THE STUDY OF NUTRITIONAL VALUE AND SENSORY PROPERTIES OF BABY COOKIES PREPARED FROM SWEET YELLOW CORN (*Zea mays L.)* AND MUNG BEANS (*Vigna radiata*)

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MASTER PROGRAM IN FOOD SCIENCE AND TECHNOLOGY

FACULTY OF AGRICULTURE

HASANUDDIN UNIVERSITY

MAKASSAR, INDONESIA

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Prepared and submitted by

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To

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STATEMENT OF AUTHENCITY OF THESIS

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ABSTRACT

THE STUDY OF NUTRITIONAL VALUE AND SENSORY PROPERTIES OF BABY COOKIES PREPARED FROM SWEET YELLOW CORN (*Zea mays L.)* AND MUNG BEANS (*Vigna radiate*)

Corn contains 9.8% protein, 7.3%, fat, and 69.1% carbohydrates, and mung beans contain 22.9% protein, 1.5% fat, and 56.8 carbohydrates. Both of these ingredients can be processed into flour for making cookies that will be suitable for babies and toddlers that have reached the stage for solid food. The research study was conducted using two products of sweet yellow corn and mung beans to develop baby cookies. this study aimed to analyze the nutritional value and evaluate the sensory properties of the cookies. in this research, a different formulation of the cookie mixture was prepared by altering the level of baby cookies with sweet yellow corn and mung bean flour. The experimental design that was used was the Randomized Block Design. The formulation (corn: mung bean) applied were; 60:40%, 55:45%, 45:55%, and 40:60%. The evaluations of sensory properties, including texture, taste, color, and aroma, were asses by 20 nursing mother panelists by using the hedonic scoring scale. Considering an equal proportion of nutritional value for good baby food, a 55% corn and 45% mung bean ratio will be best for baby food. They are both economical and will be in range for most nursing mothers. While results from the sensory evaluations shows, there is not much difference in the four formulations of the attributes of the cookies.

Keywords: Baby Food, Nutrition, Organoleptic Properties

ABSTRAK

KAJIAN NILAI GIZI DAN SIFAT SENSORI KUE BAYI YANG DIPROSES DARI JAGUNG KUNING MANIS (Zea mays L.) DAN KACANG HIJAU (Vigna radiate)

Jagung mengandung 9,8% protein, 7,3% lemak, dan 69,1% karbohidrat, sedangkan kacang hijau mengandung 22,9% protein, 1,5% lemak, dan 56,8 karbohidrat. Kedua bahan ini dapat diolah menjadi tepung untuk membuat kue kering yang cocok untuk bayi dan balita yang sudah mencapai tahap untuk makanan padat. Penelitian ini bertujuan untuk menganalisis nilai gizi dan mengevaluasi sifat sensoris cookies yang dihasilkan. Pada penelitian ini, dibuat formulasi campuran cookies yang berbeda dengan mengubah kadar tepung jagung kuning manis dan kacang hijau pada pembuatan cookies bayi. Rancangan percobaan yang digunakan adalah Rancangan Acak Kelompok. Formulasi (jagung:kacang hijau) yang digunakan adalah; 60:40%, 55:45%, 45:55%, dan 40:60%. Evaluasi sifat sensorik, termasuk tekstur, rasa, warna, dan aroma, dinilai oleh 20 panelis ibu menyusui dengan menggunakan skala penilaian hedonik. Dengan mempertimbangkan proporsi nilai gizi yang sama untuk makanan bayi yang baik, rasio 55% jagung dan 45% kacang hijau adalah yang terbaik untuk makanan bayi. Keduanya ekonomis dan berada dalam jangkauan sebagian besar ibu menyusui. Sementara hasil dari evaluasi sensorik menunjukkan, tidak banyak perbedaan dalam empat formulasi atribut biskuit.

Kata kunci: Makanan Bayi, Gizi, Sifat Organoleptik

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CHAPTER I

INTRODUCTIONS

1.1. Background

Maize or corn *(Zea mays L.)* is an important annual cereal crop of the world belonging to the family Poaceae. Zea is an ancient Greek word that means “sustaining life” and Mays is a word from the Taino language meaning “life-giver.” It is considered a staple food in many parts of the world. Maize has a nutritional value, which contains about 70-87% (carbohydrates) starch (amylose and amylopectin), 6-13% protein, 4% fat, 2-6% oil, and 1-3% sugar. The nutritional quality of maize also depends upon the processing method used for food preparations. Maize like wheat and rice is also used in supplementary nutrition programs and integrated child development service programs to feed malnourished children. (Budak et al., 2018b)

