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Preface

We would like to present, with great pleasure, the inaugural volume-10, Issue-4, April 2024, of a scholarly journal, *International Journal of Environmental & Agriculture Research*. This journal is part of the AD Publications series *in the field of Environmental &Agriculture Research Development*, and is devoted to the gamut of Environmental & Agriculture issues, from theoretical aspects to application-dependent studies and the validation of emerging technologies.

This journal was envisioned and founded to represent the growing needs of Environmental & Agriculture as an emerging and increasingly vital field, now widely recognized as an integral part of scientific and technical investigations. Its mission is to become a voice of the Environmental & Agriculture community, addressing researchers and practitioners in below areas.

Environmental Research:

Environmental science and regulation, Ecotoxicology, Environmental health issues, Atmosphere and climate, Terrestric ecosystems, Aquatic ecosystems, Energy and environment, Marine research, Biodiversity, Pharmaceuticals in the environment, Genetically modified organisms, Biotechnology, Risk assessment, Environment society, Agricultural engineering, Animal science, Agronomy, including plant science, theoretical production ecology, horticulture, plant, breeding, plant fertilization, soil science and all field related to Environmental Research.

Agriculture Research:

Agriculture, Biological engineering, including genetic engineering, microbiology, Environmental impacts of agriculture, forestry, Food science, Husbandry, Irrigation and water management, Land use, Waste management and all fields related to Agriculture.

Each article in this issue provides an example of a concrete industrial application or a casestudy of the presented methodology to amplify the impact of the contribution.We are very thankful to everybody within that community who supported the idea of creating a new Research with *IJOEAR*. We are certain that this issue will be followed by many others, reporting new developments in the Environment and Agriculture Research Science field. This issue would not have been possible without the great support of the Reviewer, Editorial Board members and also with our Advisory Board Members, and we would like to express our sincere thanks to all of them. We would also like to express our gratitude to the editorial staff of AD Publications, who supported us at every stage of the project. It is our hope that this fine collection of articles will be a valuable resource for *IJOEAR* readers and will stimulate further research into the vibrant area of Environmental & Agriculture Research.

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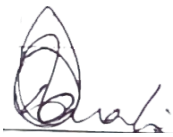

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Animal Science	Agricultural Economics
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Sustainable Natural Resource Utilisation	Management of the Environment
Agricultural Management Practices	Agricultural Technology
Natural Resources	Basic Horticulture
Food System	Irrigation and water management
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Maple syrup	Forestry Growth
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Android Phone Controlled Conceptual Prototype Model of Solar Powered Sanitization Machine

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Abstract**—** *The project titled "Android Phone Controlled Prototype Model of Solar Powered Sanitization Machine" presents a methodology for analyzing, fabricating, developing, controlling, and enhancing a Mechatronic Machine controlled by a Mobile Application. This machine finds applications in various public settings such as hospitals, schools, and colleges, particularly in rooms and corridors. Given the challenges posed by the Covid-19 pandemic, maintaining social distancing is imperative due to the virus's propensity for deeper penetration into the respiratory system, potentially causing inflammation and respiratory distress.*

The primary objective of this project is to develop a prototype model of a four-wheeled Mobile Application-controlled Mechatronic Machine, designed using Atmel Studios (Version 7.0). This Mechatronic Machine is operated via Arduino or NodeMCU ESP32 pins directly from Android smartphones, eliminating the need for manual code writing. The control system includes a Motor Control Shield and a dedicated mobile application interface. Additionally, the machine incorporates a solar panel for recharging its battery, enhancing its sustainability.

Keywords— Sanitization, Machine, Solar Power, NodeMCU ESP32, Mobile Controlled.

I. INTRODUCTION

Multi-Functionality Agile Robot System (MARC-bot) has for the first time used by US police to kill a sniper. Also, during the NASA Sample Return Robot Centennial Challenge, one of the robots displayed successful autonomous navigation, decision making, sample detection, retrieval, and return capabilities. Robots are also developed to work under extreme conditions of offshore oil and gas installation. Today Omni-channel and e-commerce need hug labour and therefore mobile robots are needed to automate these things to lessen complexities. The fast development of mobile robots with less dependence on the guidance system has been due to the huge need for piece-picking in e- commerce. Nowadays robots are being used in almost every sector including logistic facilities, the service sector, e-commerce, a wide range of supply chains, in our daily household lives, etc.

Joseph Engelberger played an important role in the history of mobile robotics and developed the first commercially available autonomous mobile hospital robots. In 1993-

1994 Dante I and Dantae II were developed to explore live volcanoes. In 1995 Ernst Dickmann drove his robot car for 1000 miles in traffic up to a speed of 120mph. In 1996- 1997, NASA sent the Mars Pathfinder along with its rover Sojourner to Mars which was expected to explore the surface and find its way in unknown terrain. In 1999, Sony introduced Aibo which was a robotic dog capable of seeing, walking, and interacting with its environment. **(Engelberger., 2015) Darmawan and Budiyanta (2020)** developed a multiplatform robot that can be used asa medium to socialize robotics technology among adolescents. This multi-platform robotis also expected to help teens who are interested in robots to facilitate them in learning

robotics technology. **Barua et al. (2020)** designed an automatic guided vehicle. In their project, a L293D motorshield was used to detect line also prevent edge and setback path. **Chaudhari et al. (2019)** designed a task and follower robot which used Arduino IDE based on Atmel microcontroller. Arduino IDE is used to program the Arduino board. It is able to simulate input and in return produces an output. **Vamsi et al. (2019)** designed a line follower robot to carry products in the manufacturing process in industries which was light in weight and equipped with 5 sensors to work upon different complex paths during the industry or workshop. They used black detector infrared sensors so that speed of response of the robot is high. The use of various mechatronic components such as Arduino UNO, 7805 voltage regulator, Infrared sensors (Black Detector), Battery 12V, Breadboard, Motor Driver were applied.

TABLE 1
PRINCIPLE COMPONENTS OF MECHATRONIC ROBOT CONTROLLED THROUGH WI-FI HOTSPOT

1. NodeMCU Development Board	9. DC Gear Motors
2. ESP8266 Wi-Fi Soc	10. Diode
3. B Type USB Cable (for program upload through computer)	11. Electrolytic capacitor
4. Servo Motor	12. Regulator- I.C
5. USPASP Programmer	13. Motor Chassis.
6. Solar Panel	14. Wheels
7. Battery	15. D.C Tullu pump
8. Motor Driver Module- L298D	16. L.E.D

II. METHODOLOGY

In the project, it was supposed to make the robot by the following method, but due to pandemic, the work had been not done on hardware. The detailed functionality of the various components had enlisted using the diagrams as shown in fig 3.12. Blynk software had been used for writing the C program which is supposed to run on Proteus Design Suite version 8.0. The circuit connection depends on the port configuration of Arduino ESP8266 NodeMCU microcontroller IC. It had been mounted on Arduino ESP8266 NodeMCU. Development Board, including DC motors L298N, L298D motor driver module, mobile hotspot module and the connections had been established. The details of exact working process and other components had been given. Only simulation and programming part had been performed.

In this project water sensor had been used for sanitization purpose and it is controlled by Arduino using Blynk app on a smartphone. Using this implementation, it can control an Arduino board-based machine from anywhere in the world. The NodeMCU ESP8266 microcontroller provides the necessary signal to the DC Motor Driver to run the robot in forward, left, right, reverse direction and to stop it respectively each for 2 minutes. The communication was set up between Internet Wi-Fi module and Android Smart Phone successfully. The communication channel between Internet Wi-Fi module and NodeMCU ESP8266 Microcontroller took place through USART serial communication protocol as shown in fig 4.1 and 4.2. The programming has coded on Atmel Studios Version 7.0 and run on Proteus 8 design suite for simulation of the circuit desired. And finally using USBASP programmer it was written on NodeMCU ESP8266 microcontroller.

2.1 Developed a conceptual prototype model of sanitization machine:

Finally, a prototype model had made manufactured with the above-mentioned concept and methodology. The model finally able to persue is required, sanitizing the environment, and designed an automatic sanitizer system that is compatible with various containers. When clicked the pump button it's close to the device sensor, the sanitizer container opened while pumped once. A novel design and subsequent fabrication of a low-cost, touchless, automated sanitizer dispenser to be used in public places, was demonstrated. The overall performance of the manufactured device was analyzed based on the cost and power consumption, and environmental factors by deploying it in busy public places as well as in indoor environment in major cities in country, and found to be more efficient and cost-effective compared to other dispensers available in the market. A comprehensive discussion on this unique design compared to the conventional ultrasonic and infra-red based dispensers, is presented to show its suitability over the commercial ones. The guidelines of the World Health Organization are followed for

the preparation of sanitizer liquid. A clear demonstration of the circuitry connections is presented herein, which facilitates the interested individual to manufacture a cost-effective dispenser device in a relatively short time and use it accordingly.

FIGURE 1: Final Mechatronic Machine Top View

FIGURE 2: Final Mechatronic Machine Side View

III. CONCLUSION

"Android Phone Controlled Prototype Model of Solar Powered Sanitization Machine" was developed for sanitization purpose. It works with the help of the battery and solar. The machine can choose the driving method and anyone of its medical operations automatically according to the needs. In this section the recent work had been analyzed which can be characterized as AI Robotics, by arranging it into the two basic issues in robot design Action and Perception. This research is a research development that aims to make a multiplatform robot as a medium for the introduction of technology among adolescents. They're used to deliver communications and drugs in a hospital. It can be suggested to run autos, mass transport systems and freestanding autos which navigating the road. They can be used in service as mole sprats, shop bottom, etc. While, investigators are working on ways to help machine move and suppose more efficiently. Since paramount robots in use now are designed for specific tasks, our meaning is to ultimately make universal robots that are flexible enough to do just about anything a human does and farther.

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AUTHORS' CONTRIBUTION

Kartikey Pandey: Conceptualization, Methodology, Software

Gargi Shekhar: Writing – Original Draft Preparation, Formal Analysis, Investigation

Anshuka Srivastava: Methodology, Validation, Writing – Review & Editing

Happy Narang: Writing – Original Draft Preparation, Formal Analysis, Investigation

CONFLICT OF INTEREST

"The authors declare no conflict of interest".

DATA AVAILABILITY STATEMENT

"Data will be made available on request".

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Sustainable Abstraction of Bio-Polymer from Seafood Trash used for Soil Drenching and Analyzed for the Plant Growth Enhancer

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Abstract— *In worldwide distribution, chitin, which is present in crustacean shells, is the second most prevalent natural polymer. Chitosan is a natural amino-polysaccharide derived from chitin, with exceptional biocompatibility, biodegradability, and non-toxicity properties. Due to its characteristics and potential uses in sustainable agriculture, regenerative medicine, etc., chitosan has attracted much attention, resulting in an increasing number of publications and patents each year. This study's objective is to synthesize and characterize nanochitosan from waste seafood, especially blue crab (Callinectes sapidus). The prepared nanochitosan by high energy ball-milling method using sea species waste was synthesized and characterized for morphology, pore size, porosity, functional group, crystallinity, and thermal analysis determination by SEM, BET, FTIR, XRD, and DSC. All the characterization data were related to commercial chitosan and confirmed the structure and properties of chitosan. The results provide better in their nano-size and are further associated with the degree of crystallinity in physicochemical properties compared to the commercial chitosan. The prepared nanochitosan is more beneficial for environmental applications like agriculture due to its biodegradability. In comparison to commercial chitosan, the application of nanochitosan in soil yields excellent results in terms of moisture content, water holding capacity, total nitrogen, and carbon, which are 39%, 84%, 3.1g/kg, and 47.7g/kg, respectively.*

Keywords— Natural polymer, Nanochitosan, Commercial chitosan, Physical Characterization, Environmental application.

