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## **SPAMAST VISION**

“A leading institution of higher learning in the fields of aqua-terrestrial and technopreneurship responsive to the development needs in Southeast Asia and beyond.”

## **MISSION**

“Imbued with sincerity, excellence, commitment and good leadership, the institution fervently carries out its functions to provide high quality instruction, relevant researches, focused extension and self-sufficient production preserving cultural heritage, addressing gender sensitivity and climate change.”

## **CORE VALUES (TOP ACCESS)**

The institution progresses with Teamwork, Openness and Positive attitudes, promoting Accountability, Commitment, Competence and Excellence for Sincere Services.

### **Research and Extension Goal**

Develop more appropriate agriculture fishery technologies from generated researches and its utilization by the institution and partner communities by the end of 2018

### **Research and Extension Objectives**

1. To develop competitive researches for food security that meets the global and/or ASEAN standards.
2. To generate appropriate Agri-fisheries technologies following the value-chain that will contribute to the economy of the service areas.
3. To preserve and sustain the environmental and cultural heritage.
4. To strengthen linkage with industries, private sectors and other institutions (PPP).
5. To operationalize the Agri-Fisheries and Natural Resources (AFNR) Research and Development Center equipped with the state-of-the-art facilities and competent manpower.

## **FOREWORD**

This 2018 version of the SPAMAST Research Journal focuses more on the agri-business potentials in the province of Davao Occidental. These studies will inspire readers to recognize the enormous possibilities of local agriculture.

The work of the authors of these studies is very much appreciated. It is also worth noting that this issue would not have been feasible without the contributions and assistance of the Editorial Board. It is a job well done, and kudos to everyone.

It is hoped that the insights gained from reading this journal issue will serve as an inspiration to the agri-business development not only in the province but also in the region.

*Editor-in-Chief*

**NILA NANETTE S. REVILLA, PhD**



SOUTHERN PHILIPPINES AGRI-BUSINESS AND MARINE  
AND AQUATIC SCHOOL OF TECHNOLOGY (SPAMAST)  
Malita, Davao Occidental



**RUTH S. LUCERO, PhD**  
President

SPAMAST is now on its 36<sup>th</sup> year of existence as the only state college in the province. It has started from just a barangay high school and has evolved to what it is now today. Its commitment to serve the people of this province is manifested in the performance of its functions to provide quality instruction, relevant researches, adaptive extension and viable resource generation activities. The dedication and motivation of the faculty researchers to continually search for new knowledge, information and discoveries are significant drivers of change and transformation geared towards the improvement of the quality of

The modest number of researches on agri-aqua based technology, environment and biodiversity, socio-economics and Information technology, education and cultural heritage can be more meaningful when disseminated and applied.

I wish to congratulate the editorial team for coming up with this research journal where research outputs are documented. This serves as a tangible repository of knowledge enhancing and enabling a wider sphere for sharing information and scientific findings.

May this research journal inspire our faculty researchers to engage themselves more in doing research and publish the same for professional and academic advancement and personal fulfillment.

Again, CONGRATULATIONS and soar high SPAMAST!!!

**RUTH S. LUCERO, PhD**  
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# **ASSESSMENT OF AGRI-BUSINESS VENTURES IN DAVAO OCCIDENTAL**

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## **ABSTRACT**

This descriptive study was conducted to assess the agri-business ventures in Davao Occidental. Four municipalities were included namely Malita, Sta. Maria, Don Marcelino, and Jose Abad Santos. The statistical tools used were frequency, percentage, and mean. Respondents were chosen through random sampling. Results showed that most of the respondents who engaged in agri-business aged 36-40 years old, mostly female, married, college graduate, Roman Catholic, and Cebuano. Moreover, majority of the respondents preferred sole proprietorship as legal form of agri-business organization, merchandising of agricultural products. The size of the agri-business in terms of capitalization fall under micro category with the investment of P3,000,000.00 and below and employed at least one worker. The practice of agri-business in Davao Occidental in terms of production was sourced out raw materials from the locality due to the availability and abundance of agricultural products. Only few respondents used technology in their businesses and workers were hired from the locality to provide employment and income for the families. Most of the respondents preferred owner's equity as initial investment and operating expenses and marketing of the products was done through retailers. The term of payment was on cash to cash basis and the mode of promotion was publicity. The problem faced by the entrepreneurs was on the transport of products from the farm to the assembly area or consumers. High cost of transportation and damage during hauling led to reduction of profits for the entrepreneurs.

**KEYWORDS:** Assessment, agri-business ventures, Davao Occidental

## INTRODUCTION

Agribusiness is an important sector in any economy in Asia. It contributes substantially to Gross National Product (GNP) and is a vital source of employment for many people. Furthermore, since most agribusiness activities are carried out in rural areas and thus, provide an important source of income and livelihood for a large part of the population as development can be an effective instrument in alleviating poverty in any country (Kohls & Uhl, 2000). Since agriculture still remains as the backbone of our country's economy, the Philippines is stepping up its efforts to raise the capability of agriculture, agri-business, forestry and natural resource sectors to meet the country's food security needs, and at the same time ensure the sustainability of its agricultural processes and the resource base. Toward this end, the Philippine government has put in place the enabling development agenda, legislations, and policies on agricultural production and trade such that they meet food safety and biosafety standards (NEDA, 2010).

Just recently, the Japan International Cooperation Agency (JICA) extended a ¥4.9 billion loan for the development of Mindanao's agriculture sector under the project called "Harnessing Agri-business Opportunities through Robust and Vibrant Entrepreneurship Supportive of Peaceful Transformation" (HARVEST) which will act as a lending facility for agribusiness and related investments. The project aims to support ordinary Mindanao farmers and concerned institutions develop and grow the agriculture sector which can generate more investments and job opportunities especially in conflict-affected areas (PSA, 2015).

According to London-based industry intelligence provider, projections for the agribusiness sector in the Philippines is positive in the long term given the country's potential for expansion into new sectors such as oil palm. The outlook for sugar mills as well as the livestock sector is also expected to show healthy growth rates, the report said (Report buyer, 2014).

Projections for Asia Pacific are positive, with the report citing the Philippines' and Indonesia's significant employment growth. The number of jobless Filipinos in 2016 has gone down to 2.4 million or 5.5 percent, lower than the 2.6 million or 6.3 percent jobless recorded in 2015 (PSA, 2016). The emergence of agribusiness ventures brings about the employment generation and ensuring the availability of food security for the people.

On the other hand, Davao Occidental, the newest and the 81<sup>st</sup> province in the Philippines with its capital, the municipality of Malita is dubbed as "a province of

endless possibilities “. Davao Occidental is an agricultural province bestowed with rich natural resources and one of the top contributors as exporter of some agricultural products in Region XI. Its major products include rice, corn, coconut, cacao, banana, mango and a variety of fruits and root crops substantially contribute to the income of the agriculture sector. About 68% of the area of the province is devoted to agricultural production (DTI, 2016).

For the agri-business or enterprise industry, groups endeavor either by a cooperative or by People’s Organization (POs) usually their products are sold only in the local markets. Assisting them in the processing, financing and marketing as well as improvement of the quality of their products are the DTI, DOLE, DOST and LGU’s. However, it is always observed that still they can hardly qualify nor meet the global market or demands. Thus, they need to enhance their skills and capabilities, as well as provide with adequate capital to be able to compete with the global market (DTI, 2016).

It is quite evident that there are few existing agri-business ventures within the province considering the vast agricultural lands and the abundance of farm inputs that are conducive for agri-business engagement. Hence, this study will serve as the basis for the entrepreneurs on what type of agri-business undertakings they will engage in the future.

### **Objectives of the Study**

This study focused on the “Assessment of Agri-Business Ventures in Davao Occidental” aimed to propose various means to improve the Agri-Business at the municipality level. Specifically, it aimed to:

1. Describe the demographic profile of respondents in terms of age, sex, civil status, ethnicity, educational attainment; religious affiliation; and household size.
2. Determine the business profile of Agri-business ventures in Davao Occidental in terms of legal forms of agri-business, nature of agri-business, capitalization, and number of employees.
3. Describe the agri-business practices in Davao Occidental in terms of production, marketing, and financing.
4. Identify opportunities and challenges confronting Agri-business in Davao Occidental in terms of trading facility, taxation, government interference, and market channels.

### **Significance of the Study**

This study was conducted to assess the agri-business ventures in Davao Occidental. The results of this study would benefit the LGUs, DTI, DOST, SPAMAST and other stakeholders in crafting plans and to develop more agri-business opportunities in the province in order to achieve an economically sound and viable business environment.

### **Scope and Limitation of the Study**

The study was conducted to assess the agri-business ventures in Davao Occidental particularly in the four municipalities namely: Sta. Maria, Malita, Don Marcelino and Jose Abad Santos. Descriptive survey was used to gather data from the respondents and frequency, percentage, and mean were employed. The parameters of this study were: agriculture, processing, merchandising and service. For agriculture, considered respondents were those who engaged in the production of raw materials and other products like fruits and vegetables. For processing of raw materials, abaca fiber, coconut chair, lumber and furniture making were considered. For merchandising business, buy and sell of agricultural products like copra, corn, palay, abaca fiber and others, agri-vet supplies and meat products were included. Moreover, for the service concern, private lending individuals who granted short term loan were involved. Lastly, this study was conducted in February 2019.

## **METHOD**

### **Research Locale**

The study focused on the assessment of agri-business ventures in Davao Occidental. The respondents were the agri-business entrepreneurs of the four municipalities of Davao Occidental, a newly created province which has a wide range of agri-business opportunities considering the vast agricultural lands, lending institutions and technologies. The province of Davao Occidental is an agricultural area in which most of the agri-business activities were carried out in the rural areas. Each municipality has an inclination to establish agri-business undertakings considering the supply-chain of raw materials from the locality.

### **Research Design**

Descriptive research design was used in the study. A survey was employed to the respondents in order to obtain the substantial information for the investigation. The researcher devised a questionnaire which was administered to the respondents in each municipality. The questionnaire covered the different areas



in agri-business endeavors which aimed to assess the level of engagement of agri-business ventures in the Davao Occidental. The areas were as follows: demographic and socio-economic profile of respondents, agri-business profile, common practices, and opportunities and challenges faced by the entrepreneurs.

### Respondents of the Study

The respondents of the study were the agri-business entrepreneurs from the four municipalities of Davao Occidental namely: Malita, Sta. Maria, Don Marcelino and Jose Abad Santos. The researcher requested a master list from the Department of Trade and Industry (DTI) of Davao Occidental for reference and source of information. Those who engaged in agri-business undertakings like agriculture, processing, merchandising and service were considered in choosing the respondents.

### Sampling Design and Technique

The study utilized random sampling of respondents to whom the self-structured survey questionnaire was administered to collect accurate information. The respondents were asked to respond to all items in the questionnaire by ticking the box most applicable to them and followed up by an interview to validate the veracity of the answers.

Table 1. Distribution of sample size of the study

Municipality	Population	Sample Size
Malita	60	43
Sta. Maria	28	20
Don Marcelino	37	26
J. Abad Santos	30	22
TOTAL		111

Source: DTI, Davao Occidental, 2018.

### Research Instrument

A survey questionnaire was produced by the researcher and used in gathering the data. It composed of the following parts; demographic and profile, agri-business profile, practices and the opportunities and challenges encountered by the respondents in doing agri-business.

### Data Gathered

The data gathered from the respondents were the demographic and socio-economic profile of respondents, business profile as to the age of business, nature of business, forms of business, size of business, capitalization, number of

employees and opportunities and challenges encountered by the respondents in doing business were also included in this study.

### **Data Gathering Procedure**

Gathering of data was done as follows: permission was sought from the respondents of the study by informing the purpose or goal. The questionnaires were administered to the respondents in their respective business establishments. The data from the questionnaire were tabulated and analyzed. Treatment and interpretation of the data collected using the processes enumerated in the statistical treatment was done.

## **RESULTS AND DISCUSSION**

### **Demographic Profile of Respondents**

The demographic profile of respondents who engaged in agri-business ventures in Davao Occidental is shown in Table 2. In terms of age, most of respondents (36.9%) belonged to the age bracket of 36-40 years old. This means that the respondents inclined in agri-business activities were in their prime years.

As to gender, majority were female (53.0%) and married (66.7%). This means that female and married respondents were more interested in doing agri-business compared with male because most of the respondents were plain housewives. Moreover, female respondents were commonly innovative and business-minded and wanted to help in augmenting their family income.

As to educational attainment, majority of respondents were college graduates (44%), followed by high school level and high school graduates with an equal 28%. Results also revealed that respondents who obtained college degrees were graduates of Commerce and Accounting prestigious universities in Davao City.

As to religion, majority of respondents were Roman Catholics (82%) followed by Protestants (13%) and Islam (5%). Catholics obtained a higher percentage in doing agri-business ventures due to the fact that no church policies hinder the operations of the agri-business like no closing of businesses during Sundays and can sell any products such as pork and the likes.

As to ethnicity, most of them were Cebuano (71.9%) followed by Tagakaolo and Manobo tribes having the same percentage of 10.8%. This means that other tribes were outnumbered by Cebuanos and can really establish good rapport to

customers without following the tribal norms and mores. Cebuano population in every municipality was incomparable with other tribes who wanted to establish agri-businesses as a source of livelihood or occupation. The sustainability of agri-business activities relied on the willingness and inclinations of the entrepreneurs.

Table 2. Demographic Profile of the respondents engaged in Agri-Business Ventures in Davao Occidental February 2019

Indicators	Frequency	Relative Frequency (%)
<b>Age</b>		
20-25	9	8.1
26-30	12	10.8
31-35	21	18.9
36-40	41	36.9
41-50	18	16.2
51 and above	10	9.0
<b>Gender</b>		
Male	51	46.0
Female	59	53.0
LGBT	1	0.9
<b>Civil Status</b>		
Single	35	31.5
Married	74	66.7
Widower	2	1.8
<b>Educational Attainment</b>		
Elementary Grad	6	5.4
High School Level	5	4.5
High School Grad	28	25.2
College Level	28	25.2
College Graduate	44	39.6
<b>Religion</b>		
Roman Catholic	82	73.9
Protestants	15	11.7
Islam	5	4.5
<b>Ethnicity</b>		
Cebuano	82	73.9
Tagakaulo	12	10.8
Manobo	12	10.8
B'laan	2	1.8
Muslim	3	2.7

### Agri-Business Profile of Respondents in Davao Occidental

Most agri-business were engaged were on sole proprietorship (92.8%), followed by corporation (3.6%), partnership (2.7%) and cooperative (0.9%).

Results showed that sole proprietorship obtained a higher percentage in legal forms of agri-business because of some advantages. In sole proprietorship, the owner was also the manager with no division of profits and had unlimited liability. The proprietors could manage his/her time and could make decisions independently for his/her business. Most of the sole proprietors ventured in merchandising as well as in agriculture, but less in processing and service concern.