Mung beans (*Vigna radiate)* are a nutritionally diverse food that belongs to the legume family. They are mainly cultivated in Asia, Africa, and South America, but mung beans are enjoyed by people all around the world. Like other types of legumes, mung beans are a rich source of plant-based protein, complex carbohydrates, fiber, and other nutrients. It has been consumed as a diet worldwide and plays a vital role in human nutrition, especially as a good source of protein (20.97–32.6%) and active compounds. The mung bean protein has been identified as an effectively excellent source of amino acids, and the essential amino acids in particular, in which many kinds of cereals are deficient. (Shi et al., 2016a)

In Africa, especially Sierra Leone, one of the main problems among nursing mothers is access to a portion of well nutritional, economical, and easily accessible food for weaning their babies. This has led to a high percentage of malnourish children on the continent. According to At least 1-3, children and under-five in Africa are stunted. Because there’s no safe, appropriate, and high-quality complementary food.

One of the main plant products that may be easily acquired in Africa are sweet yellow corn and mung beans. It presents fewer financial difficulties and is simple to process for infant food. Although their nutritional contents have been studied, nothing is known about how both ingredients can be combined to create baby-weaning meal. Both ingredients will be turned into flour in these trials, which may be used to make cookies that are healthy for infants and toddlers who are ready for solid meals. Additionally, the correct ratio of mung beans to sweet yellow corn can differ in terms of nutritional value, making it appropriate for a baby. Making baby food with mung beans and sweet yellow maize, will allow parents to experiment with new ingredients and modify recipes to suit their child's preferences, which is another novel finding. This enables parents to introduce their infant to a range of handmade vegetables and alter the texture of their baby's diet.

1.2. PROBLEM FORMULATIONS

Solid food provides babies with all the nutrition and energy they need for proper growth and development. Most baby food may be suitable for babies, but not all is good for them. Based on the background on corn and mung bean above, they can be used to solve some of the problem formulations towards that:

In this study, it will be determined the efficiency in suitability of corn flour and mung bean for making baby cookies (food).

The study of their nutritional value and their effectiveness for babies.

The evaluation of their sensory properties.

1.3. PURPOSE

The aim and purpose of this study are:

To process sweet yellow corn and mung bean into flour, and use different formulations to make baby cookies.

To analyze the nutritional content of sweet yellow corn and mung bean flour, which will be used for making cookies that are suitable for baby food, and to evaluate the sensory properties in it.

To highlight its nutritional benefits for babies.

1.4. BENEFITS

The benefits of this research are:

Through the process, procedures, and results of this research, readers especially nursing mothers can know the steps, and formulations of making baby cookies not only from sweet yellow corn and mung bean but from other plant products.

Readers can know the nutritional value of sweet yellow corn and mung bean and how they are important in a baby’s well-being and growth and know their health benefits

Knowing their organoleptic properties.

CHAPTER II

LITERATURE REVIEW

2.1. Sweet Yellow Corn (Maize)

Maize (*Zea mays* L.) is one of the most important cereal grains grown worldwide in a wider range of environments because of its greater adaptability. As the leading cereal crop in the world, corn (*Zea mays* L.) plays a significant role in human foods. Corn known as maize to many people is the leading cereal crop in the world followed by rice and wheat. It is an important crop for human consumption, particularly in developing countries, and also the leading source of livestock feed and bioenergy crops for ethanol production. Usually grown for the fresh or canned food industry sweet corn (*Zea mays* saccharata Sturt.) was developed by agriculture as a source of human food consumption, corn terms of gaining weight.

Sweet corn is favorable for fresh consumption because of its delicious taste and soft and sugary texture compared to other corn varieties. The sugar of corn contains a high amount of nutrients within the body, especially during the high amounts of sugar in the milk stage, the club holds the endosperm. In a study, 100 grams of fresh corn contained 9g protein, 1g sugar, 7g fiber, 5g fat, 15% calcium 1% vitamin A, and iron has been reported. In another study, 100 grams of corn contained 3g protein, 3g sugar, 3g fiber, 1g fat, 4% vitamin A and to be 3% iron is reported. Another analysis made Corn of 150 grams had 55.5g of magnesium, phosphorus, iron, 150gr 6% 1.2mg vitamin, vitamin B2, B1 and0.23mg, 0.15mg have been reported. A study to determine some of the physical and chemical properties have reported that it varies between protein ratios of 4.9%-7.1% between the starch ratio of 68.6-75.5% and between the humidity of 11.1%-18.2% a widely used in Turkey corn flour.