I. INTRODUCTION

Chitosan is a biopolymer formed from chitin, which is present in crustacean exoskeletons such as crabs and shrimp. Chitosan is a natural and linear polysaccharide derived from chitin by a chemical process that includes deproteinization, demineralization, and decolorization, and it is made by deacetylating chitin, which involves removing the acetyl groups from the polymer chain. (Figure 1). Chitosan has become beneficial and highly appreciated as a natural biodegradable high molecular polymer chemical that is a non-toxic and bioactive agent due to its fungicidal activities and elicitation of defensive systems in plant tissue. Chitin and chitosan are both polysaccharides that are chemically identical to cellulose, with the only difference being the presence or absence of nitrogen, which is absent in cellulose (Bautista-Baños et al., 2006). Chitin, a linear polysaccharide comprised of (1-4)-linked 2-acetamido-2-deoxy-b-D-glucopyranose units (Hu et al., 2007) (Dutta et al., 2002), is nature's second most common type of polymerized carbon. Even though it is not present in organisms that produce cellulose, it is classified as a cellulose derivative. It has a similar structure to cellulose, but it has an acetamide group ($-NHCOCH_3$) at the C_2 position. Molluscs, crustaceans, insects, fungi, algae, and other creatures make around 10 billion tons of chitin each year.

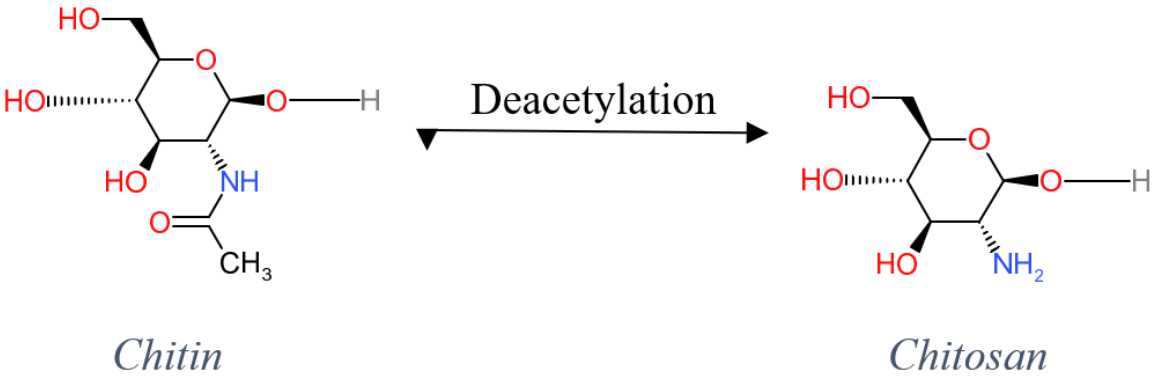

FIGURE 1: Structure of Chitosan after deacetylation from Chitin

The blue crab (*Callinectes sapidus*) (Figure 2) has a natural range that extends from Nova Scotia to northern Argentina, including Bermuda and the Antilles. The life cycle of blue crabs is similar to that of other estuarine-dependent species in the Gulf of Mexico. The blue crab sustains one of the Gulf of Mexico's most important commercial and leisure fisheries. Blue crabs were traditionally exploited by locals for immediate consumption; nevertheless, the first commercial mud crabs eventually reached local markets and formed a major component of the local crab fishery (Ikhwanuddin et al., 2011). Crab flesh is used in a variety of ways in the food business, including as an ingredient in culinary items. However, the crab shell is also beneficial in terms of cancer prevention and as a natural weight loss supplement. Chitosan, a polysaccharide, is also found in crab shells.

FIGURE 2: Blue crab *(Callinectes sapidus)*

Chitosan is the resultant material, and it has several unique features that make it valuable in a range of applications. When chitosan comes into contact with water, it forms a gel-like material, which is one of its most remarkable features. Because of its features, it is beneficial in a variety of sectors, including food packaging and wastewater treatment. Chitosan also possesses antibacterial characteristics, which make it valuable in medicinal applications such as wound healing and drug delivery. Furthermore, chitosan has been demonstrated to have potential use in agriculture, where it may be utilized as a natural pesticide or fertilizer. Because of its biodegradability, cationic nature, film-forming capacity, antibacterial characteristics, chelating capabilities, water-holding capacity, pH sensitivity, biocompatibility, and adhesion qualities, chitosan is a flexible and important agent in agriculture. It may be used to enhance soil, control disease, regulate nutrients, and promote sustainable agricultural methods. Its features are pH-adjustable, making it appropriate for organic and sustainable activities. Researchers are always looking for new methods to exploit its benefits for better agricultural yield and environmental sustainability. The degree of N-acetylation (DA) of chitosan determines its characterization, which affects not only its physicochemical properties but also its immunological activities (Mahlous et al., 2007). The functional qualities of chitin and chitosan are influenced by

physicochemical parameters, which vary depending on the crustacean species and method of manufacture. The physicochemical characteristics of various preparations will differ, particularly the degree of deacetylation, solubility, viscosity, and molecular weight. To efficiently use chitinous products for specific applications, the functional characteristics of chitin and chitosan products should be carefully evaluated (Cho et al., 1998). The presence of free amine groups throughout the chitosan chain affects its solubility, allowing it to dissolve in diluted aqueous acidic solutions.

Chitosan derived from crab shells has been shown to have several agricultural advantages. One significant advantage is its ability to improve soil structure by boosting porosity and water-holding capacity. This promotes root growth and nutrient absorption in plants. Chitosan has been found to improve plant development by promoting seed germination and boosting plant biomass, in addition to improving soil structure. It can also assist in minimizing the demand for artificial fertilizers by increasing the availability of nutrients in the soil.

Chitosan stimulates several defensive mechanisms to increase plant tolerance to a wide range of biotic and abiotic stresses, including drought, cold, salt, and water-related difficulties.(Ali et al., 2021) It has been proven that chitosan treatment increased chlorophyll content, hence increasing tomato growth under salt-induced stress conditions. (Wang et al., 2021) Under salt stress, maize height, and main root length were dramatically reduced, whereas shoot and root dry weights were both reduced, and sodium absorption increased. Salt stress dramatically reduced maize seedling photosynthesis, including photosynthetic rate, stomatal conductance, intercellular CO_2 concentration, and transpiration rate. (Jiao et al., 2024)

The use of chemical fertilizers to improve soil nutrition has increased agricultural production in recent decades (Mącik et al., 2020). However, there are numerous known disadvantages to continuously applying chemical fertilizers to the soil, such as increasing irrigation requirements, suppressing phyto-beneficial microbes in the soil, and negatively impacting soil ecology, despite some additional benefits, such as ease of handling and predictable results (Bisht and Chauhan, 2020). Simultaneously, the physical, chemical, and biological health of arable land has deteriorated due to excessive chemical use and changes to traditional agricultural methods(Chaudhary et al., 2020). As a result, with dwindling land resources and soil biological potential, the health of diverse agricultural production systems, as well as total biological resources, require proper attention. Under these circumstances, there is a compelling case for using microorganisms in integrated plant management systems to improve plant performance (Saberi-Riseh and Moradi-Pour, 2021). Chitosan, being a polysaccharide, works as a bioremediation molecule, stimulating the activity of beneficial soil microbes such as *Bacillus spp*., fluorescent *Pseudomonas spp*., *Actinomycetes*, *Mycorrhiza*, and *Rhizobacteria*. This affects the rhizosphere's microbial balance, favoring beneficial bacteria. Bioremediation of soil disturbed with a variety of heavy metals was helped by chitosan treatment in conjunction with mycorrhizal inoculation (Angelim et al., 2013). It encapsulates a consortium of various PGPR within chitosan aided in delivery while also stimulating the development and activity of the bacteria for bioaugmentation and biostimulation of hydrocarbon-polluted soils. *Bacillus subtilis* is a fungal pathogen and one of the most extensively used biopesticides in agriculture. *B. subtilis* produces chitinases in its growth media (Chen et al., 2010). The addition of chitosan to the carrier material increased *B. subtilis* multiplication and fungicidal effect, as well as the control of Fusarium wilt in pigeon pea and crown rot in peanut induced by *Aspergillus niger*. The addition of chitosan increased *B. subtilis* effectiveness against powdery mildew in strawberries (Lowe et al., 2012). It also improves soil water retention behavior by indirectly conditioning the soil (Pandey and De, 2017).

The microorganisms included in biofertilizers maintain the earth's natural nutrition cycle while increasing soil organic matter. Using biofertilizers leads to cultivating healthy plants while also enhancing soil health and sustainability. Chitosan-encapsulated microbial biofertilizer benefits tomato crops by improving nutrient absorption, disease resistance, and root growth. (Isabel et al., 2024). Overall, the usage of chitosan in agriculture has the potential to raise crop yields while also improving soil health over time. The current study aimed to develop value-added products from blue crab waste in the extraction and processing of chitosan, as well as their influence on soil drenching with plant growth enhancement.

II. MATERIALS AND METHODS

2.1 Materials

Blue crab shells (*Callinectes sapidus*) were obtained from Central de Pescados y Mariscos, La Nueva Viga market, in Mexico City. The crab shells were completely cleaned, washed, and dried under sunlight. Commercial chitosan with medium molecular weight, catalog number 448877 was from the Sigma-Aldrich company ltd. All the other chemicals used were analytical grade. Soil used for drenching is procured from the garden of CINVESTAV without any addition of fertilizer. The tomato seeds and the germination tray were purchased from the hydro environment shop.

2.2 Methods

2.2.1 Extraction of chitosan

Mechanical pulverizing method: The dried crab shells and commercial chitosan were made into coarse powder and kept in a high-speed shimmy ball mill (model number LB60G-2S0007BER) separately for 8 hours at 550rpm/m and resting for 5 hours, again 3 hours at 550rpm/m to make it as a nanopowder.

Demineralization: The crab shell powder from the pulverizing method was treated with 1N HCl at 1000rpm/ 80°C for 24 hours to remove all the mineral content. The sample was then filtered and washed with distilled water for 30 minutes until it reached a neutral pH (=7). The demineralized crab shell powder was dried for 24 hours (Shimahara and Takiguchi, 1988).

Deproteinization: The demineralized shell powder was treated with 1M NaOH with constant stirring for 15 hours at 100°C to remove all the proteins. The sample was then filtered and washed for 30 minutes with distilled water until it reached a neutral pH (=7). The deproteinized nano crab shell powder was dried for 24 hours to obtain chitin (Abdou et al., 2008).

Deacetylation of chitin: The deacetylation of chitin was then conducted according to the method by (Yen et al., 2009). The chitin obtained was treated with 40 % (w/w) aqueous sodium hydroxide (NaOH) at 110°C for 3 hours. Then, the chitin was filtered and washed with deionized water until neutral pH to obtain the chitosan. The obtained chitosan was then dried for 24 hours for further studies and analysis.

