

3. Effect of Feed Factors

Although the feed speed had no major effect on the surface roughness of sawn frozen Scots pine, it is well known that feed speed increases wood surface roughness or feed force (Aguilera et al. 2007; Barcík et al. 2010). This was most likely owing to the extreme cold, which changes the mechanical properties of wood and hence influences chip production. Cutting parallel to a radial-longitudinal surface provides higher surface roughness than cutting parallel to a tangential-longitudinal surface because wood is an orthotropic material (Beljo-Luèiæ et al. 2004; Bendikiene et al. 2015).

4. Saw Blade Factor's effect

In general, the more saw teeth, the better the surface quality. Sawing harder and thin wood necessitates more teeth, whereas sawing larger diameter wood and longitudinal cutting of softwood necessitates fewer teeth. Having more teeth improves the quality of the wood surface in general (Aguilera et al. 2007; Barcik et al. 2010). As the tool wear increases, the quality of the surface is expected to decline. Although the tool wear increases as the cutting distance increases, total surface roughness decreases. The anisotropic structure of wood absorbs some of the tool wear effect (Choudhury et al. 2003). The wood type has a big influence on how well it absorbs tool wear (Cool et al. 2011).

5. Cutting Force and Power

Energy usage is a cost and productivity indicator for a product. The torque of a driving spindle is used to determine mechanical cutting

power (Coit et al. 1998). However, a change in the electrical current used by an electrical motor is typically used to compute electrical cutting power (Tlusty et al. 2000; Dzurenda et al. 2010). Traditionally, the cutting resistance has been used to predict cutting power (Ekevad et al. 2012; Fahrussiam et al. 2016).

6. Conclusion

The impact of common factors in wood machining like tool wear, cutting power and force, surface quality, sawing quality, and dust emission was studied in this work. The literature on the sawing process for the primary processing sector with enhanced monitoring techniques received special attention. Finally, there are a few findings, such as the variations between sawing dry, saturated, and frozen wood; nonetheless, the correlations between chip thickness and cutting speed and outputs such as surface quality and tool wear remain unclear. Transferring new technologies is difficult due to the variations between laboratories and sawmills contexts. The effect of feed on sawdust formation is arguable, and there are few studies on monitoring the solid wood sawing that is in progress.

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Performance Analysis of a Compression Ignition Engine using Diesel and Biogas

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Abstract

In the present investigation, the quantity and quality of energy and exergy have been analyzed in a direct injection compression ignition engine (DICI) by applying the first and second laws of thermodynamics. The engine performance has been tested using diesel and biogas in a dual fuel mode of operation. The Taguchi method of optimization has been applied for optimum results for pure diesel and dual mode of operation. Comparative analysis has been performed for both modes for energetic and exergetic parameters such as energy and exergy distribution, exergy efficiency and different availabilities. It is observed that the performance is almost similar for both modes of operation.

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Keywords: Energy, Exergy, Taguchi method, MINITAB software, Diesel engine, Biogas

1. Introduction

Energy-based performance analysis of the engine is based on the first law of thermodynamics. Energy conversion always takes place for working any thermal engine. Some losses are always found during this energy conversion and the remaining part is available in the form of useful energy. On the other hand, exergy-based performance analysis is done by applying the second law of thermodynamics. The loss in performance of the engine is calculated from the exergy destruction which is a measure of irreversibility. Thus, exergy analysis is necessary for knowing the magnitude of exergy destruction and the source of thermodynamic inefficiencies in an engine. The overall efficiency and cost-effectiveness of an engine, which is the prime interest of this research, can be improved from the information obtained from the above analyses. In the fulfillment of the above objectives, energy and exergy analyses of the engine have been performed and the optimization of different energetic and exergetic parameters is obtained by applying the Taguchi method using MINITAB software.

2. Experimental Methodology

2.1 Experimental Setup

The experimental setup consists of a single-cylinder, direct injection diesel engine, dynamometer, fuel supply and metering systems, water supply systems and measuring devices as shown in Figure 1. All specifications of the DICI engine used in the experiment are presented in Table 1. It is provided with necessary instruments for airflow, fuel flow, temperatures and load measurements. The engine and dynamometer are cooled by a water cooling system. Water meters are

provided for flow measurement of cooling water. There is only one modification at the intake manifold of biogas and air providing a 'T' joint.

Figure1. Experimental set up

Table 1. Specifications of the engine

Parameters	Specifications
Engine type	DICI
General details	Single cylinder, water-cooled
Stroke	4- stroke
Cylinder diameter	85 mm
Stroke length	110 mm
Orifice diameter	20 mm
Compression ratio	17.5
Rated output	3.5 kW at 1500 rpm

2.2 Experimental Procedures

The diesel engine is allowed to run at 1500 rpm for a few minutes with the no-load condition. The water flow is regulated for the engine, dynamometer and calorimeter. For the experiment, loads of 2 kg to 15 kg are set for engine operation. The biogas flow is slowly taken from the balloon to reach the inlet manifold of airflow in case of biogas dual-fuel operation. The proper quantity of the air-biogas mixture is admitted into the cylinder for the dual-fuel combustion. The right amount of biogas is manually regulated till the first appearance of engine misfiring. The addition of extra chemical energy from biogas is utilized for the increase in engine speed. A constant level of power and speed from both diesel and dual-fuel modes is maintained at different load conditions with the proper regulation of diesel supply.

2.3 Analysis Procedure

The results of the diesel fuel mode and dual-fuel mode were analyzed using the laws of thermodynamics. It provides proper information for the distribution of energy supplied by fuel into power, cooling water

and exhaust gas (Moran & Shapiro, 2006). The energy that is utilized or destroyed is quantiûed through availability analysis. This analysis gives the exact amount of biogas and diesel composition which should be maintained to extract the maximum amount of energy from the fuel energy supplied. Therefore, the first law (Energy) along with the second law (Exergy) is applied to the engine for analysis. Both energy and exergy analyses for dual fuel operations are very important in the present study.

Energy analysis

According to the First Law of thermodynamics, the energy supplied in a system is conserved in its different processes and components (Sahoo et al. 2009). In a compression ignition (CI) engine, the supplied fuel energy has appeared in different forms such as shaft power, energy in cooling water, energy in the exhaust gas and uncounted energy losses in friction and radiation, and heat transfer to the surroundings etc. All these energies are determined by applying the first law of thermodynamics (Heywood, 1988).