Corn also found some of the benefits of vitamins and minerals are known to be many. Vitamin A (retinol), the immune system, bone development, including many of the functions involved is an important vitamin. Vitamin A has healthy skin and body tissues and strengthens the immune system, it is necessary for a healthy bone structure, as an antioxidant activity by making the cells protect against cancer and other diseases, to slow down the aging process. Vitamin A is a fat-soluble vitamin that is also a powerful full antioxidant. Vitamin A plays a critical role in maintaining healthy vision, neurological function, healthy skin, and more. Vitamin A- like all antioxidants is involved in reducing inflammation by fighting free radical damage.

B vitamins easier digest fats, and prevent the formation of diarrhea. In addition, relaxes the nerves, skin, and nails in a bright, vibrant, and alive. B vitamins B1, B2, B6, and B12 vitamins have called them. This group of vitamins, appetite, digestive and nervous systems a much needed and vital. Grains, lean meat, kidney, heart, brain, liver, peanuts, chicken, walnuts, eggs, whole wheat, and oilseeds have B group vitamins. B vitamins also especially are necessary for the power of learning and memory and concentration.

Vitamin C (Ascorbic Acid) involved in many functions strengthening the immune system, such as the development of bones and teeth is an important vitamin. In the body of the bones, teeth, skin, and joint development and empowerment. Heals wounds and textures. It is protective against cancer and heart disease. Strengthens the immune system. Increases resistance to diseases. In energy production and the production of hormones to stress. Especially for children helps to grow and evolve. Clears the blood poison. Reduces blood pressure. Reduces the amount of sugar in the blood. Vitamin C, sodium, potassium, calcium, and phosphorus as well as the use of vitamins and minerals are also required for more effectiveness. It also provides for the protection of the cells and remains healthy. (Budak et al., 2018a).

2.2. Mung Bean

The mung bean (*Vigna radiata* L.) is one of the most important edible legume crops, grown on more than 6 million ha worldwide (about 8.5% of the global pulse area) and consumed by most households in Asia. Due to its characteristics of relatively drought-tolerant, low-input crop, and short growth cycle (70 days or so), the mung bean is widely cultivated in many Asian countries (concentrated mainly in China, India, Bangladesh, Pakistan, and some Southeast Asian countries) as well as in dry regions of southern Europe and warmer parts of Canada and the United States. In the predominantly cereal-based diets of China and India, mung bean has been consumed as a common food for centuries. The mung bean contains balanced nutrients, including protein, dietary fiber, minerals, vitamins, and significant amounts of bioactive compounds.

Mung bean cultivars contained 20.00%–24.27% protein. Bailyu 6 had the highest protein content, and Bao 942-34 had the lowest protein content. Our results were consistent with those of Dahiya et al., who determined that there is 18%–23% protein in mung bean flour. The total starch content of these 20 mung bean cultivars ranged from 40.6% to 48.9% of the seed. The amylose accounted for 12.5%–35.4% of total starch. These results were in agreement with that of Hoover et al, who observed that the total starch content was 45.3% and the amylose content accounted for 39.8% of total starch in mung bean. Resistant starch accounted for 16.1%–22.3% of total starch, and the Inner Mongolia mung bean cultivar contained the highest resistant starch content. The fat and fatty acid content of 20 mung bean cultivars. The Jilyu 3 cultivar showed the highest fat content, 7.24 ± 0.11 mg g^{-1}, and the Jinlyu 3 cultivar had the lowest, 5.63 ± 0.27 mg g^{-1}. There were clear differences in the fatty acid contents of the 20 mung bean cultivars. In agreement with these results, Zhang et al. reported that the fat content of mung beans ranged from 3.2 to 7.5 mg g^{-1}. Palmitic acid and linoleic were the two dominant fatty acids in all beans, and their mean contents were 32.4% and 36.1%, respectively. (Shi et al., 2016)

For those individuals who cannot afford animal proteins or those who are vegetarian, the mung bean is comparatively low-cost and has a good source of protein for them. Furthermore, mung bean protein is easily digestible, as compared to protein in other legumes. The mung bean induces less flatulence and is well tolerated by children. In many studies, mung bean was recommended as a supplement for preparing an infant's weaning food because of its high protein content and hypoallergic properties. In Pakistan, approximately 25% of all iron in the diet is provided by pulses and mung bean is consumed by all households. (Hou et al., 2019a)

The mung bean has been consumed as a diet worldwide and plays a vital role in human nutrition, especially as a good source of protein (20.97–32.6%) and active compounds. The mung bean protein has been identified as an effectively excellent source of amino acids, and the essential amino acids in particular, in which many kinds of cereals are deficient. It can be served as a staple food in India and Pakistan, called "dhal", which meets people's daily needs for protein and provides sufficient bioavailability. The rich nutrients of the mung bean, such as minerals, iron, dietary fiber, and significant amounts of bioactive phytochemicals also make it a good alternative function food. Furthermore, the polyphenols, polysaccharides, and polypeptides contained in the mung bean all exert antioxidant activity, which can contribute to disease prevention. To date, the mung bean and its extracts have shown excellent health implications, such as hypoglycaemic and hypolipidemic effects and antihypertensive, anticancer, anti-melanogenesis, hepatoprotective, and immunomodulatory activities.

