JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Lesser Yam *(Dioscorea Esculenta)* Flour As an Alternative Healthy Food Bar

Joan A. Señar
Graduate School, Naga College Foundation Inc.
Naga City, Philippines
February 23, 2025

Abstract

This study produced lesser yam *(Dioscorea esculenta)* flour as an alternative ingredient in producing healthy food bar. Specifically, this study (1) determined the nutritive value of lesser yam; (2) explained the procedure used in developing lesser yam healthy food bar; (3) identified the best proportion in making lesser yam healthy food bar; (4) determined the level of acceptability of lesser yam *(Dioscorea esculenta)*, in terms of color, appearance, taste, aroma, and texture; (5) determined the shelf-life of healthy food bar based on ocular observation; and (6) identified the economic desirability of the product.

The respondents of this study were teachers, parents, children, and Senior High School cookery students from Barangay Lupi, San Fernando, Camarines Sur. This study applied the descriptive - experimental, research and development (R&D) methods to meet the objectives. In data gathering this study, used questionnaire to determine the level of acceptability of the finished product. The statistical tool used were weighted mean to translate the responses of the respondents on the general acceptability of the finished product in terms of color, appearance, taste, aroma, and texture from lesser yam energy bar in the (3) three trials.

The findings revealed that: (1) The nutritional value of fresh lesser yam per 100 grams include: food energy 76-112 (kcal), protein (2.1g), dietary fiber (1.1g), fat (0.9 g), crude fiber (4.2 g), carbohydrates (16.0 g), crude protein (1.5 g), water (76.7 g), calcium (20 mg), iron (0.2 mg), potassium (200.0 mg), zinc (0.3 mg),phosphorus (40 mg), sodium (10 mg), copper (0.20mg), ash (0.7 g), vitamin B1 (0.06 mg), and niacin (0.9 mg). (2) the procedures involved in producing lesser yam *(Dioscorea esculenta)* were cleaning and washing of unpeeled lesser yam, steaming, peeling, and grating of lesser yam, drying to lessen the moisture,

pulverizing of dried lesser yam, sifting, and storing of lesser yam flour in an airtight zip lock plastic or container. (3) the best proportion of lesser yam *(Dioscorea esculenta)* healthy food bar, using lesser yam flour as an alternative main ingredient was in proportion 2 (P2), because of the average weighted mean of 3.07 and the average amount of flour was 1 cup of lesser yam to make it moderately soft and chewy and it was interpreted as moderately acceptable. (4) the acceptability, of the three proportions, were P2 got the highest weighted mean of 3.07 while P1 obtained a weighted mean of 3.02 and P3 got the lowest weighted mean of 2.74. All three proportions were moderately acceptable to the respondents and the results of the evaluators showed that lesser yam can be an alternative ingredient in healthy food bar. (5) in terms of shelf – life, all three (3) proportions were found safe to consume up to 4 days; (6) all respondents received commendable high ratings ranging from 2.81 to 3.13, which has an equivalent descriptive interpretation of moderately desirable. Teacher-respondents got the highest score among all the respondents with an excellent rating of 3.13. Parents ranked second with a grade of 2.93. SHS-TVL Students ranked in third place with a rating of 2.90, whereas children-respondents got the last place in ranking who received the lowest weighted mean of 2.81. The results further showed that the nutritional value of a food product can impact its economic desirability.

This study concluded that: (1) Lesser yam contains essential nutrients that nourished the body to help in improving one's health, avoid diseases and satisfy dietary needs and choices for an active and healthy lifestyle; (2) there were specific procedures to be followed in producing lesser yam *(Dioscorea esculenta)* flour to save time, effort and ensure quality food product; (3) Proportion 2 (P2) with 1 cup of lesser yam flour was found to be the best proportion for producing healthy food bars. This amount, combined with jaggery as a sweetener, resulted in soft, chewy, and aromatic bars. (4) All three proportions were moderately acceptable to the respondents; (5) Lesser yam healthy food bars had a shelf life of 4 days at room temperature. (6) the lesser yam healthy food bar was moderately desirable.

Keywords: lesser yam (Dioscorea Esculenta), flour, altenative main ingredient, healthy food bar

Introduction

One of the things that people need to survive is food. Daily vital nutrition is necessary for one's physical and mental development and growth, which lowers the risk of chronic disease and promotes overall health and wellbeing. People must deal with crises that are brought by natural calamities like typhoon, earthquake, volcanic eruption, severe flooding and landslide which paralyze the entire world. During these situations, one of the major problems is food supply shortage to the affected places around the globe. For us to survive, there has been a growing interest in alternative crops as a source of food and a way to increase food security. One of these crops is the lesser yam root crop. This root crop is native to tropical regions and has a high nutritional value, making it a promising alternative to traditional wheat flour and provide energy sources and essential nutrients needed by the body.

In the quest for healthier food options, the potential of underutilized crops is often overlooked. One such crop is the Lesser Yam (Dioscorea Esculenta), a tuber rich in essential nutrients and known for its versatility in various culinary applications. The viability of Lesser Yam as the primary ingredient in creating an alternative healthy food bar. By harnessing the nutritional benefits of this humble tuber, a food product can be introduced that satisfies not only the palate, but also contributes to the overall wellness.

Nutritionally, roots and tubers have a great potential to provide economical sources of dietary energy, in the form of carbohydrates. The energy from tubers is about one-third of that of an equivalent weight of rice or wheat due to high moisture content of tubers. However, high yields of roots and tubers give more energy per land unit per day compared to cereal grains. In general, the protein content of roots and tubers is low, ranging from 1 to 2% on a dry weight basis. Yams contain high amounts of proteins among other tubers. The starchy tubers are good source of protein and vitamin B. The nutritional value of lesser yam or tugui roots were starch, protein, fat, dietary fiber, inulin, rich in minerals like calcium, iron, magnesium, and potassium (Kumar, 2016).

In addition, these root crops are primarily grown for their edible underground parts or tubers, and they rank second important crops next to cereals as a global carbohydrate source and an integral component in many packaged foods and feeds for animal and human consumption. On the other hand, the food products that can be develop while still paying attention to adequate calories, nutrients needed by the body, can reduce hunger, and is in the form of solid food is a food bar. Food bars are food products that are solid and high-calorie food made from a mixture of food ingredients enriched with nutrients, then packaged in a small form to make distribution easier. This food product can also be used as an alternative to healthy food which is processed and specially designed for consumption in conditions that make it difficult for humans to meet their nutritious food and to solve rice shortage during calamities.

According to Fadhlan (2021), Food bars are food products that are solid and are classified as semi-wet products or moisture food intermediates (IMF). The food product is high-calorie food made from a mixture of food ingredients, enriched with nutrients, then formed into a solid and compact form (a food bar form). Most existing food bars are made using wheat flour as the main ingredient. However, to solve problems of hunger, food supply shortage, malnutrition and promote local agricultural produce.

Furthermore, the Sustainable Development Goals (SDGs) otherwise known as the Global Goals, of the United Nation Transforming our world; the 2030 Agenda for Sustainable Development discussed one of the 17 goals known as “Zero Hunger”.

The number of people facing hunger and food insecurity has been rising since 2015, conflict, climate change and growing inequalities exacerbating the situation. In 2022, about 9.2 per cent of the world population was facing chronic hunger, equivalent to about 735 million people – 122 million more than in 2019. An estimated 29.6 per cent of the global population – 2.4 billion people – were moderately or severely food insecure, meaning they did not have access to adequate food. This figure reflects an alarming 391 million more people than in 2019.To achieve zero hunger by 2030, the Sustainable Development Goal 2 urgent coordinated action and policy solutions to address malnutrition, food security, and promote sustainable agricultural practices.

In relation to this issue, to solve problems of hunger, food supply shortage, malnutrition and promote local agricultural produce. The researcher utilized and developed an innovative product from lesser yam root crop that have the potential to improve nutrition, healthy foods and promote local food products.

In the Philippines, the President issued Executive Order (EO) No. 5 mandating all government agencies to align their respective strategies to AmBisyon Natin 2040, through the initiative of the National Economic and Development Authority (NEDA) this project started in 2015. The original vision statement for the Philippines, was stated in the following manner:

The Philippines shall be a country where all citizens are free from hunger and poverty, have equal opportunities, enabled by fair and just society that is governed with order and unity. To be a prosperous middle-class society where no one is poor. People live long and healthy lives, are smart and innovative. A nation where families live together, thriving in vibrant, culturally diverse, and resilient communities.

From this Executive Order, which envisions Filipinos enjoying stable, convenient, and tranquil life are oftentimes hinder by natural phenomena or disasters. These results to the destruction of the ecosystem, damage to property and injury or death to people and domestic and wild animals. Each year, natural calamities affect thousands of individuals.

Bicol Region was visited by almost 8 to 9 typhoons per year, not to mention the earthquakes, volcanic eruptions, flooding, and landslides (Altea, 2019). These calamities come because of climate change. The Council that is responsible for the protection and welfare of the people during disasters is the Philippine Disaster Risks Reduction and Management Council. One of the four areas covered by the Disaster Risk Reduction Management Program is Disaster Response, particularly on the need for the food of victims of calamities. To utilize the local products as healthy food bar to complement the government disaster response activities, these root crops play a vital role in the human diet and can be an alternative to rice that are produced by local farmers year-round.

Moreover, the researcher will innovate and develop an instant, ready to eat healthy rich food bar made from lesser yam, which also anchored to the response and needs of the community, especially malnutrition problem of the society and contribute to food sustainability. This study made used of energy-rich root crops like lesser yam (Tugi root or in Bicol also known as burot) as the main ingredient, likewise, used local products such as rice crisp, desiccated coconut, peanut, and cacao chocolate powder and other minor ingredients to produce lesser yam healthy food bar. This study offers significant benefits to local root crop farmers in the pilot Municipality of San Fernando, Camarines Sur. The focus was on creating a nutritious and edible product - a healthy food bar - from readily available local resources. This innovative approach not only adds value to often overlooked community resources but also provides Bicolano's with a convenient source of essential nutrients.

The researcher aims to explore the possibilities of utilizing lesser yam root as a viable alternative ingredient in the creation of healthy food bars, catering to individuals of all age groups. The resulting product was particularly useful for those involved in outdoor activities such as camping or hiking, as well as those participating in strenuous sports, who need a high-calorie, health-boosting food.

Furthermore, the researcher will assess the potential applications of lesser yam root crop in the baking industry and determine its acceptability among consumers. This research holds significance in promoting food security and supporting a healthy lifestyle by offering a nutritious and wholesome food bar option. This research output may also provide opportunities and eventually become another source of income in the community. This study did not include the phytochemical composition of lesser yam and microbial analysis of lesser yam healthy food bar.

