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Effect of Sorghum Flour and Anchovy Meal Substitution on Organoleptic Properties of Biscuits

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ABSTRACT

Local foods in East Nusa Tenggara (NTT) Province are highly diverse, yet they remain underutilized for promoting health. Sorghum and anchovies, abundant in this region, present alternative sources for enhancing local nutrition, especially for toddler snacks. This study aimed to develop biscuits using local ingredients (sorghum and anchovies) as a potential snack for toddlers. The research employed an experimental design with a completely randomized design (CRD) consisting of four treatment levels: P0 (0% sorghum flour: 0% anchovy flour), P1 (30% sorghum flour: 10% anchovy flour), P2 (20% sorghum flour: 15% anchovy flour), and P3 (10% sorghum flour: 20% anchovy flour). The study occurred from January to May 2024 at the Nutrition Laboratory of Poltekkes Kemenkes Kupang. The results showed that the panellists' preference for biscuit colour ranged from 3.82 to 4.04 (like), with P3 being the most preferred (4.04). The aroma scores ranged from 3.4 to 3.48 (somewhat like), with P2 receiving the highest score (3.48). Texture preference ranged from 3.9 to 4.1 (like), with P1 being the most preferred (4.1). Taste preferences ranged from 3.5 to 3.76 (like), with P3 scoring highest (3.76). In conclusion, biscuits with 20% sorghum flour and 10% anchovy flour (P3) were the most favoured overall, containing 1,111.6 Kcal of energy, 41.75 g of protein, 50.74 g of fat, and 123.51 g of carbohydrates. These findings suggest that locally sourced ingredients can be effectively used to create nutritious and appealing snacks for toddlers.

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- Development of nutrient-rich biscuits using sorghum and anchovies that are abundant in East Nusa Tenggara. The formulation with 20% sorghum flour and 10% anchovy flour was most preferred by panelists, demonstrating the potential of these ingredients to create delicious and nutritious toddler snacks.

Introduction

Protein-energy deficiency remains a significant nutritional challenge in Indonesia and other developing countries, particularly affecting infants and young children (1). This form of malnutrition, characterized by inadequate energy and protein intake, is assessed using weight-for-age indicators and has severe, long-lasting consequences on child health and development (2). According to the Basic Health Research, the prevalence of undernutrition and malnutrition in Indonesia stands at 17.7%, with 13.8% undernutrition and 3.9% malnutrition. While East Nusa Tenggara has seen a slight improvement, with rates decreasing from 33% to 29.5%, this still falls short of the National Medium-Term Development Plan target of 17% (3).

Addressing protein-energy deficiency requires strategies to increase both energy and protein intake. One approach is to develop nutrient-dense snacks that complement main meals. Biscuits, being widely accepted across age groups, present an opportunity to deliver essential nutrients in a convenient format (4). East Nusa Tenggara Province is rich in underutilized local food sources that could potentially address nutritional deficiencies. Two such resources are sorghum (Sorghum bicolor) and anchovies. Sorghum contains 10.40% protein, surpassing rice (7.90%), and has a comparable carbohydrate content (70.70%) to wheat and corn. It also provides both insoluble (6.5% - 7.9%) and soluble (1.1% - 1.23%) dietary fiber (5). Anchovies, abundant in local waters with an average catch production of 8,610.14 tons/year, are an affordable protein source at Rp. 61,876/kg. However, their utilization rate remains low at 34.97%. (6).

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The high dependence on wheat flour in Indonesia presents an opportunity for substitution with local alternatives. Sorghum, with its high starch content (80.42%) and comparable amylose and amylopectin composition to wheat flour, shows promise as a substitute (7). Apart from being a staple food, biscuits are one type of pastry that is currently favoured by people of all ages as a snack(8). This study aims to investigate the potential of incorporating sorghum flour and anchovy meal into biscuits as a strategy to address protein-energy deficiency. Specifically, we will examine the effects of these local ingredient substitutions on the organoleptic properties of biscuits. By developing a nutritious, locally-sourced snack, we hope to contribute to improving the nutritional status of children in East Nusa Tenggara and similar regions facing nutritional challenges.

Methods

The ingredients used in making sorghum flour and anchovy flour substitution biscuits are wheat flour, sorghum flour, anchovy flour, powdered sugar, eggs, margarine, baking powder and milk powder. The tools used during the research process were ovens, blenders, scales, and sieves used to make sorghum flour and anchovy flour. Then in the processing process using scales, bowls, mixers, baking sheets, and ovens. This research is experimental research with a completely randomized design consisting of 4 treatment levels, namely P0: (0% sorghum flour: 0% anchovy flour), P1: (30% sorghum flour: 10% anchovy flour), P2: (20% sorghum flour: 15% anchovy flour), and P3: (10% sorghum flour: 20% anchovy flour). The research was conducted from January to May 2024 at the Nutrition Laboratory of the Department of Nutrition the Poltekkes Kemenkes Kupang.

Processing Sorghum into Sorghum Flour (9): After sorting, the sorghum seeds were washed and drained thoroughly. The sorghum seeds are dried in the sun for about 24 hours at room temperature to reduce the moisture content to 35%. Water is added to the sorghum kernels during the crushing system, then they are dried again. A blender was used to grind the dried sorghum grains and a sieve was used to filter them.

Anchovy Processing into Anchovy Flour (10): Anchovies were washed, then impregnated with 0.8% sodium bicarbonate and soaked for 45 minutes. The anchovies were then boiled for 15 minutes at 80°C. The anchovies are then dried at 55ºC for approximately 24 hours. The anchovies are pounded and then subjected to pounding and sieving.