2.2.2 Characterization of chitosan

Yield of chitin and chitosan: Chitin yield was calculated by dividing the weight of extracted chitin by the initial dry crab shell weight, and chitosan yield was calculated by dividing the weight of produced chitosan by the dry chitin weight before deacetylation (Demir et al., 2017). The following yields were calculated:

$$\text{Yield of chitin (\%)} = [\text{Extracted chitin (g)}/\text{Crab shells (g)}] \times 100 \quad (1)$$

$$\text{Yield of chitosan (\%)} = [\text{Produced chitosan (g)}/\text{Chitin (g)}] \times 100 \quad (2)$$

2.2.3 Determination of degree of deacetylation

The direct titration method was used to determine the degree of deacetylation of chitosan extracted from blue crabs, which was conducted according to the method by(Kjartansson, 2008) with some modifications. Chitosan samples (0.1 g) were dissolved in 25 ml of 0.06 M HCl for 1 h at room temperature. The solutions were diluted to 50 ml before being titrated with 0.1 N NaOH to pH 3.75 under constant stirring. The volume of NaOH at pH 3.75 was acquired and recorded. Titration was continued to pH 8 and the total volume of NaOH (0.1 M) was recorded. The degree of deacetylation was then calculated using the following equation.

$$DD = \frac{161.16 \times (v_2 - v_1)N}{w_1} \quad (3)$$

Where, 161.16 is the mass of the chitosan monomer, V_1 and V_2 are the volumes of NaOH solution used, N is the strength of the NaOH solution (0.1 N) and W_1 is the mass of the sample after correction for moisture. The degree of deacetylation (DD) of the samples was determined in triplicate.

2.2.4 Instrumentation

A Varian 640-IR spectrophotometer detected FTIR spectra of materials. Spectral scanning was acquired in a wave number ranging from 4000 to 400 cm^{-1}. XRD patterns were obtained with the Bruker D8 Advance eco. X-ray diffractometer operating at 40kV and 30mA producing CuKα with $\lambda_{1/2}$ = 1.5416 Å. Micrographs were obtained with JOEL JSM-7401F. SEM images were obtained at 100, 500, and 30,000x magnifications. DSC analysis was done by using a TA Instruments Q2000 calorimeter under a high-purity N_2 atmosphere. The heating rate was 5 $Kmin^{-1}$, and the sample mass was weighed in Mettler-Toledo UMX2 microbalance. The specific surface area, pore size, and pore volume of the extracted chitosan were investigated using TriStar 3000 Plus, Surface Area and Pore Size Analyzer (Micromeritics Instrument Co., Ltd, America) with an N_2 adsorption-desorption method under 0.08 MPa.

2.2.5 Soil Drenching

The soil drenching process was carried out by adding chitosan solution with a 60mg/ml concentration in the soil without any addition of commercial fertilizer. The extracted chitosan was mixed with 1% glacial acetic acid in 99ml of distilled water and the pH was adjusted to 6.5 using NaOH. Control is used without the addition of chitosan. (In patent process)

2.2.6 Soil analysis

2.2.6.1 pH

In a beaker, 10 g of soil is weighed and 25 ml of distilled water is added. Approximately for 10 minutes it was shaken with a magnetic stirrer and allowed for a 10-minute resting period. Using a pH meter, it was calibrated and readings were taken.

2.2.6.2 Moisture content

Weighed a dry and clean empty container, such as a petri dish lid (weight A). The container is later filled with soil and the combined weight of the container and soil (weight B). Keep the Petri dish and soil in a 105 °C oven for 24 hours. Allow the sample to cool to room temperature. Fill the container halfway with dry soil (weight C).

(B - A) = initial wet sample weight (4)

(B - C) = denotes the initial water content (5)

$$\text{Water content percentage} = \frac{(B-C)}{(B-A)} \times 100 \quad (6)$$

2.2.6.3 Water holding capacity

Place a defined amount of soil (20 g), of known moisture, on a piece of paper previously weighed filter on a funnel, containing glasses in the lower part to receive the drained water. Saturate both the soil and the filter paper with distilled water. Add a little excess distilled water (approx. 10 ml). Simultaneously run blanks with only filter paper, previously weighed, added with enough distilled water to saturate, and a little more. Cover both the sample and the filter papers with aluminum foil to avoid water evaporation. Let the excess water drain for 24 hours. Weigh the soil together with the filter paper and the retained water. Also, weigh the water-saturated filter papers and calculate the water retention factor. water per filter paper (weight of wet filter paper divided by the weight of dry filter paper). It is usually 3.2 or higher. Calculate the Water Retention Capacity, subtracting the weight of the filter paper by its factor and the dry weight of the soil (weight of the soil sample x (1- moisture fraction)) at the total weight drained (soil + water retained by the soil + filter paper + water retained by the filter paper). Divide this result by the dry weight of the soil and multiply by 100 if expressed as a percentage, or per 1000, if it is expressed per 1000 g (kg).

2.2.7 Soil type

Weigh 50 g of soil. Add approx. 600 mL of distilled water and place in the glass of the blender 10 mL of the dispersant (Sodium hexametaphosphate solution 50 g/L). Shake for 2 min. Transfer to a 1 L measuring cylinder and dilute with distilled water. Shake by inversion for 1 min to homogenize, rest for 40 sec, and take the first reading of Temperature (T_1) and hydrometer. Let stand for 2 hours and take the second reading of the hydrometer and Temperature (T_2).

Silt % + clay % = 1st reading + (T_1-20) x 0.36 x100 g of soil (7)

% Sand = 100 – (% Silt + % Clay) (8)

$$\%\ Clay = \frac{\text{2nd reading + (T2}-20) \text{ x 0.36 x 100}}{Gram\ of\ soil} \quad (9)$$

2.2.8 Total nitrogen

Weigh 2 grams of soil and place it in the tube of the Kjendal. Weigh 3 blanks (reactive only). Add 1 gr. potassium sulfate powder, 1 pinch (1/3 g) of copper sulfate, and 10 ml of the H_2SO_4 to each tube including blanks. Place the tubes in the digester. This is ignited and brought to 120°C, and the vacuum is opened (watch for large bubbles, the valve is opened approximately ¾). Then every 30 minutes the temperature is raised in blocks of 80°C up to 320 °C. Turn off the appliance to stop the digester. Wait for the temperature to drop to 90°C and raise the tubes so that the grill cools faster, it takes about 1 hour. close the void. The samples are placed for 3 days (8 h day^{-1}) to digest. Distilled H_2O is added to detach the material from the tube, if it does not detach, heat the bottom of the tube with a lighter. The contents of the tube are placed in a 500 ml flask, brought to 200 ml with distilled H_2O, distilled, and titrated with 0.01 N HCl at the first color change.

2.2.9 Total Carbon

The soil was milled and homogenized using a mortar. A sample of 200 mg of dry soil was weighed.

The Total Organic Carbon was determined by a TOC-VCSN carbon analyzer (Shimadzu, Canby, USA). This method is based on the complete combustion of Organic Carbon to CO_2 and then measured by an Infrared Analyzer.

2.2.10 Preparation of seeds for sowing

The seeds were surface sterilized with sodium hypo chloride and then washed continuously with distilled water in a beaker. After that, it was kept at room temperature overnight and sown in the soil.

2.2.11 Planting of seeds

The germination trays were watered and 3 seeds per each cavity were sown with a spacing of 1cm apart and observed for germination.

III. RESULTS AND DISCUSSION

3.1 Extraction:

The experiment procedures were done in triplicates and all the results were reported with average in standard deviation. Blue crab (*Callinectus sapidus*) shells were used as the starting material for extraction in this study (Figure 3). The key components of the crab shells were chitin, protein, and calcium carbonate, which were around 30%, 16%, and 55% as w/w, respectively, indicating that calcium carbonate made up a large portion of the crab shells (Yihun et al., 2020). The (International, n.d.) AOAC (1990) procedures were used to determine the chitin and chitosan yield, which ranged from 43.34±0.69% and 45.01±1.06% in this study. According to earlier research, the yield of chitosan produced from *Matuta lunaris* shells ranged from 24.04 to 34.5% (Haziman Abdullah et al., 2019). *Pachygrapsus mamoratus* yielded 17% and *Sesarma plicatum* yielded 41.37%, respectively (Hossain and Iqbal, 2014). The yield of chitosan extracted from shrimp and crab shells (deacetylated using 65% (w/v) sodium hydroxide, NaOH, at 30 °C for 3 days) was 46% (Rajendran et al., 2015). The yield of chitosan produced in this study is comparable to or less than that achieved in earlier investigations, which may be influenced by the high mineral content of *Callinectus sapidus* shells.

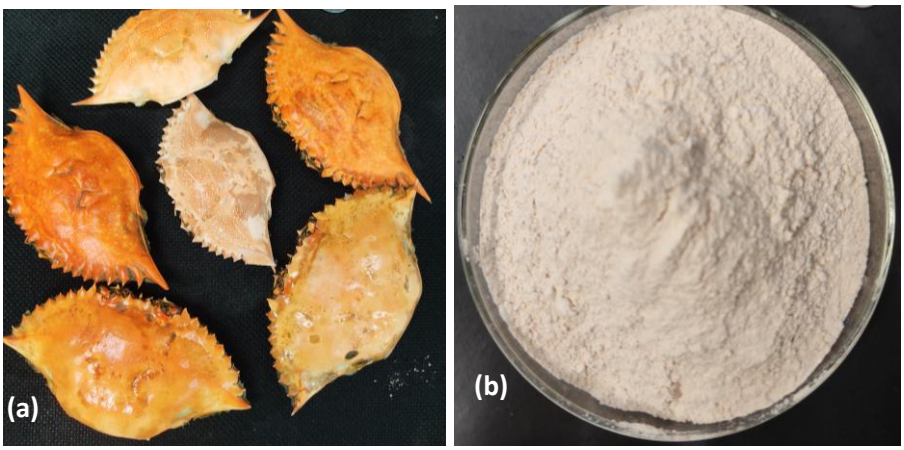

FIGURE 3: (a) Dried crab shell (*Callinectus sapidus*) (b) Extracted chitosan

3.2 Degree of deacetylation (DD)

The chitosan degree of deacetylation, DD, is a measure that reflects the molar proportion of glucosamine monomeric units and ranges from 0 (chitin) to 100 (completely deacetylated chitin). The DD of chitin/chitosan is the most critical characteristic that impacts their biological, physicochemical, and mechanical properties, and hence the efficacy of chitosan and its derivatives (Pérez-Álvarez et al., 2018). Deacetylation removes acetyl groups from the molecular chain of chitin, leaving behind a molecule (chitosan) with a high degree of chemically reactive amino group ($-NH_2$) (Baskar and Sampath Kumar, 2009). In any event, the degree of deacetylation (DDA) may be used to distinguish chitin from chitosan since it determines the concentration of free amino groups in the polysaccharides (Sarbon et al., 2015). DDA is a characteristic that influences chitosan properties such as chemical reactivity, covalent bonding ability, solubility, viscosity, and biodegradability (Lamarque et al., 2005) (LERTSUTTHIWONG et al., 2002). In this study, the degree of deacetylation of commercial chitosan was 78.69±0.0045 % which is less than the Chitosan extracted from blue crabs at 90.12±0.0014 %. Depending on the source and preparation method,

the degree of deacetylation (DD) might range from 30 to 95% (Di Martino et al., 2005). The degree of deacetylation values is highly dependent on the source and technique of purification, as well as the kind of analytical methods utilized, sample preparation and equipment type used, and a variety of other circumstances that may impact the degree of deacetylation analysis (No et al., 2002).