Lesser Yam Food Products

Lesser yam is the main ingredients in producing healthy food bar. Different studies proves that Lesser yam composed of different nutrients beneficial for one's health. The study of Kumar (2016) stated that starchy root and tuber crops are second only in importance to cereals as global sources of carbohydrates. They provide a substantial part of the world's food supply and are also an important source of animal feed and processed products for human consumption and industrial use. Starchy roots and tubers are plants which store edible starch material in subterranean stems, roots, rhizomes, corms, and tubers and are originated from diversified botanical sources. Potatoes and yams are tubers, whereas taro and cocoyam's are derived from corns, underground stems, and swollen hypocotyls. All these crops can be propagated by vegetative parts, and these include tubers (potatoes and yams), stem cuttings (cassava), and vine cuttings (sweet potatoes).

According to Chandrasekara (2016), Tugi root, also called Lesser yam, is a member of the yam family and is botanically classified as Dioscorea esculenta. The ancient tuber is sometimes referred to as the Asiatic yam, for its place of origin, or Potato yam, for its appearance. Tugi root is the underground tuber of the Tugi plant, a vine-like plant with heart-shaped leaves. The vine stem is hairy, as are the immature leaves. The Tugi root is cylindrical and rounded at each end and is sometimes covered with smaller roots or "hairs" at one or both ends. The tuber can reach up to 20 centimeters long and up to 8 centimeters in diameter. The skin is a pale brown and thin, making it easy to remove. Yam tubers have vitamins such as carotenoids and tocopherols. Mucilage of yam tuber contains soluble glycoprotein and dietary fiber.

Congruently, the study of Darkwa (2019), *Dioscorea* species are important sources of energy, micronutrients, and phytochemicals with numerous health benefits, and they are widely cultivated in many parts of the world. Among more than 600 species of *Dioscorea* reported in the world, about 60 are edible and medicinal. Also, yam contains dietary fiber, non-starch soluble sugars and a small amount of fat in addition to starch. It has been reported that yam tuber comprises ~76% starch, ~10% protein, ~0.22% fat, ~1.2% crude fiber, and certain amounts of minerals.

Yet, another research emphasized that, food and nutritional security are the major concerns in many countries of the world, and to address this concern, it's now time to transform food systems for food security, improved nutrition, and affordable healthy diets for all by searching for alternative foods. A recent undertaking by Visalakshi (2018), particularly mentioned that lesser yam is classified as an energy food source to consumers especially in sub-Saharan Africa (SSA) because of its high starch content which amounts up to 80% in dry weight basis. It contains nutrients that are beneficial for health, and it has high levels of dietary fiber and inulin, which have a hypoglycemic and hypocholesterolemia effect, reducing glucose levels and improving blood lipid. It is rich in protein and carbohydrates, making it a promising food crop in combating protein-energy malnutrition.

Lesser yam (Dioscorea esculenta) is one of the edible yams grown in Asia, such as Indonesia, Thailand, China, and some other countries in Africa like Nigeria. Lesser yam has the potential source of carbohydrates. Lesser yam flour showed that on a dry matter basis, contains 79.54% carbohydrates, 6.50% crude protein, 1% fat, and 1.5% crude fiber. These health-promoting products can help prevent cardiovascular disease, diabetes, and gut microbiome disorders. (Putra, 2020).

In the same way, Miranda (2015) discussed about Ube, Tugi, Gabi and Kamote are not only known as vegetables, but they can be processed into flour, flakes, jams, and animal feeds. They are good source of carbohydrates, proteins, vitamins, and phytochemicals. Studies show that they have medicinal uses such as

diuretic, anti-inflammatory and antioxidant. They are also the cheapest source of carbohydrates or food energy for the Filipino next to rice and corn. But besides these great characteristics they are less popular especially to younger generation.

As explained by Backian (2022), Dioscorea esculenta, is a root and tuber crop commonly used for food, providing carbohydrates and minerals especially for the indigenous peoples (IPs) in Northern Philippines, who call it Lukto, or Tugui. For the Ivatans of Batanes, it is an important staple crop while among other IPs, it supplements food and cash needs. Moreover, the study of Adebisi and Okieimen (2015) on the nutritional, functional, and pasting properties of lesser yam flour were analyzed and compared to those of wheat flour. The results showed that lesser yam flour had a higher content of starch, fiber, and essential vitamins and minerals compared to wheat flour, and exhibit good water-absorbing capacity and gelation properties. The study concluded that lesser yam flour has the potential to be used as a substitute for wheat flour in food products.

In addition, the study of Okoro and Ajieh (2014) revealed that Yam belongs to the family Dioscorea, the genus Dioscorea and class of roots and tubers. In West Africa, yams are valuable source of carbohydrates, which provides about 200 calories of energy per capita daily consumption. Likewise, yam is a major source of income and has high cultural value. The farmers and the villagers at large are always looking forward to successful cultivation and harvest of yam. In Nigeria for instance, a festival “Odun Isu” is held annually to celebrate the arrival of yam during the first phase of harvest. This happiness and celebration are simply due to the nutritional and economic value of yam that the people will derive from yam.

Consequently, the study of Otegbayo et al. (2018) found that the ash content of the food determines the presence of important dietary minerals and useful for the development of the body. The ash content of yam is lower than the other tuber crops like potato and cassava. Dietary fats help in absorption and retention of flavors during cooking which leads to increased palatability of food. The dietary fats contributed 1%–2% of the food calorific value which is sufficient for the diet and the dietary fat or lipid content of yam has been reported to be higher than potato and sweet potato. The dietary fiber of food protects the beneficial microflora of the intestine, also reduces the threat of colon cancer and cardiovascular diseases.

Likewise, the study of Padhan et al. (2018) found that zinc is an essential mineral that plays a pivotal role in development of brain and bone and wound healing capacity. It also helps in metabolic activities of carbohydrate, protein, vitamin A, and nucleic acid biosynthesis. Also, high potassium content in the body increases the iron utilization which is beneficial for controlling hypertension. The amount of potassium is

beneficial for the diuretics people to control hypertension. The yam tubers are rich in dietary minerals and among all the minerals potassium is the abundant mineral present in the yam tubers.

Again, the study of Obidiegwu (2020) discussed that yam is classified as a healthy food source to consumers especially in sub-Saharan Africa (SSA) because of its high starch content which amounts up to 80% in dry weight basis. Evaluated the starch composition of Dioscorea esculenta in SSA and reported a range between 63.2% and 65.7%. Yam's potential as a source of food is attributed to its high levels of carbohydrates including fiber, starch, and sugar, contributing about 200 dietary calories per person per day to 300 million people in the tropics. It also provides other nutritional benefits such as proteins, lipids, vitamins, and minerals. Yam (Dioscorea species) is an orphan crop, widely distributed globally; and has contributed enormously to food security especially in sub-Saharan Africa because of its role in providing nutritional benefits and income.

Different dietary vitamins help to use protein, fat, and carbohydrate to make energy and available to the body. The vitamins C and E are considered as antioxidant and act as cofactors for enzymes. Vitamin C has multiple functions as radical scavenging activities, collagen synthesis, iron absorption, wound healing properties, and anti-inflammatory activities. The yam tubers contain different vitamins higher than other tuber crops (Merrigan, 2015).

On the other hand, as explained in the article by Emelia et al. (2019), there are six types of healthy food bars based on type and functionality. Fruit based snack bar which increases polyphenols and dietary fiber content. Wheat- or soy-based bar cereal high-quality proteins, fibers, and B-complex vitamins contents. Cereal snack bar, the flour provided an increase in dietary fiber content, vitamin C, minerals, and antioxidant activity. Fruit and vegetable-based snack bars, high fiber, and protein mineral content. And vegetable-based bar, increasing in protein and dietary fiber content and the antioxidant capacity. High- protein snack bar increasing in protein content.

A healthy food bar is a processed food product specifically designed to meet the daily energy requirements of a person. Because of this DOST and food specialist continuously changed the ingredients and formulation. Thus, to innovate food with nutritive value and safety that meet the requirements. It allows the consumers to get necessary energy and nutritional benefit,(high-quality proteins, polyunsaturated fatty acids, minerals, vitamins and fibers) is one convenient and easy to store packaged (Cheng, et al., 2016).

Moreover, Ansari et al. (2021) developed a healthy food bar using figs and dates. And analyze its nutritional status with the objective to primarily meet the consumer need to provide them with the best product. This will really help people to go healthy instantly rather than relying on junk. It can be concluded that the product

provides an adequate amount of carbohydrates, fats, proteins, fiber and most importantly energy and can be used as meal replacement bar.

Furthermore, in the study by Ransilu, (2019) indicated that high calorie healthy food bar gives more energy and extra nutrition for human to heal from ailments. These foods can be used to supply adequate nutrition for athletes and with poor access to foods. Likewise, Robinson (2017) revealed that older adults which may lead to reduce access to foods and should also meet the group's protein and micronutrients requirement since they often experience malnutrition due to low energy intake, carbohydrates, protein, and fats. Lastly, in the study of Bazano and Potts (2017), it was revealed that the development of Ready-to-use Therapeutic food (RUTF) for the treatment of uncomplicated cases of severe acute malnutrition in young children has greatly improve survival. And led to a surge in demand for RUTF in low-income countries that are frequently food insecure due to environmental factors such as cyclical drought.

Procedure and Best Proportion of Healthy Food Bar

In producing food, we need to follow the right process and procedures to achieve the best results and good quality products. Likewise, in making healthy food bar the procedures may affect the quality of the finished product depending on the proportion of lesser yam flour. Through process and observation, it may easily achieve the best proportion.

One of the oldest and most prevalent method of food processing is drying. This process involves simultaneous heat and mass transfer, which requires precise process control. The drying of a moist material implies both evaporation of free and loosely bound water from inside the solid material into the atmosphere. Fruits and vegetables and even root crops can be dried to extend shelf life, improve storage ability, reduce packaging requirements, and reduce transport weight. In drying we have various techniques use like conventional drying methods, fruits and vegetables are sun-or hot-air-dried. Solar drying is often a slow process (Karam 2016). Drying and grinding method is also use in producing lesser yam healthy food bar.

According to Nwakuba (2022), Lesser yam slices are mainly preserved by drying in the sun because of their low cost. Drying with the sun is the oldest and cheapest means used for food preservation, but it causes the contamination of crops by dust and exposes them to attacks by insects and microbial infections. As cited by Okoronkwo (2021), there is usually a problem of low solar irradiance and high relative humidity prevailing during the rainy seasons, which does not support effective sun-drying. Yam flour quality depends on blanching time and drying air temperature. Blanching is a pre-treatment technique that involves boiling a food material and then removing it after a very short time interval, and finally cooling it to stop the cooking process. The preheating technique helps to achieve texture modification, and preservation of flavor, color, and essential nutrients of the yam slices. For standard quality yam flour, the use of a blanching temperature

of 40°C and a soaking period of 12 hours, whereas Ononogbo et al. (2022) recommended (80°C and 30 mins), respectively. The quality of dried and stored yam products is mostly preferred to that of fresh yam, for which reason it is often more costly than tubers of fresh yam because it has more improved taste and texture than fresh tubers.