Exergy analysis

Exergy analysis is carried out to obtain some ways to minimize energy loss and to improve engine performance. The availability to do useful mechanical work is evaluated from the second law (Flynn et al. 1984). For any CI engine, different types of exergy such as shaft availability, cooling water availability, exhaust gas availability and destructed availability and heat transfer to the surroundings are obtained from the chemical availability of fuel (Kotas, 1985; Stepanov, 1995; Goswami et al. 2014).

3. Results and Discussions

3.1 Input Energy Analysis

Response curve analysis has been performed using Minitab software as shown in Figure 4 to find the optimum set of parameters for an

engine in pure diesel mode. The optimum parameters for achieving the highest input energy were obtained from the analysis at engine load 1.75 kg, mass of fuel consumed 0.000126 kg/s and mass of air consumed 0.00952 kg/s and input energy is 8.486 kW. It was thus found from the analysis that the engine performance is affected much by engine load with little influence from the mass of air consumption.

The same was done for the engine at dual fuel mode operation. It was found that the engine will perform very well highest input energy shown in Figure 5 at engine load 1.75 kg, mass of fuel consumed 0.000220 kg/s and mass of air consumed 0.000843 kg/s and input energy of 7.869 kW.

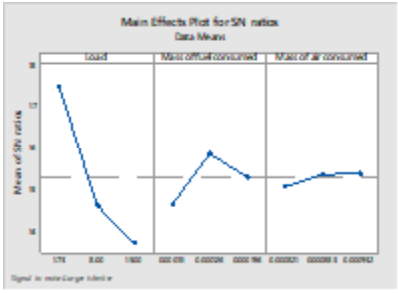

Figure 4 SN ratio (diesel mode)

Figure 5. SN ratio (dual mode)

3.2 Unaccounted Energy Analysis

Response curve analysis has been performed for unaccounted energy using Minitab software as shown in Figure 6 to find the optimum set of parameters for an engine in pure diesel mode. The optimum parameters for getting the lowest unaccounted energy were obtained from the analysis at engine load 1.75 kg, the mass of fuel consumed 0.000126 kg/s and unaccounted energy is 5.275 kW. It was thus found from the

analysis that the engine performance is affected much by engine load with little influence from the mass of fuel consumption.

The same was done for the engine at dual fuel mode operation. It was found that the engine will perform very well for the lowest unaccounted energy as shown in Figure 7 at engine load 1.75 kg, mass of fuel consumed 0.000220 kg/s and input energy of 5.625 kW. Again, it was thus found that the engine performance is much affected by engine load with little influence from the mass of fuel consumption.

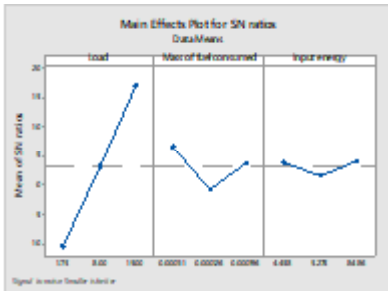

Figure 6. SN ratio (diesel mode)

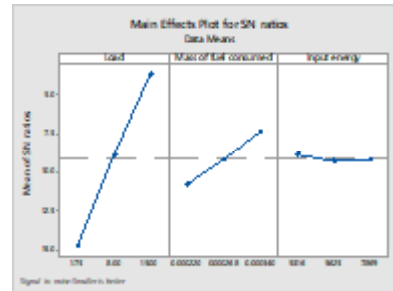

Figure 7. SN ratio (dual mode)

3.3 Exergy Analysis

The exergy analysis was performed for the engine both for pure diesel and dual-fuel mode as displayed in Figure 8 and Figure 9 respectively. In the case of dual-fuel operation, it was found that the combustion temperature in dual fuel mode is decreased because of the small heating value of biogas, thus producing a reduction in both the fuel availability and work. It reduces the efficiency and enhances the fuel availability wasted in the form of irreversibility. It is seen that the fuel availability is reduced at lower loads, while the rate of fuel energy increases for producing more shaft output at higher loads. So, it can be concluded that more shaft availability is developed at more engine loads.

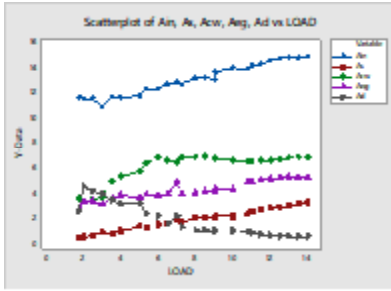

Figure 8. Availability Distributions with Fuel input as a function of Load (diesel mode)

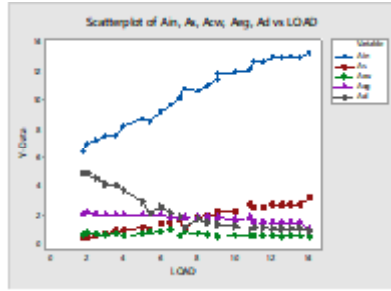

Figure 9. Availability Distributions with Fuel input as a function of Load (dual mode)

3.4 Fuel Exergy Analysis

Response curve analysis was done again for unaccounted energy using Minitab software as shown in Figure 10 to find the optimum set of parameters for an engine in pure diesel mode. The optimum parameters for obtaining the highest fuel energy were obtained from the analysis at engine load 15 kg, fuel consumption 0.000111 kg/s and unaccounted energy is 14.861 kW. It was thus found from the analysis that the engine performance is affected much by engine load with little influence from the mass of fuel consumption.

The same was done for the engine at dual fuel mode operation. It was found that the engine will perform very well for the lowest unaccounted energy as shown in Figure 11 at engine load 15 kg, mass of fuel consumed 0.000340 kg/s and input energy of 13.251 kW. Again, it was thus found that the engine performance is much affected by engine load with little influence from the mass of fuel consumption.