For the nature of agri-business, results showed that majority of the respondents were engaged in merchandising (55.8%), followed by agriculture (39.6%), processing (2.7%) and service (1.8%). Merchandising business like buy and sell of agri-products and agri-vet supplies and selling of meat products obtained the highest percentage because these can easily establish and require small capital, had small area or space requirement and products were in demand in the market. Besides, the documentary requirements when applying for business permits and licenses and other statutory obligations were easier and cheaper. For Davao Occidental, there is an office of the Department of Trade and Industry (DTI) located in Malita, where business person could register his/her agri-business.

In terms of capitalization, majority of the respondents were having a capital outlay of P3,000,000.00 and below (92.8%) under the micro category, followed by P3,000,000.00 to P15,000,000.00 (6.3%) under small category and there was only 0.9% of the respondents who belonged under medium category with a capitalization of P 15,000,000.00 to P 100,000,000.00. This means that the sizes of agri-businesses were small considering the investment and the nature of agri-business. For example, in merchandising business like buying and selling of agricultural products and agri-vet, stores were not required higher capital to start with the agri-business operations. In terms of location, majority of businesses were situated in rural areas with less dense populations.

As to the number of employees, most of the establishments employed 1-2 workers (57%), 3-4 workers (27%), 5-6 workers (15%) and the remaining were few in numbers. Results revealed that the number of employees ranged from 1 to 2 because some of the agri-businesses were particularly small like agri-vet stores, merchandising, and furniture making.

Table 3. Agri-Business Profile of the Respondents in Davao Occidental February 2019

Indicators	Frequency	Relative Frequency (%)
<b>Forms of Agri-Business</b>		
Sole Proprietorship	103	92.8
Partnership	3	2.7
Cooperative	1	0.9
Corporation	4	3.6
<b>Nature of Agri-Business</b>		
Agriculture	44	39.6
Processing	3	2.7
Merchandising	62	55.8
Service	2	1.8
<b>Capitalization</b>		
Micro (3M-below)	103	92.8
Small (3M-15M)	7	6.3
Medium (15M-100M)	1	0.9
Large (100M-above)	0	0
<b>Number of Employees</b>		
1-2	57	51.3
3-4	27	24.3
5-6	15	13.5
7-8	6	5.4
9-10	4	3.6
11 and above	2	1.8

### Practices of Agri-Business Ventures in Davao Occidental

In Table 4, under production, the sources of raw materials came from the locality (67.5%) and neighboring cities (32.4%). There was an abundant supply of raw materials in the province because of the very nature of the area. Raw materials from the farm, forest, aqua and marine resources were available. If shortages of raw materials happened, they bought from neighboring cities. Sources of manpower were rarely a problem because there were more unemployed individuals in the locality (90%). Thus, many people can be hired. But in the case of migration, the agri-business establishments can hire from the neighboring cities (9.9%). There was no need to hire workers from manpower agency and other countries because of the surplus manpower in the locality. Few of the respondents used technology (31.5%) which was appropriate to agri-business operations like in agriculture and processing of raw materials. However, most of respondents hardly used technology (68.5%) in the agri-business like merchandising, buy, and sell of agricultural products and agri-vet supplies because these activities never require machineries or equipment to be used in the operations.

Table 4. Practices of Agri-Business Ventures in Davao Occidental February 2019

Indicators Production	Frequency	Relative Frequency (%)
Sources of Raw Materials		
Locality	75	67.5
Neighboring Cities	36	32.4
Other Countries	0	0
Sources of Laborers		
Locality	100	90.0
Neighboring Cities	11	9.9
Other Countries	0	0
Technology Adopted		
With Technology	35	31.5
No Technology	76	0
Marketing		
Channel of Distribution		
Wholesaler	43	38.7
Retailer	68	61.3
Middleman	0	0
Terms of Payment		
Cash	86	77.5
Credit	19	17.1
consignment	6	5.4
Mode of Promotion		
advertisement	0	0
publicity	111	100.0
Financing		
Source of Financing		
owner's equity	100	90.0
loan	9.9	9.9
subsidy	0	0
others	0	0
Terms of Financing		
short term	11	9.9
intermediate term	0	0
long term	0	0

As to sources of financing, majority of respondents preferred owner's equity for the initial investment and also for operation expenses of agri-business (90%) and there were only few (9.9%) who availed of loan from banks for a short term. Since sole proprietorship was the most preferred form of the agri-business in Davao Occidental, it required only small capital to start the operations. Nevertheless, personal money could be used as initial investments. Other

entrepreneurs opted to avail livelihood loan from banks with small interest rate and payable within one (1) year like Landbank and Producers Bank in Malita which offered livelihood loans for those who ventured into agricultural production.

As to marketing, majority of the respondents were retailers (61.3%) followed by wholesalers (38.7%) with no middlemen involved. Retailers obtained the highest percentage because in merchandising business, establishments bought products like corn, copra, palay, etc. and sold them to contract buyers for further processing. In agri-vet supplies, establishments bought commercial products and resell those to the consumers. In terms of payment scheme, majority preferred cash (86%) on delivery and only few (19%) preferred credit and 5.4% on consignment basis. Most of the agri-business preferred cash upon delivery of the products considering the size of the business with regards to the capital. Credit was granted with a specific period of not more than one (1) month.

Respondents used publicity (100%) like putting of tarpaulin and giving leaflets to the customers for information dissemination purposes particularly on the existence of the agri-business in the area. TV advertisement was not utilized because of the high cost and since these were agricultural products.

### **Opportunities and Challenges Facing the Agri-Business Ventures in Davao Occidental**

Most of the respondents encountered problems in the marketing of products (40.5%) due to distance, transportation costs and other expenses. Besides, the high percentage of damages when transferring the products from the farm to the assembly area or to the consumers thus, reducing the profits of the entrepreneurs. Respondents also encountered problems on taxation (33.3%) with regards to the marketing of the products. The government imposed new tax system under the TRAIN law which made the agri-business sector reduced market-driven potentials to engage to other business lines. Market (40.5%) was also observed as a hindrance especially in the delivery of those goods and services to the people. Only few available market outlets in the locality for the display of the produce because some of which were situated in the remote areas where few populations existed. Government interference (9.9%) was also observed as a problem especially on the high fees of business registration and documentary requirements as mandated by the law and municipal ordinances.

Table 5. Problems/Constraints facing the Agri-Business Ventures in Davao Occidental February 2019

Indicators	Frequency	Relative Frequency (%)
Market	45	40.5
Taxation	37	33.3
Market channels	18	16.2
Government interference	11	9.9

## SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

### Summary

This study was conducted to assess the agri-business ventures in Davao Occidental. The respondents considered in this study were agri-business entrepreneurs who ventured in agriculture, processing, merchandising, and service of agri-products. The statistical tools used in this study were Slovin, frequency, percentage, and mean. The data were collected through the use of self-structured questionnaire and the same were analyzed using frequency counts and percentage. Results showed that majority of the respondents (36.9%) belongs to the age bracket of 36-40 years old, most were female (53.0%), married (66.7%) and graduate of college degree (44%).

In terms type of agri-business ventures, most respondents preferred on sole proprietorship (92.8%), engaged in merchandising (55.8%), with capitalization of P3,000,000.00 and below (92.8%), employed at least one worker (51.3%) and encountered problems in marketing (40.5%) the agricultural products or services due to distance, bulkiness and high cost of transportation.

### Conclusions

Based on the data presented, the following conclusions are drawn: most of the respondents who engaged in agri-business ventures are in the age range of 36-40 years old, female, married, and obtained college degree. As to the type of agri-business ventures, most respondents were engaged on sole proprietorship, merchandising as the nature of business, with capitalization of P3,000,000.00, categorize as micro businesses, and employed one to two workers. Marketing of the products is identified as the main problem due to the distance, bulkiness, high transportation costs, and damages during the transfer of products from the farm to market assembly.



## Recommendations

The following recommendations are suggested by the researcher.

1. The Economic Enterprises Office of each municipality shall intensify the effort to attract more investors to put up the agri-businesses in order to create more jobs and provide income for the families.

2. The Department of Trade and Industry (DTI) in the province shall conduct a “Business Opportunities and Financial Management Seminars to empower and educate the present entrepreneurs on how to deal with the investments and what assistance that the agency may offer.

3. It is advised for stakeholders in the respective municipalities to provide technical support to those newly established enterprises for sustainability of the operations.

4. The government banks like Landbank, Development Bank of the Philippines, Philippine National Bank, and other banks that are available in the locality may offer financial assistance to the newly and existing agri-businesses for the start-up capital and expansions.

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# DEVELOPMENT OF KALAMANSI NIP WITH GINGER EXTRACT

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## ABSTRACT

The study was geared towards the production of kalamansi nip enhanced with ginger extract. It was conducted to determine the acceptability of kalamansi nip with ginger extract with its concentration, acceptability of nip and juice among different market segments, available nutrients, shelf-life, and profitability of production. Experiments were carried out in a Completely Randomized Design and subjected to sensory evaluation. The nip was prepared with different ginger ratios: T1 (control); T2 (5%); T3 (10%); T4 (15%). Results showed that 5% ginger extract concentration had a higher acceptability. Using 5% concentration of ginger, the researchers tested the nip and juice's acceptability through sensory evaluation among different market segments. Both products were liked among the evaluators. Laboratory analysis revealed that the kalamansi nip with ginger extract was found to contain: 327 kcal per 100g, 71.35% carbohydrates, 4.55% crude fat, 4.12% saturated fat, 0.19% crude protein, 43.68 µg/g sodium, 508 µg/g potassium, and 101µg/g calcium. The kalamansi nip and juice lasted at room temperature for 51 and 3 days respectively. In addition, kalamansi nip production had a promising return of 15 to 35% depending on the amount of ginger extract.

**KEYWORDS:** Product development, acceptability, nutrient analysis, shelf-life, profitability

## INTRODUCTION

Health and well-being is a prevalent and important topic of interest today, especially among children and adolescents. Studies have shown that there is an increasing epidemic of childhood obesity in industrialized and urbanized communities (Ebbeling et al., 2002; Lobstein et al., 2004; Wang & Lobstein, 2006) and in developing countries (Wang & Lobstein, 2006; Gollos-Gubat et al., 2015). The Philippines is not an exception as the increase in overweight and obesity levels in children and adolescents continue from 2003 to 2011 (FNRI-DOST, 2010; FNRI-DOST, 2012).

The Department of Education (DepEd) Order No. 8, s. 2007 specifies that "School canteens shall serve as a place for the creation of appropriate pupil/student eating habits". In particular, the guidelines stipulate that drinks sold in public elementary and secondary schools shall include milk, shakes, and juices prepared from fruit and vegetables during the season, while the sale of carbonated juices, sugar-based synthetic or artificially flavored juices shall be prohibited.

However, school-based food provision and sales account for a significant proportion of children's food intake. Even in schools, children and adolescents are constantly targeted by the food industry through aggressive marketing campaigns, with evidence showing that food marketing to people under the age of 18 is controlled by unhealthy food and drink (Reeve et al., 2018). Apart from children, there are people nowadays who are obsessively conscious about their health. Kalamansi has a characteristic that can lose weight and ginger is rich in medicinal properties that help the body to detoxify and provide a general boost to the immune system.

### **Objective of the Study**

This study paves the way for the development of a new, refreshing, healthy juice drink made from kalamansi, enhanced with ginger extract. Value added is expected to improve the quality of natural kalamansi nip compared to other processed and synthetic kalamansi concentrates and commercially available juices.

## REVIEW OF LITERATURE

### **Food and Beverage Consumption and Health Issues**

Survey data from different countries indicated a growing epidemic of childhood obesity in developed and urbanized populations (Ebbeling et al. 2002; Lobstein et al. 2004; Wang & Lobstein 2006) and in developing countries (Wang

& Lobstein 2006; Gupta et al. 2012). The Philippines faces an extreme double-burden of malnutrition (ASEAN, WHO, UNICEF, 2016) stunting affects over 30% of children under the age of 5 (Hwalla et al., 2014) and diet-related NCDs are steadily increasing. NCDs accounted for 67% of total deaths in 2014, up from 61% in 2010 (World Health Organization, 2014). Under nutrition coexists, there is a continued increase in the prevalence rates of overweight and obesity in children and adolescents from 2003 to 2011 (FNRI-DOST 2010; FNRI-DOST 2012).

Among the important dietary changes in children and adolescents are the increased consumption of sugar-sweetened beverages and decreased milk intake (Blum et al. 2008; Striegel-Moore et al. 2006; Garriguet, 2008) which were associated with BMI (Blum et al. 2005; Striegel-Moore 2006; Collison et al. 2010), waist circumference, dietary choices (Collison et al. 2010) and greater risk for overweight and obesity over time (Ludwig et al. 2001; Berkey et al. 2004).

The Department of Education (DepEd) Order No. 8, Series of 2007 states that “School canteens shall serve as a venue for developing desirable eating habits of pupils/students”. In particular, the guidelines stipulate that beverages sold in public elementary and secondary schools shall include milk, shakes, and juices prepared from fruits and vegetables in season. Selling of carbonated, sugar-based synthetics or artificially-flavored juices is prohibited. Likewise, the Department of Education in 2017 issued DO 13 series of 2017 provides the policy and guidelines on healthy food and beverage choices in schools and offices. The Policy and Guidelines aim to make available healthier food and beverage choices among the learners and DepEd personnel and their stakeholders, to introduce locally available foods and drinks in accordance with geographical, cultural, and religious orientations; to provide guidance in evaluating and categorizing foods and drinks; and to provide guidance in the selling and marketing of foods and beverages in schools and DepEd offices, including the purchasing of foods for school feeding.

### **Product Development and Innovation**

Product development is a series of steps that include the conceptualization, design, development and marketing of newly created or newly rebranded goods or services. It is intended to cultivate, maintain and/or increase market share by satisfying a consumer demand (Baker, 2004). Successful product innovation can lead not just to products that satisfy the existing needs of customers, but it can also lead to market expanding breakthrough products that satisfy the needs of customers (Innocence, 2015).

## **The Health Benefits of Kalamansi**

Kalamansi (*Citrusfortunella Microcarpa*) is a fruit grown all over Southeast Asia and it is very popular in the Philippines as the “Golden Lime”. It is said to be a good source of vitamin C. Moreover, its fruit has been processed into syrups, juices, concentrates, and purees. Its juice is used as flavoring or an additive in various food preparations to enhance iron absorption and can be used as a good ingredient in making various juices and beverages (Helmiyetti, 2013). Kalamansi is rich in phosphorous, calcium, iron and Vitamin C or ascorbic acid. It is the most popular and most commonly used citrus fruit in the country. Its juice is nutritious and traditionally made into a fruit drink that helps prevent respiratory diseases. It also helps strengthen the bones and stimulates the growth of children. Calamansi has anti-bacterial property which is effective mouthwash as it eliminates morning breath. In addition, calamansi is cheaper than any other health and beauty products over the counter, but it contains similar benefits, yet natural.

## **Ginger and its Health Benefits**

Ginger (*Zingiber officinale*) is a flowering plant with rhizome. Ginger root or simply ginger is widely used as a spice or a folk medicine. It is herbaceous perennial which grows annual stems about a meter tall bearing narrow green leaves and yellow flowers. Ginger is in the family Zingiberaceae, to which also belong turmeric (*Curcuma longa*), cardamom (*Elettaria cardamomum*), and galangal. Ginger is an excellent companion, warming the body improving the circulation and activating the body defenses. Ginger has a very useful function during colds, flu, virus infection, coughs, chronic bronchial problems and low-grade infection of all kinds. Compounds from ginger include salmonella typhi, vibrio cholerae salmonella typhi, vibrio cholerae and *Trichophyton violaceum*.

