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Development of full-fatted soybean-based food products as meat alternatives

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Key words: Full-fatted soybean, Meat alternatives, Nutritional properties

Abstract

It was emphasized in the research and development initiative of the Department of Agriculture that soybean is one of the most versatile high-value crops that can help solve the chronic problems of hunger and malnutrition. The Department of Agriculture plans to expand soybean production in the Philippines. The Road Map aims to establish knowledge-based and farmer-friendly research facilities for soybean production and its development in the strategic areas in the country. A study on consumer behavior towards soybean-based products was conducted followed by the development of three soybean-based products as a meat alternative including Soybean-based Burger Patty, Soybean-based Sweet Longanisa, and Soybean-based Nuggets. Sensory evaluation among consumer panelists was done to evaluate the characteristics of soybean-based meat alternative products as to color, mouthfeel, taste, texture, and overall acceptability. The most acceptable formulation of each of the meat alternatives was subjected to nutrient analysis, cost analysis, and shelf-life testing. Regardless of their socio-demographic background, most of the respondents indicated their willingness to purchase soybean-based products when available in the market. Psychological, sensory, and marketing factors highly affect the respondent's preference and purchase of soybean-based meat alternatives. Fifty untrained panels using a complete block randomized sampling technique were invited to evaluate the samples. Results showed that the most acceptable formulation of the Full-fatted Soybean-based Burger Patty and Longganisa were rated liked moderately, and the Full-fatted Soybean-based Nuggets were rated like very much in terms of overall acceptability, color, mouthfeel, taste, and texture. The formulated soybean-based products have considerable amounts of nutrients particularly protein, sodium, potassium, and calcium. The shelf-life analysis for a 6-point rejection level to the overall acceptability of the products showed a shelf life of 8 weeks. The resulting cost analysis shows that the estimated selling price range is still lower compared to other similar commercially available products on the market. The soybean-based nuggets had the biggest price advantage as it is almost half of the average meat-based commercial product. Training and a technology transfer were conducted on processing full-fatted soybean-based food products.

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Introduction

Soybean (*Glycine max*) is a nutritious food and is a crop of global importance. Soybean has a wide range of geographical adaptations, unique chemical composition, good nutritional value, and functional health benefits (Singh, 2010). It is an exceptional source of essential nutrients needed by the body (Dolojan *et al.*, 2015). It is a good source of energy, carbohydrate, fiber, and unsaturated fat. It contains a protein that is necessary for the growth and maintenance of cells and tissues, carbohydrates that provide energy, minimum saturated fats that may help prevent cardiovascular diseases, phytochemicals that prevent cancer, and vitamins and minerals that boost overall health promotion. Consumers are increasingly aware of the healthfulness of soy-based foods. It has become an important commodity. Going green is rapidly being acknowledged as a favorable competitive strategy in the hospitality sector, notably on the supply side of the tourism industry, which is seeking to incorporate sustainable practices (Baluyot, 2024).

The consumption of vegetable proteins in food products has been increasing over the years because of animal diseases, the global shortage of animal protein, strong demand for wholesome and religious (halal) food, and economic reasons. A meat-based diet requires a significantly greater amount of environmental resources per calorie compared to a more grain-based diet i.e. 2 to 15 kg of plant foods are needed to produce 1 kg of meat. Developing new food products that are attractive to consumers is a challenge. However, it is even more complex when these new foods are meant as a substitute for products that are highly appreciated and accepted, like meat. This challenge was accepted to develop new sustainable meat substitutes to reduce the negative environmental impact of industrial-scale meat production for human consumption. Happily, there is an increasing importance of legume and oilseed proteins in the manufacturing of various functional food products due to their high-protein contents. However, the greatest obstacle to utilizing these legumes and oilseeds is the presence of anti-nutrients, though these can be successfully removed or inactivated by employing certain processing methods. Legumes and oilseeds provide well-balanced amino acid profiles when consumed with cereals.

Soybean proteins, wheat gluten, cottonseed proteins, and other plant proteins have been used for the preparation of meat alternatives successfully. Texturized vegetable proteins can substitute meat products while providing an economical, functional, and high-protein food ingredient or can be consumed directly as a meat alternative.

This project provides an alternative nutritious meal alternative as well to promote a healthy lifestyle to the consumers. The developed Full-fatted Soybean-based Food products technology was also transferred to the adopted community, the Kibungan Employees Multipurpose Cooperative (KEMPC), Poblacion, Kibungan, and Benguet to provide additional income at the same time to introduce a nutritious meat alternative.

The average worldwide yield for soybean crops, in 2010, was 2.5 tons per hectare. The three largest producers had an average nationwide soybean crop yield of about 3 tons per hectare. The most productive soybean farms in the world in 2010 were in Turkey, with a nationwide average farm yield of 3.7 tons per hectare. The world record for soybean yield is 10.8 tons per hectare, demonstrated in 2010 by Kip Cullers, a farmer in Purdy, Missouri. Total commercial production of soybeans in 2010 was 261.6 million metric tons (Mmt) worldwide, harvested from 102.4 million hectares (which comprises around 2% of the planet's agricultural land). The U.S. was the leading producer of soybeans, producing just over one-third of the world's total.

Local soybean production is very small. Almost all available soybeans are imported. The main sources are the USA, Brazil, and Argentina. Since the mid-90s when the yearly supply exceeded 100,000 tons, most of the soybeans are destined for oil extraction.

The drop-in volume in the past three years may be due to the slowdown in this industry. The volume of soybean for direct usage, whether for feed or food, is probably less than 100,000 tons per year. The food soybeans are sourced mostly from Canada and China. Around 11,500 tons per year are imported from Canada, as reported by the Canadian Soybean Exporters' Association for 2006-2008.

Soybean areas have remained less than a thousand hectares since the late 90s. The larger areas planted in the past can be attributed to the aggressive promotion by both the public and private sectors. At present, though, most of the production areas are found only in the two municipalities of Surigao del Sur: Tago and San Miguel.

Dolojon (2015) cited in his study on the development of soybean butterscotch that soybean (*Glycine max*), also called the soybean in Europe is a legume species native to East Asia that including the Philippines. It is known as an exceptional source of essential nutrients needed by the body. It can be eaten either raw or processed. Fermented soy foods include soy sauce, bean paste, natto, tempeh, and others. Traditional non-fermented food uses of soybeans include soymilk which tofu and tofu skin are made which are highly perishable. Philippine soybean blog spot 2017 reported that the production trend of soybean is now the world's most important legume crop and the sixth of all cultivated crops in terms of total harvest and the most widely produced oilseed grown in diverse climates worldwide. The Food and Agriculture Organization (FAO) classified it as an oilseed rather than a pulse. The United States, Argentina, Brazil, China, and India are the world's largest soybean producers and represent more than 90% of global soybean production.

The Cagayan Valley Organic Soybean Development Program in Support of Food and Nutrition Security in the Philippines created an awareness of the importance of soybeans for humans, livestock, and soil health in the valley through soybean production, food utilization, and processing in the uplands and highland farming communities. Further, soybean is beneficial as an intercrop and rotating crop for rice. It also lowers dependence on potential disease-causing and expensive animal-based protein foods resulting in improved household health and nutrition. Notably, farming households and young children were evidenced as already having learned to consume soybeans for reasons for a healthy food lifestyle (Aquino, 2014).

Hoek (2011) proved in his study on the replacement of meat with meat substitutes that consumer acceptance was largely determined by attitudes and beliefs towards meat substitutes and food neophobia. Key barriers for non-users and light/medium-users were the unfamiliarity with meat substitutes and the lower sensory attractiveness compared to meat. The first development with soy meat substitutes failed because it was not able to meet the sensory expectation of consumers. The soy flavor dominated. The goal of the meat alternative is to mimic the taste and consistency of animal meat.

The Philippine Soybean Roadmap 2010-2014 crafted by the Department of Agriculture entitled: “Building Sustainable Soybean Industry in the Philippines” aims to build a strong soybean production industry that is community-based, and sustainable and to establish a viable product processing industry through public-private partnership was evident to sustain soybean product development.

It was further emphasized in the research and development initiative of the Department of Agriculture in 2010 that the soybean is one of the most versatile high-value crops that can help solve the chronic problems of hunger and malnutrition. Also, as mentioned by Director Dante S. De Lima of the High-Value Crop Development Program, soybean is a legume that is a short-term, sun-loving crop that has a great potential to adapt to its extreme climate and at the same time be a source of healthy and nutritious food for the future. The Department of Agriculture plans to expand soybean production in the Philippines. The Road Map aims to establish

knowledge-based and farmer-friendly research facilities for soybean production and its development in the strategic production areas in the country. Support infrastructure and an incentive system are available that empower small farming communities to become productive units of soybeans and strong partnerships with the private sector in the processing and marketing of soy-based products in the local and international markets.

Consumers are increasingly aware of the healthfulness of soy-based foods they consume and consider such a health attribute when making soy food purchasing decisions (United Soybean Board, 2007). Consumer demand for meat alternatives has grown over the last years as customers have been on a journey of realization concerning how their lifestyle picks and purchases affect our planet. An elevated number of customers are switching to plant-based diets for plenty of reasons, including shielding animals, preserving the environment, fashionable health concerns, or changing flavor preferences. As more purchasers seek these options, the market for plant-based proteins is rapidly developing and extending past North America and to assets past soy and wheat protein. The global market for non-soy, gluten-loose plant-based total proteins is projected to be $1. five billion via 2022. As a result, manufacturers are searching for plant-based total proteins that offer functional, sustainable, and dietary attributes, including non-GMO and certified organic options. (forbes.com, 2019).

A study published in "the American Journal of Clinical Nutrition" in 2005 reported that people who obtained approximately 30 percent of their daily calories from low-fat, protein-rich sources ate fewer calories overall, felt more full, and successfully lost weight soybean is a staple food with a very high protein food, at 36.49 grams per 3.5 ounces, they do contain a notable amount of dietary fats.

While soybeans are by no means a high-fat food, at 9 grams per 3.5 ounces, they do contain a notable amount of dietary fat. However, these facts are primarily the "good" kind; in a single serving, you'll take in 2 grams of monounsaturated fat and 5 grams of polyunsaturated fat. The American Heart Association recommends that the majority of the fats we eat be mono and polyunsaturated. Just over 1 gram of soybeans' total fat is the saturated variety which has been linked to heart disease.

Moisture in foods occurs in two forms: the water bound to ingredients in the foods (proteins, salt, sugars), and free or unbound water that is available. Water activity (Aw) describes the water available for microbial growth. Water activity is a measure of how efficiently the water present can take part in a chemical reaction. The overall water activity would be reduced if half of the water is so tightly bound to a protein molecule that it could not take part in a hydrolysis reaction (Sandulachi, 2012). The water activity measurement provides important information regarding the possibility of microbiological growth on the surface. Free water in food products is responsible for the growth of undesirable organisms such as bacteria or fungi, which produce toxins or other harmful substances. Water activity ranges from 0 (bone dry) to 1.0 (pure water). When the water activity is smaller than 0.9, most molds are inhibited. Most microorganisms cease growing if water activity is smaller than 0.6. As such, the reduction of water activity will retard the growth of microorganisms, non-enzymatic browning, and enzymatic reactions (Kasai, 2014). Water could be controlled by processes such as removing water (drying or freezing), and by adding salt (curing).

The nutrients protein, fat, and carbohydrates are the macronutrients that the body needs in larger amounts to function properly. All of these nutrients provide the body with energy measured in the form of calories or kilocalories. Aside from providing energy, all of these macronutrients have specific roles in the body to function properly. Protein is a body-building nutrient that is necessary for the body to grow, build and repair tissues. Carbohydrates are hydrolyzed into glucose as the main source of energy for the body yielding 4 kcal/gram. Specific organs such as the

brain need glucose as the sole source of energy. Fat is the concentrated source of energy providing 9 kcal/gram. Fat is the storage form of energy. It also cushions the vital organs, a precursor for the synthesis of certain hormones, and helps maintain cell membrane integrity. However, excessive intake of fat specifically saturated and trans fats are known to increase the risk for cardiovascular diseases. Saturated fats come from animal sources while trans-fat comes from margarine, baked, and fried foods. It is the objective of this study to develop soybean-based food products as meat alternatives with lower amounts of fat, particularly saturated fat.

The mineral sodium is of interest in a diet. It is the major cation in the extracellular fluid that maintains fluid and acid-base balance but an excessive intake of this accumulates in the extracellular fluid resulting in edema. Excess intake of sodium can raise blood pressure or hypertension, a major risk factor for heart disease. Calcium is another major mineral essential for human nutrition. The body needs calcium to maintain strong bones and carry out vital processes such as muscular contraction, blood coagulation, nerve transmission, and enzyme activation. On the other hand, potassium is the principal cation in intracellular fluids. It maintains fluid and electrolyte balance. It is also important for carbohydrate and protein metabolism. Iron is the only micromineral analyzed in this study. Iron is the most abundant trace element in the body. One of the most important functions of iron is in hemoglobin formation, a component of the red blood cells, the carrier of oxygen needed for cellular respiration (Ruiz and Claudio, 2010). Iron-deficiency anemia (IDA) is the most prevalent micronutrient deficiency affecting a large proportion of the population in the Philippines (Palanog *et al.*, 2019)**.**

Grinding involves cutting food using tools or devices. The ancient tools used for grinding food which are still in vogue are mortar and pestle and the grinding stone. A mortar is a stone cup while a pestle is an oval-to-cylindrical shaped stone that is used to pound food. This technique is used for grinding small to medium quantities of food. The food is pounded using a pounding stone or a pounding stick. This practice is still in vogue in India, Pakistan, and a few oriental cultures. Modern-day methods of grinding employ devices such as a mixer, blender, food processor, and an electrical grinder. Grinding can be of two types-dry grinding and wet grinding. Dry grinding is where ingredients containing no moisture are ground with the help of grinding tools or devices.