Based on Setyawan (2021), processing of tubers into flour generally involves peeling, slicing, blanching, drying, and milling by common practice. Drying, either by oven or freeze drying, is done to lower the moisture content, which extends the shelf life of the product. Oven-drying is commonly used for its simple design, easy operation, and low cost. On the other hand, freeze-drying helps prevent oxidation damages, minimize degradation of chemical compounds, reduces shrinkage, and shift of soluble solids, preserve volatile compounds, and maintain the porous structure.

However, Yusuf (2022) mentioned that the tubers of the lesser yam plant are usually used as a source of carbohydrates after cooking or burning. In addition, it is also used as an ingredient in vegetable mixtures after being cooked, boiled, or fried. According to information from the community in Kabupaten Lombok Utara (KLU), before lesser yam tubers were used as a staple food substitute for rice with added value in the form of a sweet taste so that people liked it. So far, lesser yam tubers are only processed in the form of fresh tubers by boiling/steaming. Lesser yam tubers can be used as various agro-industrial products such as flour chips or flakes for snacks that can improve nutrition and people's welfare.

In another article discussed by Asiamah (2022), Yam balls were prepared according to with slight modifications. About 5.5 kilogram of peeled yam tubers were washed, sliced (4 centimeter), and boiled in 3056 milliter with water for 25–35 minutes until tender. The boiled slices were mashed manually and molded into spherical balls weighing 28 grams each. Similarly, the study of Navle (2016) stated that the common methods of preparation of lesser yam include boiling, baking, or frying. Boiled and baked yams can be eaten with vegetable sauce or palm oil. The yams are first sliced and soaked in salt water for several hours before further processing for consumption. The lesser yams were washed and peeled, and root heads were removed from the tuber. Peeled yam tubers were boiled in hot water for up to 45 minutes to increase the moisture content from 76.21 to 78.34%. After boiling, the boiled yam tubers were cut into slices (3-4 millimeter thick). These slices were placed into the convective dryer and dried at temperature 60 degrees Celsius for 6 to 9 hours up to 9 to 10 % and then slices were taken out from the dryer and allowed to cool at ambient temperature and milled using pulverized up to an average particle size of 40.00 to make flour.

Congruently, the study of Handayani (2016) stated that modification of starch and flour can be chemically or physically modified. In this research, Lesser yam (Dioscorea esculenta) flour modification using physical treatment which was steaming. Research conducted shows the process of pre-cooking (combined heating and cooling) can increase the levels of resistant starch in bananas. Yam has white tuber flesh color so that it produces white color flour. Shortly after peeled, yam tubers were immersed in 0.3% sodium meta-bisulfite solution. The maximum limit use of sulfites in dried foods by the FDA is 2000-3000 ppm. Immersing is intended to prevent browning reactions that may occur during the process of peeling and drying. Yam flour modification produced a white, powdery substance with a degree of fineness of 100 mesh, has a normal aroma and taste. Sensory characteristics of yam flour is influenced by raw material used (yam tuber) and various treatments during the flour making.

In addition, Wahab (2016) mentioned that each species of the yam tuber was washed and peeled. The peeled samples were sliced with a stainless-steel vegetable slicer into 1-millimeter pieces and washed in potable water. The yam slices were divided into two equal portions; a portion was blanched in water bath maintained at 70 degrees Celsius as the first pretreatment and other portion was sulphited by immersing them in 0.28% potassium metabisulphite (second pretreatment) solution to prevent oxidative browning. Each pretreatment was done for 15 minutes. For cabinet drying, each pretreated yam slice was dried at 60 degrees Celsius for 24 hours. For sun drying, each pretreated yam slice was dried on black polythene nylon for 2 days. The dried samples were ground separately with laboratory hammer mill and sieved through a 250-mesh screen to obtain unfermented yam flour. The yam flour samples were kept separately in airtight plastic container to prevent moisture absorption and stored at room temperature until used for further analysis.

As stated in the article of Ayuningtyas (2021), extraction of lesser yam starch was carried out using a 0.02% sodium pyrosulfate solution. First, the outer shell of the lesser yam is peeled, the damaged parts are removed and cut into cubes with a size of about 3x3x3 centimeters. Then, weigh 1000 grams before immersing in 4 liters of Sodium pyrosulfate solution with a concentration of 0.02% (b/v) for 10 minutes with a ratio of 1: 4 (lesser yam: Sodium pyrosulfate). The lesser yam has been soaked for 10 minutes then ground using a blender for 2 minutes. The slurry was separated using a filter cloth to obtain suspended starch in the filtrate. The filtrate obtained is allowed to stand at room temperature for 5 hours for the precipitation process before being rinsed twice with demineralized water and separated from the excess solvent. Then, the solid was dried in an oven 50 degrees Celsius for 18 hours and ground dried using a blender until a fine powder was formed. The fine powder is sieved with a 60-mesh sieve to obtain lesser yam starch powder.

Moreover, Nurhartadi (2018) studied the effect of taro and lesser yam flour on frozen wheygurt chemical and sensory characteristics. Lesser yam starch has low peak gelatinization viscosity, thus making ice cream melt in an ideal time range. In this study, taro and lesser yam flour are combined to find the best chemical and sensory characteristics of frozen wheygurt. Furthermore, these two tubers have prebiotic substances which can be utilized as lactic acid bacteria (LAB) growth medium in human digestion system and metabolites formation, such as oligosaccharides in taro and inulin in lesser yam. lesser yam (Dioscorea esculenta) has the potential to be used as a thickener because of their high content (about 51.34- 70.92%), and a similar ratio of amylopectin and amylose (lesser yam 24.30: 75.7). Addition ratio of taro and lesser yam flour effect on the chemical characteristics of frozen wheygurt. Sample with higher lesser yam addition has better chemical characteristic compared to sample with higher taro addition.

The study of Putra (2020) focused on Physicochemical and Sensory Properties of food bar made with lesser yam, mung bean base with pedada fruit. Bar Lesser yam Flour Preparation: Lesser yam was washed then were soaked with water at 800C for 1 minute. using the fruit slicer. The lesser yam skin was peeled manually with a sterile knife. The pulps were then cut into small pieces prior to soaking in mixed of the sodium metabisulfite 0,3%, and salt 5% solution for 2 hours. Then, the pulps were rinsed using water. The lesser yam was dried in cabinet dryer at 600 for 8 hours. The dried slices were ground using a laboratory mill to a fine powder. The powder was sifted with 80 mesh and kept in an airtight plastic container and stored in chiller prior to use.

Food bars were prepared according to the method as proposed by Ladamay and Yuwono (2014) with minor modifications. Formulation of food bars could be seen firstly dry ingredients, such as pedada fruit flour 20 grams, sucrose 30 grams, lecithin 0.5-gram, sodium bicarbonate 0,5 gram and formulation lesser yam flour and green bean flour were mixed using the blender for 5 minutes. Then Butter 30 grams, glucose syrup 20 grams, lecithin 0,5 grams was added into the mixture and blended until a uniform mixture was obtained. The present study showed “energy” food bar had higher carbohydrates than wheat base bar (10%), oat base bar (60%) and had higher crude protein than glutinous rice flour base (6%). Dahri (2017), explained that Lesser yam is a good source of carbohydrates, primary this starch that is very important to provide nutrients in our health.

The study of Winarti (2016) mentioned the procedures for making symbiotic yoghurt lesser yam tubers are as follows: firstly, mixing all the ingredients which include lesser yam tubers filtrate, sucrose, and skim milk. Secondly, heating (pasteurization) at a temperature of 70-80 degrees Celsius for 15 seconds. Then, mix and stir all the ingredients. The last step was cooling off at a temperature of ± 40-45 degrees Celsius and incubated at 37 degrees Celsius for 18, 20 and 22 hours. This research utilized the used of lesser yam to produce

symbiotic yoghurt containing inulin as prebiotic compound and combined with probiotic bacteria will produce new products that are beneficial to health.

As explained by Taylor (2019), the oldest and most used method of food preservation is dehydration. It is currently an adaptable and widespread technique in the food industry as well as a subject of continuous interest in food research. In addition to preservation, the reduced weight and bulk of dehydrated products decreases packaging, handling, and transportation costs. Furthermore, most food products are dried for improved milling or mixing characteristics in further processing.

Barrameda (2022) developed a Ready-To-Eat (RTE) Healthy Food Bar using the root crops such as cassava, and sweet potato as the main ingredients and the process involved were dehydrating, pulverizing, boiling, adding all ingredients, molding, baking, cooling, packaging, and labelling. RTE healthy food bar is predominantly carbohydrates 71.28% of the bar is made up of sugar 66% and non-sugar components like dextrin, fibers and glucose is 34%, fats 26.7% and only 2% is protein. Based on RENI of adult female (19-29 years old) energy bar meets 21% of her energy intake, for school children, energy bar meets 20% of energy requirements, 4 bar of RTE healthy food Bar 50 grams is equal to 1 meal either breakfast, lunch, or dinner. Carbohydrates is a primary source of energy to the body. The same process involves the preparation of lesser yam healthy food bar.

Likewise, the study of Formalejo (2022) focused on nutrition and to provide an alternative healthy food product that source of an individual's meal in times of scarcity, or as a supplement to a person's energy. The cookie was made from specially formulated composite flour ingredients derived from coconut, pili, cacao, and soya beans which are known for having high calorie content. It also stated the processed such as gathering of all raw ingredients, cleaning, dehydration and grinding, baking, cooling, weighing, and packaging and formulate three different proportion and select the most acceptable cookie samples. This process is also anchored in producing lesser yam healthy food bar.

Also, Beltran (2020) focused on using pili pulp and taro root crop as the main ingredients in producing healthy food bar and it undergo dehydration process. Other process used were melting, panning, cooling, slicing, weighing for 50g per bar, packaging, and labelling. Dehydration of Pili pulp and Taro was the same with the steps used in drying the lesser yam. According to the study of Francisco (2019), the different processes involved in producing pili pulp flour was gathering, washing, drying, peeling, and sifting. The pili pulp flour was subjected to determine the nutritive value and evaluated the acceptability of different delicacies and baked products produced. This process is used in the present study in preparation of lesser yam flour as the main ingredient in producing healthy food bar.

However, Prisukhina (2020) developed a healthy food bar for sports nutrition, based on the best possible combination of proteins, fats, and carbohydrates. Only natural, nutrient-dense ingredients were used to make bars. The optimum ratio of components related to high nutritional and energy values and consumer activity was identified by forecasting the nutritional values of various formulas and comparing them to quality indicators. On the other hand, according to Gyimah (2020), to avoid hydrogenated oils and bars with more than 10 grams of added sugar. And recommended to choose healthy food bars made with nuts, oats, dried fruits, and whey protein, a bar must contain at least 5 grams of protein for around 100 to 200 calories.