## **Macro and Micro Nutrients and their Importance**

Calories are measure of how much energy food or drink contains. Calories and kilocalories are commonly used as shorthand for kilocalorie. It is written as kcal on food packets. Kilojoules (kJ) are the equivalent of kilocalories within the International System of Units and both kJ and kcal on nutrition labels – 4.2kJ is equivalent to approximately 1kcal (Ng et al., 2012). Lupton et al., (2002) noted that children and adults should consume 45 to 65 percent of their calorie intake as carbohydrates, and at least 130 grams of carbs per day. Since lowering carb intake and increasing protein intake can help reduce calorie intake for weight loss. Fifty percent of calories must be consumed from carbs for successful weight loss. Athletes require more carbs to replace muscle glycogen lost during physical training; some athletes need up to 70 percent of calorie intake from carbs.

## **Carbohydrates**

The calamansi nip also contains 71.35% carbohydrates. Carbohydrates are the body's main source of energy and should make up the largest percentage of the daily calorie intake (Coleman, 2015). Traces of crude fat (4.55%), saturated fat (4.12%) and crude protein (0.19%) were also determined in the laboratory analysis.

## **Crude fat**

Crude fat content is determined by extracting the fat from the sample using a solvent, then determining the weight of the fat recovered. As lipids/fats are relatively non-polar molecules, they can be pulled out of a sample using relatively non-polar solvents. With a non-polar solvent, only non-polar molecules in the sample dissolve while polar ones do not. Problems arise however, in cases where lipids are bound in animal or plant cell membranes. Animal and plant cell membranes are made up of molecules that have both polar and non-polar regions such as triglycerides (molecule with polar glyceride heads and non-polar fatty acid tails) and phospholipids (similar to triglycerides, but a phosphate group replaces the fatty acid tail). These molecules end up grouping together with their polar heads sticking outwards and non-polar tails inwards making it difficult for non-polar solvents to interact with the non-polar tails and extract (Thiex et al., 2003).

## **Saturated fat**

Saturated fats are less healthy than polyunsaturated and monounsaturated fats. Rich resources include palm oil, butter, animal fats such as red meat, poultry, full-fat dairy products, chocolate and cheese.

## **Crude Protein**

Crude Protein is a structural molecule made up of amino acids, many of which the body cannot produce on its own. Animal foods are usually high in protein, with all the essential amino acids we need (Nadolsky, 2014). Moreover, the calamansi nip with ginger extract also contains 43.68µg/g sodium. According to Martinac et al., (2007) sodium is one of several minerals that are also electrolytes, whose primary function is to regulate fluid in the cells. The upper limit for sodium set by the Institute of Medicine is the equivalent of 1 teaspoon daily for healthy adults age 50 and under.

The presence of potassium (508µg/g) was also noted in the kalamansi nip. According to Kern (2008), fewer than two percent of American adults consume the recommended daily amount of potassium, currently set at 4,700 milligrams for most people. Potassium plays a crucial role in bone strength, kidney stone production and the risk of stroke, and as an electrolyte. It's part of the

electrochemical balance that keeps the nervous system working properly. That makes getting enough, through diet or supplements, a significant goal for most people.

The calcium available in the calamansi nip is 101.00 $\mu\text{g/g}$ . The most abundant mineral in the body is found in some foods, added to others, available as a dietary supplement, and present in some medicines (such as antacids). Calcium is required for vascular contraction and vasodilation, muscle function, nerve transmission, intracellular signaling and hormonal secretion, though less than 1% of total body calcium is needed to support these critical metabolic functions. Serum calcium is very tightly regulated and does not fluctuate with changes in dietary intakes; the body uses bone tissue as a reservoir for, and source of calcium, to maintain constant concentrations of calcium in blood, muscle, and intercellular fluids (Karohl et al., 2010).

There is 3.73  $\mu\text{g/g}$  of iron available in the calamansi nip. Iron is a mineral vital to the proper function of hemoglobin, a protein needed to transport oxygen in the blood. Iron also has a role in a variety of other important processes in the body. Iron helps to preserve many vital functions in the body, including general energy and focus, gastrointestinal processes, the immune system, and the regulation of body temperature. The benefits of iron often go unnoticed until a person is not getting enough. Iron deficiency anemia can cause fatigue, heart palpitations, pale skin, and breathlessness (Ware, 2008).

Moreover, 46.35  $\mu\text{g/g}$  of magnesium was found in the kalamansi nip. According to Erdman et al., (2012) magnesium, an abundant mineral in the body, is naturally present in many foods, added to other food products, available as a dietary supplement, and present in some medicines (such as antacids and laxatives). Magnesium is a cofactor in more than 300 enzyme systems that regulate diverse biochemical reactions in the body, including protein synthesis, muscle and nerve function, blood glucose control, and blood pressure regulation. Magnesium is required for energy production, oxidative phosphorylation, and glycolysis. It contributes to the structural development of bone and is required for the synthesis of DNA, RNA, and the antioxidant glutathione. Magnesium also plays a role in the active transport of calcium and potassium ions across cell membranes, a process that is important to nerve impulse conduction, muscle contraction, and normal heart rhythm. Moreover, 5.64  $\mu\text{g/g}$  of phosphorus is also found in the kalamansi nip. Wellman (2004) mentioned that phosphorus is the second most plentiful mineral in the body. The first is calcium. The body needs phosphorus for many functions, such as filtering waste and repairing tissue and cells.

## Conceptual Framework

### Study 1: Acceptability of Kalamansi Nip with Ginger extract at different levels

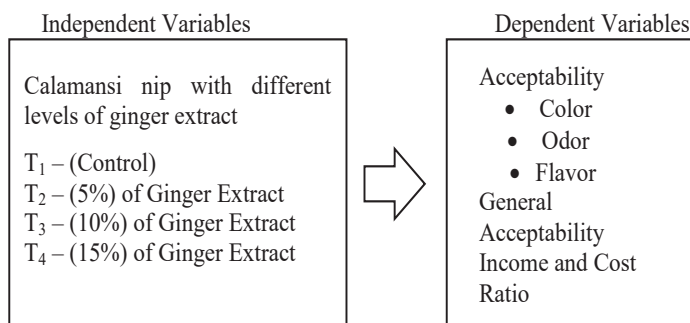


Figure 1. Schematic Diagram showing the relationship between the Independent and Dependent variables of the study: Acceptability of Kalamansi Nip with Ginger extract at different levels

The above diagram shows that the acceptability of kalamansi juice from kalamansi nip in terms of color, odor, flavor and general acceptability may vary as influenced by the different levels of ginger extract added to the kalamansi nip mixture. The income and cost ratio is also expected to differ among different treatments.

### Study 2: Nutrient analysis, Shelf-Life and Acceptability of Kalamansi Nip with Ginger Extract Among Different Market Segments (Elementary pupils, High School and College Students, and Professionals).

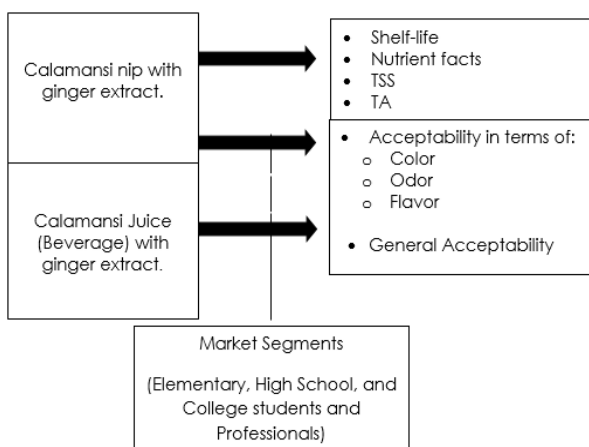


Figure 2. Schematic Diagram showing the relationship between the independent and Dependent variables of the study



The figure shows the variables of the study. Sensory evaluation as to acceptability, nutrient facts, and shelf life of calamansi nip with ginger were the dependent variables of the study. Acceptability of the calamansi nip and juice with ginger extract are expected to vary among the different market segments which are the moderating variables, thus, identifying the right segment to market the product.

## **METHOD**

### **Research Locale**

The processing of kalamansi nip was conducted at Southern Philippines Agri-Business and Marine Aquatic School of Technology (SPAMAST) Buhangin Campus, located at Barangay Buhangin, Malita, Davao Occidental. Sensory evaluation was done in the respective location of the respondents as follows: Buhangin Elementary School for the elementary pupils; Tubalan National High School for the High School respondents; SPAMAST for the tertiary respondents and the DPWH-Buhangin and SPAMAST for the professional respondents. The respondents were randomly chosen to evaluate the acceptability of the kalamansi nip with ginger extract in terms of flavor, color, odor, and general acceptability.

### **Research Design**

This study utilized experimental and descriptive research designs to describe the acceptability of the kalamansi nip with ginger extract in terms of color, odor, flavor, and general acceptability among different market segments. These were also used to describe the nutrient facts, the shelf-life, and the cost-return analysis on the processing of kalamansi nip.

The experimental stage (study 1) was laid out in a complete randomized design with 4 treatments replicated three times and ten samples per treatment. In descriptive method, one-way ANOVA was used to determine the difference on the acceptability of kalamansi nip and juice among different segments.

Fresh kalamansi, ginger, and sugar were used in the processing of kalamansi nip and juice. Mature calamansi fruits were utilized. They were washed, drained, cut across the upper portion to avoid cutting the seeds, and squeezed out by hand to extract the juice (Morte, 2017). Raw gingers were washed, drained, peeled, and sliced into small pieces to extract the juice using a juice extractor. Then, the strained kalamansi juice was mixed with ginger extract following the ratio prescribed per treatment. In the second study, the ratio most acceptable to the respondents was adopted; hence, a 5% ginger extract ratio was used for further study. The kalamansi nip with ginger extract was chilled for three days undisturbed before bottling and storing

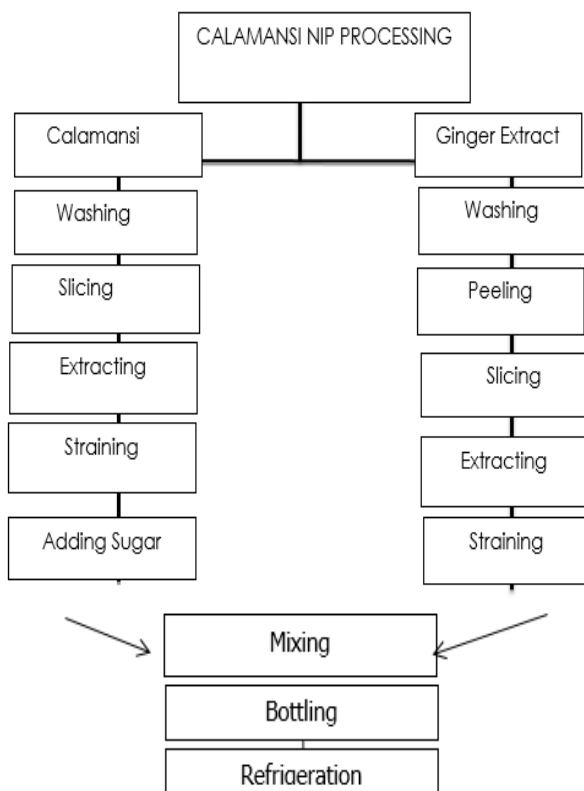


Figure 1. Flow chart on the processing of calamansi nip with ginger extract.

Purposive sampling technique was employed in the selection of the respondents who evaluated the acceptability of the product as to its flavor, color, odor, and general acceptability. Different market segments such as students from elementary, high school, and college as well as professionals were included as respondents. There were 80 respondents who comprised this study, as presented below:

Table 1. Sample Size and Distribution

Market Segment	Samples
Elementary Pupils	20
High School Students	20
College Students	20
Professionals	20
TOTAL	80

The complete nutrient analysis, shelf-life, and acceptability in terms of color, odor, and stickiness were gathered. A liter of Kalamansi nip was subjected for a complete nutrient analysis by subjecting it for a laboratory analysis at the University of Immaculate Concepcion (UIC), Davao City. Moreover, shelf-life is the length of time a commodity can be stored without becoming unfit for use, consumption, or sale. It was determined through daily visual evaluation. Furthermore, sensory evaluation was done to determine the acceptability of kalamansi nip with ginger extract in terms of color, odor, flavor and general acceptability by different market segments such as the students from elementary, high school and college as well as professionals. A 9-point Hedonic scale was used in evaluating the acceptability of the product, as follows: 9- Like extremely, 8- Like very much, 7- Like moderately, 6- Like slightly, 5- Neither like nor dislike, 4- Dislike slightly, 3- Dislike moderately, 2- Dislike very much, and 1-Dislike extremely.

### **Statistical Analysis**

To analyze the data gathered, the researchers computed the mean. Moreover, Analysis of Variance (ANOVA) in complete randomized was used to determine the significant difference on the acceptability of the calamansi nip and juice in terms of color, odor, stickiness, and general acceptability as influenced by the different levels of ginger extract and among different market segments.

## **RESULTS AND DISCUSSION**

### **Acceptability of Kalamansi Nip with different concentration of ginger extract**

Results of the study showed that the ginger flavor on kalamansi juice were more pronounced in treatments with higher levels of ginger extracts (Treatments 4 and 3) which were significantly different from control. However, Treatments 2 and 1 had moderately pronounced ginger flavor that were not significantly different from each other. In terms of acceptability of flavor, treatments with lesser concentration of ginger extract were liked more than those with higher concentration, yet no significant difference were noted on the flavor's acceptability.

Table 2. Acceptability of Kalamansi juice with different concentration of ginger extract

Particulars	Mean Acceptability Scores			
	Color	Odor	Flavor	Gen. Acceptability
T1-Control	6.61-LM	6.62- LM	6.99- LM	7.42- LM
T2- 5%	6.47- LS <sup>ns</sup>	6.28- LS <sup>ns</sup>	6.72- LM <sup>ns</sup>	7.11- LM <sup>ns</sup>
T3- 10%	6.47-LS <sup>ns</sup>	6.10- LS <sup>ns</sup>	6.30- LS <sup>ns</sup>	6.97- LM <sup>ns</sup>
T4- 15%	6.58-LM <sup>ns</sup>	6.26- LS <sup>ns</sup>	5.13- NLN <sup>ns</sup> D	6.96- LM <sup>ns</sup>

In terms of odor, treatments 4 and 3 were both described to have a moderately strong odor that were significantly different from control, whereas, treatment 2 had a mild odor that was not significantly different from treatment 1 having a slightly weak odor. However, no significant difference was noted on the odor of Kalamansi nip regardless of the level of ginger extracts.

In terms of color, treatments 4, 3, and 2 with the ginger extract produced slightly dark colored kalamansi juice that were significantly different from control with a slightly pale color. However, no significant difference was noted on the acceptability of the color as influenced by the different levels of ginger extract. General acceptability of kalamansi nip with different levels of ginger extract was found out to be liked moderately with no significant difference.