2.3. Amino Acid Content in Mung Bean

Regarding prospective applications for mung bean proteins and peptides, there hasn't been a thorough literature assessment done yet. Early studies assessed the nutritional content of mung beans against the Food and Agriculture Organization of the United Nations (FAO)/World Health Organization (WHO) amino acids dietary requirements because mung beans have been utilized as a food source for a long time. Except for methionine and cysteine deficiency, the comparison showed that mung beans are a good source of protein. Through the use of protein engineering, methionine, and cysteine residues have been inserted into the 8S globulin. Purified mung bean proteins and peptides have subsequently made it easier to research their structural and functional characteristics. In the meantime, a small number of studies have identified additional beneficial bioactivities for proteins and hydrolyzed peptides, such as trypsin inhibitory action, angiotensin-converting enzyme inhibitory activity, and anti-fungal activity. As a result, several hydrolyzed mung bean peptides have been used as efficient food additives to stop proteolysis during storage. In the end, more investigation will uncover additional nutritive, functional, and bioactive qualities of mung bean for utilization in a variety of applications.(Ahmed & Hasan, 2014)

Increased consumption of plant-based meals has been advised by numerous health organizations around the world to help prevent chronic diseases and to enhance general human health. Various plant-based functional foods have since been added to health care initiatives. Though trypsin inhibitors and low methionine concentration are assumed to be the main causes of the low protein efficiency ratio of mung beans, large amounts of proteins and amino acids are thought to be the key contributors to its nutritious content. Additionally, angiotensin-converting enzyme inhibitory activity, as well as anti-fungal and/or antibacterial activities, have been observed for mung bean proteins and peptides. Mung bean seeds have historically been primarily used as a food source, but more recently, mung bean extracts, particularly protein and peptide isolates, have drawn attention to a variety of new applications.

2.4. Characteristics of legumes

The primary source of food for humans, after cereals, are legume seeds, also known as pulses or grain legumes (Poaceae). When it comes to nutrition, these have a higher protein content than cereal grains. Legumes and cereals together meet the body's needs for protein completely. When it comes to nutrition, these have a higher protein content than cereal grains. Legumes and cereals together meet the body's needs for protein completely. While lentils, pigeon peas, and chickpeas are significant food sources in South Asia, kidney beans are a key food source in Latin America. Similarly, in the Middle East and North Africa, chickpeas, lentils, and fava beans are essential sources of protein. Peanut butter and soymilk, such as Sesbaniarostrata in rice cropping and Gliridiasepium and Leucaenaleucephala in alleycropping, are common food products derived from legumes. Legumes such as Trifolium (clover), Medicago (alfalfa), and Lupinum (lupin) are also utilized as forges. In liquid form, they can be used to manufacture milk, yogurt, and baby formula. They can also be ground into flour and used to make bread, doughnuts, tortillas, chips, spreads, and extruded treats. Certain legumes have new uses in pop-beans, licoricey, and soybean sweets. Industrial applications for legumes include the preparation of biodegradable plastic, oil, gums, dyes, and inks. Many legumes have been utilized worldwide in traditional medicine. Ibuki beans are said to have diuretic and lactagogue properties. It cleanses the body and tones the kidney-adrenal system. Leucorrhea, jaundice, ascites, mumps, boils, and diarrhea can all be effectively

treated with it. Black beans have analgesic properties, particularly for knee and lower back pain. It has been described as a diuretic, hemostatic, and tonic. Diarrhea, dysentery, conjunctivitis, oedema of lower extremities, high blood pressure, intestinal ulcers, painful urination, burns, mumps, and food, lead, and chemical poisoning can all benefit from mung bean. Peas are a moderate laxative and diuretic. These are used to treat cough, hiccups, vomiting, constipation, and belching. They are also an excellent tonic for the stomach, pancreas, and spleen. Peas speed up the healing process and lessen the likelihood of skin outbreaks like boils and cysticles. A great treatment for childhood malnourishment is soybean. It is used to treat pregnancy-related toxemia, constipation, oedema, food stagnation, arthritis, and skin eruptions. It serves as a tonic for the kidneys, pancreas, and spleen. As a diuretic, kidney beans are useful in the treatment of swelling and oedema. Lentil boosts the adrenal system and makes the kidneys more active. According to reports, lima beans improve skin tone and are a liver and lung tonic. The pancreas, kidneys, and spleen are strengthened by string beans. It is used to treat diarrhea, leucorrhea, and diabetes. (Ahmed & Hasan, 2014)

