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Chicken Nugget Products with the Addition of Purple Sweet Potato Flour (*Ipomoea Batatas* L) as Health Food for Children with Cancer

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A B S T R A C T

This study aims to determine the physical and sensory quality of free-range chicken nuggets with added purple sweet potato flour as a health food for children with cancer. This study was conducted using a completely randomized design (CRD) consisting of 4 treatments and 5 replicates for physical quality variables (water-holding capacity, cooking loss) and sensory quality was tested by 16 panelists consisting of children with cancer as replicates. The treatments in this study were formulated as follows: P_1 = 400 g of free-range chicken dough + 5% purple sweet potato flour; P_2 = 400 g free-range chicken nuggets + 7.5% purple sweet potato flour; P_3 = 400 g free-range chicken nuggets + 10% purple sweet potato flour; P_4 = 400 g free-range chicken nuggets + 12.5% purple sweet potato flour. The results of the analysis of variance of the treatment of adding purple sweet potato flour had a significant effect ($P<0.05$) on the water binding capacity and cooking shrinkage of free-range chicken nuggets but had no significant effect ($P>0.05$) on the aroma, color, taste, and texture of free-range chicken nuggets. Conclusion: The addition of purple sweet potato flour up to 10% produced good physical quality with sensory properties of aroma, color, taste, and texture of free-range chicken nuggets that were preferred.

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INTRODUCTION

The public's paradigm regarding the importance of health and healthy living has resulted in a shift in demand for food ingredients. Consumers are interested in food ingredients that not only have complete nutritional content and good taste, but also have certain physiological benefits for the body and have a healthy effect to boost immunity, known as health foods. Food is an essential need for humans, with chicken meat being one of the most popular and practical sources of animal protein. Free-range chicken meat is free from harmful chemicals and rich in nutrients that are important for human health. However, due to its limited shelf life after slaughter, free-range chicken meat is susceptible to spoilage by microorganisms, especially putrefactive bacteria. Therefore, processing and preservation efforts are needed to maintain the quality and freshness of free-range chicken meat. Several measures have been implemented to overcome spoilage and diversify processed free-range chicken products, as well as to improve and maintain the nutritional value of free-range chicken meat, namely by processing it into nuggets. Nuggets are one of the fast food products that are currently well known to the public. Nuggets, like sausages, burgers, and corned beef, have become one of the public's choices as a practical food product. On the other hand, increasing public awareness of nutrition and health has encouraged people to live healthier lives by consuming nutritious foods that have health benefits.

The fat content of free-range chicken meat is relatively high as the main ingredient in nugget production. Excessive fat consumption can be harmful to consumers, as fat is stored in the body and can cause various degenerative diseases such as stroke, heart disease, coronary heart disease, obesity, and so on. Consumption of nugget products containing fat must be balanced with the coarse fiber content in purple sweet potato flour. Another advantage is the high anthocyanin content in purple sweet potato flour. Anthocyanins have high antioxidant properties due to their ability to capture free radicals and inhibit lipid peroxidation, the main cause of cell damage associated with aging and degenerative diseases (Cevallos-Casals and Cisneros-Zevallos, 2002 in Ratulangi *et al*., 2023). The antioxidant capacity of purple sweet potatoes (4.6-6.4 µmol Trolox equivalent/g dw) is higher than that of white, yellow, or orange sweet potatoes, as observed in the Ayamurasaki variety, and is also higher than that of black soybeans (0.62-0.76 µmol Trolox equivalent/g dw), black rice (3.0-4.3 µmol Trolox equivalent/g dw), and purple eggplant (3.3-4.4 µmol Trolox equivalent/g dw) (Suda et al., 2003 in Ratulangi *et al*., 2023). Generally, the flour used as a binding agent in the production of chicken nuggets is starchy ingredients such as tapioca flour, rice flour, cornstarch, sago flour, and wheat flour. On the other hand, staple foods for the community should ideally be sourced from local raw materials in order to reduce costs. Purple sweet potatoes are rich in vitamins (B1, B2, C, and E), minerals (Ca, Mg, K, and Zn), dietary fiber, and carbohydrates. Due to their high water-binding capacity, purple sweet potato flour can be used as a binding agent in the manufacture of processed food products. Additionally, purple sweet potatoes have a fairly

intense purple color due to the presence of anthocyanin pigments, which function as antioxidants and contain dietary fiber.