**Acceptability of Kalamansi nip with ginger extract among different market segments**

Table 3 shows the acceptability of kalamansi nip with ginger extract in terms of color, odor, thickness and general acceptability among different market segments.

Table 3. Acceptability of calamansi nip with ginger extract among different market segments

Particulars	Mean Acceptability Scores			
	Color	Odor	Stickiness	Gen. Acceptability
Elementary	7.70 <sup>a</sup> LVM	6.90 LM	6.70LM	8.35 <sup>a</sup> LVM
High School	7.45 <sup>ab</sup> LM	6.65 LM	7.15 LM	7.70 <sup>ab</sup> LVM
College	6.60 <sup>c</sup> LM	7.00 LM	7.25 LM	7.40 <sup>bc</sup> LM
Professional	6.55 <sup>c</sup> LM	7.50 LM	7.65 LM	6.90 <sup>c</sup> LM

In terms of color, it was found that the highest acceptability rating was noted among elementary pupils who liked the kalamansi nip with ginger very much,

followed by the professionals, the college students, then by the high school students who liked the product moderately. Moreover, there was a significant difference on the acceptability of Kalamansi nip with ginger extract in terms of color among different market segments. Using the Tukey analysis, the researchers found that the acceptability of elementary pupils on the Kalamansi with ginger extract was significantly higher than the high school and college students but was not significantly higher than the professionals. Moreover, the professionals liking on the product was significantly different from the high school and the college students, however, no significant difference were noted between the high school and the college students.

In terms of odor, the Kalamansi nip with ginger extract was liked moderately by all market segments such as the professionals, college students, elementary pupils, and high school students. Results showed no significant difference in the acceptability of Kalamansi nip with ginger extract among different markets in terms of odor. This implies that the acceptability of Kalamansi nip with ginger extract in terms of odor among different market segments did not vary.

Further, in terms of stickiness, Kalamansi nip with ginger extract was liked very much by the professionals, while the college students, high school students, and elementary pupils liked it moderately. However, the results showed no significant difference which implies that the acceptability of Kalamansi nip with ginger extract in terms of stickiness among different market segments did not vary.

Moreover, in terms of general acceptability, the highest acceptability was noted from among the elementary pupils followed by the professionals who “liked very much”. However, other market segments such as the college students and high school students liked moderately the product. Moreover, Analysis of Variance showed a significant difference in the general acceptability of Kalamansi nip with ginger extract among different market segments. Using the Tukey analysis, the researcher found that the general acceptability of elementary pupils was significantly higher and different from that of the high school and college students, but, not significantly different from the professional. Moreover, the professionals’ acceptability of the Kalamansi nip was significantly higher than the high schools, but not significantly different from the college and elementary pupils.

Acceptability of Kalamansi juice with ginger extract among different market segments Table 4 shows the acceptability of kalamansi juice with ginger extract in terms of color, odor, taste or flavour and general acceptability among different market segments.

Table 4. Acceptability of calamansi juice with ginger extract among different market segments.

Particulars	Mean Acceptability Scores			
	Color	Odor	Stickiness	Gen. Acceptability
Elementary	7.50LVM	7.05 <sup>a</sup> LM	7.90 LM	8.30 LVM
High School	6.85 LM	6.55 <sup>b</sup> LM	7.90 LM	8.00 LVM
College	6.95LM	7.30 <sup>a</sup> LM	7.20 LM	7.70 LM
Professional	7.50LVM	7.80 <sup>a</sup> LM	7.75 LVM	7.50 LM

In terms of odor, the highest acceptability rating was noted among elementary pupils and professional who liked the Kalamansi juice with ginger very much followed by the college students, then the high school students who liked the product moderately. Moreover, there was no significant difference on the acceptability of calamansi juice with ginger extract in terms of color among different market segments.

In terms of odor, Kalamansi juice with ginger extract was liked moderately by all market segments such as the professionals, college students, elementary pupils, and high school students. Analysis of Variance showed a significant difference on the acceptability of Kalamansi juice with ginger extract among different markets in terms of odor. Pos-Hoc using Tukey showed that the professional had a higher acceptability rating on the color of the product as compared to the high school group.

In term of taste, Kalamansi juice with ginger extract was liked very much by the elementary and high school, while the professionals and college student liked it moderately. However, the results showed no significant difference on the taste acceptability.

Moreover, in terms of general acceptability, the highest acceptability was noted from among the elementary pupils followed by the professionals who “liked very much”. Other market segments such as the college students and high school students liked moderately the product. However, Analysis of Variance however showed no significant difference on the general acceptability of Kalamansi juice among different market segments.

### Nutrients Analysis for Kalamansi Nip with Ginger Extract

Table 5 shows the available nutrients in Kalamansi nip with ginger extract using the Official Methods of Analysis of AOAC International, 19<sup>th</sup> Edition.

Table 5. Nutrients available in the Kalamansi nip with ginger extract

Particulars	Kcal/100g	µg/g	%
Calories	327		
Carbohydrates			71.35
Crude fat			4.55
Saturated fat			4.12
Crude protein			0.19
Total sugars			59.87
Sodium		43.68	
Potassium		508.00	
Calcium		101.00	
Iron		3.73	
Magnesium		46.35	
Phosphorous		5.64	

It was shown that the Kalamansi nip with ginger extract had 327 kcal per 100g. In a similar study, Pangerapan (2016) found that one Calamansi fruit has 12 calories composition, with a bit of fat, 1.2 grams fiber, 37 milligrams of potassium, 7.3 milligrams of vitamin C, vitamin A 54.4 milligrams, 8.4 milligrams of calcium, and water 15.5. Coleman et al., (2015) also said that calamansi nip also contains 71.35% carbohydrates. Carbohydrates are the body's main source of energy and should make up the largest percentage of the daily calorie intake.

In this study, Kalamansi was found to have traces of crude fat (4.55%), saturated fat (4.12%) and crude protein (0.19%) were also determined in the laboratory analysis. Thiex et al., (2003) said that crude fat content is determined by extracting the fat from the sample using a solvent, then determining the weight of the fat recovered. As lipids/fats are relatively non-polar molecules, they can be pulled out of a sample using relatively non-polar solvents. With a non-polar solvent, only non-polar molecules in the sample dissolve while polar ones do not. Problems arise however, in cases where lipids are bound in animal or plant cell membranes. Animal and plant cell membranes are made up of molecules that have both polar and non-polar regions such as triglycerides (molecule with polar glyceride heads and non-polar fatty acid tails) and phospholipids (similar to triglycerides, but a phosphate group replaces the fatty acid tail). These molecules end up grouping together with their polar heads sticking outwards and non-polar tails inwards making it difficult for non-polar solvents to interact with the non-polar tails and extract them.

Also, Kalamansi nip with ginger was also found to have crude protein, sugar, sodium, potassium, calcium, iron, magnesium, and phosphorous. According to Nadolsky (2014) crude protein is a structural molecule assembled out of amino

acids, many of which the body can't produce on its own. Moreover, Kalamansi nip with ginger extract also contains 43.68µg/g sodium. Martinac et al., (2007) averred that sodium is one of several minerals that are electrolytes whose primary function is to regulate fluid in the cells. The presence of potassium (508µg/g) was also noted in the Kalamansi nip. According to Kern (2009) potassium plays a crucial role in bone strength, kidney stone production and the risk of stroke, and as an electrolyte. It is part of the electrochemical balance that keeps the nervous system working properly. Likewise, calcium is also available in the Kalamansi nip (101.00 µg/g). Karohl et al., (2010) opined that calcium is required for vascular contraction and vasodilation, muscle function, nerve transmission, intracellular signaling and hormonal secretion, though less than 1% of total body calcium is needed to support these critical metabolic functions. Further, Glasdam et al., (2016) said that like sodium, potassium and magnesium, calcium is physiologically important due to its integral roles in metabolic and biological processes.

There was 3.73 µg/g of iron available in the Kalamansi nip. Ware (2008) said that iron is a mineral vital to the proper function of hemoglobin, a protein needed to transport oxygen in the blood. Iron also has a role in a variety of other important processes in the body. Zhang et al., (2019) said that iron disorders are linked to heart failure. Iron play a fundamental role in mitochondrial function and various enzyme functions and iron deficiency has a particular negative impact on mitochondria function.

Moreover, 46.35 µg/g of magnesium was found in the Kalamansi nip. According to Erdman et al., (2012) magnesium, an abundant mineral in the body, is naturally present in many foods, added to other food products, available as a dietary supplement, and present in some medicines (such as antacids and laxatives). Likewise, 5.64 µg/g of phosphorus was also found in the Kalamansi nip. Wellman (2004) opined that phosphorus is the second most plentiful mineral in your body. The first is calcium. The body needs phosphorus for many functions, such as filtering waste and repairing tissue and cells.

### **Shelf-Life**

The Kalamansi nip and juice were placed in bottled container then sealed on January 24, 2018 at room temperature.



Table 6. Shelf-life of Calamansi nip and Juice

Product	Start of Observation	End of Monitoring	Shelf-Life
Calamansi Nip	January 24, 2018	January 27, 2018	3 days
Calamansi Juice	January 24, 2018	March 20, 2018	54 days



Plate No. 1. Image of the Kalamansi nip at 54 days showing appearance of molds.

Monitoring was done every morning until signs of molds occurred or noticed. Observation for Calamansi nip and juice started on January 24, 2018. After three days, signs of molds appeared on Calamansi nip while Calamansi juice developed signs of molds on March March 20, 2018 as shown in Plate No. 1. The shelf-life of Kalamansi nip reached 3 days, whereas, the juice lasted for 54 days.

### Profitability of Kalamansi Nip with ginger extract

The return on Investment (ROI) was computed and a summary of the results of computation is shown in Table 7 below.

Table 7. Return on Investment of calamansi nip with different levels of ginger extract

Particulars	T1	T2	T3	T4
Total Yield	500ml	510ml	520ml	530ml
No. of 300 ml bottles of calamansi nip	1.66	1.7	1.73	1.76
Suggested Retail price/bottle	60	80	85	90
Net Sales	99.6	136.00	147.05	158.4
Expenses				
Materials/Ingredients	49.5	53.21	56.99	60.7
Labor	37.5	56.25	56.25	56.25
Total Expenses	87	109.46	113.24	116.95
Net Income	12.6	26.54	34.05	41.45
ROI (%)	14.48%	24.25%	30.07%	35.44%

The costs were computed comprising of the raw materials or ingredients and the labor costs that were computed based on the number of hours spent in the production. Net sales were computed based on the quantity produced. The higher level of ginger extract produced a higher yield expressed in number of bottles with 300 ml net content. The yields were multiplied with the selling price per bottle that increased with the level of ginger extract as a result of value-adding. The costs were deducted from the net sales to arrive with the profit. The costs ratio over the profit was computed, thus, getting the Return on Investment.

Results had showed that treatment 4 (15% ginger extract) got the highest ROI of 35.44% followed by treatment 3 (10% ginger extract) with an ROI of 30.07%. Treatment 2 (5% ginger extract) had an ROI of 24.25%, whereas, treatment 1(control) got the lowest ROI of only 14.48%. However, regardless of treatments used, it could be noted that production of Kalamansi nip with different levels of ginger extract showed a good ROI and could be profitable undertaking to consider.

## **SUMMARY AND CONCLUSION**

This study was conducted in order to develop a healthier substitute for soda and other synthetic beverages. First, it was conducted to determine the acceptability of Kalamansi nip enhanced with ginger extract at different levels or concentration. Second, to determine the acceptability of Kalamansi nip with ginger extract among different market segments. Thirdly, to subject samples of the product for a complete nutrients analysis to determine the nutrients available in the Kalamansi nip with ginger extract. Lastly, to determine the shelf life of the products develop and to determine the profitability of processing.

Kalamansi juice with higher concentrations of ginger extract has more pronounced ginger flavor, stronger odor and darker color as compared to the control with significant difference. However, acceptability in terms of the above parameters had no significant difference. General acceptability was also found out to be same in all treatments that were liked moderate without significant difference.

There was a significant difference in the acceptability of Kalamansi nip with ginger extract in terms of color among different market segments. The elementary pupils liked very much the Kalamansi nip with ginger, whereas other market segments such as professionals, college students, and high school students liked

moderately the product. In terms of odor, Kalamansi nip with ginger extract was liked moderately by all market segments without significant difference.

There was no significant difference on the acceptability of Kalamansi juice with ginger extract in terms of color, taste and general acceptability among different market segments. However, in terms of odor, the professionals had a moderate liking on the product which was significantly higher as compared to the high school students.

It was shown that the Kalamansi nip with ginger extract has 327 kcal per 100g. It contains 71.35% carbohydrates, 4.55% crude fat, 4.12% saturated fats, and 0.19% crude protein. Moreover, the Kalamansi nip with ginger extract has also the following: sodium - 43.68µg/g sodium; potassium - 508µg/g; calcium - 101 µg/g; potassium - 508µg/g; and calcium - 101µg/g.

At room temperature, the shelf-life of calamansi nip lasted for 54 days, whereas, the juice reached 3 days only.

## IMPLICATION AND RECOMMENDATIONS

Based on the findings and conclusions of the study, the following recommendations are hereby offered:

1. The Kalamansi nip is proven to contain nutrients required for health, hence, mass production and commercialization may be considered. A nutrient analysis on the end product which is the Kalamansi juice may also be conducted.
2. The shelf-life of Kalamansi nip is limited to 3 days only; hence, further development may be initiated to extend its shelf-life.
3. The development of packaging materials may also be done on the products.

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# PRELIMINARY STUDY ON THE BIOACCUMULATION POTENTIAL OF SEA GRASS (*H. OVALIS*) FOR MERCURY IN SELECTED COASTAL BARANGAY IN MALITA, DAVAO OCCIDENTAL

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## ABSTRACT

Sea grass has a remarkable metal bioaccumulation capacity since it interacts directly with both water column and pore water through the leaves and roots as ionic uptake. Malita, Davao Occidental has some of the extensive sea grass meadows which support populations of species like dugong, turtles, commercially and traditionally important fishes. The aim of this study was to determine the potential of sea grass in absorbing mercury. There were five species of sea grass observed in the study area (*Halophila ovalis*, *Halodule uninervis*, *Halodule pinifolia*, *Halophila minor* and *Halophila spinolusa*). In New Argao, the highest mean percent covers (4.3%) and shoot density (519.2 shoots/m<sup>2</sup>) was obtained in *H. ovalis* while the lowest mean percent covers (1.9%) and shoot density (197.87 shoots/m<sup>2</sup>) was recorded in Culaman. It was found that there were no significant differences in the density and abundance of *H. ovalis* between the sampling stations; however, there was significant difference in the concentration in mercury between sampling stations. The mercury accumulation was observed high (41.9 ppb) and recorded from Tingolo while in Culaman the total quantity of mercury accumulated by *H. ovalis* was 21.5 ppb. There was low positive correlation between mercury concentration and percent cover of *H. ovalis* while negative correlation (-0.518) was found between mercury concentration and shoot density. Because of limited data available, conclusions of the relationships were not drawn. As to physico-chemical parameters, the temperature, salinity and pH recorded in all sampling stations were observed to be at its normal levels.