Grinding is a method of food processing where big chunks or particles of food are cut into fine pieces or bits. It could be done for various reasons. Ground food becomes more mixable with other ingredients. It is employed to process different varieties of foods. Grinding can be done with wet or moist food as well as with dry food. Grinding wet or moist food is called wet-grinding and grinding dry food is called dry grinding. Grinding can be done using a food processor, mixer, or grinder (IFOODTV, 2014).

Food preservation involves different food processing steps to maintain the food quality at the desired level to achieve maximum benefits and nutritional values. Methods of food preservation include planting, harvesting, refining, packaging, and food distribution. The key objectives of food preservation are to overcome unsuitable agricultural planning (*Amit et al.*, 2017).

In recent years, the techniques to combat these spoilages are becoming sophisticated and have gradually altered into a highly interdisciplinary science. Highly advanced technologies like irradiation, high-pressure technology, and hurdle technology are used to preserve food items. This review article presents and discusses the mechanisms, application conditions, and advantages and disadvantages of different food preservation techniques.

Gluten might be characterized as the 'strong, viscous-flexible proteinaceous material readied as a result acquired by confinement of starch from wheat flour. A natural definition may incorporate the sources of

the gluten–protein mind-boggling as being gotten from the 'capacity proteins of the wheat grain' (Shewry and Halford, 2002). The last advance of gluten extraction is the drying of the gluten extricate. Drying of the gluten extricate has gotten significant consideration from scientists since high-temperature drying regularly effectively affects the gluten usefulness (Czuchajowska and Paszczynska, 1996). For business gluten creation, the gluten is dried with high-temperature air, though in the research facility, freezing and vacuum drying have been accounted for to deliver gluten with better usefulness for bread making (Esteller *et al.,* 2005). Gluten-containing grains and foods make up a large portion of modern-day diets, with an estimated intake in Western diets around 5–20 grams per day (https://www.healthline.com/nutrition).

The gluten protein networks vary because of different components and sizes, and variability caused by genotype, growing conditions, and technological processes. The structures and interactions of this matrix contribute to the unique properties of gluten. The resulting functions are essential to determining the dough quality of bread and other baked products. Gluten is heat stable and can act as a binding and extending agent and is commonly used as an additive in processed foods for improved texture, moisture retention, and flavor. Gliadin contains peptide sequences that are highly resistant to gastric, pancreatic, and intestinal proteolytic digestion in the gastrointestinal tract. The average daily gluten intake in a Western diet is thought to be 5-20 g/day and has been implicated in several disorders. Gluten-containing grains (wheat, rye, barley, and oats) are important staple foods. Gluten is among the most complex protein networks and plays a key role in determining the rheological dough properties. Products, beverages, dairy products, and others. The objective of this study is to develop full-fatted soybean-based food products as meat alternatives.

Materials and methods

The study utilized both qualitative and experimental methods of research to determine the consumer behavior toward full-fatted soybean-based products as a meat alternative, product development of three (3) full-fatted soybean meat alternatives, and pilot testing and commercialization of full-fatted soybean-meat alternative products. Three (3) formulations for each meat alternative were conducted. Each of these soybean-based products was subjected to sensory evaluation and consumer panel testing.

Determination of acceptable soybean-based formulation was conducted through the use of the Hedonic Scale. The most acceptable formulation of each of the meat alternatives was subjected to chemical and nutrient analysis, cost analysis, and shelf-life testing. Results were used in crafting the nutrition facts. Below is the flow chart of the experimental design of the study (Fig. 1).

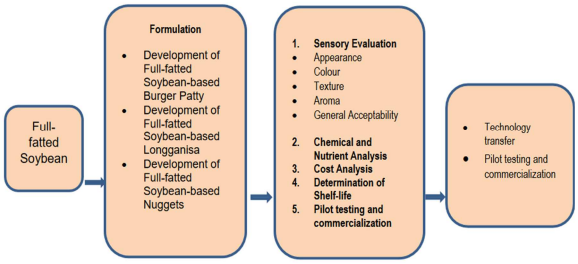

Fig. 1. The flow chart of the experimental design

Study 1: Determine the consumer behavior on full-fatted soybean-based products as meat alternatives

A deductive approach was used in this study. Descriptive or explanatory using qualitative methods was the strategy used. The research made use of a structured survey questionnaire with two parts. The first part of the survey questionnaire contains questions related to socio-demographics including age, educational level, household size, occupation, and monthly household income of the respondents. The second part of the questionnaire deals with the respondent's perception and willingness to purchase soybean-based products as meat alternatives if these are available in the market. The respondents were asked to rate how psychological (individual) factors, sensory (product-specific) factors and marketing (environment) factors affect their preference or purchase of soybean-based food products.

Study 2: Product development of full-fatted soybean-based products as meat alternatives

The experimental method in Fig. 2 and 3 was used to determine the most acceptable full-fatted soy-bean formulation as to its appearance, color, texture, taste, aroma, and general acceptability. The researcher made use of a Structured Survey questionnaire with three parts. The first part of the survey questionnaire contains questions related to the socio-demographics such as name, sex, age, and occupation of the respondent. The second part of the questionnaire deals with the respondents' acceptability in terms of overall acceptability, color, mouthfeel, taste, and texture. The third part of the questionnaire contains questions that deals with the product formulation which they like the most among the formulation of the Soybean-based Full-fatted Food product as a meat alternative.

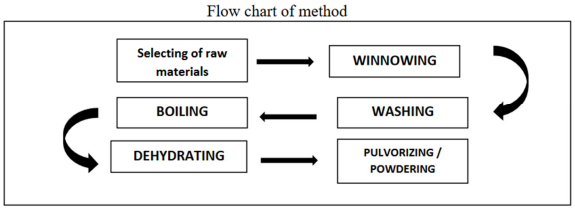

Fig. 2. Making of Full-fatted Soybean

Procedure

1. Winnowing and washing of the Local Non-GMO Soybean
2. Boiled the soybean for one (1) hour
3. Strain and wash the Boiled Soybean in running water to cool down and drained
4. Dehydrate the boiled at 55 C for 6 to 8 hours

Using a powdering machine pulverized the soybean as needed to get a Flout Texture.

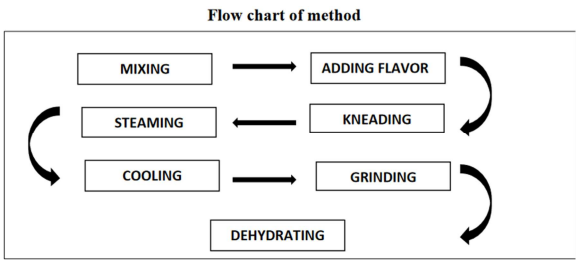

Fig. 3. Flowchart in preparing full fatted soy-bean meat alternative

Procedure

1. Ready all the ingredient
2. In one mixing bowl combine all the ingredients and knead the dough
3. Steam the dough for 30 min or more depending on the desired volume
4. Take out the dough and let it cool down for 30 min to one hour to form a rubberized texture and fiber-like meat
5. Using a meat grinding machine grind, the Soybean Meat like a ground meat

We can use the ground meat after we grind or dehydrate it for longer shelved life.

Study 3: Physical and nutritional properties of the full-fatted soybean-based products as meat alternatives

The physical and nutritional properties that were considered in the study are the moisture content, water activity, and the macro-nutrients protein, fat, and total carbohydrates. The minerals sodium, calcium, potassium, and iron were also included in the analyses. These were analyzed at the Regional Standards and Testing Laboratory at the Department of Science and Technology Regional Office No.1. This testing laboratory is PAB accredited. Other micro-nutrients such as the other minerals and vitamins were not analyzed due to logistics brought about by the community quarantine during the COVID-19 Pandemic.

Study 4: Cost analysis of full-fatted soybean-based products as meat alternatives

Qualitative data were used in the study in the form of a cost analysis. The results of the cost analysis are also presented in descriptive form. The direct material cost components were computed based on the actual purchase price of the ingredients and the amount used for the standardized formulation. The labor cost component was based on the prevailing wage rates in the area. The production overhead is set as a percentage of labor cost. The established production cost is then used for other cost analysis methods such as the break-even point and sensitivity analysis to determine the financial viability of the product formulations.

Study 5: Shelf-life analysis of full-fatted soybean-based products as meat alternatives

Soybean-based food was used in the experiments developed by the researcher, including Full-fatted soybean-based Longanisa, Soybean-based burger patty, and Soybean-based Nuggets The composition provided by the researchers was wrapped per 250 grams. the method was used to determine which time the expert will reject the full-fatted soybean-based food products as to their appearance, color, texture, taste, odor, and overall acceptability. The researcher made use of structured survey questions related to the sensorial factor of the products. While a microbial test was used to confirm if the products are safe to consume during the trial period.

Storage temperature and sampling times

To study the effect of storage temperature, shelf-life experiments were conducted at -18 ^{O}C to -30 ^{O}C storage time and were selected according to which product was likely to fail. the resulting sampling time at each temperature was, at -18 ^{O}C: 0,7,14,21,28,35,42,49, and 56 days; samples were manufactured for each of the sampling times and stored at the corresponding temperature. As samples belonged to different batches, the sensory panels performed a triangular test to ensure that there was no significant difference between a sample of the previous batch (kept at -18 ^{O}C) and that of the following batches. The study was carried out in one stage.

a. Analysis of sample with different storage in time at -18°C.

Sensory analysis

The sensory shelf-life test is designed to validate the length of time that a product will remain at the same level of acceptability or have no change in the desired sensory characteristic of the products, ensuring the level or desired sensory characteristics over the entire life of a product.

Changes in sensory properties are very sensitive to consumers rejecting products. Some product properties are too complicated to measure objectively. Moreover, instrumental measurement alone cannot indicate consumer acceptability or rejection. It is very important to ensure no change in sensory properties since consumers want to pay for desired sensory characteristics at their acceptable level.

The Self-life discrimination test panel consists of (8) eight assessors with years of experience in line with food and nutrition instruction to identify defects most likely to appear as a result of prolonged storage, a preliminary test was performed, in which three samples were presented to assessors who had to write down the descriptor, that made those sample different. By open discussion with the panel, leader assessors agreed on the best descriptor to differentiate the stored sample from the fresh sample: soybean-based food products dryness and off-flavor: or encompassed flavors such as moldy, acid, or rancid. The testing was carried out in a sensory laboratory equipped with daylight-type lighting, 5 grams per sample were given in a ceramic odorless tray at room temperature. Water was used for rinsing between samples. For scoring 9 points hedonic scale was used.

Statistical analysis

Analysis of variance (ANOVA) was performed on the trained sensory panel data for each sample using storage time assessors and their interaction as variation factors. Survival analysis methodology was used to estimate the shelf life of the full-fatted soybean-based food products at -18˚C.

Storage temperature and sampling time

To study the effect of storage temperature, shelf-life experiments were conducted at -18˚C to -30˚C storage time and were selected according to which product was likely to fail. The resulting sampling time at each temperature was, at -18°C: 0, 7, 14, 21, 28, 35, 42, 49, and 56 days; samples were manufactured for each of the sampling times and stored at the corresponding temperature. As samples belonged to different batches, the sensory panels performed a triangular test to ensure that there was no significant difference between a sample of the previous batch (kept at -18

°C) and that of the following batches. The study was carried out in one stage.

Microbiological analysis

The subject underwent the process of Serial dilution to determine the estimated colonies of the organism of an unknown sample in serial dilution, the density of the colonies is reduced in each step for easy calculation of the concentration of the cells from the original solution by calculating the dilution over the entire series. The serial dilution process was performed to avoid having to pipette a very small volume (1:10 µl) to make a dilution of a solution. diluting a sample in a controlled manner we can determine the number of colonies in the Petri film.

Study 6: Pilot testing and commercialization of full-fatted soybean-based products as meat alternatives

A descriptive qualitative exploratory research design was used for the study. In this study, the phenomenon observed was the experiences of the adoptees and the top management on the developed full-fatted soybean-based products as meat alternatives concerning the impact and different challenges affecting them after the training, as well as the strategies and initiatives to be employed for the commercialization of the three developed soybean-based products, namely; soybean longanisa, soybean burger patty, and soybean nuggets. Narratives/ scripts were utilized to capture the localized and contextualized experiences of adoptees and the top management of KEMPC. Six female adoptees and two from the top management, specifically the Board of Director-Chairman, and the KEMPC Manager were interviewed. The age of the respondents ranges from 30 – 50 years old, and all of them are currently on-call employees in KEMPC.

The study used semi-structured interview guide questions. Two (2) different questionnaires were utilized. Each questionnaire was crafted according to the participants (adoptees and top management). First, the adoptees' interview was framed to expose their experiences after adopting the transferred technology. This includes their demographic profile, the impact and challenges experienced after the training, and strategies to be employed for commercialization. Second, the top management interview was designed to validate the responses of adoptees as well as the challenges experienced in adopting the technology, and strategies to be employed for commercialization and marketing. Also, the challenges and recommendations on marketing and commercialization were probed. Conventional and unconventional ways of data gathering were observed in the implementation of the study. Personal data collection was employed. Face-to-face interviews and focus group discussions were conducted with the aid of the guide questions.