3.3 Fourier transform infrared (FTIR)

Extracted chitosan had some similar functional groups as commercial chitosan. The O-H stretching band in extracted chitosan was exhibited at 3514.91cm $^{-1}$, indicating the alcohol group in the chitosan. According to ("Organic Chemistry: A Lab Manual - PAVIA ET.AL: 9788131512432 - AbeBooks," n.d.)Pavia et al. (2009), the alcohol group (O-H band) was found to be between 3,650 cm^{-1} and 3,200 cm^{-1}. The C-O stretching band measured 1017.23cm^{-1}, while the commercial chitosan stretching band measured 1023.80cm^{-1}. Furthermore, the stretching band of N-H in the extracted chitosan was in the range of 3111.91cm^{-1}, whereas the stretching band for N-H in commercial chitosan was in the range of 3260.46cm^{-1}. According to ("Organic Chemistry: A Lab Manual - PAVIA ET.AL: 9788131512432 - AbeBooks," n.d.)Pavia et al. (2009), the amine group (N-H stretching bands) absorbs infrared between 3,500 cm^{-1} and 3,100 cm^{-1}. The bending band of N-H in the extracted chitosan was in the range of 1562.24cm^{-1}, whereas the bending band for N-H in commercial chitosan was in the range of 1565.52cm^{-1}. The amine group (N-H bending bands) absorbs infrared between 1640 cm^{-1} and 1550 cm^{-1} ("Organic Chemistry: A Lab Manual - PAVIA ET.AL: 9788131512432 - AbeBooks," n.d.). The peak at 2718.74 cm^{-1} and 2934.61 cm-1 reveals the C-H for commercial and extracted chitosan, according to Li, Weng, Wu, and Zhou (1998). When the spectra in Figure 4 are examined, the little peak at 1465.92 cm^{-1} and 1375.99 cm^{-1} is assigned as -CH^2, 1375.12 cm^{-1}, and 1450.64 cm^{-1} are the peak that shows -CH^3 groups for commercial and extracted chitosan ("Organic Chemistry: A Lab Manual - PAVIA ET.AL: 9788131512432 - AbeBooks," n.d.). The extracted and commercial chitosan had some distinct peaks and similar peaks on the spectrum, which might be due to the fact that they were produced from different sources, with the extracted chitosan being created from blue crab shells.

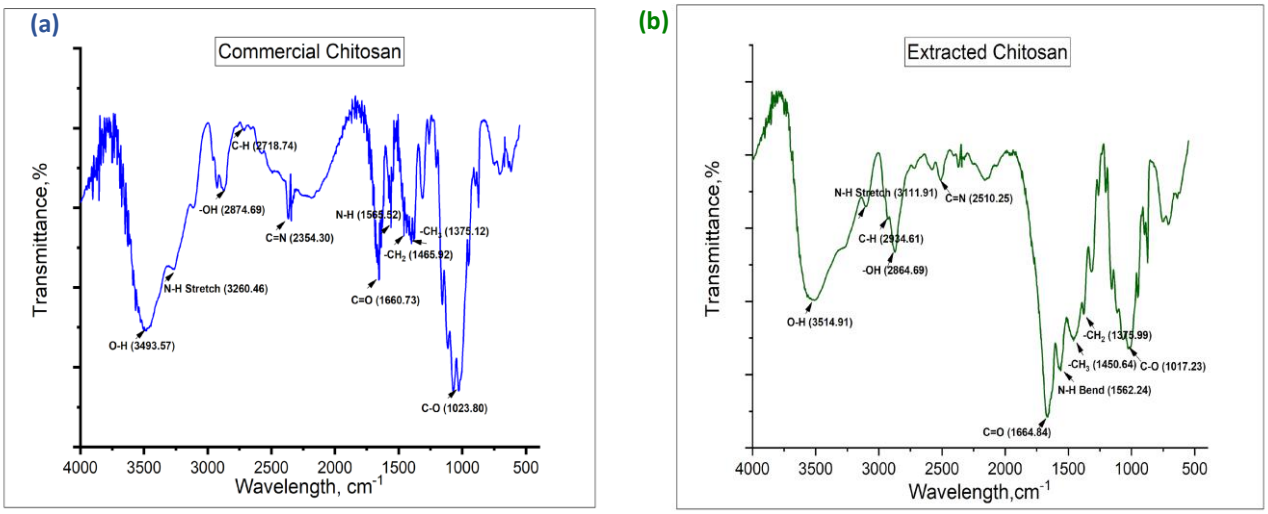

FIGURE 4: Fourier transform infrared (FT-IR) spectra of (a) commercial chitosan (b) Extracted chitosan

3.4 X-ray Diffraction (XRD)

The XRD of commercial chitosan, and nanochitosan extracted are shown in Figure 5. Sharp peaks with a diffraction angle of 2Θ 10.116°, 20.034°, 25.458°, 26.758°, 35.294°, 43.451°, and 57.559° are found in the X-ray diffractogram of commercial chitosan, and 10.901°, 12.593°, 19.084°, 26.516°, 35.252°, and 43.512° are the diffractogram of extracted chitosan, indicating that the medication is present as a crystalline substance. The commercial chitosan contains two peaks at 2Θ-10.12° and 2Θ-20.03° owing to 100 and 020 with the latter peak being weaker than the first, and the extracted chitosan contains diffraction peaks around 2Θ-10.9° and 2Θ-19.08° owing to Miller indices of 111 and 201 lattice planes, although many XRD patterns of chitosan in the literature have two typical peaks that are usually around 2Θ-10° and 2Θ-20° (Yen et al., 2009). According to

(Yen et al., 2009), the explanation for the various characteristic diffraction peaks might be due to the source of chitin. (Okuyama et al., 2000) demonstrate that chitosan chains crystallize in an orthorhombic unit cell. The wide peak at 10.12° validates the amorphous phase, whereas the sharp peak at 20.03° and 19.08° indicates the crystalline phase created by the commercial and extracted chitosan intramolecular hydrogen bonding. The intensity and diffraction angles of nano-sized extracted and commercial chitosan XRD patterns varied. The degree of crystallinity for commercial chitosan is 61.35%, and extracted chitosan is 29.66% respectively. The results show that the crystallites are substantially clustered and reasonably distributed in the milled powders.

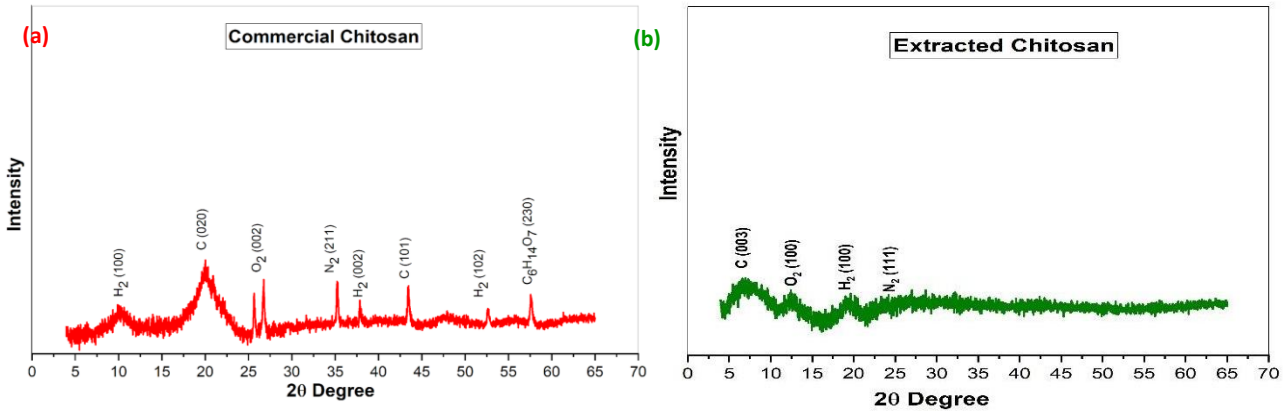

FIGURE 5: XRD Spectra of (a) commercial Chitosan (b) Extracted Chitosan

3.5 Scanning Electron Microscopy (SEM)

The morphology of the surface chitosan was examined by SEM. Figure 6 shows SEM images of commercial chitosan (Figures 6 a,b,c) and extracted chitosan (Figures 6 d,e,f). Commercial chitosan SEM scans revealed a nonporous, smooth membranous phase with dome-shaped orifices, microfibrils, layers of flakes, and crystallites. The determined pore size is 288±98.6µm and the particle size is 79.29±11.08nm. Figure 6 d,e,f shows electron micrographs of chitosan-extracted with a porous and chain-like structure. The SEM picture further revealed that the extracted chitosan had a near-spherical shape with a smooth surface. The pore size is approximately a standard deviation of 42.43±28.92µm and the particle size is 33.37±3.79nm. Chitosan nanoparticles were discovered to be spherical and have a smooth surface, regardless of size.

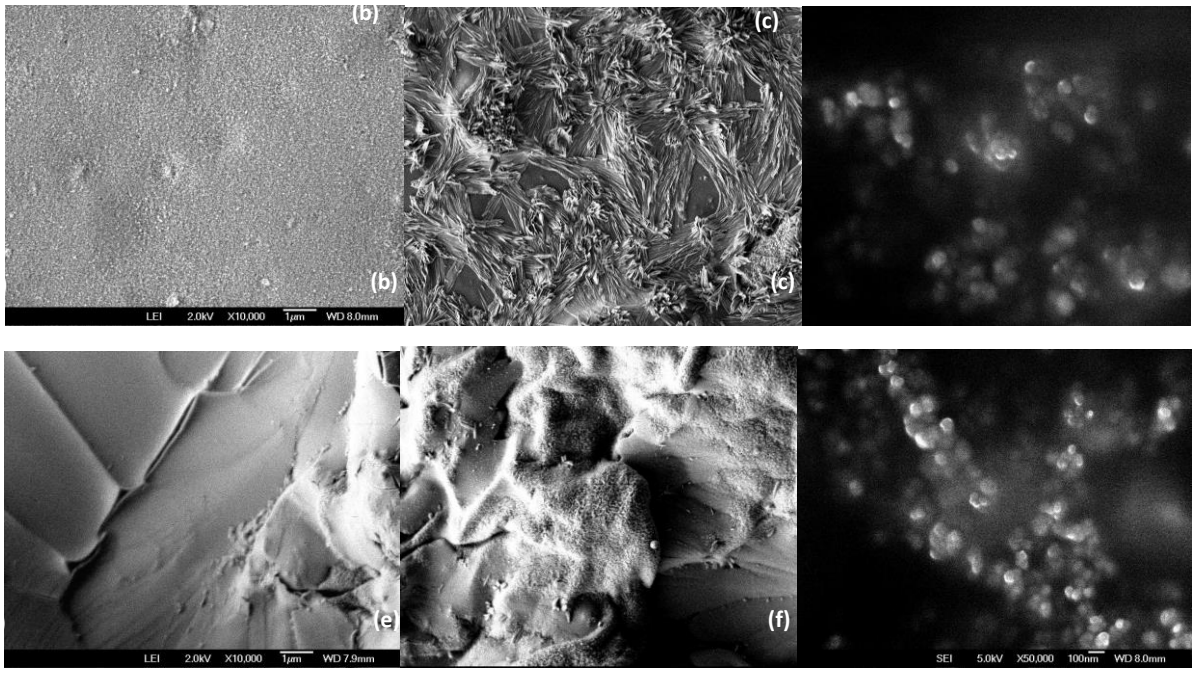

FIGURE 6: (a) Commercial Chitosan in X 10,000 (b) X 30,000 (c) Commercial Chitosan nanoparticles (d) Extracted Chitosan in X 10,000 (e) X 30,000 (f) Extracted Chitosan nanoparticles

3.6 Differential Scanning Calorimetry (DSC)

DSC was used to investigate the glass transition (T_g) and thermal behavior of chitosan .Figure 7 depicts the DSC thermogram of a commercial chitosan and extracted chitosan. Chitosan's DSC thermogram reveals two large endothermic peaks at 87.84°C and 95.14°C. The first peak might be exhibited due to water vapor. At 301.93°C and 319.18°C, there is a large and sharp exothermic peak associated to the thermal breakdown of the chitosan chains. DSC peaks indicate that the breakdown of chitosan nanoparticles will occur well over 300°C. Reduced crystallinity implies a change in the solid state structure of chitosan as a result of crosslinking (Zhang et al., 2004).