**KEYWORDS:** Bioaccumulation potential, sea grass, mercury, coastal barangay, Malita



## INTRODUCTION

Sea grasses are monocotyledonous vascular flowering plants that thrive in coastal and estuarine areas of the world. They are unique and usually submerged in water. They possess a root system with stems buried within a soft substrate; they have vegetative and sexual reproduction and have flowers fertilized by water-borne pollen (Phillips et al., 1992). These unique flowering plants grow fully in saline environments and have 12 genera with some 58 species known. In many species, the leaves are long and narrow, grow by rhizome extension and often grow in large meadows which look like grassland underwater (Den Hartog, 1970).

Factors controlling sea grass distribution and condition are of increasing interest to the scientific community due to their ecological and economic value (Duarte, 1999). Sea grasses support important grazing and detrital food webs, stabilize sediment, and are important in global carbon and nutrient cycling. Furthermore, hundreds of planktonic, epibenthic and infaunal species are dependent upon grass beds for survival (Virnstein & Howard, 1987; Jackson et al., 2006). These aquatic plants are capable of capturing and storing large amount of carbon from the atmosphere. Similar to how trees take carbon from the air to build their trunks, sea grasses take carbon from the water to build their leaves and roots. As parts of the sea grass plants and associated organisms die and decay, they are buried and trapped in the sediments. It has been estimated that in this way the world's sea grass meadows can capture up to 83 million metric tons of carbon each year (Reynolds et al., 2017).

Sea grasses have a remarkable metal bioaccumulation capacity since it interacts directly with both water column and pore water through the leaves and roots as ionic uptake hence; the result of the study can reflect the overall health of coastal water (Llagostera et al. 2011). As marine angiosperms, sea grasses interact with sediments through the roots and rhizome as well as with the column of water through the leaves (Romero et al., 2005). Therefore, the accumulation and distribution of heavy metals were not only found on the roots, but also on the rhizomes and leaves.

Malita, Davao Occidental has some of the extensive sea grass meadows which support populations of species like dugong, turtles, commercially and traditionally important fishes. However, the continuously increasing pollution will cause the sea grasses to die-off once pollution reaches lethal levels and this intertidal habitat will be lost for good as there is little opportunity for the habitat itself to migrate (Hadley, 2009). The aim of this study is to determine the potential

of sea grass in absorbing mercury in the sea grass meadows of Malita, Davao Occidental.

## METHOD

### Research Locale

The study area of this research was Malita, Davao Occidental. Malita is a 1st class municipality and the capital town of Davao Occidental, Philippines. It has 30 barangays. It is the main economic center of Davao Occidental where agriculture and fishery are the main industries. In particular, Brgy. Culaman ( $6^{\circ}24'4''\text{N}$   $125^{\circ}36'25''\text{E}$ ), Brgy. New Argao ( $6^{\circ}22'33''\text{N}$   $125^{\circ}36'38''\text{E}$ ) and Brgy. Tingolo ( $6^{\circ}21'37''\text{N}$   $125^{\circ}37'25''\text{E}$ ) are coastal barangays (Fig. 3) and are known to for dugong, sea turtles, and more since sea grass ecosystem and coral reefs were of abundance. Moreover, livestock and agricultural plantations like banana, coconut, and durian were present in these coastal areas. Industrial development such as Davao San Miguel power station, also known as the Malita power station, is a 628-megawatt (MW) coal-fired power plant is located at Brgy. Culaman.



Figure 1. Map of study areas in Malita, Davao Occidental

### Collection of Sea Grass Samples

Samples were collected in the subtidal zone of the coastal barangays in Malita, Davao Occidental specifically Brgy. Culaman, Brgy. New Argao and Brgy. Tingolo. Sea grass species were collected completely with roots, rhizomes, and leaves. Following Sanchiz et al., (2000), the samples collected were rinsed with seawater to remove sediment from the roots and rhizomes. Then, the samples were packed in clean plastic bags, sealed, frozen at  $-20^{\circ}\text{C}$  prior to analysis. Then, those were transported to Davao Analytical Laboratories, Inc., Matina, Davao City for analyses.

## Identification of Sea grass Species

The identification of sea grass species were undertaken in the laboratory. Pictures and the dichotomous key to the species of Philippines Sea grass (Calumpong & Meñez, 1997) were used.

## Determination of Sea Grass Percent Cover

To determine the percent cover of the sea grass, the researchers used the transect line quadrat method. On this method, the researcher determined the point of sea grass occurrence up to the outer limit where sea grass disappeared. Second, the researchers laid quadrats on the sea grasses along the 50 meter transect line positioned perpendicular to the shoreline. The categories developed by Saito and Atobe (1970) were used to record the percent cover of the sea grass species per quadrat. The process was repeated for each species in the quadrat. The table below shows the classes of dominance used to record percentage cover of sea grass species in the three sampling stations.

$$C = \frac{\sum(M_1 \times F_1)}{\sum f}$$

Where:

M1 = midpoint percentage of class (i)

F1 = Frequency (number of sectors with the class dominance)

f = number of frequency of the class

Table 3. Criteria in categorizing the percent cover of sea grass

Class	Amount of % Covered	Covered	Mean
5	½ to all	50-100	75
4	¼ to ½	25-50	37.5
3	1/8 to ¼	12.5-25	18.75
2	1/16 to 1/8	6.25-12.5	9.38
1	Less than 1/16	<6.25	3.13
0	Absent	0	0

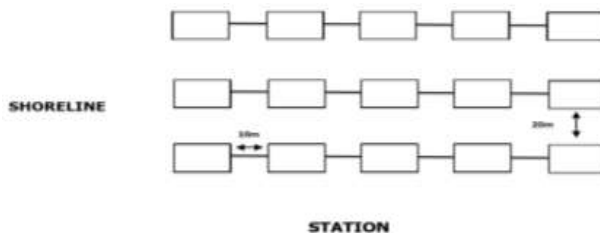


Figure 2. Sampling Layout

### **Determination of Shoot Density of *H. ovalis***

Transect line quadrat method was used to determine the above ground shoot density of the sea grass. In this method, researcher determined the point of sea grass occurrence up to the outer limit where sea grass disappeared. Second, the 50 meter transect line was used as guide in laying the metal quadrat. The transects were positioned perpendicular to the shoreline. Then, shoots of each species which were within 25 grids of the quadrant were counted and recorded. The process was repeated for each species in the quadrat. The formula given by Odum (1971) was adapted.

Where,

$$\text{Density} = \frac{\text{number of individuals of a species}}{\text{area (m}^2\text{)}}$$

### **Mercury Analysis in Sea Grass Sample**

As to mercury accumulation analysis, the samples were delivered to the Davao Analytical Laboratories, Inc. in Matina, Davao City on May 10, 2018. Cold vapor atomic absorption spectroscopy was used to analyze the mercury contents.

Physico – Chemical Parameters.

Physico – chemical parameters were determined in each sampling sites. Water temperature, salinity, and pH value were monitored in each station.

### **Statistical Analyses**

Analysis of Variance (ANOVA) was used to determine the significant difference of the percent cover, shoot density, and mercury accumulation level of sea grasses in the three sampling stations. Also, Tukey's test was also employed to find out which specific groups' means compared with each other were different. Pearson's correlation coefficients of mercury concentration to the percent cover and shoots density of sea grass were determined using Statistical Package for the Social Science (SPSS version 17).

## **RESULTS AND DISCUSSION**

### **Sea grass species identified**

Using the dichotomous key for identification of sea grass species as presented in Calumpang and Meñez (1997), five species of sea grasses found in the study area namely *Halophila ovalis*, *Halodule uninervis*, *Halodule pinifolia*, *Halophila minor* and *Halophila spinulosa*. However, only in the third station (Brgy

Tingolo) has the presence of all species of sea grasses. *H. spinulosa* was not observed in Stations 1 and 2 (Table 4).

Table 4. The occurrence of sea grass species in the study area

Seagrass Species	Culaman	New Argao	Tingolo
<i>Halophila ovalis</i>	√	√	√
<i>Halodule uninervis</i>	√	√	√
<i>Halodule pinifolia</i>	√	√	√
<i>Halophila minor</i>	√	√	√
<i>Halophila spinulosa</i>	-	-	√

Legend: - = represents absence

√ = represents presence

### Percent Cover of *H. ovalis*

The *H. ovalis* showed the highest mean percent cover of sea grass (4.3%) in Brgy. New Argao while Brgy. Culaman had the lowest mean percent cover of 1.91 (Fig 5). The substrate of the area could be the reason of its low percent cover since *H. ovalis* requires wide variety of substrate, such as mud, living corals or coral rubble and sand where the plant could occasionally almost completely buried. According to Kou and Den Hartog (2001), *H. ovalis* is an abundant sea grass in tropical and warm temperate areas, occasionally found in pure stands or may grow together with *H. minor*, *H. uninervis*, *H. pinifolia* and *H. spinulosa* and these sea grass species were also observed. There was no significant difference in the mean percent cover of *H. ovalis* among sampling stations. However, in a study conducted by Noel et al., (2013) they stated that among the dominant sea grass species identified, *Halophila ovalis* had the highest percent frequency of occurrence with 64%, which could be found in all areas in Davao Gulf.

### Shoot Density of *H. ovalis*.

Brgy. New Argao also had the highest mean shoot density of *H. ovalis* with 519.2 shoots/m<sup>2</sup> while the least value obtained by Brgy. Culaman with 197.87 shoots/m<sup>2</sup>. *H. ovalis* density might be influenced by the type of substrate conditions, seasons, tides, wave energy strength, content of organic matter in the sediment, and other environmental factors (Short & Coles, 2001). There was no significant difference in the shoot density of *H. ovalis* among sampling stations.

### Mercury Accumulation in *H. ovalis*.

According to Patra et al., (2000), mercury poisoning has become a problem of current interest as a result of environmental pollution on a global scale and its

concentrations in the stems and leaves of plants are always greater when the metal is introduced in organic form. The level of mercury in the plants should not be higher than 20ng/g. Figure 7 shows the mercury accumulation in *H. ovalis* where the concentration was high in Brgy. Tingolo with 41.9 ppb compared to the other two stations. Conversely, Brgy. Culaman had the lowest mercury concentration and there was a significant difference in the levels of mercury among sampling stations. Natural emissions of mercury form two-thirds of the input; manmade releases form about one-third. Considerable amounts of mercury may be added to agricultural land with sludge, fertilizers, lime, and manures. These were the possible and acceptable factors why Brgy. Tingolo had the highest level of mercury accumulation. Acidic rain fall caused by coal fired power plant possibly more often fell in Tingolo since coal-fired power plants emit large quantities of sulfur dioxide and mercury. Patra et al., (2000) also cited that mercury obtained from the so-called dry deposition can be rinsed out from the surface of living plants by atmospheric precipitation. However, throughout the vegetation period, the level of mercury in plant tissues increases both due to dry and wet deposition, more intensely than in the surrounding soil. This is also caused by mercury mobility in the air-soil-plant system and its accumulation by certain plant species. There was a positive but weak uphill relationship between variables (0.302) between mercury accumulation and percent over in *H. ovalis*. While correlation between mercury accumulation and shoot density of *H. ovalis* obtained a value of -.518 which indicates moderate negative relationship.

Physico-chemical Parameters. As shown in Table 5, physic-chemical parameters results were in normal condition.

Table 5. Physico-chemical parameters in the study area

Parameters	Station 1	Station 2	Station 3
Temperature	32 <sup>o</sup> C	29 <sup>o</sup> C	30 <sup>o</sup> C
Ph	7.16ppm	7.04ppm	7.85ppm
Salinity	35ppt	35ppt	35ppt

## CONCLUSION

There were five species of sea grass found in the study areas due to the soft type of substrate present. Brgy. New Argao has the highest mean percent cover (4.3%) and shoot density (519.2 shoots/m<sup>2</sup>) while Brgy. Culaman (Station 1) obtained the lowest record of mean percent cover (1.91%) and shoot density of 197.87 shoots/m<sup>2</sup>. This reflects the patchiness of sea grass stands or the cover of sea grass within the patches or both aspects. Mercury accumulation to *H. ovalis* is reported highest in Brgy. Tingolo (41.9ppb), followed by Brgy. New Argao

(22.65ppb) and Brgy. Culaman (21.5ppb). These signify that *H. ovalis* has the capability to accumulate mercury content and exceeds the standard level of 20 ppb. There is no significant difference in the percent cover and shoot density of *H. ovalis* while significant difference is observed in the levels of mercury accumulation. There is a positive relationship between the percent cover and mercury concentration of *H. ovalis* while negative relationship between the shoot density and mercury concentration of *H. ovalis*. Physico-chemical parameters results were in normal condition.

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# ROOTING RESPONSE AND SUBSEQUENT GROWTH OF SELECTED CITRUS SP. TO APPLICATION OF DIFFERENT HORMONES

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## **ABSTRACT**

The study analyzed on selected citrus species of stem cuttings on rooting responses. Different rooting hormones such as IBA, IAA, NAA, Hormex, and Saredex were used for cuttings at the recommended rate and six morphological characteristics were generated and detected after 60 days. Interaction effects between citrus species and rooting hormones in all parameters were not significant but hormones and citrus mean had significant effects in all parameters except on days to shoot, number of shoots, number of leaves and number of roots. Rooting performance of citrus species performed better and improved when NAA, IAA, IBA, and Hormex hormones were used. The result of the study clearly showed that the use of any rooting hormones especially Naphthalene Acetic Acid (NAA) could enhance the root ability of selected citrus species (Calamansi, Calamandarin, and Dalandan) as early as 60 days; also application of nitrogenous fertilizer could improve the growth of potted rooted citrus cuttings in the nursery operation.

**KEYWORDS:** Rooting response, citrus, different hormones

## INTRODUCTION

Citrus fruits have nutritive value that gave strength and have medicine for some illnesses and it has important to be daily consumption of our body diet. Citrus has different shapes that are rich in vitamin C that needed for our human body, the taste is usually sweet but occasionally sour. In the Mediterranean centuries, some citrus species mostly exist such as orange, mandarin and lemon trees establishing citrus best in good soil and climatic conditions that can achieve a high level of fruit quality than other regions.

Cutting is often the preferred method of propagation in horticulture since it is cheap, fast, and modest technology and no skill is needed unlike in grafting, budding or micro-propagation. For citrus, as many fruit crops, this method is necessary not only to maintain desirable characteristics of the mother plant (Hartmann & Kester, 1983), but also to provide them with desirable quantities of true-to-type rootstocks. This fact may be of great importance since rootstocks are known to affect many scion characteristics such as vigor, yield, and fruits quality and disease resistance, conditioning therefore the success of citrus industries (Espinoza-Nunez et al., 2011). Furthermore, it is reported that cutting has the tendency to decrease the juvenile stage of plants and reduce the time of nursery development (Spiegel-Roy & Goldschmidt, 1996). According to de Oliveira (2017) rootstock through cuttings can produce the same quality, uniform in size, good characteristics of the mother plants and production is faster and rapid to meet the demand. Like tissue culture plantlet, tissue culture production protocol is not easy and warrant for is it takes time to develop protocols and sufficient size to warrant in variety trial testing.