Results and discussion

Study 1: Determine the consumer behavior on full-fatted soybean-based products asmeat alternatives

Socio-demographic characteristics of respondents

Of the 395 respondents, 75% are Benguet residents and 25% are Baguio City residents, 65% are female and 35% are male. The ages of the respondents are distributed with 30% within 12-19 years old, 59% within 20 to 35 years old, 7% within 36-50 years old, and 4% belonging to the age group 51 years old and above. Most (48%) of the respondents are employed, followed by students (30%), unemployed (10%), and entrepreneurs (5%). Most (69%) of the respondents finished tertiary or college-level education. As to their monthly household income, 31% of the respondents indicated an income of P9,000.00; 28% with PhP10,00.00–PhP19,000.00; 23% with Ph20,000.00- Php38,000.00; 4% with P39,000.00-P66,000.00; 5% with P67,000.00-P115,000-00; and 2% with more than P115,000.00. For the household size, the highest percentage (53%) is with 4-6 members, followed by 7-9 members (23%), 1-3 members (21%), and 10 and above members (3%).

Factors affecting consumer preference for soybean-based products as meat alternatives

Socio-demographic

In general, regardless of age, sex, educational attainment and household income, 99% (391) of the respondents indicated that they will purchase

soybean-based meat alternatives when available in the market (Fig. 1). Only one percent (4) responded otherwise, aged 12-35 years old, all finished tertiary education, two students and two entrepreneurs, and with a household income of less than P9,000-P19,000. The reason/s for their responses were not considered in the survey questionnaire.

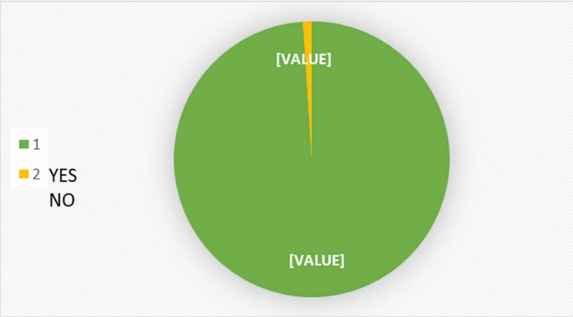

Fig. 1. Willingness to buy soybean-based products when available in the market

Income

The respondents' income will highly affect the households' preference or purchase with 38% (Fig. 2). Thirty-one percent are moderately affected, 23% are slightly affected, and the remaining nine percent said that their income will not affect their preference and purchase of soybean-based meat alternatives.

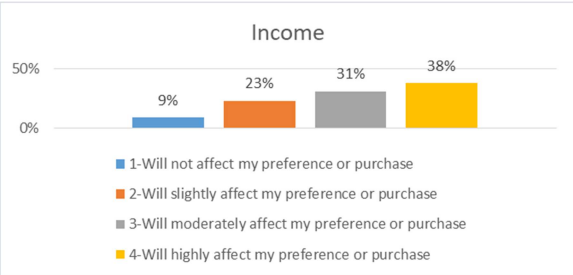

Fig. 2. Factors affecting the purchase of soybean-based meat alternative-income

Occupation

Thirty-seven percent (37%) of the respondents indicated that their occupation will moderately affect their preference or purchase of soybean-based food products, 29% said their occupation will highly affect their preference or purchase, 20% indicated that their occupation will slightly affect their preference or purchase, and the remaining 14% said that their occupation will not affect their preference and purchase (Fig. 3).

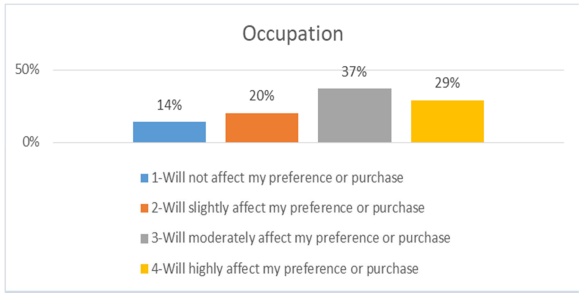

Fig. 3. Factors affecting the purchase of soybean-based meat alternatives -occupation

Lifestyle

Fig. 4 presents the personal factor in the lifestyle that might affect the preference or purchase decision of the respondents. The data shows that 40% of the respondents' lifestyle will highly affect their preference or purchase, 32% indicated this will moderately affect their purchase, 21% said their lifestyle will slightly affect their preference or purchase and 7% said that lifestyle will not affect their preference or purchase decision in buying the product if it is available in the market.

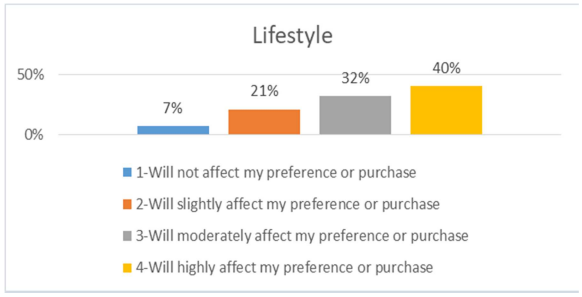

Fig. 4. Factors affecting the purchase of soybean-based meat Alternative- lifestyle

Fig. 5 shows that personality will be a factor in the respondents' preference or purchase of soybean-based meat alternatives. Thirty-five percent (35%) of the respondents said that it will affect them moderately, 32% said it will highly affect their preference or purchase, 21% said it will slightly affect their preference or purchase, and 12% said that their personality will not affect their preference or purchase.

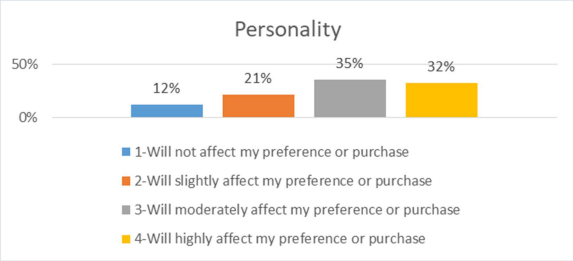

Fig. 5. Factors affecting the purchase of soybean-based meat alternative-personality

Health condition

Fig. 6 shows that 52% of the respondents said that their health condition will highly affect their preference or purchase, 27% said that it will moderately affect their preference or purchase,12% indicated that it will slightly affect their preference or purchase, and 9% said that their health condition will not affect their preference or purchase.

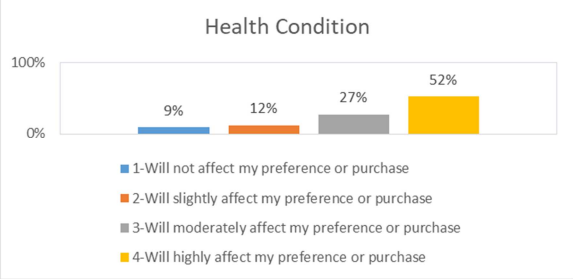

Fig. 6. Factors affecting the purchase of soybean-based meat alternative-health condition

Expectations on the quality of the product

One important psychological aspect of the factors affecting consumer behavior in a food domain is the expectation of the consumer. According to Font-i-Furnois and Guerrero (2014), expectations are important factors that determine whether or not a person adopts or rejects a product. High expectations result in a higher chance of product adoption and expectations of quality are the most crucial factor influencing purchase decisions. In this survey, the factor of quality specifically the freshness of the product was considered. Aside from continuously improving quality, ongoing innovation is also required in the current situation, given the market's many competitors. Customer satisfaction was mostly determined by the quality of service and the quality of the meal (Baluyot and Pampolina, 2021).

Freshness of product

Fig. 7 shows how important the freshness of the product is to consumers. A high percentage (64%) of the respondents said that freshness is a very important factor in purchasing the products, 24% said freshness will moderately affect their preference or purchase, and 10% indicated that freshness of the product will slight affect their preference or purchase and only 2% said it will not affect their preference or purchase.

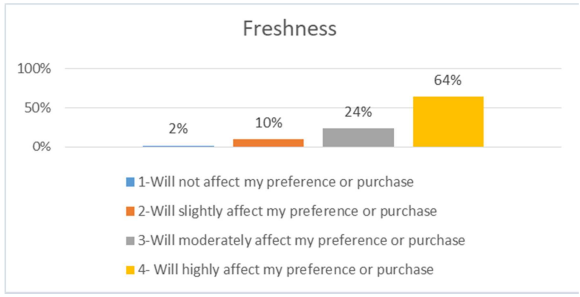

Fig. 7. Factors that affect the purchase of soybean-based meat alternative freshness

Sensory qualities

The sensory evaluation uses test methods that provide information on how products are perceived through the senses. The importance of sensory perception of food quality is widely appreciated in the food industry avoiding pulse positive results, the sensory properties of food products are an important success factor (Maeselman, 1993).

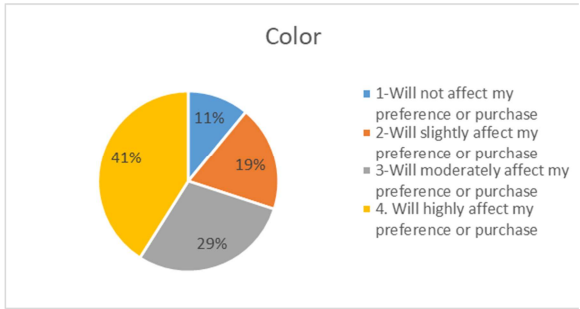

Fig. 8. Factors affecting the purchase of soybean-based meat alternative –color

Visual appearance- color

The results show that out of 395 household respondents, 41% of them will be highly affected by

the color of the food when purchasing, 29% said that the color will moderately affect their preference, 19% said it will slightly affect their preference and 11% said color will not affect their preference at all (Fig. 8).

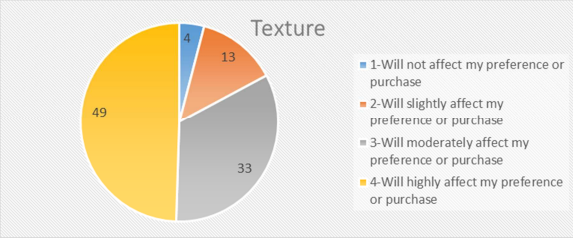

Fig. 9. Factors affecting the purchase of soybean-based meat alternative-texture

Texture

Texture refers to that perception that constitutes the evaluation of the food's physical characteristics by the skin or muscle of the buccal cavity except for the temperature or pain (Matz, 1962). The texture is the composite of those properties (attributes) which arise from the structural element of food and how it registers with physiological senses (Sherman, 1970). In this survey as shown in Fig. 9, 49% of the respondents said that texture will highly affect their preference or purchase, 33% are moderately affected by their preference or purchase, 13% are slightly affected and 4% are not affected by the texture on their preference or purchase.

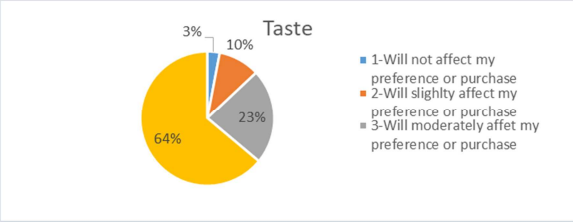

Fig. 10. Factors affecting the purchase of soybean-based meat alternative-taste

Taste

The 'taste of food' plays an important role in food choice. A total of 395 respondents completed the survey questionnaires assessing the sensory quality and taste as a factor in their preference or purchase. Results show that 64% of the respondents say that taste will highly affect their preference or purchase, 23% are moderately affected by their preference or purchase, 10% are slightly affected by their preference or purchase and the remaining 3% are not affected by their preference or purchase (Fig. 10).

The results of the study are consistent with earlier studies that taste and texture are the keys to lowering the barriers to consuming plant-based diets. In the study of Moradian and Rosand (2019) on how companies in the food industry influence flexitarians in the transition towards a plant-based diet, all interviewed company representatives indicated that an essential part of their strategy is to create a taste and texture that is similar to, or better than, meat and dairy. All companies included in their study highlighted the understanding that although consumers are becoming more conscious about their health and the environment, they are not willing to sacrifice the taste of their food. This is why the companies put taste and texture as the highest priority, attempting to create products with identical qualities to meat and dairy (Moradian and Rosand, 2019).

Aroma

Flavor and aroma are inseparably tied together, making the ability to detect and distinguish specific aroma and flavor components crucial to sensory analysis. The aroma is the first cousin of taste. Much of what we call taste is an intricately entwined matrix of flavor, aroma chemicals, and texture or mouthfeel (Anthony, 2007).

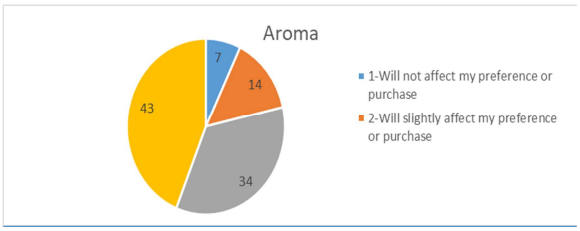

Fig. 11. Factors affecting the purchase of soybean-based meat alternative, aroma

The data gathered showed that 43% of the respondents indicated that aroma will highly affect their preference or purchase, 34% are moderately affected, 14% are slightly affected and only 7 % said that aroma will not affect their preference or purchase of the soybean-based meat alternative (Fig. 11).

Fig. 12. Factors that affect the purchase of soybean-based meat alternatives- price

Marketing-related factors

Price

The customer value level is all about getting your price position right relative to competitors in every customer segment you serve. It is about finding the position of your products correctly against your competitors on a price-benefit basis. Based on the data gathered, it shows that price will highly affect the household's preference and purchase (58%) (Fig. 12).

The amount that consumers may allot for soybean-based meat alternative

Considering that the price of a product is a vital factor for consumers in purchasing products, the survey included a question on the amount that the respondents may allot for buying soybean-based products as meat alternatives. The majority (50%) of the respondents opt to buy soybean-based meat alternatives pegged at a price ranging from P101-P200, followed by below P100 (26%), P201-P400 (19%), and P 410 (5%) (Table 1).