Furthermore, the study of Yee (2017) formulated a healthy food bar made from dragon fruit and analyze the nutritional composition, and physicochemical properties of a snack bars were prepared with addition of DFP in 0gram, 5grams ,10grams and 15grams.The result show that there are significant differences in total phenolic, flavonoid, increase in moisture, ash, and fiber content. Dragon fruit peel has the potential to be recovered into alternative sources in producing healthy food bar because of its nutrients and properties.

Lastly, Hasan (2020) studied on the "Preparation of cookies from banana flour, soy flour, and Moringa leaf flour as healthy food bar". The best composition of healthy food in the form of cookies, prepared from banana flour, soy flour, and moringa flour is F3 banana flour 20%, soy flour 20%, and Moringa flour 5%. The nutrient composition of each 100 grams of product was 14.68 grams of protein, 36.9 grams of lipids, 42.12 grams of carbohydrate and 559.35 kcal of energy. In terms of food, healthy food already fulfills the adequacy standard, which is a minimum energy of 233 kcal/50 grams and 7.9 to 8.1 grams protein. This product is swallowed easiest, delicious, with no bitter aftertaste and most preferable compared to other formulas.

Acceptability of Innovative Food Products

The most important criteria for determining food choice are the acceptance of the sensory properties of foods. Food acceptability directly relates to the interaction of food with the consumer at a given time. Some factors affect food acceptability such as customer characteristics and sensory characteristics of foods. Thus, this section discusses the level of acceptability of the different developed products using sensory evaluation.

In the study of William (2016), it mentioned the process through which an individual accepts or rejects food is of a multi-dimensional nature. There are three critical factors that determine food acceptability. They include consumer characteristics, sensory characteristics, and enjoyment of food. Sensory characteristics of food such as taste, texture, aroma, appearance have distinct and influential effects on food acceptability. Therefore, a sensory attribute of food is considered the key area in which food manufacturers can successfully

use to differentiate their products. Consumer characteristics which affect food acceptability include knowledge, innovativeness, attitude, belief, and perception of food products. Lastly, "the feel good" factor is also an essential determinant of food acceptability which is like (Maina, 2018).

The study by Alano (2023) focused on developing a newly introduced candy made form dragon fruit peel as a source of income. The experimental method was used in coming up with the dragon fruit peel candy formulated in three proportions. The best composition of candied dragon fruit peel using sensory characteristics of color, aroma, taste, texture, and appearance as indicators was revealed to be in trial 3 with a 3.17 average rating and the most acceptable product. Color plays an essential factor in food acceptability and palatability and additives enhance the appearance of the food products. In terms of color, P1 is the best color, which is light pink, which was the natural color of dragon fruit preferred by the respondents.

The study of Hade (2023) focused on using eggplant to innovate recipes. The descriptive method used to describe the level of acceptability of the pasta noodles from eggplant flour as the main ingredient through sensory evaluation in terms of color, taste, aroma, texture, and appearance and the observation of the researcher in terms of shelf-life. All the proportions were acceptable to the respondents. Likewise, Coldas (2023) studied the acceptability of "Krill (Euphausiacea) Cracker Snacks" for all ages. Descriptive-experimental method was used to describe the development of the recipes from krill and comparative method to determine the significant differences of the different trials. This study used sensory evaluation to determine the level of acceptability of the finished product. The respondents prefer fresh krill cracker since its color, texture, aroma, appearance, and taste was much more acceptable by the respondents.

The study of Castro (2019) focused on using the squash to innovate recipes for domestic consumption and commercial purposes. The level of acceptability of the innovative recipes form squash was determined by sensory evaluation in terms of color, taste, aroma, texture, appearance, and shelf-life. Also, Almen (2019) focused on utilization of "Lagkitan Banana (Musa Sapientum) an enrichment flour to make a snack item. The lagkitan banana flour served as the main ingredients to various kind of baked products like cookies and cupcakes. The ratio and proportion of Lagkitan Banana flour, wheat flour and ripe lagkitan banana can affect the taste of baked product. This study also undergone sensory evaluation on the sensory characteristics and level of acceptability in terms of its appearance, aroma, taste, and texture. And in terms of taste, the most preferred sample of banana cupcake was the sample 2 with the equal proportion of banana flour and all-purpose flour.

Kumar, et al. (2019) studied the acceptability of the Gluten-Free -Pizza base using Multigrain flour. They develop a multigrain gluten-free blend (GFD) using Bengal Gram flour, black gram flour. Soya flour at a 1:1 ratio, and fenugreek at 0.5% in the formulation. 100% wheat flour was used as the control recipe and replaced with (GFD) having 25, 50,70, and 100% levels (gluten-free). The result concluded that the use of an increasing amount of GFD from 0 to 100% increased farinograph water absorption, decreased dough stability, and caused disruption in the protein matrix thereby decreasing the spread ration in the pizza base. While the addition of a combination of additives to 100% GFD brought significant improvement in the dough strength and overall quality of pizza base. The fat, protein, and dietary fiber contents of GFD pizza base with additives were 2.3, 3.0, and 4.0 times higher than the control. Therefore, the pizza base developed is accepted to have a blend of protein and starch from gluten-free cereal and legumes sources that can help the pizza base develop into a product structurally like wheat pizza base enhanced nutritional content.

The study of Gumanit (2019) focused on the Production of Fish-Malunggay (Moringa Oleifera) Kropek. The results revealed that the varying amount of malunggay significantly affects the sensory attributes in terms of color, flavor, odor, and texture of fish-malunggay kropek. It showed that the two samples prepared were acceptable and described as "extremely like" by the ten (10) sensory evaluation panelists. It also revealed that sample one (1) was the most preferable combination of fish and malunggay ingredient which has a less amount of malunggay compared to sample two (2). Therefore, sample one (1) with 200grams fish + 5grams malunggay was recommended to produce fish-malunggay kropek.

On the other hand, as explained by Byamukama (2019), on nutritional and acceptability of wheat bread supplemented with soybean flour, maize bran and maize germ showed that the bread processed with 80% wheat, 8% soybean flour, 105 maize bran and germ had promising acceptability. Meanwhile, Teye (2020), studied the sensory qualities of frankfurter sausages with sweet potato as extender, significant findings revealed that the addition of sweet potato puree did not negatively affect the sensory and nutritional qualities of the product.

The consumer acceptability of bakery products enriched with brewer's spent grains were explored (Amoriello, et al., 2020). The addition of brewer's spent grains caused enrichment in protein, dietary fiber, lipids, and ash levels. The color of the crust and crumbs of bakery products changed significantly as well. Similarly, the consumer test revealed that 5% BSG enrichment increased overall acceptability of proposed bakery products. In the same manner, the acceptability and nutritional quality of vegetable-enriched products were seen to be contributed favorably to vitamin A, iron, zinc, and protein requirements of children (5 -13 years old. Based on these findings, protein-rich orange fleshed sweet potato composite flour van be

recommended for making porridge and can substitute (30%) for wheat flour in making snacks; while red amaranth leaf composite flour can be recommended for making soups (Onwuamaeze, 2017).

Dela Trinidad (2018) developed a healthy bar made from squash, moringa, and mung bean. Based on the result of the several trials conducted, and the result of the evaluations, the researcher was able to develop the best process to come up with the most acceptable product. Similarly, Angeles (2018) conducted a study on pulverized siling labuyo that was used to flavor cakes and cookies. Descriptive and sensory evaluation was used in the study in determining the acceptability level of the spiciness of the baked products.

The study of Butke, et al. (2018) evaluated the sensory acceptability among children and the physicochemical composition of pizzas that have different level of pumpkin skin flour. Five pizza formulations were developed with the addition of different levels of Pumpkin Skin Flour: F1 (0%), F2 (12%), F3 (18%), F4 (24%) and F5 (30%). The results notified that there were greater scores for F1 for the look and color attributes in comparison with F5. While the F1, F2, and F3 formulations had superior scores in comparison with F5 regarding the smell. Similar results were noticed for the flavor and texture attributes. The control pizza was the most accepted one in these evaluations in comparison with the F4 and F5. Additionally, F2 and F3 got superior scores in comparison with F5. Therefore, the additional levels superior to 18% of PSF in pizzas reduce their acceptability. In terms of moisture and calorie level, the results notified that there was no significant difference between F1 and F3. However, greater level of ash, protein, lipid, and dietary fiber were noticed for F3. The F1 formulation presented greater. The results concluded that an added level of 18 % of PSF in pizza improves the product's nutritional profile, aromatic odor and is well accepted by the children.

The study of Lomeda (2018) about the Acceptability on different proportions of Coco-squash peanut bar in terms of sensory evaluation and level of acceptability in terms of its appearance, aroma, taste, and texture. In determining the most acceptable product three proportions was evaluated and rated by the respondents. The most acceptable proportion of coco-squash peanut bar was sample 1, got the highest percentage of squash as compared to other samples and it was characterized with soft texture, pronounced peanuts taste, moderate squash aroma and moderate coco milk aroma that most preferred by the respondents.

In another study, Beatriz (2019) conducted about the Acceptability on different proportions of *Cocu's Nucifera* cupcakes in terms of sensory characteristics and shelf life. Three different proportions of the recipe were developed and rated by the five groups of respondents. Proportion 1 (P1) had 1 ¼ cup all-purpose flour (APF) and ¾ cup of coconut meat, p2 was composed of 1 ½ cup APF and ½ of coconut meat, while the p3 had 1 ¾ cup APF and ¼ cup of coconut meat. The sensory attributes were employed in evaluating the product. Furthermore, the sensory evaluation results shows that P1 was the most acceptable proportion and

interpreted as highly acceptable. Based on the ocular observation conducted on the shelf life of the three proportions of *Cocus Nucifera* cupcakes, it was found that the cupcake with sapal last for six (6) days and is fit for human consumption at room temperature.

Burce (2016) dealt on the utilization and acceptability of "Black Plum Seeds as Mian Ingredient for Coffee". Black plum seeds are one classical fruit that is usually eaten while the seed is thrown away unaware of its other uses and its nutritional content. Using the seeds as main ingredient in coffee is a great help to the community. In the same perspective, Soverano (2016) processed wine from "lubas fruit". Through experimentation, he found out that all treatments were significantly varied in terms of aroma, taste, and appearance. The result was based on the comments of the evaluators and respondents, The Highest acceptability using the sensory evaluation was on taste, aroma, and appearance.

Sarte (2016) conducted a study that focused on the production of preserved banana pith as the main ingredients such as banana pith patties and banana pith balls. The result of this study was significant because she used the sensory evaluation in determining the degree of acceptability of the new food product. This may encourage entrepreneur to venture to a new business. Considering the availability of the material, all food products from banana pith are sustainable and affordable to every consumer. The sensory evaluation determined the degree of acceptability of the banana pith food product.