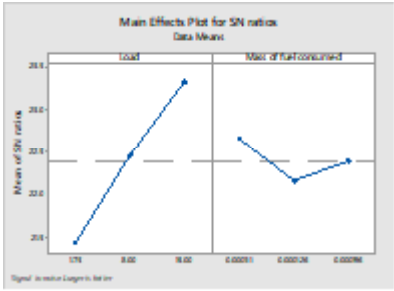

Figure 10. SN ratio (diesel mode)

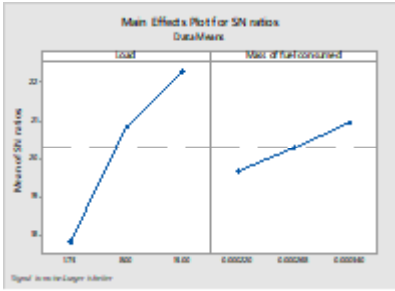

Figure 11. SN ratio (dual mode)

3.5 Destroyed Availability Analysis

Response curve analysis has been performed using Minitab software as shown in Figure 12 to find the optimum set of parameters for an engine in pure diesel mode. The optimum parameters for destroyed availability were obtained from the analysis at engine load 1.75 kg, the mass of fuel consumed 0.000126 kg/s and fuel exergy is 13.162 kW. It was thus found from the analysis that the engine performance is affected much by engine load with little influenced fuel consumption. The destroyed availability was obtained Taguchi optimization as 4.1221 kW, while 4.597kW from experiments.

The same was done for the engine at dual fuel mode operation. It was found that the destroyed availability will be lowest as shown in Figure 13 at engine load 1.75 kg, mass of fuel consumed 0.00022 kg/s and fuel exergy of 10.625 kW. Again, it was thus found that the engine performance is much affected by engine load and least affected by fuel exergy. The destroyed availability from Taguchi optimization was found as 4.565 kW, 4.943 kW from experiments.

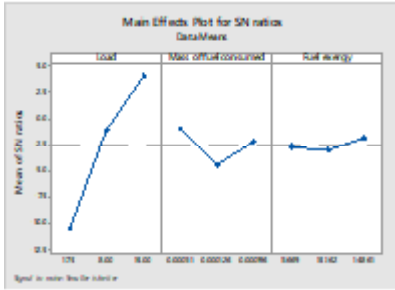

Figure 12. SN ratio (diesel mode)

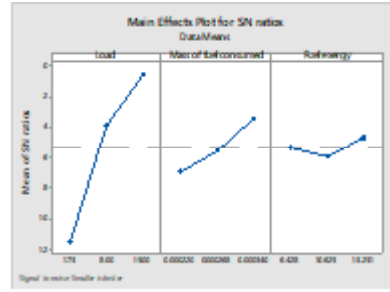

Figure 13. SN ratio (dual mode)

3.6 Exergy Efficiency

Response curve analysis has been performed using Minitab software as shown in Figure 14 to find the optimum set of parameters for an engine in pure diesel mode. The optimum parameters for exergy efficiency were obtained from the analysis at engine load 15 kg, chemical availability of fuel 14.861 kW and destroyed availability 0.576 kW. It was thus found from the analysis that the engine performance is affected much by engine load and is least affected with destroyed availability. The exergy efficiency was obtained Taguchi optimization as 85.57%, while 4.597kW from experiments.

The same was done for the engine at dual fuel mode operation. It was found that the exergy efficiency will be highest as shown in Figure 15 at engine load 15 kg, chemical availability of fuel 13.251 kW and destroyed availability 0.976 kW. Again, it was thus found that the engine performance is much affected by engine load and least affected by destroyed availability. The destroyed availability from Taguchi optimization was found as 91.43%, while 90.57% from experiments.

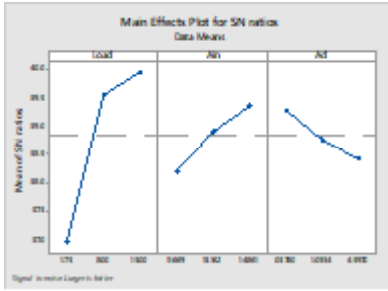

Figure 14. SN ratio (diesel mode)

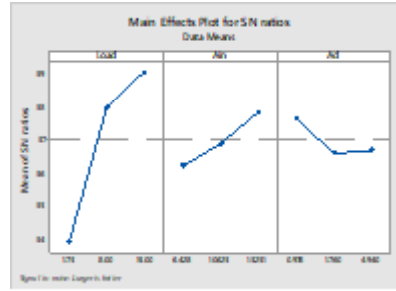

Figure 15. SN ratio (dual mode)

4. Conclusion

The entire analysis was performed in a test engine running at steady-state with a small modification in the air inlet to run it in dual fuel mode. Experiments were conducted on the engine for both modes of operation and the data collected from the experiments were used for carrying out energy and exergy analyses. Further the energetic end exergetic parameters were calculated for optimum performance of the engine. From the comparative analysis done for both modes of operation, it is concluded that the quality of diesel fuel is better than biogas. In the case of dual-mode, more biogas is needed as the calorific value of diesel is more than the biogas. It was found that both biogas and diesel fuel exhibit identical exergetic performance at all test loads and exergy loss by irreversible processes is the most deciding factor of the engine inefficiency. It is also concluded that there is not much difference in performances at all test loads.

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Health Insurance Claim Prediction using Machine Learning Techniques

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Abstract

Today's world is covering a pandemic situation, where there are different diseases such as COVID-19. Along with that a lot of accidents, disasters are creating difficulty to live. To survive this situation human needs a huge amount of money for health care. The treatments and medicines requirements are very high as the cost. There are many cases where people cannot afford the treatment and lose their life. To prevent this, government along with many private banks tied up with numerous hospitals to set up many insurance agencies. People deposit some amount of money in the bank on a monthly or yearly basis in return for which the insurance agency provides money as health insurance. Costs of health insurance throughout the globe have increased critically

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in recent times. The increased trend results in the requirement of developing intelligent models with quick decision-making capacity while providing better accuracy. This paper deals with the prediction regarding claiming health insurance i.e., whether a person claims his/her health insurance or not based on different factors. Machine Learning algorithms can be used to develop such models as they can analyze huge amounts of data. In this paper, Artificial Neural Networks (ANN), Decision Trees (DT), Support Vector Machines (SVM), and Logistic Regression Models (LRM) have been applied to classify the health insurance dataset. Amongst all the models taken into consideration, DT shows the best accuracy. Thus, it can be used for real-time applications.

Keywords: Health Insurance, Classification, SVM, ANN, Logistic Regression, Decision Tree.