2.5. Cookies

Cookies are small, flat dessert treats, commonly formed into a circular shape. They constitute an important component of the diet (Mishra et al., 2012). Research into the use of tropical crops has shown that biscuits and other pastries such as meat-pie, cookies, cake, etc could be made from flours of locally available crops such as sweet potato, cassava, corn, rice, millet, sorghum, etc (IITA, 1985). Cookies are convenient snacks product dried to a very low moisture content taken among young people and adults to provide energy (Okaka, 1997).

Cookies are associated as a source of energy and are a product that is ready to be consumed. Moreover, cookies can also be produced in high numbers in a short time, and it is easy to widely distributed (Zucco et al., 2011). Indonesia has an abundance of food sources, i.e., tubers, legumes, and cereals which can be used as a constituent of the development of gluten-free flour for making cookies. According to SNI 01-2973-1992, cookies are one of the types of biscuits made from soft dough, containing high fat, relatively crisp when broken, the densely textured. According to Mamat and Hill (2014), fat in cookies serves as shortening which affects the texture, flavor, tenderness, and mouthfeel. The essential ingredients of forking cookies consist of flour with protein, fat, sugar, and eggs. (Nugraheni et al., 2019)

Bakery products have been becoming very popular in all age groups. Among baked products, cookies are one of the most popular snacks and they can be fortified with various nutrients. These can be used as a very easy vehicle for providing the protein need of the population. (Thongram et al., 2016) Corn and mung beans are easy and cheap food ingredients. Corn contains 9.8 % protein, 7.3 % fat, and 69.1 % carbohydrates. Whereas mung beans contain 22.9 % protein, 1.5 % fat, and 56.8 % carbohydrates (Kementerian Kesehatan Republik Indonesia, 2018). Both of these ingredients can be processed into flour for making cookies. Cookies are the product of choice because they are durable, easy to make, and preferred by children as a snack. Therefore, this study aimed to analyze the characteristics of gluten-free cookies from corn flour and mung bean flour with various formulations. (Rosiana et al., 2021a)

2.6. Nutritional composition of Sweet Yellow Corn and Mung Bean

2.6.1. Sweet Yellow Corn

Sweet corn is rich in carbohydrates and sugars and contains useful amounts of vitamins A, B3 (which supports metabolism, the nervous and digestive systems), and C. It also contains folic acid, fiber, minerals, and protein (Gebhardt and Mattews, 1981). Brewbaker et al., (1975) reported a range of 46% total sugars, 18% starch, 14.5% protein, and 17% oil in sweet corn. Biochemical characteristics of super-sugar corn and the possibility of its utilization studied by Shmaraev et al., (1976) revealed that grain of super-sugar corn harvested at technical maturity contained 24- 30% dry matter 36.8% total sugar, no or very little dextrin, and 21.9% starch compared with 16.7% sugar, 24.2% dextrin, and 30.1% starch. (Swapna et al., 2020)

At 86 calories per 100 g, sugar corn kernels are moderately high in calories in comparison to other vegetables. However, fresh sweet corn has much fewer calories than that field corn and other cereal grains like wheat, rice, etc. Their calorie chiefly comes from simpler carbohydrates like glucose, and sucrose than complex sugars like amylose and amylopectin, which is a theme in the cereals. Sweet corn is a gluten-free cereal and may be used safely in celiac disease individuals much like rice, quinoa, etc. Sugar corn features s high-quality Phyto nutrition profile comprising dietary fiber, vitamins, and antioxidants in addition to minerals in modest proportions. It is one of the finest sources of dietary fiber, 100 g kernels carry 2 g or 5% of the daily dietary fiber requirement. Together with slow-digesting complex carbohydrates, dietary fiber in the food helps to regulate a gradual increase in blood sugar levels.