Nitrogen is the most important nutrient in most fertilization and can be critical in nursery situation where high densities were used. According to Razaq et al., (2017) application of fertilizer is a serious factor in plant growth development and yield of crops in both plant growth and root morphology. It is a vital factor for assessing the effects of applied elements to be capable in promoting the plant growth and early flowering in agricultural crop.

Therefore, an alternative method in propagating citrus should be explored. One method is the use of stem cutting through rooting of terminal stem. The hormone that aids the growth of adventitious roots is called auxin, however analytical forms of auxins like Indole Butyric Acid (IBA), Indole Acetic Acid, Naphthalene Acetic Acid (NAA), Hormex, and Saredex are commercially available. This study, therefore, aimed at determining the most appropriate rooting

hormone solutions for propagating stem cuttings of citrus and growth performance of citrus cutting applied with nitrogen fertilizer.

A study of stem cutting of citrus species was conducted at University of Southern Mindanao, Kabacan, Cotabato. The research aimed to evaluate the effects of different rooting hormones application on the root ability of citrus cuttings. The research was composed of two studies; first study focused on using different rooting hormones that enhance callus and rooting formation of the citrus and second, application of nitrogen fertilizer on different rooted citrus species cutting under potting condition.

### Experimental Design and Treatments

Double Factor Completely Randomized Design (CRD) was used with six treatments replicated three times. Sixty (60) sample cuttings were used per treatment. Semi-hardwood stem cuttings of citrus species served as Factor A while different rooting hormones served as Factor B. The following treatments were used:

Factor A (Species)	Factor B (Hormones )
S <sub>1</sub> - Calamansi	T1 –Control(Water only)
S <sub>2</sub> - Calamandarin	T2 – IBA (1000ppm)
S <sub>3</sub> - Dalandan	T3 – IAA(1000ppm)
	T4 – NAA (1000ppm)
	T5-Hormex(pure sol'n)
	T6 –Saradex(pure sol'n)

### Preparation of the Experimental Area

The experimental set up situated in a partially shaded area or not directly exposed to sunlight to prevent the experimental cuttings from stress shown in plate 1.

### Rooting Media Preparation

River sand and coir dust were used as the rooting media. The sand and coir dust were thoroughly sieved. The sand was mixed with coconut coir dust with a ratio of 1:1 before placing them to the polyethylene bag measuring 4 x 6 x 0.02 cm. The river sand and coir dust were disinfected by pouring with fungicide. One thousand eighty (1,080) polyethylene bags filled with  $\frac{3}{4}$  mixtures of river sand and coir dust were used. The polyethylene bags were arranged according to the design and layout of the experiment. The chamber was covered with a thick sheet

of polyethylene suspended on a wire frame to maintain moisture from 80 to 90 percent. When covered with a clear plastic bag, stem cutting about 3 to 4 inches would root.

### **Selection and Preparation of Citrus Stem Cuttings**

Proper and careful selection of experimental plants was done in order to get or produce the experimental samples. The mother plant, where the



Plate 1. Overview of the experimental area of the study on rooting response of selected citrus sp. to application of different hormones



Plate 2. (A) Deleafing of citrus cuttings and (B) soaking of cuttings to fungicide.

sample stem cuttings were taken was healthy and already bearing and free from any disease infestation. Healthy stem cuttings were selected and then carefully cut or harvested early in the morning by using sharp pruners and leaves were cut by half to reduce transpiration. These cuttings were transported and handled properly from the source to the experimental area and planted within the same day. Deleafing of citrus cuttings and soaking to fungicide shown in Plate 2.

## Preparation of Rooting Hormone Solutions

The different rooting hormone solutions used as treatments were prepared following the recommended rate. One thousand part per million (1000 ppm) of each hormone namely; Indo Butyric Acid (IBA), Indole Acetic Acid (IAA) and Naphthalene Acetic Acid (NAA) were measured, weighted and diluted to one liter of water while Hormex and Saredex used the pure solution for each hormone.

## Treatment of Stem Cuttings with Rooting Hormone Solution

Plate 3 shows the basal portions of the prepared sample stem cuttings were dipped for 10 minutes in separate plastic containers in different rooting hormones. At least 2.5 cm of the stem cuttings were depth in the different solutions based on the specific treatments.



Plate 3. Soaking of citrus cuttings to different rooting hormones



Plate 4. Planting of citrus cuttings in a prepared rooting media composed of coconut coir dust and river sand.

## Planting of Citrus Cuttings

The treated cuttings were planted into prepared potting media by inserting the basal portion of the stem cuttings. Sixty (60) sample stem cuttings per

treatment were planted with at least 5 cm deep into the soil media showed in Plate 4.

### **Care and Maintenance**

Experimental plants need proper care and maintenance. The chamber maintained 80% to 90% humidity to ensure enough moisture. Depending on the weather and moisture condition of the soil, a 250 ml of water was added. Weeding was done regularly to minimize competition of nutrients, water and sunlight.

### **Data Gathered**

Number of days to shoot formation. This was gathered from the 10 sample plants by counting the number of days from the time of planting until the emergence of the first shoot.

Number of shoots. The number of shoots was gathered from the 10 samples plants upon termination of the study or 60 days after treatment. The number of shoots per sample cutting was counted individually.

Length of shoot. The length (cm) of newly developed shoots was measured from the 10 sample plants using a ruler. The measurement was done upon termination of the study or 60 days after treatment.

Number of leaves. This was taken from the 10 sample plants by counting and recording every noticeable leaf on each plant, including the new leaves just beginning to emerge. This was counted upon termination of the study.

Number of roots. The number of roots was gathered from the 10 sample plants upon termination of the study or 60 days after treatment by carefully uprooting the rooted cuttings and then washing and counting the roots. The number of newly developed primary roots per sample cutting was counted individually.

Length of roots. The length (cm) of newly developed primary roots was measured from the 10 sample plants using a ruler after uprooting the cuttings, washing the roots. The measurement was done upon termination of the study or 60 days after treatment.

Percentage rooting. The percentage (%) rooting was gathered from the 10 sample plants upon termination of the study or 60 days after treatment the cuttings by counting the number of rooted cuttings.

Percentage survival. The percentage (%) survival was gathered from the 10 sample plants upon termination of the study or 60 days after treatment the cuttings. The percentage was computed using the formula:

$$\text{Percentage (\%) Survival} = \frac{\text{Number of rooted cuttings}}{\text{Total number of cuttings}} \times 100$$

Other observations. Aside from the above data or parameters, other observations were also noted and recorded. Photo documentation was done.

Number of Rotted citrus cutting. The number of rooted cuttings observed at 30, 45 and 60 days after treatment. Three (3) sample cuttings were uprooted (destruced) to get the number of rooted cuttings

Temperature and Relative Humidity. The temperature and relative humidity readings were taken for three months using hygrometer. Three separate recordings were taken every day

### **Statistical Analysis**

The various data collected were subjected to Statistical Tools for Agricultural Research (Tukey's). Analysis of Variance (ANOVA) was used to test or determine the significance among treatments at 0.5 % level.

Study 2. Growth Response of Potted Rooted Stem Cuttings of Citrus Species to Application of Nitrogenous Fertilizer

### **Experimental Design and Treatments**

The study was carried out using a Randomized Completely Block Design (RCBD) with three treatments replicated five times. Fifty samples of each citrus species from study 1 were used per treatment. There were a total of 150 sample plants in this study. The following treatments were used:

- T<sub>1</sub>- Rooted Dalandan Stem Cuttings
- T<sub>2</sub>-Rooted Calamansi Stem Cuttings
- T<sub>3</sub>- Rooted Calamandarin Stem Cutting

### **Preparation of the Experimental Area**

Experimental area was located at the University of Southern Mindanao Agricultural Research Center (USMARC), Kabacan, Cotabato and conducted from December 2018 to April 2019. Set-up was situated in a closed and partially shaded area to prevent cuttings from stress and stray animals and also human beings that may distract the set-up.

### **Potted Rooted Citrus Cuttings**

Two (2) months old rooted citrus species were asexually propagated through stem cuttings and planted in a 3" x 3" x 6" polyethylene bag using 2:1 ratio of top soil and coir dust as soil media and disinfected with fungicide. Only one seedling per pot of the same age was transplanted and treated with 0.5 gram of nitrogen fertilizer each sample plants.

### **Fertilizer Application**

Urea fertilizer was applied to each pot (seedling) at 0.5 grams per seedling per treatment per application to enhance the growth of the 2-months old rooted citrus cuttings. Fertilizer application was done two weeks or 15 days after transplanting at a frequency of one application per week for four weeks using the side-dress method. Two (2) weeks after the last application of urea fertilizer, the study was terminated.

### **Care and Maintenance**

Watering and weeding were employed to avoid nutrient competition and possible disturbance to the rooting performance of the potted cuttings. The cuttings inside the chamber were regularly monitored and depending on the moisture condition inside watering was done or adding 250 ml of water per seedling. If there is an occurrence of diseases and insect pests, spraying of fungicide and insecticide was done at recommended rate stipulated in the label.

### **Data Gathered**

Number of shoots. The number of newly developed shoots was determined upon termination of the study or 1 ½ months after transplanting of the rooted citrus species from the 10 sample plants. The number of shoots was counted individually per sample plant.

Length of shoot. The length (cm) of shoots was measured from the 10 sample plants using a ruler. This was done upon termination of the study or 1 ½ months after transplanting.

Stem diameter. Data were gathered by measuring the main stem base diameter (cm) on each 10 sample plants at least 1 cm above the soil surface with the use of a digital vernier caliper as measuring device. Gathering was done 1 ½ months after transplanting or upon termination.

Plant height. This was taken from the 10 sample plants by measuring the height in (cm) of the main plant from the base to the shoot tip of the plant.



Gathering was done 1 ½ months after transplanting or upon termination using the ruler and initial plant height was recorded.

Number of leaves. This was taken from the 10 sample plants by counting and recording every noticeable leaf on each plant, including the new leaves just beginning to emerge. This was counted upon termination of the study.

Percentage survival. The percentage (%) survival was determined upon termination of the study or 1 ½ months after transplanting of the 10 sample citrus cuttings. The percentage was computed using the formula:

Other observations. Aside from the above data or parameters, other observations were also noted and recorded. Photo documentation was also done as necessary.

### **Statistical Analysis**

The various data collected were analyzed using Statistical Tools for Agricultural Research (Tukeys). Analysis of Variance (ANOVA) was used to test or determine the significance among treatments at 0.5% level.

## **RESULTS AND DISCUSSION**

### **Study 1. Rooting and Subsequent Growth of Selected Citrus Species Stem Cuttings to the Application of Different Hormones**

Number of Days to Shoot Emergence Statistical analysis revealed that the number of days to shoot emergence was not significantly affected by selected citrus species and rooting hormones as presented in Table 1. Regardless of different rooting hormones, there was no different effect found out. The cuttings treated with NAA formed earlier shoot at 19.17 days and the untreated cuttings produced shoots at 23.63 days. The citrus species were significantly different from each other in term of days to shoot emergence. Calamansi cutting formed shoots as early as 16.35 days, followed by Dalandan with the mean of 21.28 days and the latest formed shoots were found in Calamandarin with mean of 26.07 days.

Citrus species can form shoot as early as possible with application of hormones. Research studies conducted by Dipa (2010) in Lanzones cuttings showed an early shoot development in hardwood than semi hardwood cuttings treated with 400 and 500 ppm ANAA, respectively. In this study, it has been observed that cuttings treated with hormones formed shoots earlier that it was

assumed that active buds were present on the said cuttings and their growth may be stimulated or encouraged.

Table 1. Number of days to shoots emergence of selected citrus species stems cuttings applied with different rooting hormones 60 days after planting. USM, Kabacan, Cotabato, 2019.

Hormones	Citrus Cutting			B-Mean <sup>ns</sup>
	Calamansi	Calamandarin	Dalandan	
Control	17	28.1	25.8	23.63
IBA	18.5	23.4	19.1	20.33
IAA	16.6	27	22	21.87
NAA	15.3	24.7	17.5	19.17
Hormex	13.9	25.8	23.7	21.13
Saredex	16.8	27.4	19.6	21.27
A – Mean <sup>1/</sup>	16.35 <sup>a</sup>	26.07 <sup>c</sup>	21.28 <sup>b</sup>	21.23

C.V. - % 19.48

<sup>1/</sup> Means of citrus species of with the same letter superscript are not significantly different at 5% level of significant (Tukeys-test) ns - not significant

Table 2. Numbers of shoots of selected citrus species stem cuttings applied with different rooting hormones 60 days after planting. USM, Kabacan, Cotabato, 2019.

Hormones	Citrus Cutting			B-Mean <sup>ns</sup>
	Calamansi	Calamandarin	Dalandan	
Control	2.21	1.33	1.35	1.63
IBA	2.09	1.25	2.10	1.81
IAA	2.43	1.30	1.53	1.75
NAA	1.73	1.10	2.67	1.83
Hormex	2.44	1.43	1.77	1.88
Saredex	1.71	1.97	1.57	1.75
A- Mean <sup>ns</sup>	2.10	1.40	1.83	1.78
C.V. - %	27.14			

ns- not significant

According to Sun and Bassuk (1993); Blythe, 2004; Ghazijahani (2017) the application of synthetic auxin to stem cuttings at high concentration can inhibit bud development, sometimes to the point at which no shoot growth will take place. Cline (1991); Takahashi et al., (1991) found that hormones, like auxin, gibberellins and cytokinins play a vital role in the control of growth not only within the plant as a whole, but apparently, also within individual organs.

Number of Shoots. There was no significant effect between different citrus species cutting and different rooting hormones on number of shoot developed per cutting shown in Table 2. Regardless of the selected citrus sp. cuttings and different rooting hormones treatment, the number of shoot developed per cutting mean ranged from 1.63 to 1.88 shoots. Result showed that Calamansi produced the most number of shoots with a mean of 2.10 shoots and the least was found in Calamandarin with a mean of 1.40 shoots. However, analysis of variance was not significant between citrus species.

Length of Shoot. There was no significant interaction effect between citrus species and rooting hormones on the length of shoots in Table 3. Application of rooting hormones showed significant difference in terms of length of shoots. Indole Acetic Acid (IAA) produced the longest shoot with a length of 3.32 cm which was significantly different from the control and the shortest shoot length of 2.37 cm was found in untreated cuttings but IAA was comparable to the rest of rooting hormone (IBA, NAA, Hormex and Saredex) while NAA, IBA, Hormex and Saredex were comparable to untreated cuttings. Moreover, selected citrus species has significantly difference between treatments mean. Calamansi and Dalandan had no significant different term of length of shoots but significantly longer than Calamandarin.

Table 3. Length (cm) of shoots of selected citrus species stem cuttings applied with different rooting hormones 60 days after planting. USM, Kabacan, Cotabato, 2019.