Nowadays, there is a growing trend of diversifying processed meat products by using plant-based ingredients with the aim of improving product quality. Substitution or addition of plant-based ingredients is quite popular because it has several advantages that can be utilized by processed meat products. The advantages that can be gained through substitution and addition of plant-based ingredients include improving nutrition, promoting health, and increasing the appeal of these processed products. Research examining the addition of up to 30 g of purple sweet potato flour to broiler chicken nuggets resulted in physical properties and sensory qualities that were preferred by panelists (Ratulangi and Rimbing, 2019). The study of the use of purple sweet potato flour in processed meat products such as nuggets is an interesting area for further research. It is hoped that the addition of purple sweet potato flour will produce free-range chicken nuggets with physical and sensory qualities that are appealing to children with cancer as a source of healthy food.

THEORETICAL REVIEW

Purple sweet potatoes are a potential food source. In addition to being a source of calories, they also contain various functional compounds that play an important role in health. Purple sweet potatoes contain bioactive compounds such as beta-carotene, vitamin A, anthocyanins, and phenolic compounds that work synergistically to determine antioxidant activity (Laga et al., 2020). Purple sweet potato flour has a high water-binding capacity, making it suitable as a binding agent in the production of processed food products. Additionally, purple sweet potatoes have a deep purple color due to the presence of anthocyanin pigments, which function as antioxidants and contain dietary fiber (Permata et al., 2023). Research on adding up to 30 g of purple sweet potato flour to broiler chicken nuggets resulted in physical properties and sensory qualities that were preferred by panelists (Ratulangi & Rimbing, 2019). Free-range chicken meat is free from harmful chemicals and is quite popular among consumers because it tastes better and is low in fat and cholesterol. The fat content in free-range chicken meat is approximately 1.65% (Anggraeni et al., 2022). The addition of purple sweet potato flour to free-range chicken nuggets was done on a trial basis as an initial step to determine whether free-range chicken nuggets could be physically accepted and sensorially preferred as a health food for children with cancer being treated at the Estela Clinic of Prof. Kandouw General Hospital in Manado, North Sulawesi.

METHODOLOGY

Research Materials

The ingredients used are free-range chicken, purple sweet potato flour, tapioca flour, powdered milk, onions, garlic, chicken eggs, vegetable oil, pepper, salt, and ice cubes.

Research Design

The design used was a completely randomized design (CRD) consisting of 4 treatments and 5 replicates for physical quality variables (Malau, 2023) and for sensory variables tested by 16 panelists consisting of children with cancer as replicates.

Data Analysis

The data obtained from variable measurements were tabulated and then analyzed using analysis of variance, followed by a Honest Significant Difference Test to determine the differences in means between treatments (Setyaningsih *et al*., 2010 in Ratulangi *et al*., 2023).

RESULTS AND DISCUSSION

The results of observations of free-range chicken nuggets with the addition of purple sweet potato flour (Ipomoea batatas L) as a health food for children with cancer were assessed in terms of physical quality (water binding capacity and cooking shrinkage) and sensory quality (color, aroma, taste, and texture), as shown in Table 1.

Table 1. Average Values for Water Binding Capacity, Cooking Shrinkage, Aroma, Color, Taste, and Texture of Free-Range Chicken Nuggets with Purple Sweet Potato Flour Added.

Variables	Treatments			
	P_1	P_2	P_3	P_4
Water holding capacity (%)	42,09^{a}	40,27^{a}	32,40^{b}	31,67^{bc}
Cooking loss (%)	1,33^{a}	2,42^{a}	5,27^{b}	5,30^{bc}
Aroma	4,44	4,37	4,31	4,25
Color	3,75	3,81	3,81	3,87
Flavor	4,62	4,56	4,68	4,61
Texture	4,50	4,44	4,44	4,37

Note: Different superscripts on the same line indicate significant differences ($P<0.05$).