2.6.2. Mung Bean

The mung bean has been consumed as a diet worldwide and plays a vital role in human nutrition, especially as a good source of protein (20.97–32.6%) and active compounds. The mung bean protein has been identified as an effectively excellent source of amino acids, and the essential amino acids in particular, in which many kinds of cereals are deficient. It can be served as a staple food in India and Pakistan, called “dhal”, which meets people’s daily needs for protein and provides sufficient bioavailability. The rich nutrients of the mung bean, such as minerals, iron, dietary fiber, and significant amounts of bioactive phytochemicals also make it a good alternative function food. Furthermore, the polyphenols, polysaccharides, and polypeptides contained in the mung bean all exert antioxidant activity, which can contribute to disease prevention. To date, the mung bean and its extracts have shown excellent health implications, such as hypoglycaemic and hypolipidemic effects and antihypertensive, anticancer, anti-melanogenesis, hepatoprotective, and immunomodulatory activities.

Growing clinical evidence suggested that the consumption of calorie-rich diets, that are high in fat and carbohydrate but low in protein, has led to increased rates of metabolic syndromes, such as hyperglycemia, dyslipidemia, and inflammation. A variety of plant-based functional foods have been recommended by many worldwide health organizations, prompting a call for serious changes in dietary patterns, to improve health statuses and prevent chronic diseases. Legumes (Fabaceae/Leguminosae) are considered the second most important human food crops, just after cereals (Gramineae). However, legume seeds constitute an essential part of the human diet as they are excellent sources of proteins, bioactive compounds, minerals, and vitamins, in comparison with cereals, and are referred to as “the poor man’s meat”. (Hou et al., 2019b)

2.7. Nutritional Composition of Cookies

Cookies are traditionally made from soft wheat and are nutritious and convenient foods with long shelf life. The major attraction of cookies is the wide variety of types that are possible. The nutritional value of cookies varies with the type of cereal used. Cookies are known to generally contain 18.5% fat, 78.23% carbohydrates, 1.0% ash, 7.1% protein, and 0.85% salt.

2.8. The Effect on Processing Method

2.8.1. Sweet Yellow Corn

Types of corn include sweet, popcorn, dent, and flint, which are also used as animal or human feed. Although white or yellow corn is the most commonly consumed variety compared to red, blue, purple, and orange. A variety of whole and processed products are the main factor that influenced corn consumption. Thus, whole-grain corn is consumed boiled, soaked, dehulled, fermented, and roasted. These processes include physical and biochemical operations through which this corn passes, thereby modifying its biochemical quality, its texture, and its nutritional values. The work of Tshité et al. shown that roasting leads to the development of new organoleptic characteristics leads to a decrease in protein content, and increases the content of reducing sugars, lipids, and pre-gelatinized starch. Tambo et al. have shown that dehulling increases the digestibility of flour, decreases the anti-nutrient content, and facilitates swelling during cooking.(Dongmo et al., 2020)

2.8.2. Mung Bean

Generally, legumes have been reported to have low nutritive value due to low amounts of sulphur-containing amino acids, low protein digestibility, and the presence of anti-nutritional factors. Cooking is usually done before the use of legumes in a human diet. This improves the protein quality by destruction or inactivation of the heat-labile antinutritional factors (Chau, Cheung, & Wong, 1997; Wang, Lewis, Brennan, & Westby, 1997; Vijayakumari, Siddhuraju, Pugalenthi, & Janardhanan, 1998). However, cooking causes considerable losses in soluble solids, especially vitamins, and minerals (Barampama & Simard, 1995). Increasing the time and temperature of processing has been reported to reduce the nutritive value and available lysine of legumes (Kon & Sanshuck, 1981). Germination also enhances the nutritive value of legumes by inducing the formation of enzymes that eliminate or reduce the antinutritional and indigestible factors in legumes (Bau, Villanme, Nicolos, & Mejean, 1997). The chemical composition and oligosaccharides of raw and germinated mung bean seeds were reviewed by El-Beltagy (1996). Dehulling, soaking, germination, cooking, autoclaving, and microwave cooking affected the chemical composition, antinutritional factors, and nutritional quality of mung bean seeds. However, dehulling and soaking processes caused smaller losses in minerals than in cooking processes. All processes improved the IVPD and protein efficiency ratio of mung bean seeds. (Mubarak, 2005)

Agoreyo et al. (2011) reported that heating would cause a Maillard reaction which resulted in complex changes due to the reaction between carbohydrates and amino acids, thus reducing the protein content. Heating could also result in the formation of a tannin-protein complex which consequently reduced the protein content (Akpan & Umoh, 2004). These observations explained the lowered protein content in SD and OD as compared to FD. In terms of fat and ash content, OD recorded values lower than FD and SD, owing to the different drying techniques using different temperatures and drying duration. (Bawa, Songsermpong, Kaewtapee, & Chanput, 2020). (Brishti et al., 2020)