Table 1. The amount that the household may allot for soybean-based meat alternatives in a week

	Frequency	Percentage
Below P100.00	102	26%
P101.00-P200.00	197	50%
P201.00-P400.00	75	19%
P401.00 and above	21	5%

Availability and accessibility

The availability of a product in the market is also an important consideration among consumers. The respondents were then asked about their willingness to buy the products when available in the market. It is worth noting that 99% of the respondents will consider buying soybean-based meat alternatives when available in the market. Today more and more companies are looking into vegetarian alternatives to meat (Michail, 2015). To get a competitive edge in the swiftly expanding and ever-changing market, businesses need to be proactive, flexible, and quick to find and assess alternative technologies for manufacturing and processing to improve organizational efficiency (Tan *et al.*, 2021).

The accessibility of a product is important for most individuals. According to Kotler, Place marketing means designing a place to satisfy the needs of its target markets. The 395 respondents were asked how important for them is the accessibility to store location. Forty-eight (48%) percent of the respondents answered that accessibility of the store location moderately affects their preference and purchase, 10% will slightly be affected and 6% said that it will not affect their preference or purchase (Fig. 13). will highly affect their preference or purchase of soybean-based products, 36% said that it will.

Fig. 13. Factors affecting the purchase of soybean-based meat alternative- Accessibility to Store Location

Table 2. Possible location of soybean-based products as a meat alternative for purchase

	Frequency	Percentage
Wet/Fresh market	162	41%
Supermarket	110	28%
Direct from local Entrepreneurs	119	30%
Others, pls., specify	4	1%

Possible location of soybean-based meat alternative

The survey also considered the possible location of the soybean-based products for them to purchase when these products will be available. Among the

respondents, the most convenient place of purchase for soybean-based products is the wet/fresh market (41%), direct from local entrepreneurs (30%), and supermarkets (28%) (Table 2).

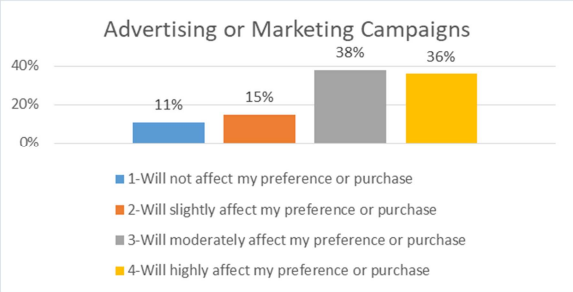

Fig. 14. Factors affecting the purchase of soybean-based meat alternative-advertising or marketing campaigns

Advertising

Fig. 14 shows that advertisement/ marketing campaign will highly (36%) affect the households' preference or purchase, 38% of the respondent said that their preference or purchase will be moderately affected by advertising or marketing campaigns, 15% percent will slightly be affected on their preference or purchase. However, 11% said advertisement will not affect their preference or purchase.

Table 3. Soybean-based meat alternative products that the respondents may purchase

	Frequency	Percentage
Burger Patty	321	81%
Longganisa	305	77%
Nuggets	315	80%

Purchase of soybean-based food products as meat alternatives

The respondents were asked whether they would purchase soybean-based food products when available in the market. The survey showed that the majority would purchase the three products namely, burger patty (81%), meatballs (80%) and longganisa (77%) when available in the market (Table 3).

The respondents were asked about the amount in kilograms of soybean-based products that they will consume in a week. It is noteworthy to know that most of the respondents (86% combined) indicated they will be consuming one-half kilogram to two (2) kilograms in a week of soybean meat alternatives (Table 4).

Table 4. Amount (kg) of soybean-based meat alternatives that the household might consume in a week

	Frequency	Percentage
500 grams or ½ kg	169	43
1-2 kg	169	43
3-4 kg	56	14
5 kg and above	1	0

Quantity per pack

Fig. 15 shows that 55% percent of the respondents' preference or purchase will be highly affected by the quantity per pack of the product, 30% will be moderately affected, 12% will be slightly affected, and 3% said that quantity per pack will not affect their preference or purchase.

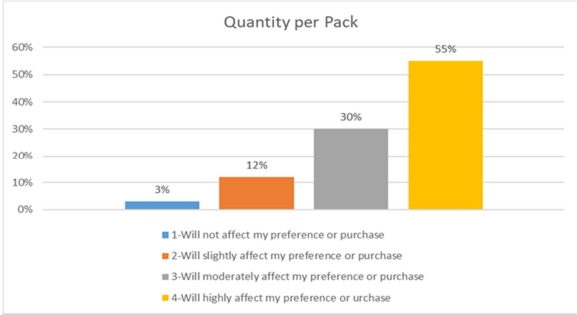

Fig. 15. Factors that affect the purchase of soybean-based meat alternatives- quantity per pack

The respondents were asked about the preferred quantity per pack of soybean-based products and when these will be available in the market. As shown in Table 5, most (66%) of the respondents would prefer that the products be packed by ½ kilograms. Some (30%) want these products to be packed in one kilogram.

Table 5. Quantity per pack of soybean-based products

	Frequency	Percentage
½ kg	259	66%
1kg	117	30%
Others, pls. specify	19	5%

Table 6. Frequency of possible consumption of soybean-based meat alternative

	Frequency	Percentage
Once a week	186	47
Twice a week	138	35
Thrice a week	44	11
Daily	23	6
Others	4	1

Frequency of consumption

The respondents were likewise asked about the possible frequency of consumption. Almost one-half of the respondents (47%) responded that they will be consuming the soybean-based meat alternative once a week, followed by 35% twice a week, 11% thrice a week, and 6% daily (Table 6).

Table 7. Criteria that will satisfy the respondents with soybean-based meat alternatives

	Frequency	Percentage
Affordability	254	64%
Taste	249	63%
Nutrition Value	383	97%
Health Benefits	270	68%

Other factors considered by the respondents

The respondents were asked about other criteria that they will consider in buying soybean-based meat alternatives. Nutrition value (97%), health benefits (68%), affordability (64%), and taste (63%) are important criteria and factors that will make the respondents satisfied with soybean-based meat alternatives (Table 7).

Table 8. Respondents who check the nutritional value of the foods they purchase

	Frequency	Percentage
Never	66	17%
Very Rarely	33	8%
On Certain Products	121	31%
On Most Products	123	31%
On All Products	52	13%

On the nutritional value, the respondents were asked if they are checking the nutrition labels to know the nutritional value of the food products they are buying. Overall, the majority (75%) of the respondents check the nutritional value of the foods they buy. Only one-fourth (25%) never or rarely check the nutritional value of foods that they purchase (Table 8).

Study 2: Product development of full-fatted soybean-based products as meat alternatives

Locally non-GMO soybean was used for experimentation because of its characteristics. The basis of selecting the ingredients is locally grown non-GMO soybean. the developed soybean flour was used as a based ingredient for the development of a Full-fatted soybean-based food product as a meat alternative. The overall acceptability was considered in the study. The ingredients used in the study are represented in Tables 9 to 11 and Fig. 16.

Table 9. A full-fatted soybean-based food product as a meat alternative (soybean burger patty)

Soybean burger patty	
Soybean meat alternative (textured meat)	
Beef	Ground
Egg	medium
Salt	iodized
Pepper	ground
Oil	Vegetable
Onion	minced
Garlic	minced
Garlic	Powder
Soy Sauce	Dark
Paprika	Powder
Beef Powder	Powder

Table 10. A full-fatted soybean-based food product as a meat alternative (soybean sweet longanisa)

Full-fatted soybean-based soybean sweet longanisa	
Soybean meat alternative (textured meat)	
Pork	Ground
Egg	medium
Salt	iodized
Oil	Vegetable
Pepper	ground
Onion	minced
Garlic	minced
Garlic	Powder
Soy Sauce	Dark
Sugar	Powder
Pork powder	Powder

Table 11. A full-fatted soybean-based food product as a meat alternative (Soybean Nuggets)

Soybean nuggets	
Soybean meat alternative (textured meat)	
Pork	Ground
Egg	medium
Salt	iodized
Oil	Vegetable
Pepper	ground

Onion	minced
Garlic	minced
Garlic	Powder
Soy Sauce	Dark
Sugar	Powder
Pork powder	Powder
Bread crumbs	Powder

Actual raw soybean

Soaking

Washing before boiling

Actual boiling process

Washing after boiling

Layering into pan for dehydrating process

Dehydration after 4 hours

Dehydration after 8 hours

Dehydration after 12 hours

Dehydrated soybean ready for grinding process

Powdered soybean

Ready to use powdered soybean

Powdered soybean after more courses in processor

Fig. 16. Full-fatted soybean-based processes

Sensory evaluation

The three locally produced Full-fatted soybean-based meat food products as meat alternatives were presented to fifty (50) untrained panelists to be evaluated in terms of overall acceptability, color, mouthfeel, taste, and texture. The following are the

result of the overall acceptability of the development of full-fatted soybean-based food products as meat alternatives. The statistical range and descriptive equivalent used are shown in Table 12.

Table 12. Statistical range

Statistical equivalent	Descriptive equivalent
9.00 -8.12	Like Extremely (LE)
8.11 -7.23	Like Very Much (LVM)
7.22 - 6.34	Like Moderately (LM)
6.33 - 5.45	Like Slightly (LS)
5.44 - 4.56	Neither Like nor Dislike (NLD)
4.55 - 3.67	Dislike Slightly (DS)
3.66 - 2.78	Dislike moderately (DM)
2.77 - 1.89	Dislike Very Much (DVM)
1.88 - 1.00	Dislike Extremely (DE)

The result of the level of the overall acceptability of the full-fatted soybean-based burger patty and longganisa in terms of color, mouth feel, taste, texture significance, mean scores, and descriptive equivalence is shown in Table 5-6.

Full-fatted soybean-based burger patty

Table 13 presents the overall acceptability of soybean burger patty findings in the overall acceptability suggest that two of the three samples were significantly different from one sample although they are all evaluated as being moderate "like Moderately" by the panelist.

Table 13. Level of overall acceptability of soybean burger patty

Characteristic/TRT	Mean	DE	Fc	Sig
404	7.18^{A}	LM		
603	7.60^{A}	LVM	2.424*	0.099
439	7.06^{B}	LM		

*Means f the same letter is not significantly different using Least Significant Difference (LSD)

Color

With the discovery of the purple color by William Henry Perkins in 1856 the first synthetic color of purple become a big factor it become historically favored in the food industry and routinely added to colorless or color loss during the processes. Colors in food acceptability and palatability is an indispensable factors (Corradini, 2019). Table 14 present the mean rating on consumer acceptability of the Full-fatted soybean-based as food product meat alternative. The three treatments do not significantly differ and the mean score is equivalent to "Like Very Much "in terms of their color a small difference in mean shows that the 603=70% percent formulation got the highest mean in terms of color which is 7.60 followed by 404 =50%, and 439=90% thus this shows how color affects the palatability of the consumer.

Table 14. Level of acceptability in terms of color of soybean burger patty

Characteristic/TRT	Mean	DE	Fc	Sig
404	7.34^{A}	LVM		
603	7.56^{A}	LVM	.944ns	0.396
439	7.32^{A}	LVM		

*Means f the same letter is not significantly different using Least Significant Difference (LSD)

Table 15 shows the level of acceptability of the development of Full-fatted soybean-based food product as meat alternative Burger Patty in terms of Mouth Feel the table presents that the mouth feel of the consumer got a descriptive equivalent of "like Moderately" all the three formulations are acceptable the consumer 404=50% formulation is not significantly different to 603=70% formulation but significantly different to 439=90%, 603 =70% formulation is not significantly different to 404=50% formulation but significantly different to 439=90% percent thus 439=90% percent is both significant differences to both 404=50% percent formula and 603=70% percent formulation.

Table 15. Level of acceptability in terms of mouth feel of soybean burger patty

Characteristic/TRT	Mean	DE	Fc	Sig
404	7.26^{A}	LM		
603	7.50^{A}	LV	4.837*	2.00
439	6.82^{B}	LM		

*Means f the same letter is not significantly different using Least Significant Difference (LSD)

Taste is a wide range of combinations of the five basic flavors when we eat. Prescott explains that taste matters. The brain distinguished the chemical qualities of food in the mouth. Based on the information the taste bud provides the brain. Table 16

shows that the level of acceptability of the Soybean based-food products in terms of taste is based on the result the three formulations were acceptable with the descriptive equivalent of "Like Very Much" this implied a favorable result for Full-fatted soybean-based burger patty that all three treatments are acceptable considering the result of the acceptability of the untrained panel to the product presented and can be produced commercially based on its taste.

Table 16. Level of acceptability in terms of taste of soybean burger patty

Characteristic/TRT	Mean	DE	Fc	Sig
404	7.26^{B}	LVM		
603	7.68^{A}	LVM	9.24**	0.00
439	6.54^{C}	LM		

*Means f the same letter is not significantly different using Least Significant Difference (LSD)

Table 17. Level of acceptability in terms of texture of soybean burger patty

Characteristic/TRT	Mean	DE	Fc	Sig
404	7.28^{A}	LVM		
603	7.52^{A}	LVM	4.769*	0.013
439	6.92^{B}	L M		

*Means f the same letter is not significantly different using Least Significant Difference (LSD)

The texture of the product plays a very important role in the consumers' acceptance. There are few studies dealing with the effect of texture attributes on food acceptability. Meullenet(2004) Szczesniak's access to the importance of texture in comparison to flavor was 0.89 with the group the study show that texture was especially important in food that is bland in flavor.