Water Holding Capacity of Free-Range Chicken Nuggets

The observed data on the physical quality of the water-binding capacity of free-range chicken nuggets with added purple sweet potato flour ranged from 31.67% to 42.09%, with the lowest average value in treatment P_4 at 31.67% and the highest average value in treatment P_1 at 42.0%. In terms of water-binding capacity, there was a decrease in value as the level of purple sweet potato flour used increased. Starting from treatment P_1 with a DIA value of 42.09%, there was a decrease with each addition of purple sweet potato flour until it reached the lowest value in treatment P_4 of 31.67% at a level of 12.5%. The results of the analysis of variance of the treatment of adding purple sweet potato flour had a significant effect ($P<0.05$) on the water-binding capacity of free-range chicken nuggets. The results of the honest significant difference test

showed that treatment P_1 was not significantly different from treatment P_2, but was significantly different from treatments P_3 and P_4, and treatment P_2 was significantly different from treatments P_3 and P_4. Treatment P_3 did not differ significantly from P_4. The addition of purple sweet potato flour caused an increase in the cooking shrinkage value of free-range chicken nuggets. This is thought to be due to the quality of the starch contained in purple sweet potato flour as a filler, which has a low ability to bind free water, thereby affecting the water-binding capacity of free-range chicken nuggets. The DIA values in this study were still lower than the DIA values of broiler chicken nuggets with purple sweet potato flour added, as reported by Ratulangi and Rimbing (2021), which ranged from 51.28 to 61.47%. According to Kusumaningrum, 2013, fillers function as emulsion stabilizers, increase water binding capacity, reduce shrinkage, and reduce costs. Usmiati and Komariah (2007) stated that if the water binding capacity is high, the viscosity of the gel formed can increase the elasticity of the product, thereby affecting the softness of the product.

Cooking Loss of Free-Range Chicken Nuggets

The observed data on the physical quality of cooked chicken nuggets with added purple sweet potato flour ranged from 1.33% to 5.30%, with the lowest average value in treatment P_1 at 1.33% and the highest average value in treatment P_4 at 5.30%. In terms of cooking loss, there was an increase in value as the amount of purple sweet potato flour used increased. Starting from treatment P_1 with a cooking loss value of 1.33%, there was an increase with each addition of purple sweet potato flour until it reached the highest value in treatment P_4 of 5.30%. The addition of purple sweet potato flour in free-range chicken nuggets showed that the higher the level of purple sweet potato flour added, the higher the cooking loss value, but conversely, the WHC value decreased.

The results of the analysis of variance of the treatment of adding purple sweet potato flour had a significant effect ($P<0.05$) on the cooking loss of free-range chicken nuggets. The results of the honest significant difference test showed that treatment P_1 was not significantly different from treatment P_2, but was significantly different from treatments P_3 & P_4, and treatment P_2 was significantly different from treatments P_3 and P_4. Treatment P_3 was not significantly different from P_4. There was an increase in cooking shrinkage in free-range chicken nuggets, which was influenced by the amount of purple sweet potato flour added. This phenomenon of increased cooking shrinkage indicates that purple sweet potato flour has a lower capacity to retain the water content of the product during the cooking process. This can be attributed to the ineffective binding agent properties of purple sweet potato flour in the matrix of free-range chicken nuggets. The characteristics of purple sweet potato flour, whose starch content has lower stability than other types of flour starch, form a less solid gel matrix, thereby preventing water loss during the cooking process. This is in line with the opinion of Widhaswari *et al.* (2014), who stated that purple sweet potato flour cannot be used in large quantities in food production because its starch characteristics have less robust stability, which tends to soften

more quickly when heated. Furthermore, Rokhayati and Pateda (2025) stated that low cooking shrinkage has better quality than high cooking shrinkage, resulting in less nutrient loss during the cooking process.