Moreover, Lalugan (2016) focused on the usage of Indian mango as primary ingredient in wine, the degree of acceptability of the product in terms of appearance, color, clarity, scent, and taste was determined through sensory evaluation. In terms of alcohol content, the physicochemical composition of various samples of Indian mango wine was assessed. Furthermore, the study of Bantog (2015), focused on the development of Tiessa-Pili Ice cream utilizing riped tiessa and pili pulp. The main aim of the study was to develop a new product by combining the tiessa and pili, considering the following activities such as ingredient formulation, actual development, subjective an objective evaluation of the product. This study was also used Development, descriptive and evaluative methods including experimenting, proving, and testing to come up with a good result.

Finally, the study of Parekh, et al. (2014), An experiment for preparation of mango (Mangifera indica L.) bar. Kesar with fortified desiccated coconut powder (DCP) was investigated with two factors of treatment. The First one was chemical preservative viz., (unsulphited i.e., without application of KMS) and P1 (su). The i.e., with the application of KMS). The second fortification was done viz. D0 (0% DCP), D1 (1% DCP), D2 (2% DCP) and D3 (3% DCP) with overall eight total combinations. The bar was packed with a polyethylene bag and stored under ambient conditions and the Physico-chemical parameters, acidity, total sugar, reducing sugar,

non-reducing sugar ascorbic acid, and organoleptic quality with respect to color, flavor, taste, texture, and overall acceptability were evaluated at initial and monthly interval up to 6 months of storage. The result indicated that the bar prepared by treatment P1 was significantly superior with respect to Physico-chemical parameters except for reducing sugar were significantly higher that recorded in P0. Considering the organoleptic evaluation of mango bar, the treatments P1 and D2 (2% DCP) scored the highest scores and found better quality during 6 months of storage.

Methodology

This study applied the descriptive - experimental, research and development (R&D) methods to meet the objectives and problems of the study in producing lesser yam healthy food bar. Descriptive method was used to describe the processes of the development and formulation of lesser yam healthy food bar. Specifically, it described the collection, gathering, formulation and preparation of healthy food bar. Experimental method was used in the formulation of the different proportions of measurement of ingredients of the three (3) samples in terms of level of acceptability such as color, appearance, taste, aroma, and texture. Organoleptic evaluation was also used to determine the shelf-life of lesser yam healthy food bar at room temperature and economic desirability of the product was also determined. The Research and Development (R&D) method was used on the product which underwent the processes of gathering data, during the production of lesser yam flour and in making lesser yam healthy food bar. Furthermore, it was used to develop lesser yam healthy food bar employing various ingredients and processes which were accomplished through careful experimentation and finalization of the sample being developed for possible commercialization.

The researcher used purposive sampling in selecting the group of respondents who are the target consumers and evaluators of the product. The respondents of the study were composed of (40) forty individuals were 10 Teachers (A), 10 Parents (B), 10 Children (C) and 10 Students (D) from barangay Lupi San Fernando, Camarines Sur. The first group were teachers, who were considered knowledgeable, and capable of evaluating the finished product. Another group were parents, and the last two groups were children from 10 to 13 years old and senior high school grade 11 and 12 cookery students. This study used questionnaire with 4-Point Likert rating scale to determine the level of acceptability of the finished product in terms of color, appearance, taste, aroma, and texture and appearance and were statistically treated using weighted mean.

Results and Discussion

Nutritive Value of Lesser Yam

In various studies, Lesser yam (Dioscorea esculenta) was one of the edible yams grown in Asia, such as Indonesia, Thailand, China, and some other countries in Africa such as Nigeria. In the Philippines Lesser yam, it was also known as tugui or burot that has the potential to be a source of carbohydrates and more nutrients and health benefits to the human body.

As shown in Table 3, the nutritional value of fresh lesser yam per 100 grams include: food energy 76-112 (kcal), protein (2.1g), dietary fiber (1.1g), fat (0.9 g), crude fiber (4.2 g), carbohydrates (16.0 g), crude protein (1.5 g), water (76.7 g), calcium (20 mg), iron (0.2 mg), potassium (200.0 mg), zinc (0.3 mg), phosphorus (40 mg), sodium (10 mg), copper (0.20mg), ash (0.7 g), vitamin B1 (0.06 mg), and niacin (0.9 mg). Lesser yam is classified as an energy food source to consumers especially in sub-Saharan Africa (SSA) because of its high starch content which amounts up to 80% in dry weight basis and high levels of dietary fiber and inulin, which have a hypoglycemic and hypocholesterolemia effect reducing glucose levels and improving blood lipid are beneficial for the health.

Table 3

Nutritive Value of Lesser Yam

Nutrients	Fresh Lesser yam per 100 grams	Lesser Yam Flour
Food Energy/starch	76 -112 kcal	71 - 83 %
Protein	2.1 g	9.0 %
Dietary fiber	1.1 g	12 %
Fat	0.9 g	10.16 %
Inulin		1.00 -1.10 %
Crude fiber	4.2 g	7.49 %
Carbohydrates	16.0 g	79.54 %
Crude protein	1.5 g	6.50 %
Protein tuber flour		7.19 %
Water	76.7 g	
Calcium	20 mg	30 mg
Iron	0.2 mg	0.54 mg
Magnesium		21 mg
Potassium	200.0 mg	816 mg

Zinc	0.3mg	
Phosphorus	40mg	
Sodium	10mg	
Copper	0.20mg	
Ash	0.7 g	2.1 %
Vitamin B1	0.06 mg	
Niacin	0.9 mg	

Yam also contains dietary fiber, non-starch soluble sugars and a small amount of fat in addition to starch. This was close to the study of Darkwa (2019) that *Dioscorea* species are important sources of energy, micronutrients, with numerous health benefits. It has been reported that yam tuber comprises ~76% starch, ~10% protein, ~0.22% fat, ~1.2% crude fiber, and certain amounts of minerals. Starch was a good alternative food source to rice like yams, sweet potato, and cassava.

This was also correlates to the study of Obidiegwu (2020) particularly mentioned that the evaluated starch composition of Dioscorea esculenta reported a range between 63.2% and 65.7%. Yam's potential as a source of food is attributed to its high levels of carbohydrates including fiber, starch, and sugar, contributing about 200 dietary calories per person per day to 300 million people in the tropics. In addition, lesser yam flour on a dry matter basis, it contains 79.54% carbohydrates, 6.50% crude protein, 1% fat, and 1.5% crude fiber as explained in the study of Putra (2020). It provides other nutritional benefits such as proteins, lipids, vitamins, and minerals.

Moreover, the presence of zinc in lesser yam is an essential mineral that plays a pivotal role in development of brain and bone and wound healing capacity. High potassium content in the body increases the iron utilization which is beneficial for controlling hypertension. This was close to the study of Padhan (2020), that the amount of potassium is beneficial for the diuretics people to control hypertension. The yam tubers are rich in dietary minerals and among all the minerals potassium is the abundant mineral present in the yam tubers.

The ash content of food determines the presence of important dietary minerals and are useful for the development of the body. The dietary fiber of food protects the beneficial microflora of the intestine, also reduces the threat of colon cancer and cardiovascular diseases. It is supported by the findings of the study of Otegbayo et al. (2018), that dietary fats contributed 1%–2% of the food calorific value which is sufficient for the diet. And the dietary fat or lipid content of yam has been reported to be higher than potato and sweet potato.

Different dietary vitamins help protein, fat, and carbohydrate in making energy and are available to the body. Vitamin C has multiple functions as radical scavenging activities, collagen synthesis, iron absorption, wound healing properties, and anti-inflammatory activities. In the article of Merrigan (2015), vitamins C and E are considered as antioxidant and act as cofactors for enzymes. The yam tubers contain different vitamins higher than other tuber crops.

Food and Security can only be achieved when all people have when needed; physical, social, and economics success to adequate, safe and nutritious food to satisfy their dietary needs and choices for an active and healthy life. The Food and Nutrition Security theory by Simelane and Worth (2020), as cited by Lingao, (2022) supported this study because all the nutrients required to nourish the body to develop, grow, resist diseases, and meet ordinary physiological demands.

Procedures in Producing Lesser Yam (Dioscorea esculenta) Flour

To perform the procedures with ease, the researcher had prepared and gathered Lesser Yam tubers; tools and equipment to process the tubers into Lesser Yam flour. After preparing and gathering all materials, the researcher followed the chronological order of procedures. In appendix E shown the procedures in producing lesser yam these include cleaning; washing; steaming; peeling grating; drying; pulverizing; sifting; and packing.

Lesser yam tubers were washed with running water, cleansed the tubers and removed the dirt, together with other harmful particles which may cause contamination. After washing, next procedure was steaming in medium heat for about 45 minutes.

Appendix E

Fig. 6.1. Cleaning & Washing

Fig. 6.2. Steaming

Fig. 6.3. Peeling

Fig. 6.4. Grating

Fig. 6.5. Drying

Fig. 6.6. Pulverizing

Fig. 6.7. Sifting

Fig. 6. 8. Packed Lesser Yam flour

According to the study of Yusuf (2022), tubers of the lesser yam were processed in the form of fresh tubers by boiling/steaming. Peeling is the process of removing the outer covering of the Lesser Yam tubers using a knife. After peeling the tubers, the next step was grating, making it into small particles and putting in a utility tray. This will ensure that the Lesser Yam tubers are easily and evenly dried. Then, the grated lesser yam was put in a dehydrator, or the tray was placed under the sun for 2 days or up, until the tubers are totally dried.

In the study of Setyawan (2021), the lesser yam is dried, either by oven or freeze drying, to lower the moisture content, which extends the shelf life of the product. After drying, it is removed from the tray, then, it was ready for pulverizing using the blender after that sifting to separate the big particles to small particles. After sifting the tubers, they were turned into a semi-fine, brown powder with a fragrant earthy aroma. The lesser yam flour was packed and stored in a clean sealed plastic bag to prolong its shelf-life.

Best Proportions in Making Lesser Yam (Dioscorea esculenta) Healthy Food Bar

To determine the best proportion, there was three various proportions prepared in making healthy food bar. Each proportion had different amount of lesser yam flour, while the other ingredients were constant. On the other hand, each proportion had different results in terms of color and consistency of the food bar.

The quantity of Lesser yam flour used for this experiment in three trials was indicated in the table. Formulation 1 contains one-half (1/2) cup of lesser yam flour, formulation 2 contains one cup (1) cup of lesser yam flour and formulation 3 contains one and one-half (1 1/2) cup of lesser yam flour. Figure 4 shows the flow chart containing the formulation of the ingredients, procedures and packaging applied in baking lesser yam healthy food bar.