This study supported the result of the study (Szczesniak, 1963). Table 17 shows the level of acceptability in terms of the texture of Soybean Based-food products as a meat alternative. Among the three formulations, the 603=70% formulation got the highest acceptability with the descriptive equivalent of "like moderately" however 603=70% is not significantly different from 404=50% in terms of Texture it indicates that they almost had the same texture but the 439+90% was significantly different with 603=70% with least acceptability among the three which indicate that the most acceptable was the 603=70% even they all get the descriptive equivalent of Like Very Much" this implies that the treatment has a potential of imitating the nuggets texture that we can buy commercially. Frequency of likeness of full-fatted soybean-based burger patty is shown in Fig. 17.

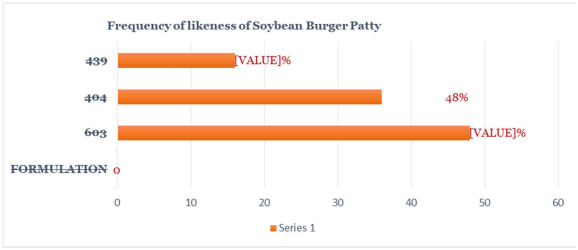

Fig. 17. Frequency of likeness of full-fatted soybean-based burger patty

Table 18 shows the frequency of likeness of Soybean based Burger Patty that 603=70% and 404=50% got an equal percentage with 48% and 603 with the least with 16% result show the difference among the three formulations the 439=90% Soybean formulation has the least likeness was accurately supported the tables above that the 439 is significantly different with the two formulations, thus the 404=50% and 603=70% has almost the same with each other with a small difference in terms of acceptability.

Table 18. Frequency of likeness of soybean burger patty

TRT	Like f	Percentage
404	18	36.0
603	24	480
439	8	160
Total	50	100.0

The demographic variable is based on different factors such as sex, age, occupation, and more that have a strong relationship to consumer purchase. Table 19 shows the association of the demographic profile of the consumer on the likeness of the Soybean-based Burger Patty the result shows that sex, age, and occupation are not significantly different in liking the soybean-based Burger Patty. Thus, this indicates that the soybean-based Burger patty is acceptable to different types of consumers in terms of sex, age, and occupation.

Table 19. Association of demographic profiles on the likeness of the soybean-based burger patty

Profile	TRT			X^2	SIG
	404	439	603		
SEX					
Male	6	2	6	.397^{ns}	.820
Female	12	6	18		
AGE					
Early adult	16	6	16	3.316^{ns}	.506
Midlife	2	2	7		
Mature adult	0	0	1		
Occupation					
Employed	11	6	23	10.446ns	.235
Unemployed	1	0	0		
Self-employed	1	1	0		
Entrepreneur	1	0	0		
Student	4	1	1		

Nuggets

Overall acceptability of food is very important as well as color flavor and texture (Cardello, 1994; Love1994). Table 20 shows the Level of Overall acceptability of the soybean-based Nuggets. The result showed that the three formulations show no significance in overall acceptability with the descriptive equivalent of "Like Moderately" thus the three formulations have a slight difference the 896=50% formulation has the highest acceptability among the three with 7.60 followed by 387=90% with the mean of 7.48 and 757=70% with a mean of 7.40.

Table 20. Level of overall acceptability of soybean nuggets

Characteristic / TRT	Mean	DE	Fc	Sig
896	7.60^{A}	LVM		
757	7.40^{A}	LVM	0.578ns	0.565
387	7.48^{A}	LVM		

*Means f the same letter is not significantly different using Least Significant Difference (LSD)

Color plays a very important factor in food since ancient history colorants in Egypt cities around 1500 BC by adding a natural color to improve the product appearance for example grape Color, Saffron, and many more (Natural Colorant for Food: A healthy Alternative 2019). Table 21 shows the level of acceptability of soybean-based food nuggets in terms of Color the result shows that two among the three got "Very Much Like" descriptive equivalent and the least with "Like Moderately" Thus the result was of the Natural Colorant for Food: A Healthy Alternative is true, even without the use of the commercial colorant by using organic color from other ingredients. That the color of all treatment was accepted by the consumer.

Table 21. Level of acceptability in terms of color of soybean based food nuggets

Characteristic/TRT	Mean	DE	Fc	Sig
896	7.64^{A}	LVM		
757	7.46^{A}	LVM	0.810^{ns}	0.451
387	7.06^{A}	LM		

*Means f the same letter is not significantly different using Least Significant Difference (LSD)

Chicken nuggets satisfying mouthfeel provide an appealing characteristic an article stated that the factor to the sensory experience of a consumer, providing a golden-brown color moist interior, and pleasant aroma that contributes to the satisfying mouth feel of common chicken Nuggets. Table 22 below shows the acceptability level of the full-fatted soybean-based burger patty in terms of mouthfeel shows that all the three treatment is not significantly different from each other in terms of mouth feel however among the three the 896= (50%) treatment got the highest mean result with 7.62 followed by 387+90% with 7.54 and 757=70% with the least result of 7. 46 with the descriptive equivalent of Like Very Much it suggested that the soybean-based nuggets less likely reach the potential mouthfeel description of a Nuggets in terms of Mouthfeel like the commercial chicken nuggets that we can buy.

Table 22. Level of acceptability in terms of mouth feel of soybean burger patty

Characteristic/TRT	Mean	DE	Fc	Sig
896	7.62^{A}	LVM		
757	7.46^{A}	LVM	0.618^{ns}	0.543
387	7.54^{A}	LVM		

*Means f the same letter is not significantly different using Least Significant Difference (LSD)

The acceptability of taste is one of the key ingredients. According to the Science of Taste (2015), simply those Nuggets with nutritional value, low in cholesterol good textural properties nice flavor, and taste profile will become the

favorite choice of palatability (Behrends *et al.*, 2005: Calkin and Hodgen, 2007) it shows in Table 23 below the acceptability of Soybean-based Nuggets in terms of taste the comparison of the mean score of the three formulation result shows a significant result of (Sig 0.186) 896 =50% with 7.52, 757=70% (M=714), and 387=90% (7.20). This means that the identified three treatments are not statistically different to each other in terms of the level of acceptability of the Taste of the customers with the Soybean-based Nuggets thus among the three treatment the 896 50% with the descriptive equivalent of "Like Very Much". The acceptability of taste is one of the key ingredients result shows that all the consumers are satisfied with the taste of the Soybean-based Nuggets.

Table 23. Level of acceptability in terms of taste of soybean nuggets

Characteristic/TRT	Mean	DE	Fc	Sig
896	7.52^{A}	LVM		
757	7.14^{A}	LM	1.74^{ns}	0.186
387	7.20^{A}	LM		

*Means f the same letter is not significantly different using Least Significant Difference (LSD)

Texture

The Korean J Food Anim Resource (2015) stated that the appearance and texture of crispiness and golden color are very important to the consumer.

Table 24. Level of acceptability in terms of texture of soybean burger patty

Characteristic/TRT	Mean	DE	Fc	Sig
896	7.28^{A}	LVM		
757	7.22^{A}	LM	1.196ns	0.311
387	7.44^{A}	LVM		

*Means f the same letter is not significantly different using Least Significant Difference (LSD)

Table 24 shows the level of acceptability of the Soybean-based Nuggets in terms of Texture the comparison of the three formulations shows that there is no significant difference between the three treatments with the (sig 0.311) result however the 387=90% Soybean-based formulation got the highest score of 7.44 mean score followed by 896=50% soybean formulation and 757=70% soybean-based formulation with the descriptive equivalent of "Like Moderately" result show that the difference in texture among the three formulations is very small mean (0.8 to 0.12) difference and not significant with each other. Chart of frequency of likeness of full-fatted soybean-based nuggets is shown in Fig. 18.

Table 25. Frequency of likeness of the soybean-based nuggets

TRT	Like f	Percentage
387	14	28.0
757	15	30.0
896	21	42.0
Total	50	100.0

Table 25 shows the Frequency of likeness of the Soybean-based Nuggets result shows that among the three formulations the percentage of the likeness of 896=50% Soybean-based Formulation is higher among the three Soybean-based formulations with Forty-two percent (42%) followed by 757=70% Soybean-based formulation with thirty percent (30%) and 387=90% with twenty-eight percent (28%) of Likeness among the three it means that among the three formulation respondent like the 896 =50% Soybean formulation among the three.

Table 26. Association of demographic profiles on the likeness of 531(50 grams of Soybean formulation and 50 grams of ground pork), 851(70 grams of Soybean formulation and 50 grams of ground pork), and (90 grams of Soybean formulation and 50 grams of ground pork)

Profile	TRT			X^2	SIG
	387.0	757.0	896.0		
SEX					
Male	4	8	2	3.399ns	.183
Female	10	7	19		
AGE					
Early adult	11	11	16	2.420ns	.659
Midlife	3	3	5		
Mature adult	0	1	0		
Occupation					
Employed	11	11	18	10.212ns	.250
Unemployed	0	0	1		
Self-employed	2	0	0		
Entrepreneur	0	1	0		
Student	1	3	2		

The said formulation was supported by other tables above in terms of Color, mouth feel, taste, and texture that show a significant factor in liking the 387=50% soybean-based formulation.

Table 26 below shows the association of the Respondent's Demographic profile with the likeness of the Soybean-based Nuggets. The table shows a significant difference in the likeness of Soybean-based Nuggets Between Male and Female respondent Karen Bronso et al (2012) women is more conservative in food choice and more likely health conscious. Health is strongly linked to basic life values and purchase motives. A significant difference shows in terms of likeness between males and females. The association of the consumer age was differentiated with three stages early adult, midlife, and Mature adult result show that there is no significant difference among the three stages which means that the Soybean-based is acceptable to all ages. The result shows that the association of the consumers' demographic profile in terms of occupation is not significantly different with each category with a sign of (0.250) which means that the occupation of the consumer is not associated with liking the Soybean-based Nuggets. Thus this result means the importance of household decisions USDA's 1994-96 Diet and Health Knowledge Survey U.S Department of Agriculture; (2000) cited the maternal responsibility of the woman in feeding the children thus this may indicate the importance of the female consumer thus study show that they are the major responsibility in deciding what we will eat in our daily life.

Longanisa

According to McWilliams (1974) acceptance of food is based on the impression the product makes on the senses. Just the Thought of the Sausage makes up something they expect from sensing the product. Panelists expected to taste the beany flavor.

Table 27 shows the overall acceptability of the Soybean-based food product as meat alternative treatment is not significantly different from each other with a sigh of 0.896 and the descriptive equivalent of "like Moderately this is further proved with the significant score of 0.110ns.

Table 27. Level of overall acceptability of soybean sweet longanisa

Characteristic/ TRT	Mean	DE	Fc	Sig
531	7.14^{A}	Like Moderately		
851	7.04^{A}	Like Moderately	0.110^{ns}	0.896
387	7.08^{A}	Like Moderately		

*Means f the same letter is not significantly different using Least Significant Difference (LSD)

The result implicates that all the three treatment is not different from each other in terms of overall acceptability with the descriptive equivalent of "like Moderately" the result was supported by different factors the treatment 531 (50%) was supported by different factors affecting the overall acceptability of the product.

Table 28 shows the level of acceptability of the Soybean-based Sweet Longanisa in terms of Color Bennion (1980) stated that the eye appeal of the food is contributed by such qualities as color it can stimulate a person's appetite. As shown, there is no significant difference among and between the three treatments presented with sig. 0.189 with the descriptive equivalent of "Like very much".

Table 28. Level of acceptability in terms of color of soybean sweet longanisa

Characteristi/ TRT	Mean	DE	Fc	Sig
531	7.36^{A}	Like very Much		
851	7.52^{A}	Like very Much	1.728ns	0.189
468	7.58^{A}	Like very Much		

*Means f the same letter is not significantly different using Least Significant Difference (LSD)

The result implicates that all three treatment is very much acceptable in terms of color that the product exudes or replicate the Color of the meat-based ordinary Commercial Longaniza in the market.

Table 29 shows the acceptability of the Soybean-based Longanisa in terms of Mouthfeel that the

three treatments is not significantly different from each other as they perceived almost the same mean score with a statistical equivalent range of 7.22-6.34 with a descriptive equivalent of "Like Moderately". This implies that the three treatment is almost the same in terms of Mouth feel that the different percentage of treatment is not significantly observed among the three treatment presented that all the treatment is acceptable and replicates a similar mouthfeel to commercial Longanisa in terms of Mouth feel.

Table 29. Level of acceptability in terms of mouth feel of soybean sweet longanisa

Characteristic/Mean TRT		DE	Fc	Sig
531	6.76^{A}	Like Moderately		
851	6.78^{A}	Like Moderately	.478^{ns}	0.623
468	6.94^{A}	Like Moderately		

*Means f the same letter is not significantly different using Least Significant Difference (LSD)

Table 30 shows the level of acceptability of the soybean-based Sweet longaniza in terms of Taste the table shows that the three treatments is likely the same as each other as the result indicates no Significant difference between all the treatment. This claim was supported with the sig score of 0.885. This result implies that the three formulations are accepted by the consumer however it indicates that even though the 531 = (50%) is the most picked by the respondent the small difference between and among the other treatment is not significantly different and most likely they are similar to each other. This may indicate that all three treatments taste similar and are acceptable to the consumer.

Table 30. Level of acceptability in terms of taste of soybean sweet longanisa

Characteristic/Mean TRT		DE	Fc	Sig
531	6.86^{A}	Like Moderately		
851	6.76^{A}	Like Moderately	.123^{ns}	0.885
468	6.78^{A}	Like Moderately		

*Means f the same letter is not significantly different using Least Significant Difference (LSD)

Table 31 shows that all the treatment does not differ significantly from one another. This implies that the level of acceptability of the full-fatted soybean-based Sweet Longanisa shows that generally, they are possessing similar texture. However, treatment 531 is the most acceptable treatment with a mean of 6.94 results suggesting that treatment 531 (50%) should be used in producing the product in terms of texture as it was the most accepted by the consumer. Chart of Frequency of Likeness of Full-fatted Soybean-based Sweet Longanisa is shown in Fig. 19.