1. Introduction

The health care framework is an immersed necessity for a human being for decent health. It needs life protection insurance, where it is most important for humans to expenses of life protection insurance. In a large number of health care insurance data, health care insurance is not easy to analyze the cost. To create better individual health care profiles, technology, and scientific advances increase the health insurance plans in a better manner (Mimra et al. 2020). Nonlinear expense in health care coverage energizes transient replacements since patients can decrease their cash-based expenses by focusing on the correct time in the years when they hit the deductible (Lin et al. 2019). Policymakers are keen on the effect of health care coverage on people's clinical uses (Chen et al. 2019). This paper (Cardon et al. 2020) fostered a model of protection decision and determined the ramifications for insurance plan determination when customers are misfortune disinclined since past work had shown that medical coverage plan

exchanging expenses can expand government assistance by lessening unfavorable choices. A costly protection strategy doesn't support interest in loss reduction work as much it ought to (Pannequin et al. 2019). A model of backup plan with value setting and consumer's health care assistance under hazard change, a strategy usually used to battle wasteful arranging due to unfavorable determination in health care coverage markets was created concurring to the review (Layton et al. 2017). In this review (Kelly et al. 2017), it was tracked down that a 10% increment in last merchandise and clinical area usefulness stuns, each has a constructive outcome on total government assistance. In this review (Pelgrin et al. 2016), the lifetime impacts of exogenous changes in health care coverage included on the dynamic ideal designation (utilization, recreation, and wellbeing use), status (wellbeing and riches), and government assistance and results feature positive impacts of protection on wellbeing, riches, and government assistance, just as midlife replacement away from solid relaxation for more wellbeing costs, brought about by cresting compensation, and speeding up medical problems. The impact of a singular protection order on the interest for private health care coverage in the US was investigated in this review (Stavrunova et al. 2014) and it was shown that this arrangement essentially affects the general interest for private health care coverage in the US. Since dissecting of the medical care protection costs is presently a major information issue, there is a need to utilize computational insight draws near due to high nonlinearity and an enormous piece of information. To streamline the expectation interaction of the medical services protection costs in this review, a determination strategy is performed to separate the main elements. Artificial Neural Network and some concepts of Adaptive Neuro-Fuzzy Inference System (ANFIS) (Jang et al. 1993; Gavriloviæ et al. 2018; Nikoliæ et al. 2016; Petkoviæ et al. 2017; Nikoliæ et al. 2017; Petkoviæ et al. 2016; Petkoviæ et al. 2020), Logistic Regression, Decision Tree Classifier, and Support Vector Machine are utilized for the chosen method.

2. Data Description

The dataset utilized in the paper depends on the Database available on Kaggle (Kaggle 2021). The data is additionally accessible over GitHub (GitHub 2021). The recipient's living regions are the northeast, southeast, southwest, what's more, the northwest in the US. Totally 1338 input/output tests values on the expenses of the singular health protection are present. Output addresses charges on the singular clinical expenses charged by medical coverage. There are five contributions to add up to as given underneath:

A. Current Age: time of the essential recipient, which is at least 18 summers and the most extreme, is 64. Normal is 39.2.

B. Gender: female, male.

C. BMI: The Body mass index is giving comprehension of the body along with weights that are moderately high or low comparative with tallness, target file of this (kg/m2) utilizing the proportion of tallness to mass, preferably over 18.5 to 24.9. 15.96 BMI is insignificant and 53.12 is the greatest. 30.66 is the Normal BMI.

D. Kids: No of kids covered by medical coverage. Markers reach between 1 and 5.

E. Smoker: Smokes or not. Overall in total 1064 smokes and 274 don't.

2.1 ANN Methodology

ANN is a hybrid AI procedure, which utilizes the artificial neuron framework. The association of this technique empowers the framework to learn and to save the learned information. The learned information can additionally be utilized without retraining the ANN. This hybrid learning technique builds an input/output planning dependent on human

information and specified input/ output sets. Figure 1 represents the basic workflow of building the ANN model. In the beginning, raw data is collected from a verified source for processing further. The collected data is to fulfill the requirement of the proposed network and it is completely compatible as per the format of the data which the proposed network supports. Otherwise, the network will not process the dataset further.

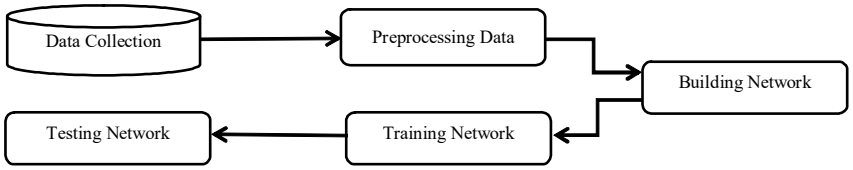

Figure 1: Basic Flow Diagram of ANN Model

We are using Relu Activation Function (RAF) with 20, 18, 16, and 12 as weights respectively in the hidden layer while the sigmoid for the final output layer has 1 as weight. Where the Adam optimizer is used.

$$Z_i = (\sum_{k=1}^{N_{j-1}} X_k^{j-1} W_{k,i} - b_k) \quad (1)$$

$$f(Z_i) = \frac{1}{1 + e^{-Z_i}} \quad (2)$$

2.2 Logistic Regression Methodology

Factual investigation techniques used in anticipating any information consider depending on earlier psychology of an information collection is named as Logistic Regression. The logistic regression somewhat relates to the neural network. Logistic Regression can also be presented as a single-layer neural network. Using a logistic sigmoid function for activation functions (Figure 2) in a neural network's hidden layer is very much common.

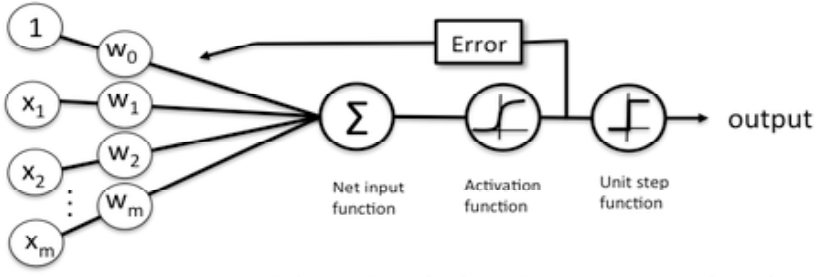

Figure 2: Schematic of a Logistic Regression Classifier

This methodology allows a calculation to be applied in an AI program for groups approaching information determined on verifiable information. This had turned into an important instrument in this AI discipline.