Hormones	Citrus Cuttings			1/ 2
	Calamansi	Calamandarin	Dalandan	
Control	3.28	1.5	2.34	2.37
IBA	3.07	2.41	3.32	2.93 <sup>ab</sup>
IAA	3.44	3.06	3.46	3.32 <sup>a</sup>
NAA	3.23	2.57	3.45	3.08 <sup>ab</sup>
Hormex	2.9	2.52	3.39	2.94 <sup>ab</sup>
Saredex	3.31	1.95	2.89	2.72 <sup>ab</sup>
A-Mean	3.21 <sup>a</sup>	2.34 <sup>b</sup>	3.14 <sup>a</sup>	2.89
C.V. – 1%	19.19			

<sup>1/</sup> Means of rooting hormones with the same letter superscript are not significantly different at 5% level of significant (Tukeys-test)

<sup>2/</sup> Means of citrus species with the same letter superscript are not significantly different at 5% level of significant (Tukeys-test)

Mancera (2013) reported that in calamansi cuttings, the application of 200 ppm ANAA promoted the development of more leaves and hardwood cutting developed longer shoots. Seran and Umadevi (2011) noted that lemon stem

cuttings had higher shoot length (5.73 cm), rooting percentage (73.33 percent) and survival rate (90.0 percent) when treated with 3000 ppm IBA under sand medium.

**Number of Leaves.** The data presented in Table 4, (Plates 5, 6, 7) show no significant interaction effects between selected citrus species and rooting hormones on the number of leaves. Different rooting hormones did not significantly affect the number of leaves; hormones mean ranged from 5.25 to 6.76. However, selected citrus species were significantly influenced by rooting hormones. Calamansi formed the most number of leaves with 8.19 leaves, which was significantly different from Dalandan which formed 5.65 leaves and Calamandarin with 4.99 leaves. However, Dalandan and Calamandarin were comparable to each other.

As cited by Cordon (2006), the research studies conducted by Dipa (2010) in Lanzones cuttings showed an early shoot development in hardwood than semi hardwood cuttings treated with 400 and 500 ppm ANAA, respectively. In this study, it has been observed that cutting treated with hormones formed shoots earlier, it was assumed that active buds were present on the said cuttings and their growth may be been stimulated or encouraged.

Cline (1991); Blythe et al., (2004); Ghazijahani et al., (2017) found that hormones, like auxin, gibberellins and cytokinin play a vital role in the control of growth not only within the plant as a whole, but apparently, also within individual organs.

Table 4. Number of leaves of selected citrus sp. stem cuttings as applied with different rooting hormones 60 days after planting. USM, Kabacan, Cotabato, 2019.

Hormones	Citrus Cutting			B-Mean <sup>ns</sup>
	Calamansi	Calamandarin	Dalandan	
Control	8.44	3.72	3.6	5.25
IBA	8.86	4.75	6.37	6.66
IAA	9.77	5.08	5.23	6.69
NAA	6.86	5.07	8.2	6.71
Hormex	8.78	5.79	5.7	6.76
Saredex	6.44	5.55	4.8	5.6
C.V. - %	26.87			

<sup>1</sup> Means of citrus species with the same letter superscript are not significantly different at 5% level of significant (Tukeys-test)

ns – not significant

**Number of Roots.** The data Table 5, (Plate 5, 6, 7), that there were no significant interaction effects between selected citrus species and different hormone on the number of roots. The result revealed that different rooting

hormones affect the number of roots of selected citrus species stem cuttings. After 60 days of treatment, number of roots produced from 1.57 to 2.93 roots. IBA was significantly different from the control but comparable to IAA and NAA. Hormones like IAA, NAA and Hormex were comparable to each other and also IAA, Hormex and Saredex were not significant to each other. Also observed, that there was no significant difference on number of roots in selected citrus species. Number of roots produced range from 2.03 to 2.40.

Based on the data presented, the application of hormone can improve the number of roots and prolonging the period of collection of data can improve the number of roots. Rooting of cuttings would not be due to hormone treatment but interaction of factors in the stem and the environmental condition may also be considered. According to Mancera (2013), 200 ppm ANAA is good enough to initiate development of roots of calamansi cuttings 90 days after treatment of hormone. The possibility of higher amount of endogenous auxin accumulated of cuttings and its effective response to synthetic hormone treatment favor the development of roots. While Hartmann and Kester (1983) reminded that auxin treatment is not an absolute guarantee for root formation, they further emphasized that physiological as well as environmental conditions of the stocks play an important role in the process. Bhatt and Tomar (2011) reported that the maximum root formation, root length, root diameter, and shot sprout were recorded in citrus cuttings below 500ppm IBA concentration.

Table 5. Number of roots of selected citrus species stems cuttings as applied with different rooting hormones 60 days after planting. USM, Kabacan, Cotabato, 2019.

Hormones	Citrus Cutting			1/
	Calamansi	Calamandarin	Dalandan	
Control	1.57	1.29	1.86	1.57 <sup>d</sup>
IBA	3.17	2.94	2.67	2.93 <sup>a</sup>
IAA	2.32	2.47	2.53	2.44 <sup>abc</sup>
NAA	2.00	3.26	3.23	2.83 <sup>ab</sup>
Hormex	1.61	2.18	2.40	2.06 <sup>bcd</sup>
Saredex	1.5	2.06	1.70	2.26 <sup>cd</sup>
A-Mean <sup>ns</sup>	2.03	2.37	2.40	2.26
C.V. - %	25.03			

<sup>1/</sup> Means with the same letter superscript are not significantly different at 5% level of significant (Tukeys-test)

ns – not significant

Length (cm) of Roots per Cutting. The analysis of variance revealed no significant interaction effects developed between different citrus species stem cuttings and hormones, 60 days after treatment as shown in Table 6, Plate 9. There was a significant effect on treatment means on length of roots. NAA hormones had

the longest root length with 4.51 cm that was significantly different from the control which had the shortest roots length of 2.33 cm. However, all rooting hormones were comparable but Saredex, IAA and IBA were the same to the control. On the other hand, length of roots of selected citrus species had significant difference on mean. Calamansi had the longest root length of 4.84 cm which was significantly different to Calamandarin and Dalandan, but the last two citrus species were comparable. Moreover, Dalandan produced shortest roots length.

As cited by Marcera (2013), 200 ppm ANAA is enough to initiate calamansi cuttings root growth 90 days after hormone treatment. The possibility of higher quantities of endogenous auxin accumulated from cuttings and their effective response to synthetic hormone treatment favored to root development and encouraged the development of more leaves and longer shoots developed from hardwood cutting. While Hartmann et al., (1997) recalled that treatment with auxin is not an absolute root formation guarantee. They also stressed out that stocks physiological and environmental conditions play a significant role in the process.

Table 6. Length (cm) of roots of selected citrus species stem cuttings as applied with different rooting hormones 60 days after planting. USM, Kabacan, Cotabato, 2019.

Hormones	Citrus Cutting			1/
	Calamansi	Calamandarin	Dalandan	
Control	2.13	2.64	2.22	2.33 <sup>b</sup>
IBA	4.34	4.32	3.13	3.93 <sup>ab</sup>
IAA	5.82	2.75	2.82	3.80 <sup>ab</sup>
NAA	5.55	3.81	4.16	4.51 <sup>ab</sup>
Hormex	6.58	3.72	2.56	4.29 <sup>a</sup>
Saredex	4.6	2.91	3.02	3.51 <sup>ab</sup>
A-Mean <sup>2/</sup>	4.84 <sup>a</sup>	3.36 <sup>b</sup>	2.99 <sup>b</sup>	3.73
C.V. - %	32.16			

<sup>1/</sup> Means with the same letter superscript are not significantly different at 5% level of significant (Tukeys-test)

<sup>2/</sup> Means of citrus species with the same letter superscript are not significantly different at 5% level of significant (Tukeys-test).

Percentage Rooting. There was no significant interaction effects between two factors on rooting percentage of selected citrus species cuttings applied with different rooting hormones as shown in Table 7.

Analysis of variance revealed that there were significant effects among treatment means on the rooting percentage. Naphthalene Acetic Acid (NAA) was significantly different to untreated cuttings but comparable to all rooting hormones applied. Indole Butyric Acid (IBA), Indole Acetic Acid (IAA), Hormex and

Saredex had no significant differences and were comparable to control. There were significant effects of citrus species on percentage rooting. The result implied that Dalandan cutting had better performance in rooting percentage than Calamansi and Calamandarin cuttings but both Calamandarin and Calamansi were comparable.

Table 7. Percentage (%) rooting of selected citrus species stem cutting as applied with different rooting hormones 60 days after planting. USM, Kabacan, Cotabato, 2019.

Hormones	Citrus Cutting			B-Mean <sup>1/</sup>
	Calamansi	Calamandarin	Dalandan	
Control	20.0	15.0	43.3	26.11 <sup>b</sup>
IBA	60.0	46.7	53.3	53.33 <sup>ab</sup>
IAA	53.3	40.0	46.7	46.67 <sup>ab</sup>
NAA	53.3	33.3	90.0	58.7 <sup>a</sup>
Hormex	30.0	33.3	56.7	40.00 <sup>ab</sup>
Saredex	33.3	30.0	46.7	36.67 <sup>ab</sup>
A-Mean <sup>2/</sup>	41.65 <sup>b</sup>	33.05 <sup>b</sup>	56.12 <sup>a</sup>	43.61
C.V. - %	45.19			

<sup>1/</sup> Means of rooting hormones with the same letter superscript are not significantly different at 1% level of significant (Tukeys-test)

<sup>2/</sup> Means of selected citrus species with the same letter superscript are not significantly different at 1% level of significant (Tukeys-test)

Maximum rooting and shoot growth characters have been recorded below IBA concentration of 500ppm (Singh et al., 2015). Bhusal (2001) showed that the ability to root varied between species and varieties (0-100 %).

There was 100% rooting of rough lemon, while Tengu and Kuno satsuma mandarin had 0%. Root initiation is temperature driven but subsequent root growth was strongly dependent on available carbohydrates present in the cuttings. Control of temperature was a must and very important factor in the rooting of cuttings since cuttings with leaves should be handled carefully to prevent desiccation and the rooted under condition which be avoided excessive water loss from the leaves. Temperature was maintained during rooting between 23 to 27°C at the base of cutting and 30 to 32 to ambient, without detriment to rooting (Lesturgez et al., 2004).

Percentage Survival. The percentage survival of selected citrus species cuttings applied with different rooting hormones at 60 days after planting is presented in Table 8. Formation of buds, leaves, shoots and roots were considered as viable cuttings.

There were no interaction effects between selected citrus species and rooting hormones. But analysis of variance revealed that there were significant effects

among treatment means. Rooting hormones mean cuttings treated with IAA got a 95.56% survival rate and were comparable to cuttings treated with IBA, IAA, NAA and Hormex had a survival rate from 92.22% to 93.33% that were significantly different from untreated with survival rate of 82.21%. Moreover, Saredex survival rate of 90% was comparable to the control. In selected citrus means, analysis of variance showed significantly different results. It was revealed that Calamansi and Dalandan were comparable with mean of 97.22% which was significantly different from Calamandarin with 78.89% survival.

Table 8. Percentage (%) survival of different Citrus sp. stem cutting as applied with different rooting hormones 60 days after planting. USM, Kabacan, Cotabato, 2019.

Hormones	Citrus Cutting			B-Mean 1/
	Calamansi	Calamandarin	Dalandan	
Control	83.30	76.70	86.7	82.21 <sup>b</sup>
IBA	100.00	76.70	100.0	92.22 <sup>ab</sup>
IAA	100.00	90.00	96.7	95.56 <sup>a</sup>
NAA	100.00	80.00	100.0	93.33 <sup>a</sup>
Hormex	100.00	80.00	100.0	93.33 <sup>a</sup>
Saredex	100.00	70.00	100.0	90.00 <sup>ab</sup>
A-Mean <sup>2/</sup>	97.22 <sup>a</sup>	78.89 <sup>b</sup>	97.22 <sup>a</sup>	91.11
C.V. - %	6.88			

<sup>1/</sup> Means of rooting hormones with the same letter superscript are not significantly different at 5% level of significant (Tukeys-test)

<sup>2/</sup> Means of citrus species with the same letter superscript are not significantly different at 5% level of significant (Tukeys-test)

The result implied that citrus species cuttings applied with rooting hormones performed better root development which led to higher percentage survival. In Singh's (2018) study of citrus production through cuttings, he observed that cuttings treated with high IBA concentration had the best rooting and survival percentage performance, whereas the mist house growing condition was found to be effective in increasing the cuttings success rate.

## Other Observations

Number of Rooted Citrus Cuttings. The numbers of rooted cuttings were observed at 30, 45 and 60 days after treatment. After 30, 45 and 60 days after planting, three 3 sample cuttings were destructed to get the number of rooted cuttings as shown in Table 9.



Table 9. Number of rooted citrus species as applied with different rooting Hormones at 30, 45 and 45 days after planting. USM, Kabacan, Cotabato, 2019.

Citrus	Days			Total Rooted Cuttings
	30	45	60	
Calamansi				
Control	0	1	1	2
IBA	2	3	2	7
IAA	1	3	3	7
NAA	1	3	4	8
Hormex	0	1	2	3
Saredex	0	1	2	3
Calamandarin				
Control	0	0	2	2
IBA	0	2	1	3
IAA	1	3	3	7
NAA	0	1	1	2
Hormex	0	1	2	3
Saredex	0	3	4	7
Dalandan				
Control	0	2	4	6
IBA	0	3	3	6
IAA	1	3	2	6
NAA	1	3	4	8
Hormex	0	3	4	7
Saredex	0	3	3	6

At 30 DAP application, after uprooting, Calamansi treated with IBA, IAA and NAA had the presence of roots with 2, 1, and 1, respectively while cuttings treated with Hormex, Saredex and control did not produced root. Dalandan treated with IAA and NAA produced only 1 rooted cutting while in Calamandarin treated with IAA had the presence of root. After 45 DAP application, 3 samples uprooted from all treatments. Cuttings treated with IBA, IAA and NAA, the 3 samples uprooted produced roots while Hormex, Saredex and control, only produced one rooted cutting. The least number of rooted cuttings were found in Calamandarin treated with NAA and Hormex while cuttings treated with IAA had the most number of rooted cuttings. Moreover, Dalandan cuttings, all treatments produced rooted cuttings. Upon termination of the study, all selected citrus species formed roots in all hormone treatments. Dalandan had the highest number of rooted cuttings, followed by Calamansi and Calamandarin with 14 and 12 rooted cuttings, respectively.

Temperature and Relative Humidity. The data on temperature and relative humidity is presented in Table 9, Plate 17. Temperature ranged from 32.1°C in the morning to 38.2°C during noon time and 33.3°C in the afternoon while the relative humidity ranged from 96.3% to 97%.

In asexual propagation by cuttings, the main problem was keeping the cuttings from decaying and drying until the missing organ is generated, resulting in a new individual plants. The essential environmental requirements are proper temperature (not higher than 27°C), very humid atmosphere (85 to 100% relative humidity), and ample light and clean, moist, well aerated and well drained rooting medium.

The temperature that is too high for normal growth caused physiological disorders by inhibiting or inactivating certain enzyme systems and possibly accelerating other systems. They also caused protein denaturation and coagulation, disruption of cell membrane and eventual death of cell. Damage by high temperature is increased several fold by lack of moisture and too intense light (Bautista et al., 1983).