Table 31. Level of acceptability in terms of the texture of soybean-based sweet longanisa

Characteristic/ TRT	Mean	DE	Fc	Sig
531	6.94^{A}	Like Moderately		
851	6.80^{A}	Like Moderately	.226^{ns}	0.799
468	6.82^{A}	Like Moderately		

*Means f the same letter is not significantly different using Least Significant Difference (LSD)

Table 32 shows the frequency of likeness of the Full-fatted soybean-based food burger patty the result shows all three treatments is equality chosen by the untrained panel with a small difference of 2% which implies that all the three treatment was acceptable by the untrained panel that all the treatment is acceptable.

Table 32. Frequency of likeness of soybean burger patty

TRT	Like f	Percentage
468	16	32.%
531	17	34.%
851	17	34.%
Total	50	100.%

Table 33 shows the association of the Demographic profile of the untrained panel in terms of Sex, age, and occupation result shows that the demographic profile of the untrained panel is not significantly associated. it implies that the demographic profile of the respondent does not affect the likeness of the respondent towards the Full-fatted Soybean-based Sweet longanisa. Regardless of the sex, age, and

occupation the Full-fatted Soybean based Sweet longaniza is acceptable to sex, age, and gender.

Table 33. Association of demographic profiles

Profile	TRT			X^2	SIG
	404	439	603		
SEX					
Male	3	5	7	1.978ns	.372
Female	13	12	10		
AGE					
Early adult	14	12	13	4.806ns	.308
Midlife	1	5	4		
Mature adult	1	0	0		
Occupation					
Employed	14	16	10	12.292ns	.139
Unemployed	0	0	1		
Self-employed	0	0	2		
Entrepreneur	1	0	0		
Student	1	1	4		

Study 3: Physical and nutritional properties of the full-fatted soybean-based products as meat alternatives

The physical and nutritional properties that were considered in the study are the moisture content, water activity, and the macro-nutrients protein, fat, and total carbohydrates. The minerals sodium, calcium, potassium, and iron were also included in the analyses. These were analyzed at the Regional Standards and Testing Laboratory at the Department of Science and Technology Regional Office No.1. This testing laboratory is PAB accredited. Other micro-nutrients such as the other minerals and vitamins were not analyzed due to logistics brought about by the community quarantine during the Covid 19 pandemic.

Moisture in foods occurs in two forms: the water bound to ingredients in the foods (proteins, salt, sugars), and free or unbound water that is available. Water activity (Aw) describes the water available for microbial growth. Water activity is a measure of how efficiently the water present can take part in a chemical reaction. The overall water activity would be reduced if half of the water is so tightly bound to a protein molecule that it could not take part in a hydrolysis reaction (Sandulachi, 2012). The water activity measurement provides important information regarding the possibility of microbiological growth on the surface. Free water in food products is responsible for the growth of undesirable organisms such as bacteria or fungi, which produce toxins or other harmful substances. Water activity ranges from 0 (bone dry) to 1.0 (pure water). When the water activity is smaller than 0.9, most molds are inhibited. Most microorganisms cease growing if water activity is smaller than 0.6. As such, the reduction of water activity will retard the growth of microorganisms, non-enzymatic browning, and enzymatic reactions (Kasai, 2014). Water could be controlled by processes such as removing water (drying or freezing), and by adding salt (curing).

The nutrients protein, fat, and carbohydrates are the macronutrients that the body needs in larger amounts to function properly. All of these nutrients provide the body with energy measured in the form of calories or kilocalories. Aside from providing energy, all of these macronutrients have specific roles in the body to function properly. Protein is a body-building nutrient that is necessary for the body to grow, build and repair tissues. Carbohydrates are hydrolyzed into glucose as the main source of energy for the body yielding 4 kcal/gram. Specific organs such as the brain need glucose as the sole source of energy. Fat is the concentrated source of energy providing 9 kcal/gram. Fat is the storage form of energy. It also cushions the vital organs, a precursor for the synthesis of certain hormones, and helps maintain cell membrane integrity. However, excessive intake of fat specifically saturated and trans fats are known to increase the risk for cardiovascular diseases. Saturated fats come from animal sources while trans-fat comes from margarine, baked, and fried foods. It is the objective of this study to develop soybean-based food products as meat alternatives with lower amounts of fat, particularly saturated fat.

The mineral sodium is of interest in a diet. It is the major cation in the extracellular fluid that maintains fluid and acid-base balance but an excessive intake of this accumulates in the extracellular fluid resulting in edema. Excess intake of sodium can raise blood pressure or hypertension, a major risk factor for heart disease. Calcium is another major mineral essential

for human nutrition. The body needs calcium to maintain strong bones and carry out vital processes such as muscular contraction, blood coagulation, nerve transmission, and enzyme activation. On the other hand, potassium is the principal cation in intracellular fluids. It maintains fluid and electrolyte balance. It is also important for carbohydrate and protein metabolism. Iron is the only micromineral analyzed in this study. Iron is the most abundant trace element in the body. One of the most important functions of iron is in hemoglobin formation, a component of the red blood cells, the carrier of oxygen needed for cellular respiration (Ruiz, A and Claudio, V., 2010). Iron-deficiency anemia (IDA) is the most prevalent micronutrient deficiency affecting a large proportion of the population in the Philippines (Palanog *et al*., 2019).

Table 34. The moisture content of soybean-based Foods

Samples of soybean-based products	Moisture content (g/100g)
Soybean-based Nuggets	48.99g
Soybean-based *Longanisa*	50.38g
Soybean-based Patties	57.75g

Moisture content was analyzed following AOAC Official Method 9455.39A. Following Official Methods of Analysis of AOAC International, 20th Edition, 2016

Moisture content

Moisture content is a measurement of the total amount of water contained in a food. It is useful in determining the dry weight of food and the ingredients. The moisture content of a food has a direct effect on the way the food is processed and its appearance, mouthfeel, and texture (Bogart, 2018). For the three soybean-based food products developed as meat alternatives, the result of analyses shows that the raw or uncooked products have a considerable amount of moisture. Soybean-based Patties have the most with 57.75 g/100g, followed by Soybean-based *Longanisa* with 50.38g/100g and Soybean-based Nuggets with 48.99g/100g (Table 34). It is expected that the moisture content will be lessened when these products will be cooked due to evaporation during cooking. Proper cooking temperature, however, is important for soybean-based food products to have the proper moistness, texture, and mouthfeel.

Table 35. The water activity of soybean-based food products

Samples of soybean-based products	Water activity
Soybean-based *Longanisa*	0.95
Soybean-based Patties	0.95
Soybean-based Nuggets	0.96

Water activity

Water activity (Aw) is an important factor in food product development because it affects the texture, taste, appearance, safety, and shelf life of foods. Results of the analysis show that the water activity of the three soybean-based food products is relatively high as follows: Soybean-based *Longanisa*, 0.95, Soybean-based Patties, 0.95 and Soybean-based Nuggets, 0.96 (Table 35).

This is similar to the study of Lewicki (2009) cited by Kasaai, (2014) that the water activity of fresh foods (meats, seafood, fresh fruits, and vegetables) is high and close to1. As stipulated, high water activity favors the growth of microorganisms such as bacteria, fungi, and molds which results in the deterioration of the products if not controlled. According to the US Food and Drug Administration, foods with a water activity above 0.95 will provide sufficient moisture to support the growth of bacteria, yeasts, and molds. Bacteria such as *Salmonella*, *Clostridium botulinum*, *Serratia*, and *Lactobacillus* grow at a water activity ranging from 0.91-0.95 while *Pseudomonas*, *Escherichia*, *Clostridium perfringens*, and *Klebsiella* grow at 0.95 to 1.0 (Bogart, H., 2018). The water activity increases with temperature (US FDA). Hence, it is recommended that soybean-based products be kept refrigerated or frozen to reduce water activity and prevent the growth of microorganisms to prolong the shelf-life.

Table 36. Macro-nutrient content of soybean-based food products

Samples of soybean-based products	Protein (g/100g)	Total carbohydrates (g/100g)	Fat (g/100g)
Soybean Patties	23.43	8.42	7.94
Soybean Nuggets	21.97	15.97	10.79
Soybean *Longanisa*	20.42	16.02	10.47

Macro-nutrient content

The three Soybean-based food products have a considerable amount of protein. Soybean-based Patties have 23.43 g/100 grams, Soybean-based Nuggets with 21.97 g/100 grams, and Soybean-based *Longanisa* with 20.42 g/100 grams (Table 36). The amount of protein of the three soybean-based products is higher than full meat Hamburger Patty with 16.6g/100 grams, Chicken Nuggets with 15.5g/100 grams, and Pork *Longanisa* with 10.7g/100 grams as analyzed by the Food and Nutrition Research Institute, Department of Science and Technology (The Philippine Food Composition Tables, 1997). The most acceptable formulation of the Soybean-based Patties has 200 grams of soybean textured, Soybean-based Nuggets have 240 grams of soybean flour and Soybean-based *Longanisa* has 160 grams of textured soybean as the main ingredients. Soybean is a good source of protein. Soy protein has a very significant amino acid composition as it complements that of cereal. Although soybeans are deficient in methionine, one of the essential amino acids, they contain sufficient lysine to complement the lysine deficiency of cereals (Lajalo and Genevese, 2002 cited by Sharma *et al.*, 2014). Soybean-based meat alternatives are best taken with cereals such as rice in a meal to get all the eight essential amino acids needed to build and repair body tissues for growth and development and regulation of body processes.

For carbohydrates, the Soybean-based *Longanisa* has the most with 16.02 g/100 grams followed by Soybean-based Nuggets with 15.97 g/100 grams, and the Soybean-based Patties has the least with 8.42 g/100 grams. Soybean seeds are also a good source of carbohydrates providing 35.9 grams/100 grams (The Philippine Food Composition Table, 1997). Aside from the soybeans that have contributed the most carbohydrates, the brown sugar added to the Soybean-based *Longanisa* has provided additional carbohydrates since brown sugar provides 98.7 g/100 grams. For Soybean-based Nuggets, the bread crumbs have provided a considerable amount of carbohydrates.

For fat, Soybean-based Nuggets and *Longanisa* have more fat content than Soybean-based Patties, 10.79g/100 grams, 10.47 g/100 grams, and 7.94 g/100 grams respectively. Soybeans have a lower amount of fat content (17.2 g/100g). The pork added to the formulation of Soybean-based *Longanisa* and Soybean-based Nuggets as well as the cooking oil and chicken egg added to all of the three products has contributed to the fat content of these meat alternatives. However, the fat contents are much lower when compared to the usual Pork *Longanisa* with 60.0 g/100 grams, Chicken Nuggets, 11.2 g/100 grams, and Hamburger Patties, 29.2g/100 grams (The Philippine Food Composition Tables, 1997).

Mineral content

The sodium content of Soybean-based Longanisa is the highest at 550mg/100grams, followed by Soybean-based Patties, 469 mg/100 grams, and Soybean-based Nuggets, 430 mg/100 grams (Table 37). The Adequate Intake (AI) for sodium is 500 mg. per day for adults aged 19 years to ≥70 years old based on the 2015 Philippine Dietary Reference Intakes (PDRI) (2018 Food and Nutrition Research Institute-DOST). Adequate Intake is the daily nutrient intake level that is based on an observed or experimentally-determined approximation of the average intake by a group of apparently healthy people that are assumed to sustain a defined nutritional state (FNRI-DOST, 2018). Additionally, the FNRI-DOST recommendation is to limit sodium intake to <2 grams in adults about the WHO Guideline on Sodium Intake for Adults and Children (2012). It must be emphasized that excessive intake of

sodium has been shown to increase blood pressure leading to hypertension. In the Dietary Approaches to Stop Hypertension (DASH) to lower or control high blood pressure, foods high in sodium should be limited. The DASH-sodium diet recommends cutting back sodium to 1,500 milligrams a day (about 2/3 teaspoon). People who followed the DASH-Sodium plan lowered their blood pressure (Beckerman, 2021). The consumption of just enough amount (100-200 grams) of these soybean-based products will provide the sodium needs of the body.

Calcium content is highest in Soybean-based Patties with 49 g/100 grams, and Soybean-based Longanisa has the least with 28 g/100 grams. The calcium contents are lower compared with usual Hamburger Patty (114g/100grams), Pork Longanisa (25 g/100grams) and Chicken Nuggets (48 g/100 grams) as analyzed by the Food and Nutrition Research Institute indicated in the the1997 Philippine Food Composition Table. To provide the Recommended Nutrient Intake (RNI) of 750 mg. of calcium per day for adults aged 19 years to ≥70 years old as well as the RNI for other age groups, other calcium-rich foods such milk, sardines, dried anchovies, small fishes and cheese should be included in the diet.

Legumes including soybeans are rich sources of potassium. The three Soybean-based products developed have a considerable amount of potassium. Soybean-based Patties have 624 g/100 grams followed by Soybean-based Nuggets with 531g/100 grams and Soybean-based Longanisa with 469 g/100 grams. Considering the recommended amount for Adequate Intake (AI) of 2000 mg/day of potassium for adults, the consumption of 100 grams of these products namely; Soybean-based Patties will provide 31.2 % of Adequate Intake level, Soybean-based Nuggets provide 26.55%, and Soybean-based Longanisa, 23.45%. The recommendation of the Food and Nutrition Research Institute- Department of Science and Technology is to increase the intake of potassium to 3,510 mg. in adults about the WHO Guideline on Potassium Intake for Adults and Children (2012). Hence, the intake of greater amounts of these products will warrant the intake of adequate potassium.