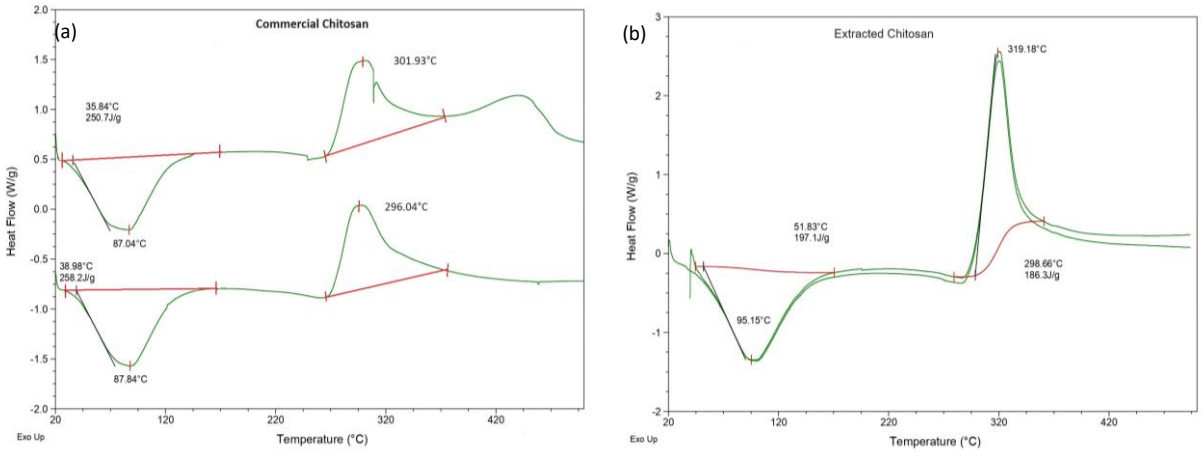

FIGURE 7: DSC Spectra of (a) Commercial Chitosan (b) Extracted Chitosan

3.7 Brunauer-Emmett-Teller (BET) analysis

To investigate the porosity nature of the chitosan, Brunauer-Emmett-Teller (BET) gas sorptometry measurements were performed. Using the BET (Brunauer, Emmett, and Teller) equation, the surface area may be estimated from the amount of gas necessary to produce an adsorbed monolayer. The gas pressure is gradually raised until all pores are filled with liquid to determine the pore volume and pore size distribution. The gas pressure is then gradually lowered, evaporating the condensed gas from the system. The analysis of the adsorption and desorption isotherms offers details on the pore volume and size distribution. The commercial and extracted chitosan BET surface area and pore volume were 11.3892 m^2/g, 15.9057 m^2/g, and 0.0102 cm^3/g, 0.197 cm^3/g respectively. Table 1 summarizes and compares the BET surface area of either natural or manufactured chitosan adsorbents reported in earlier research with that of the extracted chitosan from blue crab. The BET data clearly corroborate the porous nature of the chitosan (Luo et al., 2018a).

TABLE 1
CHITOSAN BET SURFACE AREA AND TOTAL POROSITY COMPARISON WITH OTHER LITERATURE STUDIES

S.No	Samples	BET surface area (m^2/g)	Total porosity volume (cm^3/g)	Reference
1	Chitosan-EGDE beads	0.62	-	(AZLAN et al., 2009)
2	Chitosan	1.22	-	(Zhang et al., 2021)
3	PVA/chitosan	1.95	-	(Rajeswari et al., 2020)
4	CMC beads	0.49	-	(Luo et al., 2018b)
5	Chitosan powder	11.85	0.010	(Ngamsurach et al., 2022)
6	Chitosan beads mixed ZnO	12.46	0.013	(Ngamsurach et al., 2022)
7	Commercial Chitosan	11.39	0.010	This work
8	Extracted Chitosan	15.90	0.197	This work

3.8 Soil Analysis

The most important practical application of Chitosan is in agriculture and horticulture, particularly for conserving water in arid and desert environments and accelerating plant development. As a result, research into the moisture content, soil type , pH,

Total nitrogen and carbon of chitosan in addition to the soil is essential. Table 2 describes the analysis between commercial and extracted chitosan drenched in the soil. Soil pH is a critical state that has a significant impact on soil biology, chemistry, and physical processes, all of which have direct effects on plant growth and development. It is obvious that pH affects soil and crop yield. Soil pH is classified as follows by the United States Department of Agriculture's National Resources Conservation Service: ultra-acidic (3.5), extremely acidic (3.5-4.4), very strongly acidic (4.5-5.0), strongly acidic (5.1-5.5), moderately acidic (5.6-6.0), slightly acidic (6.1-6.5), neutral (6.6-7.3), slightly alkaline (7.4-7.8), moderately alkaline (7.9-8.4), strongly alkaline (8.5-9.0), and very strongly alkaline (>9.0). (Burt 2014) Agricultural crop production is often undertaken in the slightly acidic to slightly alkaline range, a window linked with optimal soil nutrient availability. Though plant tolerance to high pH varies, most agricultural plants grow best at a pH close to neutral (Läuchli and Grattan, 2017). The impact of crop production and plant development is influenced by the moisture content of the soil. Water retention is essential and less uptake of water due to the addition of chitosan to the soil plays an important role in water saving.

TABLE 2
ANALYSIS OF SOIL AFTER BEING DRENCHED WITH CHITOSAN AND COMPARED WITH CONTROL

Source	Moisture content %	Water holding capacity %	pH	Sand %	Clay %	Slit %	Texture Classification	Total Nitrogen (g/Kg)	Total Carbon (g/Kg)
Commercial chitosan	34	82	7.3	47	19	34	Loam	2.9	46.4
Extracted Chitosan	39	84	7.2	46	20	42	Loam	3.1	47.7
Control	20	63	7.8	40	17	30	Loam	2.0	22.1

The total nitrogen concentration of the soil demonstrated statistically significant changes between treatments in the study's interaction zone. According to (Man et al., 2021), the total N concentrations in soil (2.0-2.2 g/kg). A substantial outcome in soil was obtained with the treatment of commercial and extracted chitosan are 2.9g/kg ha^{-1} and 3.1 g/kg ha^{-1} of N, which had a 45% increase of extracted chitosan in N content when compared to the control without chitosan.

The amount of carbon inputs into the soil rises when crop production and crop litter reach the soil (Batlle-Bayer et al., 2010) (Khan et al., 2007) (Mahlous et al., 2007), and so soil carbon stocks may grow with N fertilization (Batlle-Bayer et al., 2010) (Buyanovsky and Wagner, 1998). Soil organic carbon contents varied from 21.7 to 23.1 g/kg and did not differ substantially. The soil organic carbon increased after the addition of chitosan to the soil ranging around 46.4g/Kg for commercial and 47.7g/Kg for the extracted chitosan. Soil organic carbons have an important role in soil physical, chemical, and biological qualities, as well as overall soil fertility.

3.9 Seed Germination

Seed germination is an important process that impacts crop output and quality. Understanding the molecular components of seed dormancy and germination is therefore critical for increasing agricultural output and quality (Tuan et al., 2019). Both chitosan were applied properly in order to examine the normal effect of chitosan in seed germination and seedling growth of Roma tomatoes (*Solanum lycopersicum*). Its use resulted in considerable improvements in many plant components. For healthy growth, plants rely on minerals found in the soil. Plant production suffers as a result of nutrient deficiency. These nutrients are provided by chitosan. The time of seed germination in experimental plots was closely monitored. Table 3 shows the total number of seeds germinated and their potential percentage.

TABLE 3
EFFECT OF CHITOSAN ON SEED GERMINATION AND GROWTH PARAMETER

Parameter	Time of germination (in Day)	Seed germination(%)	Plant Height(cm)	Wet weight (g)	Dry weight (g)
Commercial Chitosan	8	55.56	23.92±1.05	0.626933±0.078908	0.083867±0.003535
Extracted Chitosan	6	78	29.14±0.55	1.435167±0.0056	0.213±0.013018
Control	11	22	17.60±10.16	0.4105±0.237002	0.0665±0.038394

Different parts of the plant were measured using suitable methods to determine the effect of chitosan amendments. After 35 days, the shoot length was measured on a centimeter scale. Extracted chitosan-treated seedlings germinated in 6 days, whereas commercial chitosan-treated and controlled seeds sprouted in 8 and 11 days. The maximal length of the shoot seen with extracted chitosan and commercial chitosan treatment was 29.14±0.55cm and 23.92±1.05cm after 35 days respectively, whereas control exhibited 17.60±10.16cm after 35 days, respectively. Dry weight refers to all plant elements excluding water and is a more trustworthy weight analysis method. The dry weight and wet weight of the germinated plants are given in Table 3.

IV. CONCLUSION

This study investigated the physicochemical properties and characterization of chitosan derived from blue crab (*Callinectus sapidus*) shells, which are discarded and pollute the environment. The study's findings were also compared to commercial chitosan derived from crabs. Based on the findings, it is claimed that blue crab has a high potential for producing chitosan. With appropriate deacetylation conditions, this study shows that blue crab (*Callinectus sapidus*) may be employed as a possible source for chitosan extraction. The chemical composition of the extracted chitosan was determined using FTIR, and the crystalline diffraction peaks were examined using XRD. Chitosan has a porous structure and porosity, according to morphological studies. Chitosan, when added to the solution, functions as a plant growth booster in various crops such as bean plants, radishes, passion fruit, potatoes, cabbage, soybean, and others. It improves plant productivity and protects plants from diseases. Chitosan has a considerable influence on root, shoot, blooming, and flower number growth rates (Pandey and De, 2018). Chitosan application in soil reduced seed germination time and increased germination percentage. The foregoing explanation suggests that drenching chitosan in soil resulted in improved tomato plant growth and development.