As revealed by the chart, for the first formulation, one-half cup of lesser yam flour is combined with other ingredients for lesser yam healthy food bar, then followed by the step-by-step procedure in producing healthy food bar. The mixture is baked for 15 minutes until it is totally done. After baking, it is placed in a cooling tray and is sliced individually then weighed for 50 grams. It is then packed in a pastry pouch and placed in a cooling tray and is sliced individually then weighed for 50 grams. It is then packed in a pastry pouch and placed with a label on it. For the second formulation, the same ingredients and procedures was used, except for lesser yam flour with one (1) cup. The same ingredients and procedures are also used in the third formulation, except for lesser yam flour, which is only one and one half (1 ½) cup. All three proportions were formulated with the same procedures in making healthy food bar. For the second proportion, the same ingredients and procedures is used, except for lesser yam flour with one (1) cup. The same ingredients and procedures are also used in the third proportion, except for lesser yam flour, which is only one and one half (1 ½) cup. All three proportions were formulated with the same procedures in making healthy food bar.

Lesser Yam Healthy Food Bar

Proportion 1	Proportion 2	Proportion 3
½ cup Lesser yam flour ½ c Desiccated coconut ½ c Cacao chocolate powder ¾ c Rice Crisp 1 c Jaggery 1 c water 1 tbsp Butter 1 tbsp corn syrup 3/4 c Roasted crushed peanut	**1 cup Lesser yam flour** ½ c Desiccated coconut ½ c Cacao chocolate powder ¾ c Rice Crisp 2 c Jaggery 2 c water 1 tbsp Butter 1 tbsp corn syrup 3/4 c Roasted crushed peanut	**1 ½ cup Lesser yam flour** ½ c Desiccated coconut ½ c Cacao chocolate powder ¾ c Rice Crisp 2 ½ c Jaggery 2 ½ c water 1 tbsp Butter 1 tbsp corn syrup 3/4 c Roasted crushed peanut
PROCEDURE		
The first step is mis en place and prepare all the materials, tools and equipment needed. Preheat oven for 5 minutes at temperature 120°C. Prepare and measure all the ingredients according to the recipe. Next, in a non-stick pan, turn on the gas stove with low heat, melt the jaggery in water, sift the mixture then pour it to the pan and add the butter. Followed by combining all the remaining ingredients. Blend well through constant stirring and transfer into a rectangular pan with parchment paper. Oven for about 15 minutes at 120°C. Let it cool, slice and weigh for 50 grams. Lastly, seal in a pastry pouch, label then store.		
Packaging and Labeling		

Figure 4
Flow Chart of Experimentation in making Lesser Yam Healthy Food Bar with the Different Proportions of Ingredients

On Table 4, through the respondents and researcher's observation, Proportion 2 was the best proportion among the three because of the average weighted mean of 3.07 and the average amount of flour which was 1 cup of lesser yam flour to make it moderately soft and chewy. While in proportion 1 got 3.02 and proportion 3 got 2.74 weighted mean it was all interpreted as moderately acceptable. Primarily, this starch is very important in providing nutrients in our health.

Table 4

Best Proportions of Lesser Yam Healthy Food Bar

Respondents	Proportion 1			Proportion 2			Proportion 3		
	Wm	**Int.**	**Rank**	**Wm**	**Int.**	**Rank**	**Wm**	**Int.**	**Rank**
Teachers	3.26	HA	1	3.28	HA	1	2.84	MA	1
SHS-TVL Students	2.88	MA	4	3.10	MA	2	2.72	MA	3
Parents	3.00	MA	2	2.98	MA	3	2.82	MA	2
Children	2.94	MA	3	2.92	MA	4	2.58	MA	4
AWM	**3.02**			**3.07**			**2.74**		
Rank	**2**			**1**			**3**		

Legend: Int: Interpretation
Wm: Weighted mean

Range	**Interpretation**
3.26 – 4.00	Highly Acceptable (HA)
2.51 – 3.25	Moderately Acceptable (MA)
1.76 – 2.50	Less Acceptable (LA)
1.00 – 1.75	Least Acceptable (LsA)

Level of Acceptability of Lesser Yam Healthy Food Bar

The acceptability of the lesser yam healthy food bar and the summary of the results from the sensory evaluation of the respondents in terms of color, taste, aroma, texture, and appearance from Barangay Lupi, San Fernando, Camarines Sur, was shown in table 5. The acceptability level was rated and evaluated by the four groups of respondents. Respondents were composed of (10) teachers, (10) SHS students, (10) parents, and (10) children from Barangay Lupi, San Fernando, Camarines Sur.

Color. In this study, the color was the first sensory characteristics being noticed by the consumers. It particularly pertains to the outside look of the healthy

Table 5

The Acceptability Levels of Proportions in Sensory Characteristics

Quality	Proportion 1		Proportion 2		Proportion 3	
	WM	**Int**	**WM**	**Int**	**WM**	**Int**
Color	3.00	MA	3.40	HA	2.63	MA
Taste	2.65	MA	2.80	MA	2.20	LA
Aroma	3.08	MA	3.10	MA	2.95	MA
Texture	3.05	MA	2.90	MA	3.10	MA
Appearance	3.33	HA	3.15	MA	2.83	MA
Overall	**3.02**	**MA**	**3.07**	**MA**	**2.74**	**MA**
Rank	**2**		**1**		**3**	

Legend:

P1 – Proportion 1
P2 – Proportion 2
P3 – Proportion 3
WM – Weighted Mean
I - Interpretation

Range	Interpretation
3.26 - 4.00	Highly Acceptable (HA)
2.51 - 3.25	Moderately Acceptable (MA)
1.76 – 2.50	Less Acceptable (LA)
1.00 - 1.75	Least Acceptable (LsA)

food bar and can be used as a visual appeal to attract more consumers. The result revealed that in terms of color, proportion 2 or P2 got the highest level of acceptability with a weighted mean of 3.40 among the two (2) proportions, P1 yielded 3.00 and P3 with a rating of 2.63, P1 and P3 were moderately acceptable. This implies that dark brown color which was the color of lesser yam flour was preferred by the respondents. The result was the same to the study of lesser yam flour was preferred by the respondents. The result was the same to the study of Alano (2023) on the utilization of dragon fruit peel candy that color plays an essential factor in food's acceptability and palatability. Natural color of food product was preferred by consumers rather that synthetic colorant.

Taste. The taste of the lesser yam healthy food bar was unknown to the respondents, but the rating in terms of taste revealed that P2 has the highest weighted mean yielded 2.80 and P1 yielded 2.65 ratings, both of

which assessed as moderately acceptable. P3 got the lowest weighted mean of 2.20 rating interpreted as less acceptable. Based on the result, the taste of P2 and P1 have a sweet and bitter taste, interpreted as moderately acceptable by the respondents. On the other hand, P3 was less sweet and bitter and interpreted as less acceptable by the respondents. This implies that small amount of lesser yam flours has better taste, while the greater proportion of flour makes it less sweet. This means that the result was congruent to the study of Almen (2019) on utilization of "Lagkitan Banana an enrichment flour to make a snack item. The lagkitan banana flour served as the main ingredients to various kind of baked products and the ratio and proportion of Lagkitan Banana flour, wheat flour and ripe lagkitan banana can affect the taste of baked product. In terms of taste, the most preferred sample of banana cupcake was sample 2 with the equal proportion of banana flour and all-purpose flour.

Aroma. The sense of smell is the major contributing sensory system in the perception of food aromas and volatile flavors. In terms of aroma of lesser yam healthy food bar, based on the respondent's analysis, lesser yam healthy food bar has an aromatic smell due to dehydrated lesser yam flour and jaggery as a sweetener. The results showed that P2 got the highest rating of 3.10, P1 received a rating of 3.08 and P3 got a rating of 2.95. The aroma of all three proportions was interpreted as moderately acceptable. As stated in the study of Butke, et al. (2018), sensory acceptability among children and the physicochemical composition of pizzas that have different level of pumpkin skin flour. Five pizza formulations were developed with the addition of different levels of Pumpkin Skin Flour. The results notified that there were greater scores for F1 for the look and color attributes in comparison with F5. While F1, F2, and F3 formulations have superior scores in comparison with F5 regarding smell. The results concluded that an added level of 18 % of Pumkin Skin Flour in pizza improves aromatic odor, at the same time, was well accepted by children.

Texture. The texture is characterized by the mouth feel when consumers eat the product and can have strong influence on food intake and nutrition. The texture of cooked lesser yam healthy food bar was evaluated and rated. P3 got the highest weighted mean of 3.10, P1 got a rating of 3.05 and lastly P2 got the lowest rating of 2.90. The results show that P3 and P2 were smooth and interpreted as moderately acceptable, while P1 was nutty and crunchy and was interpreted as moderately acceptable by the respondents. Likewise, the study of Lomeda (2018), about the Acceptability on different proportions of Coco-squash peanut bar in terms of sensory evaluation indicated that among the different indicators, texture received moderately acceptable proportion of coco-squash peanut bar as compared to other samples. It was characterized with soft texture and pronounced peanuts taste that were most preferred by the respondents. On the other hand, texture in a healthy food bar plays an important role in the acceptability of food products and a key area which food manufacturers can successfully use to differentiate their products to help enhance their acceptability (Maina, 2018).

Appearance. In the presentation of the product, appearance was the most important because it sets its value. If the appearance of a food product was not appealing to the eyes, then, there was a big possibility that it would be rejected by the consumers. Based on the results gathered from the sensory evaluation of the three samples of respondents, P1 with the weighted mean of 3.33 in terms of appearance was highly attractive, meanwhile, P2 got a rating of 3.15 and P3 with the lowest weighted mean of 2.83.

In general, the results of the evaluation gathered from the three evaluators were evident based on the weighted mean of each proportion. Both P1 (3.02), P2 (3.07), and P3 (2.74) were moderately acceptable. But P2 got the highest weighted mean in the level of acceptability based on sensory evaluations among the three proportions. The results of evaluations show that there were differences in the level of acceptability of the different proportions used in producing lesser yam healthy food bar and lesser yam flour was effective and can be an alternative main ingredient in making healthy food bar.

Appendix J

Shelf -Life of Lesser Yam *(Dioscorea Esculenta)* Healthy Food Bar

	P1	P2	P3
Day 1-3			
Remarks	Constant shelf–life. Fit and safe for human consumption with quality in terms of sensory attributes.		
Day 4			
Remarks	P1 were slightly moist. P2 and P3 has already few spots of molds.		

Day 5-6			
Remarks	Increased molds in all three proportions on the 5th and 6th day and on the next succeeding days. P3 contains many molds due to the high amount of moisture. Lesser yam flour helps in preserving the shelf life of the finished product because of less moisture and adds hardness to the healthy food bar.		

Shelf-life is essential to determine the shelf-life of every product to ensure food safety, maintaining quality, minimizing waste, and meeting consumer satisfaction especially when the product is for commercial purpose for the consumers to be aware of the expiration date. Since, the study was innovating new recipes from lesser yam flour, the researcher discovered the shelf-life through ocular observation everyday using different senses and recorded the changes that occurred.