Table 37. The mineral content of soybean-based food products

Samples of soybean-based products	Sodium (mg/100g)	Calcium (mg/100g)	Potassium (mg/100g)	Iron (mg/100g)
Soybean Patties	469	49	624	0.06
Soybean Nuggets	430	40	531	0.05
Soybean *Longanisa*	550	28	469	0.05

For the trace element iron, results show that the three soybean-based products developed will provide a negligible amount. The Recommended Nutrient Intake of iron for adult females aged 19-49 years old is 28 mg./ day; 50-≥70 years old, 10 mg/day and for adult males aged 19- ≥70 years old,12 mg./day. The products will have to be consumed with other rich sources of iron to provide the daily iron needs.

Nutrition facts of the soybean-based food products per serving size

The nutrition facts for labeling the three Soybean-based products were determined. The nutrition facts will inform consumers about the nutrient content and help them choose a healthy diet. Serving sizes are standardized to make it easier to compare with similar foods. The serving size reflects the amount that people typically eat but it is not the recommended amount that a person should eat. The % Daily Value (%DV) is the percentage of the Daily Value for each nutrient in a serving of food. The Daily Values are reference amounts of nutrients to consume or not exceed each day. The % DV shows how much a nutrient in a serving of food contributes to a total diet (US FDA).

The nutrient content per serving size (50 grams/serving) of the three soybean-based products

was calculated. For energy, one serving of Soybean-based Patties provides 90 kcal., Soybean-based Nuggets will provide 120 kcal. and one serving Soybean-based *Longanisa* will provide 110 kcal. Soybean-based Patties have the least amount of total fat with 3g/50 grams. One serving of Soybean *Longanisa* will be the providing the most sodium with 275 grams. and total carbohydrate with 8 grams. One serving of Soybean-based Patties will be providing the most protein, and potassium with 11g. and 310 mg. respectively. One serving of Soybean-based Patties and Soybean-based Nuggets will provide the same amount of calcium with 20mg. The percent Daily Value based on a 2000 kilocalorie diet for some nutrients to include total fat, total carbohydrate, and sodium are shown in Table 38.

Table 38. Nutrition facts of soybean-based food products per serving size

Nutrients	Soybean patties amount	%DV	Soybean nuggets amount	%DV	Soybean *Longanisa* amount	%DV
Serving size (g)	50		50		50	
Energy (kcal)	90		120		110	
Total Fat	3g	4%	5g	7%	5g	7%
Sodium	230 mg	9%	215 mg	8%	275	11%
Total Carbohydrate	4g	1%	7g	2%	8	2%
Protein	11g		10g		10	
Calcium	20mg		20mg		10	
Potassium	310mg		265mg		230	
Iron	0mg		0mg		0mg	

Note: The % Daily Value (DV) tells how much a nutrient in a serving of food contributes to a daily diet- 2000 kilocalories a day is used for general nutrition advice.

Study 4: Cost analysis of full-fatted soybean-based products as meat alternatives

The cost analysis is performed first by looking at the production cost components of each product. The total production cost is composed of the direct materials, direct labor, and production overhead. Break-even analysis is applied next to determine the point at which profits are expected. Finally, sensitivity analysis is used to project the production cost and selling price in the future after considering various economic variables.

Direct materials cost

Direct materials are those materials and supplies that are consumed during the production of a product, and which are directly identified with such product or form part of it. The direct materials cost was calculated based on the bill of materials and the number of ingredients used for each product formulation. Tables 39 to 41 show the direct materials cost allocation for one production batch of the three product formulations namely Soybean-based Burger Patty composed of 70% soybean, Soybean-based Longganiza (Chorizo) comprising 50% soybean, and Soybean-based Nuggets with 90% soybean component. The cost per unit column is calculated by dividing the purchase price of each ingredient by its total unit of measure which is grams for dry ones and milliliters for liquids. It is then multiplied by the actual quantity of ingredients used. Table 42 shows how the cost of the soybean component of each product formulation, the textured soybean base, is calculated.

Each production batch yields an output of 510 grams for Soybean-based Burger Patty, 590 grams for Soybean-based Longganiza (Chorizo), and 570 grams for Soybean-based Nuggets, respectively. The total cost allocation is then apportioned based on the 250 grams weight of each product when packaged. The direct materials cost component therefore per 250 grams is computed at Php 31.98 for Soybean-based Burger Patty, Php 34.96 for Soybean-based Longganiza (Chorizo), and Php 25.98 for Soybean-based Nuggets, respectively, as presented in Table 43. Concerning the Full-fatted Textured Soybean Base, one batch produces 2,400 grams of output with a materials cost of Php 197.46.

Table 39. Soybean-based burger patty direct materials cost allocation

Ingredients	Unit of measure	Purchase quantity	Purchase price	Cost per unit	Quantity used	Cost allocation
Textured Soybean Base	Grams	1,000	109.98	0.11	200	22.00
Ground Beef	Grams	1,000	380	0.35	60	22.80
Distilled Water	Milliliters	18,927	25	0.00	100	0.13
Egg (large)	Piece	1	7.5	7.50	1	7.50
Iodized salt	Grams	1,000	20	0.02	5	0.10
Ground pepper	Grams	100	60	0.60	5	3.00
Palm oil	Milliliters	485	45	0.09	30	2.78
White onion	Grams	1,000	100	0.10	15	1.50
Garlic powder	Grams	30	15	0.50	5	2.50
Fresh Garlic	Grams	1,000	100	0.10	5	0.50
Dark soy sauce	Milliliters	1,000	45	0.05	15	0.68
Paprika powder	Grams	30	15	0.50	1	0.50
Beef powder	Grams	1,000	250	0.25	5	1.25
Total						65.24

Table 40. Soybean sweet longganisa (chorizo) direct materials cost allocation

Ingredients	Unit of measure	Purchase quantity	Purchase price	Cost per unit	Quantity used	Cost allocation
Textured Soybean Base	Grams	1,000	109.98	0.11	160	17.60
Ground pork	Grams	1,000	370	0.35	100	37.00
Distilled Water	Milliliters	18,927	25	0.00	100	0.13
Egg (large)	Piece	1	7.5	7.50	70	7.50
Iodized salt	Grams	1,000	20	0.02	5	0.10
Ground pepper	Grams	100	60	0.60	5	3.00
Palm oil	Milliliters	485	45	0.09	30	2.78
White onion	Grams	1,000	100	0.10	15	1.50
Garlic powder	Grams	30	15	0.50	10	5.00
Fresh Garlic	Grams	1,000	100	0.10	5	0.50
Dark soy sauce	Milliliters	1,000	45	0.05	15	0.68
Paprika powder	Grams	30	15	0.50	5	2.50
Pork powder	Grams	1,000	235	0.24	5	1.18
Cane vinegar	Milliliters	1,000	35	0.04	15	0.53
Brown sugar	Grams	1,000	48	0.05	45	2.16
Longganisa casing	Grams	20,000	600	0.03	11.7	0.35
Total						82.50

Table 41. Soybean nuggets direct materials cost allocation

Ingredients	Unit of measure	Purchase quantity	Purchase price	Cost per unit	Quantity used	Cost allocation
Textured Soybean Base	Grams	1,000	109.98	0.11	240	26.40
Ground pork	Grams	1,000	370	0.35	20	7.40
Distilled Water	Milliliters	18,927	25	0.00	100	0.13
Egg (large)	Piece	1	7.5	7.50	70	7.50
Iodized salt	Grams	1,000	20	0.02	5	0.10
Ground pepper	Grams	1,00	60	0.60	5	3.00
Palm oil	Milliliters	485	45	0.09	30	2.78
White onion	Grams	1,000	100	0.10	15	1.50
Garlic powder	Grams	30	15	0.50	10	5.00
Fresh Garlic	Grams	1,000	100	0.10	5	0.50
Pork Powder	Grams	1,000	235	0.24	15	3.53
Breadcrumbs	Grams	1,000	45	0.05	30	1.35
Total						59.23

Table 42. Full-fatted textured soybean base direct materials cost allocation

Ingredients	Unit of measure	Purchase quantity	Purchase price	Cost per unit	Quantity used	Cost allocation
Soybean flour	Grams	1,000	60	0.06	1,500	90.00
Gluten flour	Grams	1,000	230	0.23	450	103.50
Distilled Water	Milliliters	18,927	25	0.00	100	0.66
Iodized Salt	Grams	1,000	20	0.02	15	0.30
Ground pepper	Grams	1,000	60	0.60	5	3.00
Total						197.46

Table 43. Direct materials cost

Products	Total Materials cost	Yield per batch (in grams)	Materials cost per gram of yield	Direct Materials cost per 250 grams pack output
Soybean Burger Patty	65.24	510	0.13	31.98
Soybean Sweet Longganisa	82.50	590	0.14	34.96
Soybean Nuggets	59.23	570	0.10	25.98

This is the basic component of all three products. It takes an hour to produce one batch of output. It has a direct labor cost allocation of Php 47.50 and an overhead of Php 19.00 allocated based on 40% of labor. The total production cost of a Full-fatted Textured Soybean Base is Php 263.96 per batch or Php 0.11 per gram. This means that 1,000 grams of the soybean base have a cost of Php 109.98.

Direct labor and production overhead cost

Direct labor refers to the salaries and wages paid to workers directly involved in the manufacture of a specific product. The direct labor component is computed based on the minimum wage in the Cordillera Administrative Region of Php 380 per day or Php 47.50 per hour (DOLE, 2022). It is estimated that an hour is needed to produce three batches of Soybean Burger Patty and Soybean nuggets. On the other hand, two and a half batches of Soybean Sweet Longganisa are produced in an hour. The labor allocation is then computed at Php 7.76 for the Burger Patty, Php 8.05 for the Sweet Longganisa, and Php 6.94 for the Nuggets. The production overhead component is applied at 40% of the cost of direct materials cost. The overhead cost encompasses all other indirect expenses such as cooking gas, utilities, depreciation of equipment and machinery used, rent, normal spoilage and wastage, packaging materials, and other selling and administrative expenses that can be traced to the product that are not otherwise part of direct materials or direct labor. The computation of direct labor and production overhead is presented in Table 44.

The final output is projected to cost Php 42.85 for the Burger Patty, Php 46.23 for the Sweet Longganisa, and Php 35.70 for the Nuggets as presented in Table 45. The markup is initially set at 50% of production cost, using the cost-plus pricing method. The cost-plus pricing method is the simplest pricing strategy where the selling price of a product is determined by adding a specific fixed percentage to the product's unit cost.

The resulting estimated selling price range is still lower compared to the prices of other similar commercially available products on the market as shown in Table 46. The soybean-based nuggets had the biggest price advantage as it is almost half of the average price of a meat-based commercial product. Common products that are readily available in markets were first identified. Then a survey was conducted to determine their price in 250-gram packs both for the meat-based and non-meat variants. Those that do not have variants of 250 grams were adjusted according to their packing weight. All samples were collected from local public markets and grocery stores to establish the average prices. Details of the survey are presented in the appendices.

Table 44. Direct labor cost and production overhead

Products	Direct Labor cost per hour	Production time per batch (in hours)	Labor cost per gram of yield	Direct Labor Cost per 250 grams portion	Overhead Cost Allocation (40% of Direct Labor)
Soybean Burger Patty	47.50	0.33	0.031	7.76	3.10
Soybean Sweet Longganisa	47.50	0.40	0.032	8.05	3.22
Soybean nuggets	47.50	0.33	0.028	6.94	2.78

Table 45. Total product cost and estimated selling price

Products	Direct Materials Cost	Direct Labor Cost	Production Overhead	Total Production Cost	Estimated Selling Price (50% mark-up)
Soybean Burger Patty	31.98	7.76	3.10	42.85	64.27
Soybean Sweet Longganisa	34.96	8.05	3.22	46.23	69.34
Soybean nuggets	25.98	6.94	2.78	35.70	53.55

Table 46. Average price of similar commercial products in the market

Products	Similar Meat-based Products' average price	Similar Meat-free Products' average price
Burger Patty	78.03	146.52
Longganisa (Chorizo)	72.11	116.88
Nuggets	102.50	149.23

Break-even point

Breakeven analysis is a useful tool to support businesses in identifying business scenarios and help managers to issue business decisions in the short term and long term in various ranges (Tang Tri *et al.*, 2016). The break-even point in economics, business, and specifically cost accounting, is the point at which total cost and total turnover are equal: there is no net loss or gain, and one has "broken even." Once achieved break-even point, the marginal turnover per unit of product sold is the profit (Potkany *et al.*, 2015). This means that the contribution margin of every product sold beyond the break-even point contributes goes directly to profits. Of the three products, Soybean-based Burger Patties has the highest contribution margin at Php 24.53 per unit. This means that if there are resource restrictions, it should be prioritized over the other two products as it is more profitable. The break-even point in units is derived by dividing the total fixed costs per month by the contribution margin. Assuming that the three products have the same production volume thus the fixed costs are divided equally among them. The fixed monthly costs comprise the depreciation of the equipment and machinery used in production, rent, and other fixed expenses. Fixed costs are those that are incurred regardless of the volume of production.

Table 47. Computation of break-even point

Particulars	Soybean Burger Patties	Soybean Longganisa	Soybean Nuggets
Monthly fixed costs	2,666.67	2,666.67	2,666.67
Selling price	64.27	63.76	46.41
Variable costs	39.74	45.02	32.92
Contribution margin	24.53	18.74	13.49
Break-even point (in units)	109.00	142.00	198.00
Break-even point (in pesos)	7,005.17	9,053.92	9,188.83

The contribution margin shows how much additional revenue is generated by making each additional unit product after the company has reached the breakeven point and is computed by deducting all variable costs from the selling price. Variable cost is a cost that varies concerning production volume. Table 47 reveals that 109, 142, and 195 units of Soybean burger patties, longganisa, and nuggets, respectively, have to be sold to break even. That involves monthly sales totaling Php 25,247.93 for all three products to cover the fixed monthly expenses estimated at Php 8,000. It is broken down into Php 7,000 hypothetical rent

for the production area, depreciation of machinery and equipment of Php 833.33, and the remaining Php 166.67 representing other fixed expenses.