Table 10. Average Temperature and Relative Humidity of Experimental Area, USMARC, Kabacan, Cotabato

Month	Temperature (°C)			Relative Humidity (%)		
	9am	12nn	3pm	9am	12nn	3pm
Jan	30.2	35.2	32.0	96.0	97.0	96.0
Feb	33.6	40.6	35.5	97.0	97.0	97.0
Mar	32.7	39.2	32.8	96.0	97.0	96.0
Average	32.2	38.3	33.4	96.3	97.0	96.0

## Study 2. Subsequent Growth of Potted Citrus Cuttings as Applied with Nitrogenous Fertilizer

Number of Shoot. Table 11, column 1, shows the data on the number of shoot of rooted and selected potted citrus species as influenced by nitrogenous fertilizer at 45 days after transplanting. The data showed no significant difference among treatment means. Number of shoots ranged from 2.58 to 3.03 shoots. The most number of shoots was found in Calamandarin, followed by Dalandan and less found in Calamansi.

Length of Shoot. Analysis of variance revealed no significant difference in shoot length (cm) of potted citrus species as influenced by nitrogen fertilizer at 45 days after transplanting. As shown in Table 11, column 2, numerically, the longest

shoot length was found in calamansi with mean of 7.63 cm, followed by Calamandarin and Dalandan with mean of 6.71 and 6.52, respectively.

Table 11. Number of shoot and length of shoot of potted citrus cuttings applied with nitrogen fertilizer (45 days) after transplant. USM, Kabacan, Cotabato, 2019

Citrus	Number of Shoot <sup>ns</sup>	Length of Shoot(cm) <sup>ns</sup>
Dalandan	2.89	6.52
Calamansi	2.58	7.63
Calamandarin	3.03	6.71
CV	20.70%	23.70%

ns – not significant

Table12. Stem diameter of rooted citrus cutting applied with nitrogen fertilizer (15, 30 and 45 days). USM, Kabacan, Cotabato, 2019

Citrus	Number of Leaves		
	15	30	45
Dalandan	2.79	3.00	4.0 <sup>b</sup>
Calamansi	2.57	2.65	5.1 <sup>a</sup>
Calmandarin	2.57	2.65	5.3 <sup>a</sup>
			1/
Tukeys test	ns	ns	
CV%	15.87	12.80	5.88

<sup>a</sup> Means with the same letter superscript are not significantly different at 5% level of significant (Tukeys-test)

ns –not significant

**Stem Diameter (mm).** The stem diameter of potted rooted citrus species applied with nitrogenous fertilizer showed no significant difference from each species at 15 and 30 days but at 45 days. Significant difference on treatment mean was noted at 45 days as shown in Table 12, Plate 15. At 15 DAP; It was observed that the broadest stem diameter was found in Dalandan, while Calamandarin and calamansi had the same stem diameter. At 30 DAP, still Dalandan had the broadest stem diameter and the least was found in both Calamandarin and calamansi. At 45 DAP, Dalandan has significantly different to Calamansi and Calamandarin while Calamandarin and Calamansi were not significant from each other. A wider stem diameter was observed from Calamandarin with the mean of 5.3 mm while the narrowest was observed in Dalandan with mean of 4.0 mm. In most instance, as cited by Bell and Robson (1999); Liu et al, (2008), the application of nitrogen fertilizer resulted in the increased vigor in growth and development of plants. Ahmed et al., (2018); Bracke et al., (2019) said that in cutting propagation nutrients can be leached out from both plants and potting medium. The combination of ammonium sulfate and chicken dung according to Naik et al., (2018); Pereira et al., (2017); Yaldiz (2018) had significantly affected the stem diameter of guava seedling as reported.

Plant Height (cm). As shown in Table13, Plate 16 the data on plant height at 15, 30 and 45 days after transplanting of rooted selected citrus species. Analysis of variance revealed that there was no significant difference among citrus species. At 15 DAP, Dalandan obtained the highest plant height and the shortest found in Calamandarin. It ranged from 12.23 cm to 14.5 cm. After 30 DAP, observed that Dalandan had the highest plant height followed by calamansi and Calamandarin. At 45 DAP, it was observed that Dalandan had the highest plant height followed by calamansi and Calamandarin, it ranged from 16.4 cm to 18.8 cm in height.

Number of Leaves. A significant effect on the number of leaves of potted rooted citrus cuttings as influenced by application of nitrogen fertilizer 15 days after transplanting was found showed in Table 14 Dalandan had significant difference to Calamansi but not to Calamandarin, whereas Calamansi had no significant difference to Calamandarin. After 30 DAP, It was observed that the most number of leaves was found in Dalandan, Calamandarin and the least found in Calamansi. It was observed in the study that plants developed greater number of leaves applied with nitrogen fertilizer at 45 days ranging from 12.8 to 15.7 leaves.

Table 13. Plant (cm) height of potted rooted citrus cuttings applied with nitrogen fertilizer (15, 30 and 45 days). USM, Kabacan, Cotabato, 2019.

Citrus	Plant Height		
	15	30	45
Dalandan	14.52	17.11	18.8
Calamansi	13.80	14.85	16.7
Calmandarin	12.23	14.24	16.4
Tukeys test	ns	ns	ns
CV%	11.45	12.09	12.18

ns – not significant

Table 14. Number of leaves of potted rooted selected citrus seedlings applied with nitrogen fertilizer (15, 30 and 45 days). USM, Kabacan, Cotabato, 2019

Citrus	Number of Leaves		
	15	30	45
Dalandan	9.67 <sup>a</sup>	10.60	12.9
Calamansi	6.84 <sup>b</sup>	8.40	12.8
Calmandarin	8.26 <sup>ab</sup>	9.05	15.7
	1/		
Tukeys test		ns	ns
CV%	18.15	24.42	20.91

<sup>1/</sup> Means with the same letter superscript are not significantly different at 5% level of significant (Tukeys-test)

ns –not significant

This implied that the use of nitrogen can support in the vegetative growth and development of juvenile plant. The result showed that the taller the plant, the more leaves developed and further promote growth because the leaves photosynthesized and produced food to support further seedlings, thus, it had also bigger stem diameter. Villasurda (1989) observed a significant increase on the number of leaves of guava nine months after fertilizer application and continued growth of plants in nursery necessitates the addition of supplementary mineral especially nitrogen.

Percentage Survival. Table 15 shows the data on the percentage survival of potted rooted citrus cuttings as influenced by nitrogenous fertilizer at 45 days after transplanting. Analysis of variance revealed that there were significant differences among citrus species mean percentage survival. Potted citrus cuttings planted obtained a percentage survival of 96% in Dalandan followed by Calamandarin with 66% and the lowest was found in Calamansi with 48 %.

This implied that the application of nitrogenous fertilizer enhanced the growth of plants. Pangilanmen (2004) observed that mortality was numerically higher during the hardening off period for leaf bud cutting than terminal and basal Pomelo cuttings.

Table 15. Survived Potted Citrus Seedlings applied with Nitrogen Fertilizer (45 days)

Citrus	Percentage survival <sup>1/</sup>
Dalandan	96 <sup>a</sup>
Calamansi	48 <sup>b</sup>
Calamandarin	66 <sup>b</sup>
CV-%	18.35

<sup>1/</sup> Means with the same letter superscript are not significantly different at 5% level of significant (Tukeys-test)

## SUMMARY, CONCLUSION AND RECOMMENDATION

The study aimed to evaluate the effects of different rooting hormone applied to selected citrus sp. and determine what hormones that can enhance the rooting of citrus species and growth performance of potted rooted citrus species applied with nitrogen fertilizer.

The results of the study are summarized as follows: there were no significant interaction effects between the selected citrus species and different rooting hormones in all parameters at 60 days after treatment. Different hormones had significant effect on number of roots, length of roots, rooting percentage,

percentage survival and length of shoots whereas not significant on days to shoots, length of shoot and number of leaves. Citrus cuttings had significant effect as to rooting percentage, length of roots, number of leaves, days to shoot and length of shoots while no significant effect was observed as to number of roots and number of shoot.

All rooting hormones improved the rooting performance of selected citrus species. Naphthalene Acetic Acid performed better in term of rooting percentage, length of roots and number of days to shoot emergence. Indole Acetic Acid also performed better in percentage survival and length of shoots, while IBA performed better in number of roots. Hormex performed better in number of shoots and number of leaves.

Subsequent growths of potted citrus cuttings were improved by application of nitrogenous fertilizer.

It can be concluded that the use of any rooting hormones can enhance the root ability of selected citrus species as early as 60 days and application of nitrogenous fertilizer can improve the growth of potted rooted citrus cuttings in any nursery operation.

Based on the results of the study, rooting of selected citrus species (Calamansi, Calamandarin and Dalandan) cuttings are possible with treating any rooting hormones especially Naphthalene Acetic Acid (NAA) at recommended rate. The researcher recommended for future studies to conduct similar study using different potting media and levels of the same rooting hormones and soaking time be considered, more experimental sample should be used and prolonging the period of experimental used for better result and comparative study on field growth of rooted citrus species cutting.

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**Literature Review (Optional):** a section dedicated to the significant literature resources, consulted or employed, that contributed to the study. It surveys scholarly articles, books and other sources (e.g. dissertations, conference proceedings) relevant to a particular issue, area of research, or theory, providing a description, summary, and critical evaluation of each work. The purpose is to offer an overview of significant literature published on a topic.

**Material and Methods:** a section intended to contain a detailed description of all the methods, materials, collaborators and participants at the study. The protocols used for data acquisition, techniques and procedures, investigated parameters, methods of measurements and apparatus should be described in sufficient detail to allow other scientists to understand, analyze and compare the results. The study subjects and participants should be described in terms of number, age and sex. The statistical methods should be described in detail to enable verification of the reported results. This section could contain a separate sub-section that comprises the explanation of the abbreviated terms used on the study.

**Results and Discussion:** a comparative or descriptive analysis of the study based on results, on previously studies, etc. The results should be presented in a logical sequence, given the most important findings first and addressing the stated objectives. The number of tables and figures should be limited to those absolutely needed to confirm or contest the premise of the study. The authors should deal only with new or important aspects of the results obtained. Material from the Results section should not be repeated, nor new material introduced. The relevance of the findings in the context of existing literature or contemporary practice should be addressed.

**Conclusion:** in this final section, the main findings are concisely reiterated. Only conclusions supported by the study findings should be included.

**Recommendations (Quantitative) & Implications (Qualitative):** this section contains theoretical and practical recommendations, further research ideas, new approaches, suggestions and concerns regarding potential social and cultural impacts, etc.

**Acknowledgements (Optional):** people who contributed towards the work in any way for the manuscript preparation, but do not meet the criteria for authorship should be listed in acknowledgements section mentioning their contributions. These also include funding source(s) of each author and describe the involvement of funding body or organization in the whole work. It is recommended to

acknowledge the editor if any manuscript was revised for language corrections. Permissions should be obtained from all those who are acknowledged in this section.

**References:** the references section should followed the APA 6<sup>th</sup> edition.

#### *Book*

East, H., & Jackson, B. (2001). *The social and cultural impact of short-term study-abroad strategies*. Chicago, IL, USA

#### *Journal article*

Smith, A., White, D., Hokanson, C., and Grant. S. (2010). Situations of Pre-Competitive Stress of Young Italian's Athletes. *Journal of Sport Sciences* 95: 633-637. doi: 10.1008/s00421-009-04965-7

#### *Thesis*

Sami, K. (2005). Factors affecting the educational development in severe obese children. PhD Thesis, University of Padua

#### *Online document*

Wright, K. (2007). The role of social media networks on acquisition of second language technical terms and expressions. <http://academyscience.org/articles/11/6/16/1>. Accessed 14 April 2020.

### **Elements**

**Figures and Tables** should have a numbered explanatory label posted below the graphic element. Each figure and table should have a descriptive caption that describes and defines all the abbreviations included. If the element contains data from external sources, an explanatory citation should be included. Photographic images can be submitted if they are saved in JPEG format at a resolution of 300 dpi. The tables are required to have, if appropriate or possible, the width and the height of the size of an entire page avoiding the splitting on more pages.

**Formulas and Equations** could be inserted as objects if created with another external program (Wolfram Mathematica, Mathlab, etc) or by using Microsoft Equation Editor included on the last editions of Microsoft Office.

### **Ethical Matters**

Authors involving in the usage of experimental animals and human subjects in their research article should seek approval from the appropriate Ethical committee

in accordance with "Principles of Laboratory Animal Care". The Method section of the manuscript should include a statement to prove that the investigation was approved and that informed consent was obtained.

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The role of the editors is to evaluate the suitability of submitted manuscripts for the journal, including: (a) the quality of the manuscript, (b) whether it meets the Aims and Scope of the journal, and (c) the originality of the work. The editors will not disclose information about a submitted manuscript to anyone other than the corresponding author, reviewers or potential reviewers, or other members of the editorial board. Editors will ensure the prompt handling of the review process. Editors will evaluate the merit of manuscripts for intellectual content without regard to race, gender, country of origin, ethnicity, religion, or sexual orientation.

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significant error in the published work, the author is obligated to inform the journal editor in order to either correct or retract the paper.

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In cases of proven scientific misconduct, plagiarism, or fraudulent publication, the publisher, in collaboration with the editorial board, will take appropriate action to clarify the situation, publish an erratum, or retract the work in question.

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Any major divergence from the standard manuscript format should be indicated.

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The research article should be technically presented instead of being presented as a story. Mere repetition of past work should not be accepted. You can look for conceptual advancement over previously published work. Any major omission of the previously published findings on the similar problem must be checked.

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The discussion should hover around the result and should not include irrelevant and unachievable statement.

### **Statistical Presentation**

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Plagiarism of Data: Data showing any type of suspicion, duplication and manipulation must be brought to the notice of the author(s).

### **Summary**

Pin point the strength and weakness of the article considering potential importance of the work in the context of present and future.

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At the end reviewer(s) can recommend necessary corrections needed to accept the paper, if they are required, else recommend it for publication. If the paper found unsuitable, the reviewer can reject the paper for publication.



## THE SRJ REVIEW PROCESS

The complete review process of the manuscript is expected to take a month or two but can take longer depending on the bulk of the manuscript in review. Authors can expect to hear from the Journal Editor or Editorial Team member within three weeks of submission of the manuscript.

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  - contribution to the field;
  - technical quality;
  - clarity of presentation; and
  - depth of research.
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- accepted as is (The manuscript is accepted without modification);
  - accepted with minor corrections (The manuscript requires some revisions before it can be accepted);
  - accepted with major corrections (The journal is interested, but the manuscript is not acceptable in its current form and needs to be revised to be considered for publication);
  - rejected (The manuscript is not suitable for publication unless the authors conduct further research or collect additional data);

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The results of the review will be communicated to the Editor for onward transmission to the author(s). The editorial workflow gives the Editors the authority to reject any manuscript because of inappropriateness of its subject, lack of quality, or incorrectness of its results. The Editor cannot assign himself/herself as an external Reviewer of the manuscript. This is to ensure a high-quality, fair, and unbiased peer-review process of every manuscript submitted to the journal, since any manuscript must be recommended by one or more (usually two or more) external reviewers along with the editor in charge of the manuscript in order for it to be accepted for publication in the SRJ.

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