2.3 Decision Tree Classifier Methodology

A supervised learning technique is used for both Regression along with classification problems, yet generally, the decision tree is liked in supporting Classifications. Under Machine Learning, DT is one of the simplest and most versatile structures that can be used very much for classification problems. A DT under Machine Learning is fundamentally a "tree" of decisions that makes up the nodes where "branches" are the split of the tree. Figure 3 represents a decision tree.

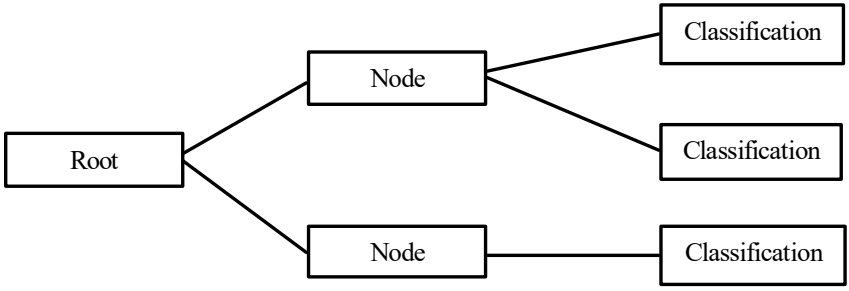

Figure 3: Decision Tree Classifier Process

Each node along with the sub-nodes is a decision relying on values of defined variables that end with the classification of every element into any one of the classes. The root is the first variable that divides the dataset and from here everything starts. Every decision is known as the node and the line which connects these decisions are called the branch.

These are the organized tree classifiers, where inward hubs address the provisions of a dataset, branches address the choice guidelines and each leaf hub addresses the result.

Mathematical Entropy with 1 attribute:

Mathematical Entropy with 1 attribute:

$$E(S) = \sum_{i=1}^{c} -p_i log_2 p_i \quad (3)$$

Mathematical Entropy with multiple attributes:

$$E(T,X) = \sum_{c \in X} P(c)E(c) \quad (4)$$

2.4 Support Vector Machine Methodology

SVM is the general, most famous Supervised Learning algorithm, which is handled for Classification just as Regression. Figure 4 describes the SVM calculation's main objective is to build the appropriate line or choice limit which can identify n-dimensional space into classes which can undoubtedly allow us to place the new data point in the appropriate classification later on.

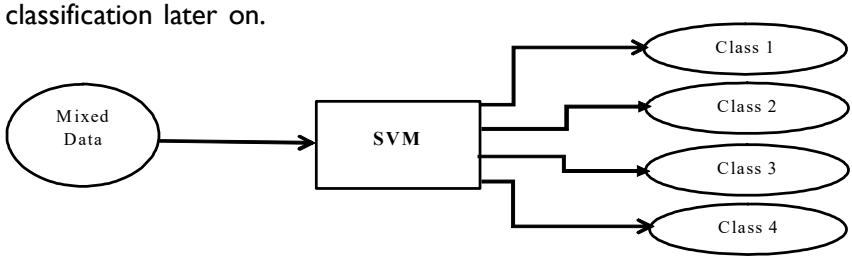

Figure 4: Support Vector Machine Process

This solves different linear and non-linear problems and also works very well in the case of many practical problems. Moreover, fundamentally, In AI Domain for classification SVM is utilized. This best-chosen limit is coined as a hyperplane that separates the data into classes. SVM collects the excessive vectors/focuses that assist in making the hyperplane. Those unusual cases are known as help vectors, and consequently, the calculation is named Support Vector Machine. Data is being applied on 4 different kernels of SVM i.e, sigmoid, linear, poly, and RBF explain in figure 5.

3. Proposed Methodology

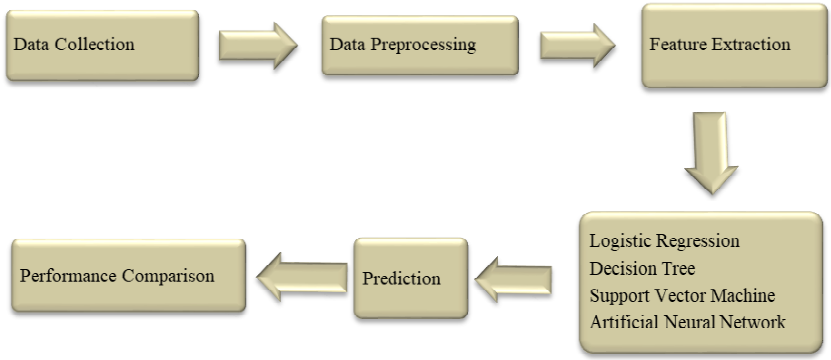

Figure 5: Workflow Diagram of Proposed Methodology

In the beginning, data is collected from a website named "Kaggle" in the raw form. Then this raw information is preprocessed where all the NAN values were handled and then the standardization of the data is done. After the preprocessing of the data, the required features are extracted as per the need, and then the data splits for training and testing purposes.

For training 70% of the data is provided and for testing 30%. Then this data is fitted into the proposed models i.e., LR, DT, SVM, ANN. After the

testing of the models, the prediction is taken out and the performance of all the proposed models is compared.

4. Result Analysis

When we compare the output of the processed data on different proposed models, we get to know that the Artificial Neural Network model gives 93% accuracy which is a good one followed by Logistic Regression with 87% of accuracy then comes the Decision Tree with the highest accuracy of 96.76% which depict that our decision tree model can predict more accurately.

If we talk about the Support vector Machine, with its 4 different kernels the accuracy of the sigmoid kernel is comparatively less with 78.6%. While the linear kernel gives 88% along with the polynomial kernel having 89% whereas out of all 4 kernels the radial basis function kernel gives the highest result with 90.54%.

Table 1 represents the output accuracy of different machine learning methods.