Sensitivity analysis

Price changes have an impact not only on the company itself but also on its suppliers and competitors. The price of a product may change depending on many factors but the most obvious reason is its changing production cost. The company's market share is conditioned not only by brand building but also by the right pricing decisions and price changes, the selection of which can be made using sensitivity analysis (Majerova, 2015). Kubjatkova (2020) posited that sensitivity analysis is based on an explicit representation of the influence of risk factors on the effects of the project or profit, expressed, for example, by the profitability of the project or by market share. A sensitivity analysis for three years is conducted as part of the cost analysis to reflect the effect of inflation and other risks on the three products. This will aid in many facets of decision making such as cost control, looking for cheaper sources of raw materials, devising appropriate marketing strategies, and other relevant business decisions. The estimates are based on trends in the increase of all aspects of production.

Table 48. Projected production cost and selling price for year 2 operations

Products	Direct Materials Cost	Direct Labor Cost	Production Overhead	Total Production Cost	Estimated Selling Price (50% mark-up)
Soybean Burger Patty	33.70	8.17	3.27	45.14	67.71
Soybean Sweet Longganisa	36.98	8.47	3.39	48.85	73.27
Soybean Nuggets	27.11	7.31	2.92	37.35	56.02

Table 49. Projected production cost and selling price for year 3 operations

Products	Direct Materials Cost	Direct Labor Cost	Production Overhead	Total Production Cost	Estimated Selling Price (50% mark-up)
Soybean Burger Patty	35.38	8.17	3.27	46.82	70.23
Soybean Sweet Longganisa	39.04	8.47	3.39	50.91	76.36
Soybean Nuggets	28.14	7.31	2.92	38.38	57.57

Table 50. Projected production cost and selling price for year 4 operation

Products	Direct Materials Cost	Direct Labor Cost	Production Overhead	Total Production Cost	Estimated Selling Price (50% mark-up)
Soybean Burger Patty	37.41	8.87	3.55	49.83	74.75
Soybean Sweet Longganisa	41.41	9.20	3.68	54.29	81.44
Soybean Nuggets	30.05	7.94	3.17	41.16	61.74

Table 51. Summary of production cost and selling price projected for 3 years

Products	Year 2		Year 3		Year 4	
	Production Cost	Selling Price	Production Cost	Selling Price	Production Cost	Selling Price
Soybean Burger Patty	45.14	67.71	46.82	70.23	49.83	74.75
Soybean Sweet Longganisa	48.85	73.27	50.91	76.36	54.29	81.44
Soybean Nuggets	37.35	56.02	38.38	57.57	41.16	61.74

Concerning the direct materials cost, the average meat inflation rate computed from the data published by the National Economic Development Authority (NEDA) for the last two years (2020-21) and the first six months of the year (2022) of 8.58% was used in projecting the price of meat as a raw material.

The average general food inflation rate for the same period of 3.79% is used to adjust the cost of the other remaining ingredients. The same inflation rates were also used to project year three and four production costs. The average inflation rates are presented in the appendices. Concerning the direct labor cost, the

hourly rate is increased to Php 50 for the second and third years of operations and is projected to increase further to Php 54.29 in the fourth year of operations.

This complies with the minimum wage second tranche increase to Php 400 per day starting January 2023 based on Wage Order Number RB-CAR-21 issued by the Regional Tripartite Wages and Productivity Board of the Department of Labor and Employment applicable to private sector workers in certain areas of Cordillera Administrative Region such as Baguio City, Tabuk City, and the Municipality of La Trinidad (DOLE, 2021). The minimum wage effective June 14, 2022, is Php 380 per day. For year four, a labor rate increase of 8.57% is estimated based on the labor rate increase used in the Wage Order Number RB-CAR-21. The Production Overhead follows the increase in the direct labor cost where it is based at 40%. The projected production cost and estimated selling price for years two, three, and four are presented in Tables 48, 49, and 50, respectively. The details of the computation of projected production costs are found in the appendices.

From the projected figures presented in Tables 48 to 50, it can be inferred that there is a slight increase in the cost and selling price for the future production periods caused by the abnormally high inflation rate experienced by the country which started from the end of 2020 displaying the effects of the Covid-19 pandemic. Table 51 below summarizes the trend in the projected cost and selling increases for the four years.

Table 51 shows that from the actual production cost and selling price of Php 42.85 and Php 64.27, respectively for Soybean Burger Patty and it is projected to cost Php 49.83 and sell at Php 74.75 by year 4 of operations with an increase of 16.29%. For the Soybean Sweet Longganisa, its actual production cost and estimated selling price of Php 46.23 and Php 69.34, respectively, are projected to increase to Php 54.29 and sell at Php 81.44 by year 4 of operations with an increase of 17.43%. For the Soybean Nuggets with a production cost and selling price of Php 35.70 and Php 69.34, it is projected to cost Php 41.16 and sell at Php 61.74 by year 4 of operations with an increase of 15.29%.

Study 5: Shelf-life analysis of full-fatted soybean-based products as meat alternatives

The food product samples underwent the process of Serial dilution to determine the estimated colonies of the organism of an unknown sample in serial dilution, the density of the colonies is reduced in each step for easy calculation of the concentration of the cells from the original solution by calculating the dilution over the entire series. The serial dilution process was performed to avoid having to pipette a very small volume (1:10 µl) to make a dilution of a solution. diluting a sample in a controlled manner we can determine the number of sample present number colonies in the Petri film.

Period of trial

The result of the rapid aerobic count and rapid yeast and mold of the soybean-based Sweet Longanisa shows a significant countable range of colonies by the reciprocal of the dilution used. The change of microbial count at week 9 at $331x10^3$ shows a controlled environment for the product sample during the stages of the processing of the product it shows a satisfactory level of food safety concern (Table 52).

Table 52. Soybean-based burger patty

Time	Rapid aerobic count (CFU/g) ml	Rapid yeast and mold (CFU/g) ml
Week 1	0	0
Week 3	0	0
Week 5	$36x10^3$	0
Week 7	$67x10^3$	$2x10^3$
Week 9	$69.5X10^3$	$1x10^3$

Table 52 below shows the succeeding duration of the soybean-based burger patty during the period of trial. A trace of the aerobic count was detected at week 5 at $36x10^3$ until week 9 with $69x10^3$ thus a guide in calculating *the Shelf life of food (New Zealand food safety Authority)* indicates in the Guidelines for the microbiological examination of ready-to-eat food that the level 2 where the product was categorized and has

a microbiological quality (CFU per gram) of $<10^6$ to $\geq 10^7$. Thus, results show minimal aerobic count which indicates that the product is safe for consumption until the time of trial.

Table 52. Soybean-based sweet longanisa

Time	Rapid aerobic count (CFU/g) ml	Rapid yeast and mold (CFU/g) ml
Week 1	0	0
Week 3	0	0
Week 5	$4x10^3$	0
Week 7	$21.5x10^3$	$1x10^3$
Week 9	$331x10^3$	$1 x10^3$

Application of Standard of rapid aerobic plate count at (30^0f /24 hours level and Rapid Yeast and mold test at 28 ^{0} for 48 hours).

Microbial changes in Soybean-based nuggets are shown in Table 53. The initial count of the rapid aerobic microbial count was at a low level while they are increased during the time it did not reach the maximum limit of $<10^6$ *to* $\geq 10^7$ after the 9 weeks trial duration. The opening of the environment might cause rapid growth of microbes. However, it could be inferred with the water activity a_w level of the soybean-based food products where the a_w of the product relates to the susceptibility to spoilage.

Table 53. Soybean-based nuggets

Time	Rapid aerobic count (CFU/g) ml	Rapid yeast and mold (CFU/g) ml
Week 1	0	
Week 3	0	0
Week 5	0	0
Week 7	$426x10^3$	0
Week 9	$393x10^3$	$1x10^3$

Application of Standard of rapid aerobic plate count at (30^0f /24 hours level and rapid yeast and mold count at (28 ^{0} for 48 hours).

M table

Table 54 shows the survival analysis estimation of shelf life. As expected, shelf life decreases when the storage duration increases. Considering the shelf-life for a 6-point rejection level to the overall acceptability of the products, the statistical analysis showed a shelf life of 8 weeks even when the study was carried out for 9 weeks.

Table 54. Overall acceptability

	Week	Mean	Std. Dev.
Overall acceptability	1	9.00	.00000
	2	9.00	.00000
	3	8.50	.53452
	4	8.00	.00000
	5	7.75	.46291
	6	7.75	.46291
	7	7.62	.51755
	8	7.25	.46291
	9	6.25	.88641

Study 6: Pilot testing and commercialization of full-fatted soybean-based products as meat alternatives

A. Technology Transfer/Training conducted

The transfer of technology to identified/interested households/entrepreneurs for the adoption of the technology is one way to promote alternative meat products for a healthier lifestyle as well as for additional livelihood opportunities.

Fig. 18. Presentation of the objectives of the research projects, and lecture on the results of the studies on the consumer behavior, nutrient analysis, and the cost analysis. Afterwards, the training on the product development follows

The training was conducted on ten (10) participants from the Kibungan Employees Multipurpose Cooperatives (KEMPC), Kibungan, Benguet. During the training, lectures on consumer behavior and

nutrient analysis, demonstration, and return demonstration on the three (3) developed full-fatted soybean-based food products were conducted.

Fig. 19. Technology transfer/Hands-on training on the developed full-fatted soybean-based food products conducted in Kibungan Employees Multipurpose Cooperatives (KEMPC), Kibungan, Benguet on December 13-14, 2021.

B. Training conducted

Fig. 20. Photo documentation during the training on meat processing with African swine fever awareness campaign sponsored by the department of agriculture – Agricultural Training Institute to 30 Women's Association in Baguio City, on July 21, 2022.

C. Focus Group Discussion/Interview on the Adoption and Commercialization

During the focus group, discussion and interview with the six (6) trained/adoptees and two (2) officers of the Kibungan Employees Multipurpose Cooperatives (KEMPC), Kibungan, Benguet on July 26, 2022, on the adoption and commercialization of the developed full-fatted soybean-based food products as meat alternatives, majority of the participants shared that they need assistance in marketing the soybean-based products.

Fig. 21. Focus Group Discussion on the adoption of the developed full-fatted soybean-based Food

Products as Meat Alternatives was conducted with the KEMPC BOR Chair Mr. Macario and Ms. Wakat the KEMPC Manager on July 26, 2022.

Fig. 22. Focus group discussion on the impact of the technology transfer and training as well as the commercialization of the developed full-fatted soybean-based Food Products as Meat Alternatives was conducted with the trainees/adopters on July 26, 2022.

The majority of the participants mentioned that the lack of soybean supplies in the region particularly in the Municipality of Kibungan is the main challenge on their part as adoptees.

Conclusion

In general, consumers in the locality regardless of age, sex, educational attainment, and household income are willing to buy soybean-based products as meat alternatives when available. Following the multidisciplinary model of the main factors affecting consumer behavior in a food domain, psychological (individual), sensory (product-specific) and marketing (environment) factors will highly affect the preference and purchase of soybean-based food products as meat alternatives among consumers in Baguio City and Benguet Province. The nutritional value, health benefits, affordability, and taste of the product are the top most important factors that are considered by the consumers.

Soybean foods and soybean products (especially fermented soyfoods) exhibit significant contributions to human welfare. Many issues, however, need to be addressed, including the safety of microorganisms, economic analysis of various innovations, government regulations (e.g., labeling), and clinical experiments, to realize and sustain its commercialization.

This study was conducted to increase the utilization of Locally Non-GMO Soybean in the Philippines Specially It Aims to characterize and produced Soybean based food products as a meat alternative in terms of Color Mouthfeel, taste, and texture and to determine the most acceptable treatment sample. Three different treatments were produced based on the preparation of three different soybean-based meat alternatives these were made using different kinds of methods of preparing the products, addressing the sensory evaluation, and 50 untrained panels were selected using a random full block design.

The researchers of Full-fatted soybean-based products as meat alternatives conducted a sensory evaluation to determine the consumer acceptability of the following: full-fatted soybean-based burger patty, full-fatted soybean-based Sweet Longanisa, and Full-fatted soybean-based nuggets. The products were subjected to sensory evaluation to determine their acceptability in terms of color, mouthfeel, texture, taste, and overall acceptability using the randomized complete full-blocked design. The result of the study showed that the three products have different acceptability results.

Based on the findings of the study, it is concluded that there is a great potential for the full-fatted soybean-based food product as a meat alternative to be viable in Baguio and Benguet. This conclusion is based on the prevailing condition of the high acceptability of the product and can be promoted as a healthy food. The difference between and among the full-fatted soybean-based food product varied in different methods of cooking. The method used in cooking affects the ratio of soybean-based flour. There is a high significance between and among the Soybean-based Food product as a meat alternative in terms of their characteristic attributes.

Recommendations

1. Based on the findings of the study, the full-fatted soybean-based food products as meat alternatives accessibility by having these products available in the wet market or to be supplied directly by local entrepreneurs.
2. The soybean-based food products should be properly labeled to include the nutritional value and health benefits.
3. Farmers in the region and nearby regions are encouraged to plant soybean.
4. Conduct a further study of the Full-fatted Soybean Based Food product as a meat alternative.

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