2.9. The Effects of Cookies Consumption on Babies

The development of gluten-free cookies is currently required in line with the growing demand for functional foods that can minimize the occurrence of allergies to constituents such as gluten and eggs. Gluten-free food products also have benefits to reduce the risk of type 1 diabetes mellitus. Wheat flour which is high in gluten is commercially used for the production of cookies and this can be an issue for people who are allergic to gluten. High protein gluten and egg-free cookies made with RS3 of M. arundinaceous flour is a new product that has a composition of different constituent materials from wheat flour-made cookies that are currently sold to consumers. The difference in the composition of material may affect the characteristics of the cookies, in terms of the nutrients, physical properties, but also sensory properties. The development efforts of commercialization of high protein gluten-free cookies enriched with RS3 into functional food must be supported with clear information on the nutrition, physical and sensory properties. So, it is necessary to research the formulation impact of the developed RS3 high-protein gluten-free cookies (Aini et al., 2022)

2.10. Nutrient Analysis

2.10.1. Moisture Content Determination (Oven Dry Method)

Several practical air-oven procedures have been standardized to determine the moisture content of grains (Hart et al., 1959; United States Department of Agriculture (USDA), 1971; Association of Official Analytical Chemists (AOAC), 1980; American Society of Agricultural Engineers, 1982; Jindal and Siebenmorgen, 1987; De Datta Surajit (1981) These methods are based on drying whole or ground grains in an oven over a fixed period. The cleaning, drying, and storage of grains are postharvest operations required to maintain their product quality (Bakker-Arkema et al., 1999). The drying temperature and time are usually specified for a particular type of grain based on moisture content compared with the reference method. Moisture content determinations made with different oven methods and different grains may not be the same due to the empirical nature of the methods. Oven exposure time depends upon the type of grain and the method used (Hart and Neustadt, 1957; Warner and Browne, 1963; Young et al., 1982; Bowden, 1984).(Talpur, n.d.)

The moisture content of the cookies ranged from 3.24 - 4.64%, following the national standards for Indonesian cookies (SNI 01-2973 2011) where the moisture content of freshly produced cookies should be under 5% (Okaka, 2019). The moisture content influences the shelf life, appearance, texture, and taste of the food. Low water levels are expected to increase the shelf life of cookies. On the contrary, the moisture content of cookies that are too low will produce burnt cookies. Whereas, if the moisture content is too high then the cookies produced are not crispy and will trigger the changes in flavor during storage (Manley, 2001). (Nugraheni et al., 2019)

2.10.2. Protein Content Determination (Lowry Method)

Most other methods of protein analysis are sensitive to the amino acid composition of the protein, and absolute concentrations cannot be obtained (1). The procedure of Lowry et al. (2) is no exception, but its sensitivity is moderately constant from protein to protein, and it has been so widely used that Lowry protein estimations are a completely acceptable

alternative to a rigorous absolute determination in almost all circumstances in which protein mixtures or crude extracts are involved. The method is based on both the Biuret reaction, in which the peptide bonds of proteins react with copper under alkaline conditions to produce Cu+, which reacts with the Folin reagent, and the Folin–Ciocalteau reaction, which is poorly understood but in essence, phosphomolybdotungstate is reduced to heteropolymolybdenum blue by the copper-catalysed oxidation of aromatic amino acids. The reactions result in a strong blue color, which depends partly on the tyrosine and tryptophan content. The method is sensitive down to about 0.01 mg of protein/mL and is best used on solutions with concentrations in the range of 0.01–1.0 mg/mL of protein. (Waterborg & Matthews, 2003a)

2.10.3. Fat Content Determination (Soxhlet Method)

The interest in dietary fat is widespread, and the determination of fatty compounds is a basic requirement in testing food material. Consumers demand a reduction of the total fat contents in food to improve human health, thus forcing government agencies to use more precise methods for fat determination, which assures accuracy in labeling products. The lipid extraction is carried out in different ways depending on the sample characteristics. Thus, some extraction methods (Weibull–Berntrop, Röse–Gottlieb, Mojonnier, Folch, Werner–Schmid, Bligh–Dyer, Babcock, etc.) are based on acid, alkaline, or, enzymatic hydrolysis before solvent extraction. After some innovations, both in the solvent mixtures and laboratory practices, the previous procedures have not been greatly improved, and long preparation times, with a second re-extraction step to ensure complete lipid isolation, are required.
Soxhlet extraction is another alternative, which does not require prior hydrolysis. The long time and high temperature needed for the last alternative and some of the previous ones are their principal shortcomings because chemical transformations of the triglycerides can take place. (Priego-Capote et al., 2004a)