Table 1: Different ML Models results

Models	**Accuracy**
Artificial Neural Network	93.03 %
Logistic Regression	87.06 %
Decision Tree Classifier	96.76 %
Support Vector Machine (Kernel = Sigmoid)	78.60 %
Support Vector Machine (Kernel = Linear)	88.80 %
Support Vector Machine (Kernel = Polynomial)	89.80 %
Support Vector Machine (Kernel = Radial Basis Function)	90.54 %

Table 1 shows that the Decision tree being the highest of all gives the best accuracy with 96.76% closely followed by Artificial Neural Network with 93.03%. Out of all the cases, it is visible that the SVM model with Sigmoid kernel gives the least accuracy with 78.6%.

5. Attributes Co-Relation

The variable selecting process is worked for the choosing of necessary variables in the prediction of the costs of health insurance. For simplification of the process of prediction, it is necessary to extract the most important variables. We are using age, gender, BMI, steps, children, smoker, region, and charges as the independent variable while an insurance claim is a dependent variable.

Figure 6 shows the comparison of the accuracies of the different models.

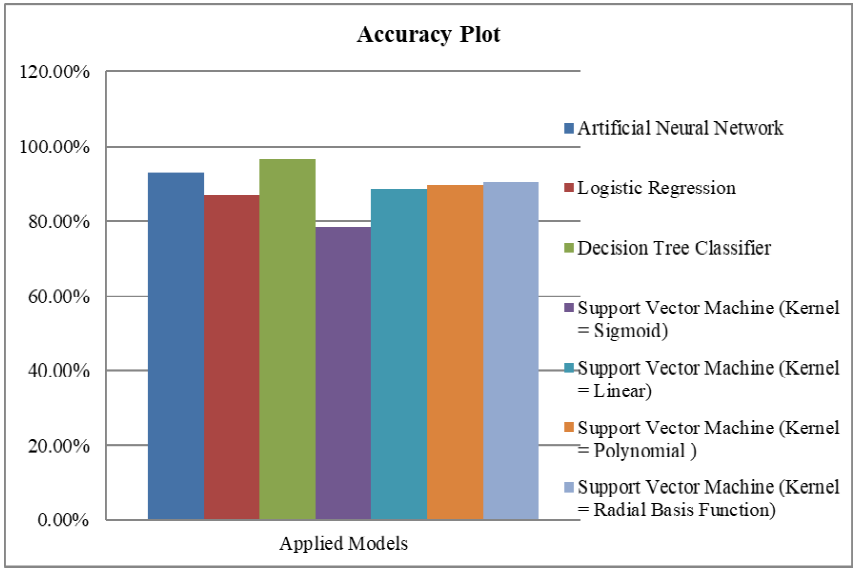

Figure 6: Result Analysis of different ML Models

The Heat Map highlights that as per our dataset the feature named steps (i.e. number of steps the person walked daily) and children (i.e. number of kids the person is having in his family) are highly correlated with the target variable named as the insurance claim in figure 7.

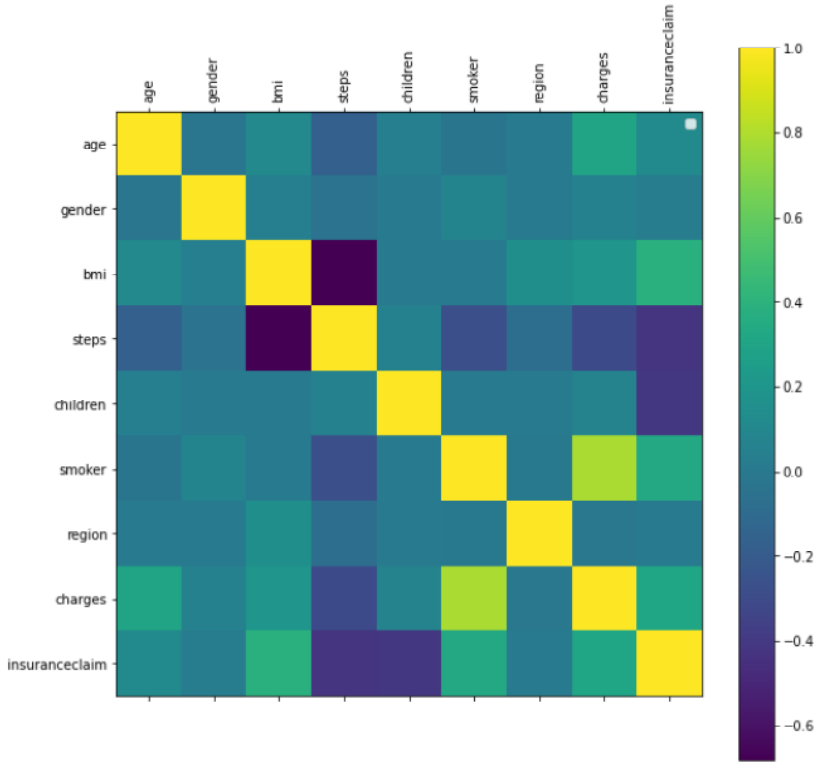

Figure 7: Different Attribute Co-Relation Process

6. Conclusion and Future Work

Medical care framework improvement is a vital errand for any nation to guarantee supportable medical services for each resident. However, the advancement is affected by various bearings, which ought to be

followed. Medical coverage costs are quite possibly the main direction for the improvement of the entire medical care framework. Examining and foreseeing the medical care protection costs is an extremely difficult assignment as a result of the enormous number of information where customary relapse techniques couldn't be helpful. To work on examining the medical services protection price in this review, the chosen strategy was performed with the principle objective of separating the main factors for the expectation of the medical services protection costs. The acquired outcomes showed that the decision tree classifier got the highest accuracy. The accuracy of the Artificial Neural Network Model is satisfactory but in the future, we can tune the parameters applied to increase the accuracy further.

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Nutrient uptake and yield of *Vigna radiata (L.) Wilczek* as influence by organic manures

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Abstract

Green gram is considered as one of the protein-rich pulses. After red gram and black gram, the most important crop in our country is the green gram (*Vigna radiata* (L.) Wilczek)which is commonly known as Mung bean. It is an annual plant with short harvesting periods and full of dietary proteins which is the common protein source for vegetarians. This crop improves soil fertility by the process of nitrogen fixation using bacteria rhizobium present in their root nodules. The objective of this study is to show the effect of organic manures on the growth and yield of mungbean and their nutrient content. Four levels of treatments were done to grow the mung bean plant i.e.,(a) Control

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T1- only Soil (b) T2- Soil + NPK (c) T3- Soil + Vermicompost (d) T4- Only vermicompost. However, the soil + Vermicompost (T3) in 1:1 ratio was significantly better for the improvement of stem length, root length and healthy leaves without hampering the soil quality.