AUTHORS CONTRIBUTION

Divya Shanmugavel: Data Curation, Writing - Original Draft, Writing - Review & Editing, Visualization, Validation, Methodology. **Omar Solorza – Feria :** Conceptualization, Methodology, Validation, Resources, Supervision, Project administration, Funding acquisition. **Sathish Kumar Kamaraj:** Conceptualization, Methodology, Validation, Resources, Supervision, Project administration, Funding acquisition.

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COMPETING INTEREST

There are no conflicts that we need to report.

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Effect of Basil (*Ocimum sanctum*) Leaf Coating on Ripening Duration and Shelf Life of Banana cv. Jahaji

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Abstract— *The present research was conducted to understand the effect of basil leaf coating on the ripening duration and shelf life of banana cultivar Jahaji. The experiment was laid down under completely randomized design (CRD) with two treatments – T1 (uncoated) and T2 (coated with basil leaf extract) having seven replications. The coating was prepared by grinding the basil leaves followed by sieving and filtering to obtain a liquid extract of the leaves. The method of application was dipping the fruits in the liquid extract. Observations were made at periodic intervals to record the ripening duration and shelf life of the fruits. The ripening duration of T1 (uncoated) fruits was recorded as 8.5 days while that of T2 (coated) fruits was found to be 8.16 days. Again, the shelf life of T1 (uncoated) fruits recorded as 12.66 days while the shelf life of T2 (coated) fruits was 11.33 days. Thus, the results of the research was not satisfactory as the basil leaf coating application on banana cv. Jahaji could neither extend the ripening duration nor the shelf life of the fruits as compared to the untreated ones. Further research in this field is needed to come up with new such alternatives as a part of the solutions to problems reported in the present study.*

Keywords— banana cv. Jahaji, basil leaf coating, ripening duration, shelf life, dipping method.

I. INTRODUCTION

Fruits and vegetables are an integral part of human diet and act as the major source of carbohydrates, vitamins, dietary fibre, minerals, antioxidants, proteins, fat and phytochemicals. Handling operations during harvesting and packing of fruits, causes breaks on the skin and loss of cuticle thus predisposing the fruits to quick deterioration due to high water loss, high respiration, and pathological attack (Maguire *et al*, 2001), (Zheng *et al*, 2012). In order to preserve fruits for longer periods of time it is important to extend their shelf life and preserve postharvest quality through various postharvest technologies such as Controlled Atmosphere Storage (CAS), modified atmosphere packaging, evaporative cooling, chemical waxing and cold storage have been found to be effective. However, some of these postharvest technologies produced some negative effects on fruits including environmental pollution, economically less viable, residual effect and limited accessibility by small farmers especially those in developing countries. Therefore to overcome such challenges research on alternative postharvest technologies which would be affordable, accessible, eco-friendly and easy to use must be developed to obtain sustainability in storage of fruits.

Banana (Musa spp.) belongs to the family Musaceae is one of the oldest fruits known to mankind. It is also known as Apple of Paradise and one of the most important sources of tropical fruits in the world as it is a significant staple food as well as a major export commodity (Rahman *et al.*, 2013). Banana is one of the important tropical and sub-tropical fruit crop providing good income to the growers as well as its taste and high nutritional value keep it in high demand throughout the year. Being a climacteric fruit, where the level of ethylene present in ripe fruits is more than sufficient for inducing major ripening processes

such as softening and colour changes, thus banana is harvested in unripe stage. Fruits like avocado, banana, mango, pear and tomato produce 500, 40, 3, 40, 35 µg/l (µg l) ethylene at the climacteric peak (Belitz *et al*., 2009) while the threshold level of ethylene for fruits like avocado, banana, mango, tomato ranges from 0.1 to 0.5 ppm.

Coating of plant leaf/flower extract forms a thin film around each fruit, which act as a semi-permeable membrane to regulate the diffusion of oxygen and carbon dioxide into and out of the fruit, thereby reducing the rate of metabolism and also preventing water loss (Umesh *et al*., 2017). Edible coatings obtained from natural sources have great potential for enhancing food quality and safety as well as effecting shelf life and ripening days. Therefore in the recent times of increasing preference for organic options, there have been growth in the use of degradable coatings in fruits for improving the shelf life of fruits and also for understanding its effect on ripening duration. Post-harvest application of botanicals such as Azadirachta, Ocimum, Aloe, Tagetes, Mentha, Gingiber, Curcuma, and Eucalyptus are known to contain higher amounts of some principle natural substances exhibiting growth regulating, fungicidal, insecticidal properties can be exploited for retaining freshness and enhancing the shelf life of horticultural crops (Tanuja *et al*, 2021). Successful marketing of edible cultivated bananas requires control over the ripening process to ensure predictable ripening and good quality ripe fruits along with increased shelf life.

II. MATERIALS AND METHODS

The experiment was conducted with completely randomized design (CRD) with seven replications (R1, R2, R3, R4, R5, R6 and R7) and two treatments (T1 and T2). The treatment details include T1- uncoated and T2- coated with basil leaf extract. The fruits were picked at green mature stage from Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat. Fresh, mature and clean fruits with uniform shape and size were selected and then washed with water before applying the basil leaf coating.

2.1 Preparation of basil leaf coating:

The method consists of collecting fresh basil leaves, followed by cleaning properly with water and then grinding them with an electric blender to form a thick paste. The paste is then strained with a sieve to obtain a liquid extract of the basil leaves. Finally, the liquid extract was filtered until the residual portion of leaves were filtered off completely before use.

2.2 Application of basil leaf coating:

The basil leaf coating was applied on bananas by dipping method and then the residual coating solution was allowed to drip off for a minute. When the fruits got dried after the first dipping, then the fruits were once again dipped in the liquid extract and allowed to dry. When the banana got dried completely, they were kept under normal room temperature (31±2 °C) without any disturbance for observations.

2.3 Statistical Analysis:

The ANOVA test ($P<0.05$) was performed for the statistical analyses of the data using MS-Excel.

III. RESULTS AND DISCUSSIONS

3.1 Physical appearance changes:

The changes in physical appearance of fruit as influenced by storage time and basil leaves coating on the fruits of treatment 2 (T2) are shown in Fig 1. As per the observation, the peel colour of fruits belonging to both the treatments- T1 (uncoated) and T2 (coated with basil leaf liquid extract) remained green for about 6^{th} -7^{th} days. Gradual change in the colour to slight yellowish was observed starting from 7^{th} -8^{th} days in both the treatment groups.

3.2 Observation on Ripening duration:

Bananas of both the treatment groups were observed carefully and periodically to study the ripening duration and records were taken as given in Table 1. In case of T1 (uncoated), fruit belonging to replication1 (R1) took the minimum time (7days) to ripen while the fruits belonging to replication 3, 5 and 6 (R3, R5 and R6) had the maximum ripening duration of 9 days. Therefore, the mean value for the ripening duration of T1 fruits was recorded to be 8.5 days. Similarly, for the fruits of T2 (coated), the least time was taken by the fruit belonging to replication 4 (R4) to ripen i.e, 7days while the maximum time (9 days) was taken by the fruits belonging to replication 3and 5 (R3 and R5) to ripen. Therefore, the mean value for the ripening duration of T2 fruits was recorded to be 8.16 days. However, as per statistical analysis of the data, no significant difference was recorded for the ripening duration of the fruits. Thus, we could conclude that fruits of T2 (coated) ripened earlier than the fruits of T1 (uncoated) and the basil leaf coating did not affect the ripening duration of the fruits in a positive way as it was expected to slow down the ripening process and extend the ripening duration as compared to the normal ripening duration of Jahaji banana so that they could be stored for longer period of time. Therefore, the result was not found to be satisfactory in terms of applying basil leaf coating to Jahaji banana for extending the ripening duration or the method of application (dipping the fruits in the liquid extract) was not suitable for the objective to be fulfilled.

TABLE 1
OBSERVATIONS RECORDED ON RIPENING DURATION

	R1	R2	R3	R4	R5	R6	R7	Mean	SE (d)
T1 (uncoated) (days)	7	8	9	8	9	9	8	8.5	0.755
T2 (coated) (days)	8	8	9	7	9	8	8	8.16	0.69

3.3 Observation on Shelf life:

Fruits of both the treatments- T1 (uncoated) and T2 (coated with basil leaf extract) were carefully observed at particular intervals of time to take records of the shelf life as shown in Table 2. Appearance of few dark or blackish patches on the peel of bananas belonging to both the treatments were observed from 13^{th}-14^{th} day onwards. In case of T1 (uncoated), fruits belonging to replication 1, 2 and 5 (R1, R2 and R5) showed the minimum shelf life of 12 days whereas the fruits belonging to replication 3, 4, 6 and 7 (R3, R4, R6 and R7) had the maximum shelf life of 13 days. Thus, the mean value for the shelf life of the fruits of T1 was found to 12.66 days. Similarly, for the fruits of T2 (coated), the least shelf life was recorded in the fruit belonging to replication 6 (R6) i.e, 11days while the highest shelf life (13 days) was recorded in the fruit belonging to replication 1 (R1). Thus, the mean value for the shelf life of the fruits of T2 was found to 11.83 days. Also the statistical analysis of the data for shelf life of the fruits belonging to both the treatments was found to be significant. However, the basil leaf coating did not increase the shelf life of the fruits as the mean value (11.83 days) of shelf life of T2 (coated) fruits was found to be lesser than the mean value (12.66 days) of shelf life of T1 (uncoated) fruits. Therefore, we could conclude that the application of basil leaf coating (T2) or the method of application (dipping the fruits in the liquid extract) on Jahaji banana did not prove to be satisfactory in terms of extending the shelf life of the fruits.

TABLE 2
OBSERVATIONS RECORDED ON SHELF LIFE

	R1	R2	R3	R4	R5	R6	R7	Mean	SE (d)	CD (5%)
T1 (uncoated) (days)	12	12	13	13	12	13	13	12.66	0.534	0.418
T2 (coated) (days)	13	12	12	12	12	11	12	11.83	0.577	0.418

FIGURE 1: Physical appearance of coated and uncoated banana

IV. CONCLUSION

From the present study, it could be concluded that even though in the recent times coating of fruits with natural substances such as basil leaf is gaining popularity and also has been producing good results in case of extending the ripening duration and shelf life of fruits, however certain research regarding the proper concentrations, method of extraction or method of its application must be carried out in a multidisciplinary manner in order to come up with solutions to the problems and draw satisfactory conclusions which could not be achieved through this study.

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Design of a Performance Measurement Model in Cassava Agroindustry Supply Chain Management

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Abstract— *The purpose of this study was to determine the mechanism of supply chain and the pattern of cassava of agroindustry supply chain flow and analyze the relationship between the components of SCM and the impact on supply chain activity improvement and agroindustry performance. Sample of research were producers of agroindustry local food of cassava as much of 106 respondents were taken by simple random sampling. The data analyzed by qualitative and quantitative analysis. Qualitative analysis used to describe the mechanism and pattern of cassava of agroindustry supply chain flow and principles of SCM. While quantitative analysis used to analyze the components, SCM activity improvement and agroindustry performance by using a structural equation model. The results showed that the mechanism of cassava agroindustry supply chain is the creation of collaboration and coordination among supply chain actors ranging from farmer, processor, distributor and consumer.*

Keywords— Agroindustry, Cassava, Local Food, Supply Chain Management, Structural Equation Models.