Based on observation, the shelf-life of lesser yam healthy food bar shown in appendix J in room temperature lasted for 4 days. Three different proportions of Lesser yam healthy food bar recipe are developed. The findings show that in P1, the qualities remain the same until 4th day where no observable changes (NOC). On the 5th day, the color texture and appearance have few of moisture precipitates (FMP). Changes occurred on the 6th day with the presence of molds (PM) developed. While P2, on the 3rd day has no observable changes. On the 4th day had few moisture precipitates, on 5th day with presence of molds, day 6th day were plenty of molds appeared In P3, 2nd day no observable changes, 3rd day has few moisture precipitates, day 4th to 5th few of molds have been developed. On 6th day the color, texture and appearance have changed with plenty of molds.

As to the result of shelf-life of lesser yam healthy food bar in room temperature, among the three proportions, P1 has longer shelf-life than of the two remaining proportions because P1 was harder, less of lesser yam flour and less water content, while P2 and P3 have shorter shelf-life because of more lesser yam flour and water content and the texture was soft and smooth that have already evidence of the growth of molds. On the 6th day, molds increased in all proportions, and it indicated that the lesser yam healthy food bar is already unsafe for consumption.

Economic Desirability of the Lesser Yam *(Dioscorea esculenta*) Healthy Food Bar

The economic desirability of lesser yam healthy food bar could provide a significant source of income for farmers in the community. It can also contribute to the local economy by providing jobs and supporting other businesses and entrepreneurs.

To determine the overall economic desirability of the healthy food bar with different proportions of Lesser Yam flour, the researcher summarized and interpreted the data from the questionnaires which were answered by the respondents/evaluators. The subsequent table below contains the summarized data of the overall economic desirability of the outputs after the organoleptic evaluations conducted to the respondents.

These results were congruent to the findings of the study of Nurhartadi (2018) on the effect of taro and lesser yam flour on frozen wheygurt chemical and sensory characteristics. Lesser yam starch has low peak gelatinization viscosity, thus making ice cream melt in an ideal time range. In this study, taro and lesser yam flour were combined to find the best chemical and sensory characteristics of frozen wheygurt. Lesser yam (Dioscorea esculenta) has the potential to be used as a thickener because of their high content (about 51.34-70.92%), and a similar ratio of amylopectin and amylose (lesser yam 24.30: 75.7).

The present study is anchored to the Innovation Theory which was introduced by Schumpeter strengthened by Tóth (2020). This theory is related to the creation of quality food products, and the introduction of a new method of production. The young entrepreneurs can adopt and developed new products from local materials to promote food security and sustainability. Innovations in the agri-food sector found space in the international market emphasizing the opportunity to improve the ability of the agri-food companies to move from a traditional production sector focused on raw materials, like lesser yam root crop as the main ingredient in making a new product, the lesser yam healthy food bar.

Conclusions

Lesser yam contains essential ingredients that nourish the body to become healthy. Thus, consuming Lesser Yam healthy food bar would help in improving one's health, avoid diseases and satisfy dietary needs and choices for an active and healthy life. In addition, there were specific procedures to be followed in the production of lesser yam flour. Following the procedures correctly would save time and effort and ensure quality product of Lesser Yam flour. Aso, the best proportion of lesser yam healthy food bar, using lesser yam flour as an alternative main ingredient was Proportion 2 with 1 cup of lesser yam flour due to the average amount of lesser yam flour, cocoa powder and jaggery as sweetener it makes the healthy food bar soft, chewy,

and aromatic. Across the three proportions, Proportion 2 got the highest weighted mean and most acceptable to the respondents. Proportions 1 and 3 were moderately acceptable to the respondents. Moreover, all three proportions found that Proportion 1 was safe to consume up to 4 days, while Proportion 2 was safe up to 3 days, and Proportion 3 was safe for 2 days for human consumption. Changes were occurred after five to six days, molds increased in all proportions, and it indicated that the lesser yam healthy food bar is already unsafe for human consumption. Lastly, it can be inferred that the utilization of lesser yam flour in the recipe was useful to the consumers for eating this innovative recipe because it provides healthy and nutritious snacks that can boost energy, and it aids to the malnutrition of the younger individuals. Researcher used lesser yam as the raw materials in producing healthy food bar because it presents sustainable solution to the rice shortage for families as well as to the agricultural production to satisfy market demand and increase sales to the market. Entrepreneurs can utilize lesser yam flour as alternative ingredients in baked products to help small scale business, gain more profit and augment extra income to their families as well as to the community.

Recommendations

The study recommends a complete microbial analysis and phytochemical composition testing of lesser yam to determine the vitamins and minerals content or nutritive value, per serving of the lesser yam based on the determined highly acceptable proportion. Also, explore other specific sources of nutritive value of lesser yam and compare it with other nutritive value and benefits of lesser yam using any method of cooking. Then, the procedures given must be followed properly to avoid spoilage of raw materials and to achieve the desired quality. Additionally, dehydration of lesser yam using dehydrator can be used as an alternative way to save time and effort than sun-drying. The lesser yam can be dried using dehydrator maintain its aromatic smell and to prolong its shelf-life. On the other hand, sun-drying of lesser yam under the heat of the sun can be an alternative way of drying if electricity is unavailable. Furthermore, the absence of jaggery in the healthy food bar that acts as a binder hinders the ingredients together and cannot hold its shape. Future researchers can add or modify other ingredients that would improve the consistency of the lesser yam healthy food bar mixture. All proportions were found moderately acceptable to the respondents. Continuous research and development of this study was highly recommended to provide a highly acceptable result. Other researchers can utilize the finished product and used in different recipes to make it more palatable and commercially profitable. Continuous research and development of this study on the shelf-life is recommended to provide a highly acceptable result in terms of shelf-life of the product. To avoid spoilage and extend the shelf-life of the healthy food bar the researcher suggests putting it in the fridge to prolong the shelf-life. The researcher also suggested to use Lesser Yam flour in other bakery products to improve the level of its economic desirability and conduct feasibility study for commercialization of the product in the market.

Acknowledgment

The research is thanking the teachers and senior high school students of Lupi National High School and the children and parents from Lupi, San Fernando, Camarines Sur for their cooperation being the respondents of the study. Similarly, she is thankful to the school principal for the permission granted to her to undertake the study.

References

Adebisi, O. A. & Okieimen, F. E. (2015). Nutritional, functional, and pasting properties of lesser yam (Dioscorea esculenta) flour. Journal of food science and technology, 52(7), 4040-4048.

Alano, Rizza S.B. (2023). "Dragon Fruit Peel Candy: A Source of Income". Unpublished Master's Thesis, Naga College Foundation, Naga City.

Almen, Marichu L. (2019), "Lagkitan Banana (Musa Sapientum) Cupcake" Unpublished Master's Thesis, Bicol University Graduate school, Legazpi City.

Altea (2018) "Packing Disaster/Emergency Foods with needed Nutritional Value "Retrieved from https://www.dost.gov.ph/knowledge-resources/news/342014news/91-dost-cooks-up-a-pack-of-hope-for-hungry-disaster-voctims.html (September 2023).

Amoriello, T., Mellara, F. Galli, V., Amoriello, M. & Ciccoritti, R. (2020). Technological properties and consumer acceptability of bakery products enriched with brewers' spent grains. Foods, 9(10), 1492.

Angeles, Melissa B. (2018). Siling Labuyo (Capsicum Frutescence)- Flavored Cakes and Cookies. Unpublished Master's Thesis, Naga College Foundation, Naga City.

Ansari, H. Ansari, E. Gupta, M. & Valecha, S. (2021). Preparation of energy bar using figs and dates and analysis of its nutritional status. International Journal of Applied Chemical and Biological Sciences, 2(2), 54-62.

Asiamah, E. Buckman, E. S. Peget, F. Akonor, P.T. Padi, A. Boateng, C. & Affrifah, N. S. (2022). Effect of xanthan gum and carboxymethyl cellulose on structure, functional and sensorial properties of yam balls. Heliyon, 8(10).Ayuningtyas, L. P. Benita, A.M. & Triastuti, D. (2021, April). Functional properties of hydrothermally modified lesser yam (Dioscorea esculenta) starch. In IOP Conference Series: Earth and Environmental Science (Vol. 746, No. 1, p. 012007). IOP Publishing.

Ayuningtyas, L., Benita, A.M. & Triastuti, D. (2021, April). Functional properties of hydrothermally modified lesser yam (Dioscorea esculenta) starch. In IOP Conference Series: Earth and Environmental Science (Vol. 746, No. 1, p. 012007). IOP Publishing.

Backian, G. S. Gayao, B. T. & Meldoz, D.T. (2022). Lesser Yam (Dioscorea esculenta) Grown and Knowledge Transfer Among Indigenous People in Northern Philippines. Mountain Journal of Science and Interdisciplinary Research (formerly Benguet State University Research Journal), 82(2), 21-32.

Bantog, April Joy A. (2015), "Tiessa-Pili Ice Cream". Unpublished Master's Thesis, Bicol University Graduate school, Legazpi City.

Barrameda, Ma. Cristina B. (2022). "RTE Energy Bar", Unpublished Master's Thesis. Bicol State College of Applied Sciences and Technology (BISCAST), Naga City.

Bazzano, A. N., Potts, K. S., Bazzano, L. A. & Mason, J. B. (2017). The life course implications of ready to use therapeutic food for children in low-income countries. International Journal of Environmental Research and Public Health, 14(4), 403.

Beatriz, Myla L. (2019). Cocus Nucifera Cupcake: Insights and Implications for a Healthier and Happier Mother Earth, Unpublished Master's Thesis, Naga College Foundation, Naga City.

Beltran, Grace A. (2020)." Pili Pulp Taco Energy Bar". Unpublished Master's Thesis. Bicol State College of Applied Sciences and Technology (BISCAST), Naga City.

Burce, Cherry B. (2016). Black plum seed as main ingredients for coffee, Unpublished Master's Thesis, Naga College Foundation, Naga City.

Butke, W. Romeiro, M. Aparecida, L. F., Santos, Do & Novello, D. (2018). The addition of pumpkin skin flour in pizza changes the physicochemical and sensory acceptability of children. International Journal of Development Research, 8(07), 21409-21415.

Byamukama, J. (2019). Nutritional composition and sensory acceptability of wheat bread supplemented with soybean flour, maize bran, and maize germ (Doctoral dissertation, Makerere University).

Castro, Cyrell S. (2019). Innovative Recipes from Squash (Cucurbita Maxima Duchesne) For A Home-School Income-Generating Project. Unpublished Master's Thesis, Naga College Foundation, Naga City.

Chandrasekara A. & Kumar, Josheph T. (2016). Roots and tuber crops as functional foods: A review on phytochemical constituents and their potential health benefits. International Journal of Food Science, 2016. https://doi.org/10.1155/2016/3631647.