Keywords: Mung bean, Nutrient, Organic manures, *Vigna radiata*, Vermicompost.

Introduction

India is the most wide-ranging pulses producer country in the world (Bhavya et al.,2018). *Vigna radiate* (L.) Wilczek (Green gram) is a member of the Fabaceae family and domesticated in the Indo-Pak subcontinent. It is a primary leguminous crop in our country after red gram and black gram. Mung bean is a hot season crop needing 3-4 months from planting to maturity. It is an annual plant with a short harvesting period and is suitable for many intensive crops (Singh et al., 2017; Jali et al., 2021). The pulses contain a rich source of proteins and amino acids which keeps the fertility of the soil through a process of nitrogen fixation by symbiotically associating rhizobium bacteria present in their root nodules. Agro-technical research conducted in organic production shows the usage of materials acquired from biotic waste with the help of some earthworms (Clive, 2006; Gutierrez-Miceli et al., 2007). The vital activity of the earthworms makes the soil more fertile (Karbauskiene,2000). The pulse crops are broadly used as a soil builder. Presently the major challenge for the scientists who are doing fieldwork for decreasing the application of inorganic fertilizers which greatly influence the quality of food as well as the surroundings with the soil (Dai et al., 2004; Rao et al., 2015). Although it is a principal crop, the average yielding of mung bean is entirely low as compared to the potency of its production which is a serious concern. The seed carries about 25% of protein, 0.7% fat, 10% fiber and 3.8% ash (Potter and Hotchkiss, 1997).

The key macronutrient of green gram plants is phosphorus, which constitutes up to 0.2% of plants' dry weight (Abbas et al.,2011). Phosphorus is the key ingredient of major molecules like nucleic acids, lipids of phosphate composition and ATP. Therefore, these herbs need a good amount of these for healthy growth. The metabolic path and enzymatic actions in the plants are carried away by the involvement of phosphorus (Theodorou and Plaxton, 1993). Studies revealed that seed development occurs due to the presence of phosphorus and provides a huge amount of food. It plays an important role in root extension and is correlated with the pre-maturation of crops. It enhances both the food quality and takes part in the immunity development of the plant (Brady and Weil, 1999). Although nitrogen is fixed symbiotically by the root nodules of the pulse plant, the addition of nitrogenous fertilizers in the initial stage of production results in the extension and yield of the crop faster (Ardeshana et.al., 1993). Nitrogen is mostly used in legumes production as having high protein content (Anon,2005). Potassium helps in maintaining the turgor pressure of the cell and eventually boosts cell growth by balancing osmotic pressure in plant cells and taking part in the process of photosynthesis, protein synthesis and also resistance to diseases (Tariq et.al.,2001). However, the insufficiency of these nutrients in the soil disrupts the metabolic and physiological activity within the plant (Babaeian et al., 2011). The requirement of these nutrients can be fulfilled via organic manures which are natural products. Green gram is an excellent source of nutritional therapy containing proteins for living beings including tribal persons and also for vegetarians (Gwin, 1978). A study was conducted on the comparison between organic manures and inorganic fertilizers, mainly the NPK fertilizers. They observed that many grains are cultivated by using the poultry manure @3.5 t/ha with respect to FYM @5 t/ha. Among the other four varieties of NPK highest yielding has been found by using @ 25-50-50Kg/ha. Hence, concluded that both the varieties have the same yielding capacity (Naeem et al., 2006). Another study

was conducted on the effects of plant and animal waste and chemical fertilizers on *Vigna radiata* L. yield under arid climate during hot seasons by taking varieties of the mixture of both the fertilizer. This study observed that the combination of both the fertilizers remarkably influences the yielding capacity of mung bean and the highest grain acquired by the implementation of 124 Kg DAP together with 10 tons/ ha of poultry liter (Abbas et al., 2011).

An experiment was conducted on how organic and inorganic fertilizers affect the growth, yield and nutrimental condition of green gram (BARI mung 5) by treating with organic fertilizer with approved doses of inorganic fertilizer. This shows that the composition of "10 t/ha vermicompost + 75% inorganic fertilizer (T8)" has the highest yielding with maximum numbers of pods and seeds and the lowest numbers have been found in the controlled one (T1) (Rupa et al., 2014). A study on how nutrient sources and bio-fertilizers impact on growth, yield and dealing of mung bean were carried out. It was done by taking a split-plot design (SPD) with 4 levels of nutrient sources in the main plot (control, 30:60:40 Kg N: P: K per ha, 10 t FYM per ha and 15:30:20 Kg N: P: K per ha + 5 t FYM per ha) and 4 levels bio-fertilizers in subplot (no biofertilizer, Rhizobium, phosphate solubilizing bacteria PSB + vesicular-arbuscular mycorrhiza VAM and rhizobium+ PSB+ VAM). A higher level of plant growth limit was observed in RDF 0.5 +FYM 5 t / ha used with the mixture of Rhizobium+ PSB+ VAM and height, growth and yield occur during the use of 15:30:20 Kg N: P: K per ha +5 t FYM per ha together with +PSB+VAM (Barakzai et al., 2019). The combined mixture of vermicompost and bio compost performs a better yielding in mung bean and increases the plant height, number of leaves, nodules, lengthy shoot, branches and long root. It was experimented with four equal-sized pots and marked as T1, T2, T3 and C. For the Viable agricultural process with organic fertilizer, this combined form of vermicompost and bio compost would be the better option (Manoharan and Ganesamoorthi, 2015).

Materials and methods

Conditions

The green gram seeds were collected from the local market and were sown in four different pots under four different treatments i.e., T1 (only soil), T2 (soil + NPK), T3 (soil + Vermicompost in 1:1 ratio) and T4 (only Vermicompost). The green gram seeds were sown in all four conditions in a wired house and the NPK fertilizer was given in T2 every week in lesser amounts.

Morphological study

Plants from each of the four pots were taken and their root and shoot length were measured. The primary and secondary leaves were counted and their length was also measured.