The Aroma of Free-Range Chicken Nuggets

Aroma is the smell produced by chemical stimuli detected by the olfactory nerves in the nasal cavity when food enters the mouth (Winarno, 2004). Aroma determines the deliciousness of food ingredients. The actual taste of food consists of three components, namely smell, taste, and mouth stimulation. The smell produced by food largely determines the palatability of the foodstuff. In terms of smell, it is more closely related to the sense of smell.

The data from observations of the addition of purple sweet potato flour to the sensory properties of free-range chicken nuggets ranged from 4.25 (like) to 4.44 (like). The results of the analysis of variance showed that the addition of purple sweet potato flour at concentrations of 5-12.5% had no significant effect ($P>0.05$) on the level of liking for the aroma of free-range chicken nuggets. The addition of purple sweet potato flour did not affect the aroma of free-range chicken nuggets, meaning that the treatment of adding purple sweet potato flour was the same for each treatment. Although there were variations in the aroma values of free-range chicken nuggets, statistically, they were not significant or were the same. The addition of purple sweet potato flour had no effect because the distinctive aroma of sweet potato flour comes from degraded starch content. According to Dewandari *et al.* (2014), the formation of aroma and flavor is caused by the degraded carbohydrate content in sweet potatoes. Similarly, the panelists, who were children with cancer being treated at the Estela Clinic of Prof. Kandouw Manado General Hospital, were untrained panelists with physical, mental, and psychological conditions that were ill, thus affecting their sense of smell in assessing the level of preference for the aroma of free-range chicken nuggets in each treatment with the addition of purple sweet potato flour. The observation data shows that treatment P1 is the best treatment based on a hedonic test value of 4.44, which indicates a liking.

Color of Free-Range Chicken Nuggets

Color is one of the sensory properties of food products that determines quality. If there is a deviation in color, then the food product can be said to have decreased in quality. Color can also attract consumers to consume the product. Therefore, color is an important part of the sensory properties of food.

The results of the analysis of variance showed that the addition of purple sweet potato flour at concentrations of 5-12.5% had no significant effect ($P>0.05$) on the level of liking for the color of free-range chicken nuggets. The addition of purple sweet potato flour did not affect the color of free-range chicken nuggets, meaning that the addition of purple sweet potato flour was the same for each treatment. although the data showed variations in the color preference ratings of free-range chicken nuggets, indicating an increase in ratings from treatment P_1 of 3.75 (like) to treatment P_4 of 3.87 (like), but statistically this was not significant or the same. The addition of purple sweet potato flour had no effect due to the ability of the panelists, who were children with cancer being treated

at the Estela Clinic of the Regional General Hospital. Prof. Kandouw Manado was an untrained panelist with physical, mental, and psychological conditions that were ill, thus affecting the ability/response of the sense of sight in assessing the level of preference for the color of free-range chicken nuggets, even though there were visual differences in color in each treatment of purple sweet potato flour addition caused by anthocyanin pigments. The purple color in purple sweet potatoes comes from the purple pigment anthocyanin (Pakorny *et al.,* 2001). Different shades of purple in a food are caused by different concentrations of anthocyanin. The higher the concentration of purple sweet potato flour used in the production of crackers, the more anthocyanin it will contain and the more intense/dark the color will be (Ratulangi and Rimbing, 2021). In addition, according to Winarno (1987), the color contained in food ingredients can be caused by several sources, namely the presence of pigments, the effect of heat on sugar (caramelization), the reaction between sugar and amino acids (Maillard), and the mixing of additives. The observation data shows that treatment P_4 is the best treatment based on a hedonic test value of 3.87, or like.

The Flavor of Free-Range Chicken Nuggets

Flavor is one of the important sensory properties in the acceptance of a food product. Flavor is assessed by the sense of taste (tongue), which is a combination of the sensory properties of aroma, taste, and texture that make up the overall taste of food (Widhaswari *et al*., 2014). Flavor compounds in products can stimulate the sense of taste (Winarno, 1987).