2.10.4. Ash Content Determination (Dry Ashing Wet Method)

The ash content is a measure of the total amount of minerals present within a food, whereas the mineral content is a measure of the amount of specific inorganic components present within a food, such as Ca, Na, K, and Cl. Determination of the ash and mineral content of foods is important for several reasons.
Analytical techniques for providing information about the total mineral content are based on the fact that the minerals (the analyte) can be distinguished from all the other components (the matrix) within a food in some measurable way. The most widely used methods are based on the fact that minerals are not destroyed by heating and that they have low volatility compared to other food components. The three main types of analytical procedures used to determine the ash content of foods are based on this principle: *dry* Ashing, *wet* Ashing, and *low-temperature plasma dry* Ashing. The method chosen for a particular analysis depends on the reason for carrying out the analysis, the type of food analyzed and the equipment available.

Dry ashing procedures use a high-temperature muffle furnace capable of maintaining temperatures of between 500 and 600 ^{o}C. Water and other volatile materials are vaporized and organic substances are burned in the presence of oxygen in the air to CO_2, H_2O, and N_2. Most minerals are converted to oxides, sulfate, phosphates, chlorides, or silicates. Although most minerals have fairly low volatility at these high temperatures, some are volatile and may be partially lost, *e.g.,* iron, lead, and mercury. If an analysis is being carried out to determine the concentration of one of these substances, then it is advisable to use an alternative ashing method that uses lower temperatures. (Priego-Capote et al., 2004a)

2.10.5. Carbohydrates Content Determination

Molecules in which the carbohydrates are covalently attached to proteins are known as *glycoproteins*, whereas those in which the carbohydrates are covalently attached to lipids are known as *glycolipids*. Some carbohydrates are digestible by humans and therefore provide an important source of energy, whereas others are indigestible and therefore do not provide energy. Indigestible carbohydrates form part of a group of substances known as *dietary fiber*, which also includes lignin. Consumption of significant quantities of dietary fiber is beneficial to human nutrition, helping reduce the risk of certain types of cancer, coronary heart disease, diabetes, and constipation. As well as being an important source of energy and dietary fiber, carbohydrates also contribute to the sweetness, appearance, and textural characteristics of many foods. It is important to determine the type and concentration of carbohydrates in foods for several reasons. (BeMiller, 2017). A large number of analytical techniques have been developed to measure the total concentration and type of carbohydrates present in foods (see *Food Analysis* by Nielssen or *Food Analysis* by Pomeranz and Meloan for more details). The carbohydrate content of a food can be determined by calculating the percent remaining after all the other components have been measured: %carbohydrates = 100 - %moisture - %protein - %lipid - %mineral.

2.10.6. Mineral and Vitamin Content Determination

Pulses are an important source of nutrients, and their daily consumption is recommended for a balanced diet (Bessada et al., 2019). The presence of many bioactive substances, essential minerals, and other compounds confers their nutritional importance (Shahidi & Ambigaipalan, 2015; Afshin et al., 2014), which has stimulated the development of food made with this unconventional component to make them more nutritious (Wrigley et al., 2016). Many bakery and confectionery products are used as a means for the incorporation of nutrients. Among these, cookies stand out for the technological facilities that allow them to have a wide variety of ingredients as well as long shelf life, good acceptability, low manufacturing cost, ability to be eaten anywhere, and serving as a valuable source of instant nutrition (Maia et al., 2021)

2.11. Sensory Evaluations

Product developers make use of many tools in the development of a product. These tools include, for example, chemical tests, microbiological procedures, and the use of physical equipment to determine elasticity, hardness, viscosity, color intensity, and more. It is, unfortunately, possible for food products to reflect similar measurements or results when these tools are applied individually, yet still result in different perceptions, acceptability, or preferences on the consumption of the product. Grading methods for food and beverage products traditionally involved one or two trained “experts” assigning quality scores on the appearance, flavor, and texture of the products based on the presence or absence of predetermined defects. These traditional judging methods have several shortcomings: they can’t predict consumer acceptance; their quality assessments are subjective; assigning quantitative scores is difficult; and they don’t combine analytically oriented attribute ratings with effectively oriented quality scores (Claassen & Lawless, 1992). Thus by using traditional methods of evaluation, some products with very different sensory characteristics, such as those identified by a product flavor profile, but with no product defect will obtain the same quality score. (Singh-Ackbarali & Maharaj, 2014a)