Cheng, Y. L. Lee, C. Y. Huang, Y. L. Buckner, C. A. Lafrenie, R. M. Dénommée, J. A. Bee, P.C. (2016). We are IntechOpen , the world ' s leading publisher of Open Access books Built by scientists , for scientists TOP 1 %. Intech, 11(tourism), 13 .https://www.intechopen.com/books/advanced-biometric-technologies/liveness-detection-in-biometrics.

Coldas, Agrix M. (2023). "Krill (Eupausiacea) Cracker: An Alternative Snacks for all Ages". Unpublished, Master's Thesis, Naga College Foundation, Naga City.

Darkwa, K. Agre, P. Asibe, F. Edemodu, A. Bauchet, G. Asiedu, R. & Asfaw, A. (2019). Phenotypic and molecular assessment of genetic structure and diversity in a panel of winged yam (Dioscorea esculenta) clones and cultivars. Scientific reports, 9(1), 18221.

Dela Trinidad, Mary Grace (2018) "Squaringo Heath Bar (Unpublished Master's Thesis, Bicol State College of Applied Sciences and Technology (BISCAST), Naga City.

Emelia, Oana et.al (2019), "Functional Properties of Snack Bars, Retrieve from https://www.intechopen.com/chapters/63677.

Fadhlan, A., Nurminah, M., & Karo-Karo, T. (2021). Characteristics of food bar from composite flour (modified breadfruit, purple sweet potato, mocaf, and saga seeds). IOP Conference Series: Earth and Environmental Science, 782(3), 8–14. https://doi.org/10.1088/1755-1315/782/3/032081.

Formalejo, Cheryll M. (2022). "High Energy Cookie", Unpublished Master's Thesis. Bicol State College of Applied Sciences and Technology (BISCAST), Naga City. from https://2040.neda.gov.ph/about-ambisyon-natin-2040, (Retrieved.

Goal 2: Zero Hunger (Retrieved 2023). Sustainable Development Goals.https://unstats.un.org/sdgs/report/2023/Goal-02/.

Gumanit, Gilbert (2019) "Production of Fish-Malungay (Moringa Oleifera) Kropek." Ascendens Asia Journal of Multidisciplinary Research Abstracts 3.2N.

Gyimah, Aja MHsc, the 12 Best Energy Bars of 2020, According to Nutritionists, Retrievedfromhttps://www.womenshealthmag.com/food/g34275690/bestenergy-bars/.

Hade, Janine N. (2023). "Eggplant (Solanum Melongena): An Alternative Main Ingredient in Producing Pasta Noodles". Unpublished, Master's Thesis, Naga College Foundation, Naga City.

Handayani, M. N. Cakrawati, D. & Handayani, S. (2016, April). Effect of modified yam (Dioscorea esculenta) flour on some physicochemical and sensory properties of symbiotic yoghurt. In IOP Conference Series: Materials Science and Engineering (Vol. 128, No. 1, p. 012035). IOP Publishing.

Hasan, N. W. & Putri, T.P. (2020, April). Preparation of cookies from banana flour, soy flour, and Moringa leaf flour as an emergency food product. In IOP Conference Series: Earth and Environmental Science (Vol. 486, No. 1, p. 012059). IOP Publishing.

Karam, M.C., Petit, J.D., Zimmer, E.B. Djantou & Scher, J. (2016). Effects of drying and grinding in production of fruit and vegetable powders: A review. Journal of Food Engineering, 188, 32-49.

Ladamay, N. A. and Yuwono, S. S. (2014). The use local material in the production food bars (Study of tapioca: green bean flour ratio and CMC proportion) J. Food and Agroindustry 2 pp 67-78.

Lalugan, Elizabeth B. (2016)." Indian Mango (Magngifera Indica) Wine". Unpublished Master's Thesis. Bicol State College of Applied Sciences and Technology (BISCAST), Naga City.

Lomeda, Michelle M. (2018), "Development and Characteristics of Coco-Squash Peanut Bar". Unpublished Master's Thesis, Bicol University Graduate school, Legazpi City.

Maina, J. W. (2018). Analysis of the factors that determine food acceptability. The Pharma Innovation, 7(5, Part D), 253.McLeod, Saul (2019). Likert Scale Definition, Examples, and Analysis. Simply Psychology. https://www.simplypsychology.org/likert-scale.html.

Merrigan, K. Griffin, T. Wilde, P. Robien, K. Goldberg, J. & Dietz, W. (2015). Designing a sustainable diet. Science, 350(6257), 165-166.

Miranda, C.T. Corales, V. T. & V. T. Acebedo, V. T. (2015). Collection and Cultivation of Organic Root Crops in Support to Organic Agriculture Philippines. Kjna.Ubru.Ac.Th,14 (02),36–39. http://kjna.ubru.ac.th/j_files/document/JUR100017.

National Economic Development Authority "Ambisyon Natin 2040, "Retrieved from https://2040.neda.gov.ph/about-ambisyon-natin-2040, (Retrieved 2023).

Navle, S. A. Swami, S. B. & Thakor, N. J. (2016). Effect of flour composition (arrowroot, lesser yam, and potato) on its nutritional and functional properties. Journal of Root Crops, 42(1), 61-73.

Nurhartadi, E. Utami, R. E. Widowati, B. M. Karunawati, (2018, January). IOP Conference Series. Earth and Environmental Science; Bristol Vol. 102, Iss. 1, DOI:10.1088/1755-1315/102/1/012061.

Obidiegwu, J. E. Lyons, J. B. & Chilaka, C. A. (2020). The Dioscorea Genus (Yam) - An appraisal of nutritional and therapeutic potentials. Foods, 9(9), 1304.

Okoro, B.O. & Ajieh, P.C. (2014). Farmers' perception and adoption of yam minisett technology in Anambra State. International Journal of Agricultural Science, Research and Technology in Extension and Education Systems (IJASRT in EES), 4(4), 211-214.

Ononogbo, C., Nwakuba, N.R., Nwaji, G.N., Nwufo, O.C., Nwosu, E.C, Okoronkwo, C.A. & Anyanwu, E.E. (2022). Thermal efficiency and drying behavior of yam slices in a dryer driven by the waste heat of exhaust gases. Scientific African, 17, e01310.

Onwuamaeze, N. P. Hedwig, A. & Dorothy, N. (2017). Acceptability, Nutritional Quality and Contribution of Vegetable-Enriched Products to Nutrient and Energy Requirements of School Children Aged 5 to 13 Years. Food and Nutrition Sciences, 8(02), 242.

Otegbayo, B.O. (2018). State of Knowledge Report on Fresh Yam and Pounded Yam-WP2. p RTBfoods Project Report. Iwo (Nigeria). [Google Scholar], 29.

Padhan, B. & Panda, D. (2020). Potential of Neglected and Underutilized Yams (Dioscorea spp.) for Improving Nutritional Security and Health Benefits. Frontiers in Pharmacology, (April), 1–13. https://doi.org/10.3389/fphar.2020.00496.

Parekh, et al. (2014). Quality Evaluation of Mango Bar with Fortified Desiccated Coconut Powder during Storage. Retrieved from https://www.researchgate.net/publication/332670587_Quality_Evaluation_of_ Mango_ Bar_ with_ Fortified_ Desiccated_ Coconut_ Powder_ during_ Storage. November 12, 2020.

Prisukhina, N.et al. (2019). Development of energy bars formulae for athletes, based on the essential nutrients balance. Retrieved from https://iopscience.iop.org/article/10.1088/1755-1315/548/8/08/2019/pdf.January 15, 2022.

Putra, A. Y. T., Susiloningsih, E. K. B., Susanti, M. A. (2020, July) Journal of Physics: Conference Series; Bristol Vol. 1569, Iss. 3, DOI:10.1088/1742-6596/1569/3/032013.

Ransilu, P. Y. Mahanama, H. A. H. M. Pitipanaarachchi, R. Binduhewa, A. M. C. U. MGDS, P. Jayawardhana, D. & Hewajulige, I. G. N. (2019). Product development and quality assessment of Pearl Millet based high calorie biscuit.

Robinson, E. L. Ashida, S. Gay, J. Slagel, L. E. & M. R. Ramirez (2017). Personal disaster and emergency support networks of older adults in a rural community: changes after participation in a preparedness program. Disaster medicine and public health preparedness, 11(1), 110-119.

Sarte, Dexter C. (2016). Food products from the banana pith (Musaceae Zingiberales), Unpublished Master's Thesis, Bicol State College of Applied Sciences and Technology (BISCAST), Naga City.

Setyawan, N. Maninang, J. S. Suzuki, S. & Fujii, Y. (2021). Variation in the Physical and Functional Properties of Yam (Dioscorea spp.) Flour Produced by Different Processing Techniques. Foods, 10(6), 1341. MDPI AG. Retrieved from http://dx.doi.org/10.3390/foods10061341.

Simelane, K. S. & Worth, S. (2020). Food and nutrition security theory. Food and Nutrition Bulletin, 41(3), 367-379.

Soverano, John Rey SR. (2016) Lubas (Spondias Pinnata) Wine (Unpublished Master's Thesis, Bicol State College of Applied Sciences and Technology (BISCAST), Naga City.

Taylor & Francis, Duan, L. Duan, X. & Ren, G. (2019). Structural characteristics and texture during the microwave freeze drying process of Chinese yam chips. Drying Technology.Teye, G. A., Ossom, R. N., Adzitey, F., Abu, A & Amagloh, F. K, (2020). Sensory and nutritional qualities of beef sausages prepared with sweet potato puree as extender. Nigerian Journal of Animal Science, 22(1), 338-348.

Tóth, J. Migliore, G. Balogh, J. M. & Rizzo, G. (2020). Exploring innovation adoption behavior for sustainable development: The case of Hungarian food sector. Agronomy, 10(4). https://doi.org/10.3390/agronomy10040612.

Wahab, B. A. Adebowale, A. R. A. Sanni, S. A. Sobukola, O.P. Obadina, A. O. Kajihausa, O. E. & Tomlins, K. (2016). Effect of species, pretreatments, and drying methods on the functional and pasting properties of high-quality yam flour. Food Science & Nutrition, 4(1), 50-58.

Williams, A. A. (2016). Food acceptability. In: Piggott, J.R., Paterson, A. (eds) Understanding Natural flavors. Springer, Boston, MA. https://doi/org/10.1007/978-1-4615-2143-3_3.

Winarti,Sri & Erwan, Adi & Saputro (2016). "Physicochemical and Organoleptic Properties of Dried Synbiotics Yoghurt from Lesser Yam (Dioscorea Esculenta) Tubers MATEC Web of Conferences; Les Ulis, Vol. 58, DOI:10.1051/matecconf/20165801020.

Yee, Low Pinn & Wan, Chan Sook (2017). Application of red dragon fruit powder as a natural food colorant in fruit pastille. Https//rb.gy/afdo1.

Yusuf, M., Abdullah, & Usman. (2022, Dec). IOP Conference Series. Earth and Environmental Science; Bristol Vol. 1107, Iss. 1: 012032. DOI:10.1088/1755-1315/1107/1/012032.