The data from observations of the addition of purple sweet potato flour to the sensory properties of free-range chicken nuggets ranged from 4.56 (very like) to 4.68 (very like). The results of the analysis of variance showed that the addition of purple sweet potato flour at concentrations of 5-12.5% had no significant effect ($P>0.05$) on the level of liking for the flavor of free-range chicken nuggets. The addition of purple sweet potato flour had no effect on the taste of free-range chicken nuggets, meaning that the addition of purple sweet potato flour was the same for each treatment. Although there was variation in the data regarding the level of preference for the taste of free-range chicken nuggets, statistically it had no effect or was the same. The lack of effect of adding purple sweet potato flour is due to the ability of the panelists, who are children with cancer being treated at the Estela Clinic, Prof. Kandouw Manado General Hospital.

These panelists are untrained and are physically, mentally, and psychologically ill, which affects their ability/response of their taste buds/senses in assessing the level of preference for the taste of free-range chicken nuggets. Flavor compounds are compounds that cause taste sensations (sweet, bitter, sour, salty), trigeminal sensations (astringent, cold, hot), and aroma after consuming these compounds (Fisher and Scott, 1997 in Widhaswari *et al.,* 2014). Flavor compounds are a mixture of chemical compounds that can affect the body's senses, such as the tongue as the sense of taste. The taste that arises in chicken nuggets with purple sweet potato flour added is a slightly

sweet taste, which comes from the purple sweet potatoes used. During processing and storage, carbohydrates are converted into glucose, so that the more purple sweet potato flour is used in the nuggets, the more pronounced the sweet sensation will be. However, the use of purple sweet potato flour is only around 5-12.5%, causing the panelists' response to the flavor sensation to be less pronounced (Widhaswari *et al.*, 2014). The observation data shows that the P_3 treatment is the best treatment based on a hedonic test value of 4.68, or very much liked.

Texture of Free-Range Chicken Nuggets

Texture is the sensation of pressure that can be observed with the mouth when bitten, chewed, and swallowed) or by touch with the fingers. Texture is also an important property in food quality, because each food product has very broad differences in its properties and structure. The texture of food products is one of the components assessed in organoleptic testing (Kartika *et al*., 1988) in Laksmi *et al*. 2012).

The data from observations of the addition of purple sweet potato flour to the sensory properties of free-range chicken nuggets ranged from 4.37 (like) to 4.50 (like). The results of the analysis of variance showed that the addition of purple sweet potato flour at concentrations of 5-12.5% had no significant effect ($P>0.05$) on the level of liking for the texture of free-range chicken nuggets. The addition of purple sweet potato flour did not affect the texture of free-range chicken nuggets, meaning that the treatment of adding purple sweet potato flour was the same for each treatment. Although there were variations in the data on the level of liking for the texture of free-range chicken nuggets, statistically, there was no effect or the results were the same. The addition of purple sweet potato flour had no effect because the panelists, who were children with cancer being treated at the Estela Clinic of Prof. Kandouw Manado General Hospital, were untrained and in poor physical, mental, and psychological condition, which affected their sensory perception abilities/responses in assessing their preference for the texture of free-range chicken nuggets. Additionally, the addition of purple sweet potato flour as a treatment to the free-range chicken nugget product did not affect the level of texture preference, as the processing was carried out properly, resulting in purple sweet potato flour with fine and homogeneous particles. This is in accordance with the opinion of Ratulangi *et al*. (2023), who stated that the addition of purple sweet potato flour in the processing of nugget products will produce a smooth and soft texture, which is highly determined by the fineness of the purple sweet potato flour and the level of its use.

CONCLUSION

Adding up to 10% purple sweet potato flour produces good physical quality with sensory qualities of aroma, color, taste, and texture in free-range chicken nuggets that are preferred as health food for children with cancer.

RECOMMENDATION

- Purple sweet potatoes can be processed into flour that can be used as a food ingredient.
- Purple sweet potato flour can be added up to 10% in the processing of free-range chicken nuggets as a health food.
- Chicken nuggets made with purple sweet potato flour have good physical quality and sensory properties that are appealing as a health food for children with cancer.

FURTHER STUDY

Further studies are needed on chicken nuggets with added purple sweet potato flour to determine their antioxidant activity and chemical and microbiological quality as a health food for children with cancer.

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