I. INTRODUCTION

Supply chain management (SCM) have been presented by many researchers, which mostly defined as synonym for logistics, and supply chain (SC) control. SCM is the designing and management of all activities involved in sourcing and purchasing, transformation, and all logistics management activities (Aramyan, Lansink, Vorst, Kooten, 2007). It linked the relationship between the buyers, the sellers, and relationship with its network partners i.e. middlemen, suppliers, transportation and customers (L. Condrațchi, 2014). The cassava industry is an essential processing industry that supports food security in many countries, and the development of agro-industry based on local commodities, especially based on cassava, is encouraged to support food security (Timaboot, Suthikarnnarunai, 2017). Cassava supply chain refers to the coordination and management of all activities involved in the production and delivery of cassava and cassava-based products to customers (Chinyophiro, 2012). Cassava supply chain starts from the raw material (cassava roots) which are cultivated by the farmers. They can be supplied directly by the farmers or from the middleman who collected cassava roots from the farmers and supplied to the manufacturing (D. Slavic & A Jambrišak, 2011). These studies aimed to maintain the competitive advantage of the cassava supply chain and improve overall performance. The cassava supply chain is an important component of the cassava industry, and improving its performance can contribute to the development of local commodity-based agro-industry, especially cassava-based, to support food security (Timisela, Leatemia, Polnaya, Breemer, 2017). Most of cassava studies in Thailand are to improve the production yield, enhance the supply chain efficiency, reduce total cost, increase the percentage of starch content, have the resistance to pests and diseases, etc.

TABLE 1
LITERATURE REVIEW ON SUPPLY CHAIN PERFORMANCE MEASURES

Author	Sector	Customer Responsiveness	Efficiency	Flexibility	Other	Number of Indicators
Eppen (1979)	Steel Production		X			1
Hannus (1991)	Manufacturing		X	X		3
Lee & Ballington (1992)	Manufacturing		X			1
Berry and Naim (1996)	Manufacturing	X		X	X	4
Murphy et d. (1996)	Different Industries		X		X	35
Beamon (1998)	Manufacturing	X	X	X	X	16
Beamon (1999)	Manufacturing	X	X	X	X	33
Li & O'Brien (1999)	Manufacturing	X	X	X	X	11
Talluri et al.	Manufacturing	X	X		X	9
Van der Vorst (2000)	Food	X	X	X	X	8
Gunasekarn (2001)	Not Specified	X	X	X	X	43
Thonemann & Bradley (2002)	Manufacturing	X	X			2
Korpela et a. (2002)	Not Specified	X	X	X		3
Lai et al. (2002)	Transport	X	X	X	X	4
Talluri & Baker (2002)	Manufacturing	X	X	X	X	15
Person & Olhager (2002)	Manufacturing	X	X	X	X	7
Claro et al. (2003)	Horticulture		X	X		2
Gunaekaoa (2004)	Different Industries	X	X	X	X	45

Most of the problems resulted from there are no collaboration in the supply chain which they made the problems occur repeatedly. Many problems that found today need more improvement, and it is the burden to the supply chain. The purpose of this study is to review the previous studies on the SCM contexts by applying to cassava supply chain focuses on the case study in Thailand with the objective to improve the performance of the supply chain in order to sustain the advantage for the future competition (A. P. Utami and A. Kusumawardhani, 2021). It involves various study on SCM such as collaborate among all parties in the supply chain, select the strategy, manage the cost by using financial management concept, inventory management, use software & technology in managing the supply chain, use green logistics in order to reduce cost and able to sustain the competitive advantage to the future (Timisela, Leatemia, Polnaya, Breemer, 2017).

II. CASSAVA SUPPLY CHAIN

Cassava is cultivated in many tropical countries situated in the equatorial belt. The best time to harvest cassava is about 7-18 months after planting [33]. However, harvesting can be any time between six months to two years. Cassava can grow and produce dependable yields in places while other crops will not grow or produce well. It can tolerate drought and grow on soils with low nutrient capacity. Many countries in the world have demands and uses of cassava differently depend on their needs. The farmers' perceptions of cassava cultivation and the results showed that the farmers' reasons for growing cassava are (1) ease of growing (2) good price (3) ease of selling and (4) ability to grow on poor soils (Van der vorst, Da Silva, Trienekens, 2007).

The general approach to supply chain development can be summarized in 6 basic concepts:

2.1 Bottom up approach:

Vertical co-operation initiatives typically come from potential chain partners who are attempting to overcome specific obstacles or to solve specific management problems and who discover the power of chain leveraged solutions. Generally these will be at least two private companies who form contiguous links in a potential supply chain. Before setting up a supply chain project it is necessary to ascertain whether the proposed chain affiliation is commercially, technically, and politically feasible. These

three issues strongly relate to the position of the business within its environment and the competitive advantage. Porter (1980, 1985) recognizes five forces that determine the competitive position and strength of a company: its suppliers, substitutes, new entrants, rivals and customers. Three generic strategies that can be derived from this are: cost leadership, differentiation and focus. A Value Chain Analysis can be used to assess the commercial and technical feasibility of the proposed chain relationship within the selected strategy. An appropriate tool to assess the political feasibility of a chain project is conducting a socio-economic impact analysis. Especially in emerging or transition economies, local governments can be worried or suspicious about the impact of new competitive partnerships upon the existing market order. Potential employment generation or losses, increased competition with local (state-owned) companies, and other effects need to be estimated in advance. Self-evidently, the impact analysis should be combined with a stakeholder perception analysis on basis of the assumption "perception is reality and opinion is truth".

2.2 Demand oriented agri supply chain development:

Customer demands should be the starting point for each new agri-supply chain design. Only those products that respond to consumer demands with faster, cheaper, better solutions, will be sustainable over the long term.

2.3 Public-private partnerships:

The team of stakeholders that co-operate in a pilot project should ideally consist of not only representatives from the business community but also from universities and research institute. Depending upon the project, Ministries of Agriculture and Commerce, Food and Drug Administration and public agencies may also be actively involved. The private and public partners work together on the development and application of chain knowledge aiming at resolving bottlenecks in the chain and in developing a learning environment to facilitate education and training on these issues.

2.4 Learning by doing:

It is important to work with partners on their worksite i.e. fields, warehouses, processing plants and offices. The hands-on experiences should be an integrated part of the overall knowledge management system, which includes knowledge development, knowledge dissemination, knowledge use and knowledge storage. The practical experiences that are generated within the chain can be supported by tailor made training courses in each of the supply chain development fields: chain differentiation (e.g. category management training), integral chain quality assurance (e.g. HACCP training), and chain process realignment or chain optimization (logistical training).

2.5 Strengthening chain knowledge infrastructure:

A critical success factor for supply chain competitiveness is knowledge infrastructure—in particular infrastructure that is able to support production, processing and trade at each level of the supply chain in an integrated way. Tailor-made training and education modules can be developed and added to existing educational programs (e.g. at MBA level). This means a vital structure in which the private sector and public knowledge infrastructure co-operate effectively and continuously in the field of chain knowledge.

2.6 Synergy and progressive alignment:

Knowledge development is accelerated through the process of gaining initial market acceptance. Winning early operational successes helps lock in partner commitments. In practice we see various stakeholders making individual efforts to effectuate supply chain performance improvements. At various levels of the upstream and downstream supply chain stakeholders work on quality and safety issue. Coordinated efforts between seed companies that successfully organizes training in the field of good agricultural practices and integrated pest management, and a retailer that sets up a certification program for safe and organic vegetables, can have a spin -off that is bigger than the individual separate pilots. The co-operation allows the retailer to communicate product specifications directly to the growers and guarantee the sales of the quality produce and the seed company on its turn can teach and monitor the correct farming practices and pre-harvest intervals and improve it seed sales. ACC-like organizations can contribute to supply chain knowledge system innovation by systematically gathering the case based information in a toolkit and provide this expertise for other future supply chain projects.

III. SUPPLY CHAIN AGROINDUSTRY OF CASSAVA

The spects of the study were structurally organized covering target the supply chain, supply chain structure, resources, chain management, business process chain and supply chain performance. By studying these aspects, the researcher could find out the chain supply phenomenon and propose the best development ideas.