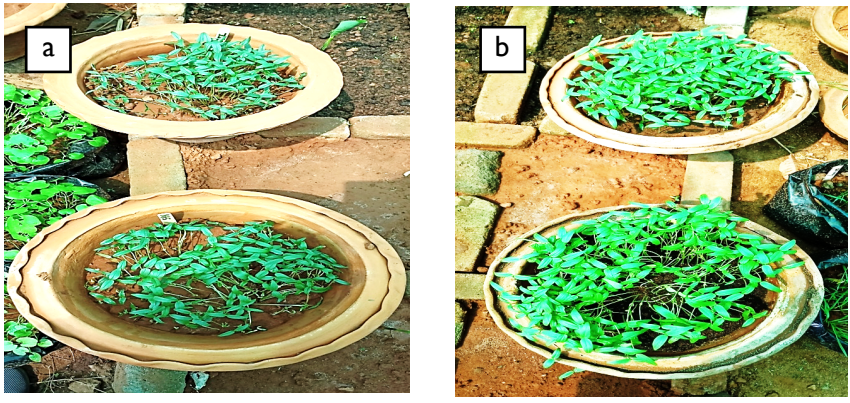

Fig 1 a & b. Representing the plant growth in the four pots under different conditions

Chlorophyll estimation

The chlorophyll estimation was done by using the UV-visible Spectrophotometer. 100 grams of fresh leaves were taken and suspended

in 10 ml of 80% acetone. Then mixed well with mortar and pestle and kept at 4p C overnight in dark. The supernatant was withdrawn after centrifugation at 5000 RPM and the data was recorded at 470 nm,663.2 nm and 646.8 nm (Panda et al., 2020)

Soil test

To know the chemical composition of the soil, soil samples of about 1 gram from each of the four pots were taken and were given to the chemical lab of Centurion University of Technology and Management.

Result and discussion

The result on *Vigna radiata* (L.) Wilczekyielding was put through a statistical overview and remarkable differentiation was observed through the treatments. The morphological study of the plants was measured in Table-1 and the Table-2 represents the chlorophyll content of the plant. The highest growth in shoot occurred in T4 pot (only Vermicompost)followed by T3 (Soil+ Vermicompost), T2 (Soil+NPK), T1 (Soil) and highest growth in root occurred in T3 (Soil + Vermicompost) pot in 1:1 ratio followed by T1 (Soil), T2 (Soil+ NPK), T4 (Vermicompost).

Morphological Analysis

The morphological traits such as the length of the root and shoot and a number of leaves were measured after 21 days. The vermicompost condition showed that the shoot length is 18.4 cm, root length is 2.1 cm, number of leaves are 5, number of primary and secondary leaves are 3 and 2respectively, length of primary and secondary leaves are 2.5 and 4.3 cm respectively. In the case of soil + vermicompost condition, the shoot length becomes 17.7 cm, root length is 4.2 cm, total leaves number count is 4 with an equal number of both primary and secondary

leaves, Length of primary and secondary leaves are 1.1 and 4.1 cm respectively. In the third pot soil + NPK is used and the shoot length becomes 13.2 cm, root length is 2.3 cm, the total number of the leaf is 2 with no primary leaf and two secondary leaves and the length of the secondary leaf is 4.2 cm. In only soil condition, the shoot length is 10.3 cm, the length of the root is 3.9 cm, the number of secondary leaves is 2 which is the total number of leaves with a length 4.0 cm (Table 1).

Table 1: The morphological study of *Vigna radiate* growth on different soil conditions

Plant traits	**T4 (Only Vermicompost)**	**T3 (Soil + Vermicompost)**	**T2 (Soil + NPK)**	**T1 (Only Soil)**
Shoot length	18.4	17.7	13.2	10.3
Root length	2.1	4.2	2.3	3.9
Number of leaves	5	4	2	2
Number of primary leaves	3	2	0	0
Number of secondary leaves	2	2	2	2
Primary leaf length	2.5	1.1	0	0
Secondary leaf length	4.3	4.1	4.2	4.0

Fig 2. Physical Traits of the Plant

Chlorophyll Estimation

The chlorophyll estimation of the mung bean plant was measured and showed that the content of chlorophyll a (chl a) is 1.01 mg / ml; chlorophyll b (chl b) is 0.36 mg / ml; the total number of chl a and chl b is 1.37 mg/ml and the ratio of both chl a and chl b is 2.80 mg/ml.

Parameters	Value
Content of Chl a (mg / ml)	1.01
Content of Chl b (mg /ml)	0.36
Chl a + chl b (mg / ml)	1.37
Chl a / chl b (mg / ml)	2.80

Table 2: Chlorophyll content of the plant

Soil analysis

The soil analysis of the controlled condition was done and found essential heavy metal oxides such as Fe_2O_3 (11.012%), CuO (114.3ppm), ZnO (106.7ppm), MnO (0.165%), NiO (137.7ppm), CaO (0.282%). Oxides of some toxic heavy metals are also found such as Al_2O_3 (20.545%), V_2O_5 (487.1ppm), Cr_2O_3 (269.6ppm), Ga_2O_3 (45.5ppm), As_2O_3 (3.6ppm), SrO (40.1ppm), PbO (88.7ppm). The highest metal oxide element found was SiO_2 i.e., 63.070%.The soil analysis of Soil: Vermicompost in 1:1 ratio was also carried out and found that the highest metal oxide element was SiO_2 (62.491%). Toxic heavy metals oxides were also found such as Al_2O_3(19.265%), V_2O_5(525.5%), Cr_2O_3(240.1ppm), Ga_2O_3(50.2ppm), As_2O_3(19.8ppm), SrO(45.1ppm) and PbO(74.9ppm). CaO(0.515%), MnO(0.213%), NiO(140.6%), CuO(132.9ppm), ZnO(151.7ppm) and Fe_2O_3(11.176%) are nutrient metals which is essential for plant growth.

Conclusion

The above experiments were performed to know about the impact of various fertilizers on the growth of the Mung bean (*Vigna radiata*) plant. Among the four treatments, it was noticed that the excessive shoot length was found in the use of only vermicompost and the excessive root distance was shown by the plant which was grown in soil and vermicompost treatment.

Authors contribution

GM: Conceptualization and designing the work; GD & APM (Equal contribution as the first author): Collection, interpretation of data; BJ, APM & GD: Editing as per Journal format and reviewing the article; All authors approved the final version of the manuscript.

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