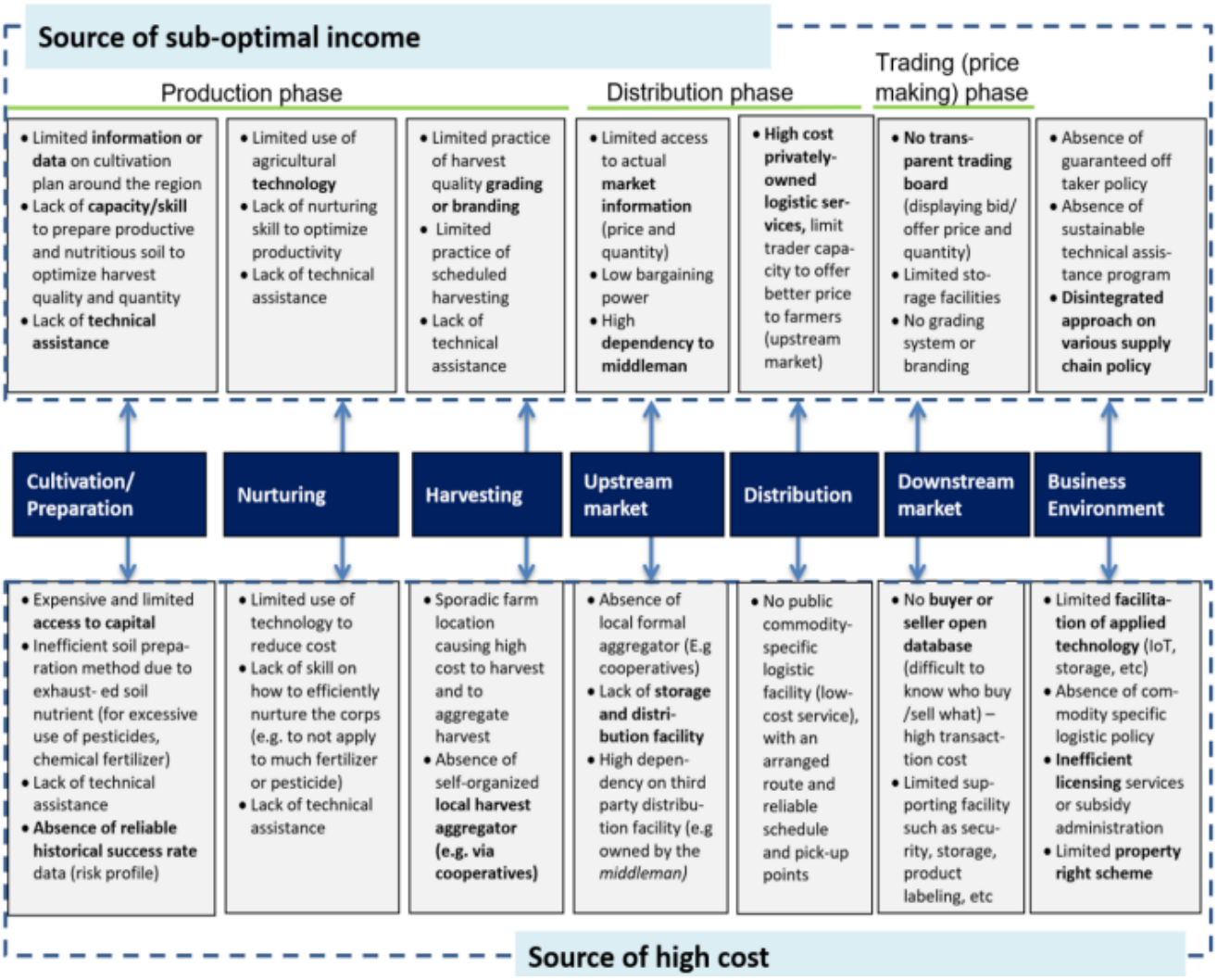

FIGURE 1: Summary of the General Supply Chain Problems

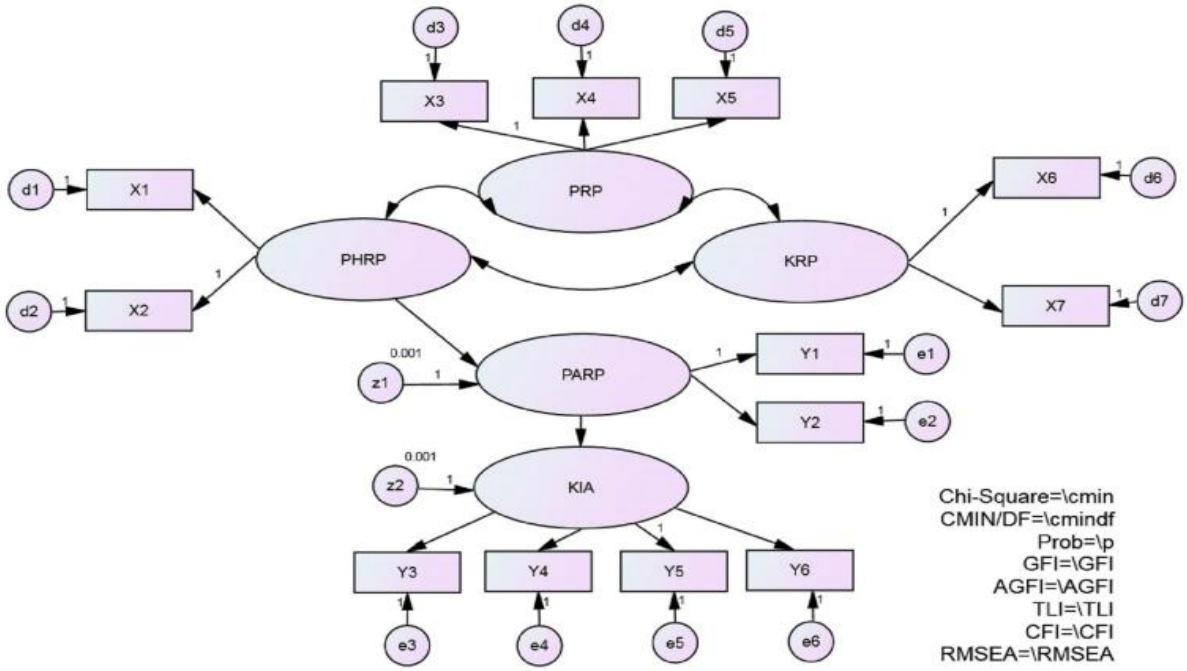

FIGURE 2: The Conceptualization of Structural Equation Models (SEM) of SCM Agroindustry

Description:

X1 = coherence or fusion; X2 = the proximity of the area; X3 = integrity of service customers and suppliers, X4 = dissemination of information; X5 = the speed of communication and supply chain; X6 = quality and service, X7 = operations and distribution; Y1 = integrity and synergy principles of supply chain management, Y2 = improved management of agro-industry input-output; Y3 = increase product diversification and relative efficiency of agro-industry, Y4 = increasing of profitability of agro-industry; and Y5 = increased performance of agroindustry product marketing; Y6 = increase value of SCM actors.

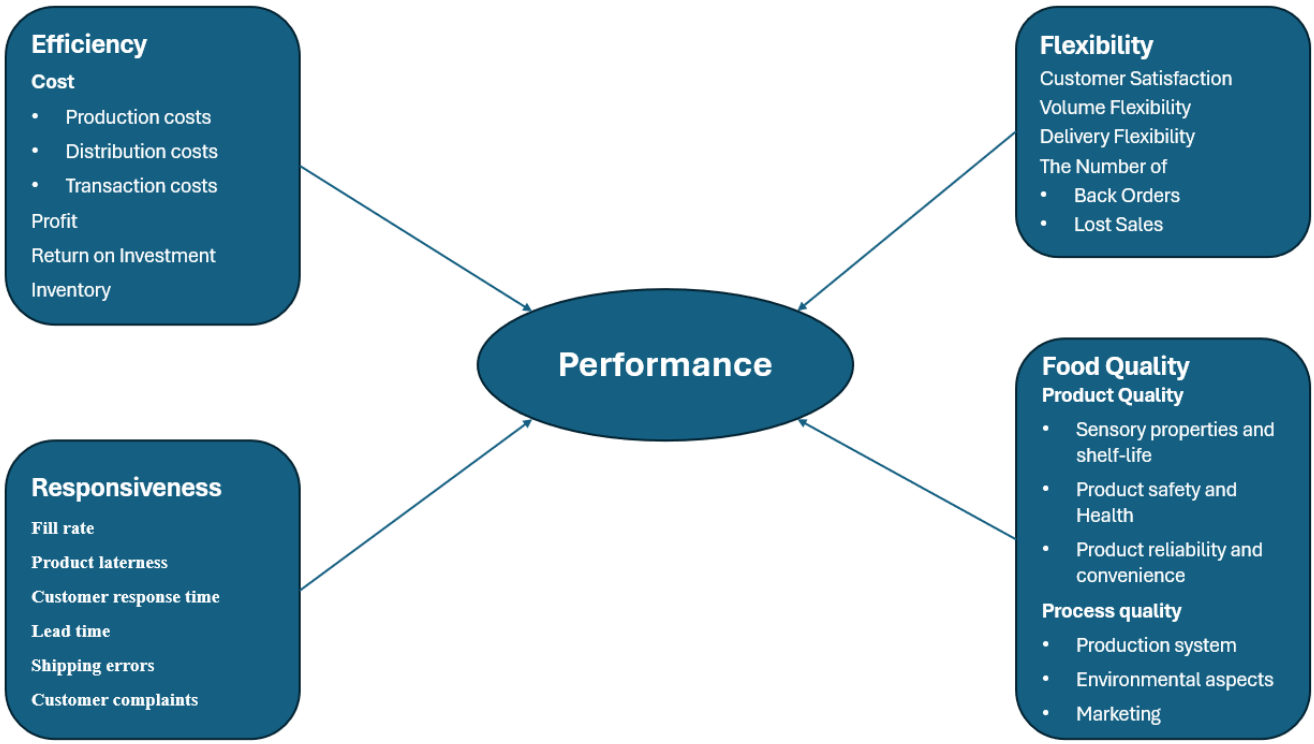

FIGURE 3: Conceptual Framework of Agri-Food Supply Chain Performance Indicators

There was a study on the presence of market and production risks which they resulted in farmers temporarily changing the market in which they sell their cassava and diversifying into other crops. As it regards production risks faced, pest attacks are the most outstanding. Traders like the farmers, are prone to market risks, poor storage and generally post-harvest handling constitute a significant source of risk for traders as any changes in market demand results in either build up in stocks requiring additional storage and increased risk for spoilage, while reduced demand in the market equally results in longer storage time and by extension increased risk of spoilage (Xanthavanij, Amornsawadwatana, 2019).

IV. DISCUSSION AND RECOMMENDATION

Many studies in the scope of SCM with the objectives to improve the efficiency of the supply chain by applying SCM contexts study i.e. define framework, having performance measurements, apply strategy concept, financial management, collaboration, and sustainable competitive advantage to the future competition. From the study, it is found that many problems in the cassava supply chain needed more analysis and improvement. Presently, there are no benchmarks to be used as tools to help the related party cope with the supply chain problems. Most problems occur regularly and no systematic solution planning by not allow the problems to occur repeatedly. One of the major problems in the cassava supply chain is the fluctuation of the cassava price, they are so volatile that the farmers may switch to cultivate other kind of agriculture products when cassava price is low.

The main reasons are the payoff return to the farmers which resulted from Thai farmers are poor. They can't afford with the low price of cassava for the extended period, they have to switch to cultivate other agriculture products that generate better return. Another crucial problem of cassava supply chain is the short shelf life of cassava roots since they are the perishable products. Many experts try to keep and extend the shelf life of cassava roots to prolong the cassava use to be available for the longer period. Moreover, most of the problems that found in the cassava supply chain in Thailand are the lower efficiency of cassava production, lesser yield in cassava plantation and low percentage of starch content. All of these problems can be

improved if there are the collaboration among all parties consist of the government sector, technician expert, academic expert, manufacturers, farmers, etc.

They should have the organization/association that will oversee/monitor the operation of the cassava supply chain, and ready to provide the support to the farmers & related parties once they have the problems. This association will delay/relax he farmers from switching to cultivate other agriculture products, by provide the support the farmers to keep on cultivating the cassava. Furthermore, it also needs the decision support tools that will be used to help them justify the cassava supply chain situation. It has to encourage the farmers to harvest and sell the cassava roots on the high percentage of starch content, by not having the early harvest on the young cassava in order to have better percentage of starch content and selling price. Financial management is very important issue for cassava supply chain, especially in Thailand since the competition of cassava not only compete with the players in the same industry, but they also have to compete with other substitute agriculture products especially with corn. The related parties in the supply chain have to manage the cost with effectiveness and efficient, otherwise, they will lose the competition ability. By setting high efficiency on performance measurement i.e. KPIs, SCOR model, suitable strategy, or use the technology to help in managing the supply chain, etc., these will allow the related party in the supply chain to have the ability to compete in the market.

The price of cassava and its products depended on demand and supply in the supply chain. The price was fluctuated from time to time, and there are many factors that affected the price. Most studies are intended to improve the production efficiency, the plantation yields, and find the reasons to support whether cassava was well harvested by the farmers in the world. Some study on the presence of market and production risks which they resulted in farmers temporarily changing the market in which they will cultivate or switch to other agriculture product. As it regards production risks faced, pest attacks are the most outstanding. Traders like the farmers, are prone to market risks, poor storage especially on postharvest handling constitute a significant source of risk for traders as any changes in market demand results in either build up in stocks requiring additional storage and increased risk for spoilage.

V. CONCLUSION

The study on this paper on the SCM context by apply to cassava supply chain, it allows the related parties in supply chain to analyze the markets and competitions, in order to have the competitive advantage over other competitors in the industry and other competitors in the related industries. This study, it will be able to apply to other country's cassava supply chain, by not specific only in Thailand. Moreover, the researcher hopes that this study will be used as the groundwork to other researchers who interested to study in cassava or other agriculture products. They can apply by using some concept from this study; the factors that affect the performance of the supply chain are addressed and know how to improve the efficiency to the supply chain.

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