Biscuit dough-making process (11): Powdered sugar 50 g, margarine 65 g, and salt 1 g were beaten for 10 minutes to form a cream. Then 15 g skimmed milk and 20 g egg yolk are added and beaten again for 4 minutes. 100 g wheat flour is added, then the ingredients are mixed until combined, and the dough is smooth for 30 minutes. The soft dough is molded and baked in the oven for 30 minutes.

Data analysis, namely ANOVA and Tukey test using the SPSS program and the level of significance is $p < 0.05$.

Results

Based on Table 1, the conversion of sorghum and anchovy into flour shows that from 500 g sorghum can produce 440 g sorghum flour with a conversion factor of 1.14:1 and 500 g anchovy can produce 120 g anchovy flour with a conversion factor of 4.17:1.

Table 1. Conversion of Sorghum Flour and Anchovy Flour

Ingredient	flour weight	conversion
500 g	440 g	1,14:1
500 g	120 g	4,17:1

Based on Table 2, it is known that the average value of the panellists' level of liking for the colour of biscuits with substitutions of sorghum flour and anchovy flour ranges from 3.82 to 4.04 (like). The most preferred treatment in terms of colour is P3 with an average value of 4.04 (like). Based on the ANOVA test, it was found that there was an effect of sorghum flour substitution and anchovy flour on the organoleptic properties (colour) of biscuits with a P value of 0.000 (<0.05). After further testing using the tukey test, it is known that the treatment that is significantly different is P0. The average value of panelists' level of liking for the aroma of biscuits with sorghum flour and anchovy flour substitutions ranged from 3.4 to 3.48 (somewhat like). The most preferred treatment in terms of aroma is P2 with an average value of 3.48 (somewhat like). Based on the ANOVA test, it was found that there was an effect of sorghum flour substitution and anchovy flour on the organoleptic properties (aroma) of biscuits with a P value of 0.000 (<0.05). After further testing using the tukey test, it is known that the significantly

different treatments are P0. The average value of panellists' level of liking for the texture of biscuits with sorghum flour and anchovy flour substitutions ranged from 3.9 to 4.1 (like). The most preferred treatment was P1, with a value of 4.1 (like). Based on the ANOVA test, it was found that there was an effect of sorghum flour substitution and anchovy flour on the organoleptic properties (texture) of biscuits with a P value of 0.000 (<0.05). After further testing using the Tukey test, it is known that the significantly different treatments are P0. The average value of panellists' liking for the taste of biscuits with sorghum flour and anchovy flour substitution ranged from 3.5 to 3.76 (like). The most preferred treatment in terms of taste is P3, with an average value of 3.76 (like). Based on the ANOVA test, it was found that there was an effect of sorghum flour substitution and anchovy flour on the organoleptic properties (taste) of biscuits with a P value of 0.000 (<0.05). After further testing using the Tukey test, it is known that the significantly different treatments are P0.

Table 2 Organoleptic Test based on Colour, Aroma, Texture, Taste

Attributes	Sample Code	Mean	Anova test	Tukey test
Colour	P0	4,68	0.00	0.000
	P1	3,82		0.975
	P2	3,88		0.676
	P3	4,04		0.413
Aroma	P0	4,64	0.00	0.000
	P1	3,4		0.967
	P2	3,48		0.986
	P3	3,42		0.999
Texture	P0	4,56	0.00	0.029
	P1	4,1		0.620
	P2	3,9		0.930
	P3	4		0.930
Taste	P0	4,66	0.00	0.000
	P1	3,72		0.619
	P2	3,5		0.479
	P3	3,76		0.996

Notes: P0 (0% sorghum flour: 0% anchovy flour); P1 (30% sorghum flour: 10% anchovy flour); P2 (20% sorghum flour: 15% anchovy flour); P3 (10% sorghum flour: 20% anchovy flour).

Table 3 Nutritional Content Test of Biscuits

Sample Code	Energy (Kcal)	Protein (g)	Fat (g)	Carbohydrate (g)
P0	1.031,8	15,45	48,16	107,5
P1	1.082,49	29,37	50,17	132,37
P2	1.096,51	35,6	50,45	127,85
P3	1.111,18	41,75	50,74	123,51

The nutritional analysis reveals that the energy content of the biscuits increases from P0 to P3, indicating that later samples may be more calorific per serving (Table 3). Sample P3 stands out with the highest protein content, making it a suitable option for those seeking increased protein intake. While fat content remains relatively stable across all samples, there's a slight decrease in carbohydrate content from P1 to P3, albeit with minimal differences.

Discussion

Colour

Based on the organoleptic test results, the most preferred biscuit colour is P3 with a value of 4.04 (like) substitution of 10% sorghum flour and 20% anchovy flour. The colour of P3 is slightly lighter (light brown) than other treatments. The difference in colour in each treatment is due to the substitution of sorghum flour and anchovy flour which tend to be brown so that the more sorghum flour substitution, the darker the colour. This research is in line with the research of Hermeni et al. (2023), on the acceptability, hedonic quality and nutritional value profile of sorghum flour substitution cookies (sorghum bicolor) said that based on the results of the acceptability assessment of sorghum cookies, F2 containing 50% sorghum flour received the most votes with an average preference of 4.53 (12). There was a decrease in the normal value of idealism as the amount of sorghum increased. Because the tannin

content in sorghum flour can cause the colour of the product to become darker, the sorghum substitute cookies tend to have a darker colour.

This research is in line with the research of Y. P. Lestari, (2016) on the effect of sorghum flour substitution (sorghum biocol l. moech) and the proportion of meat with tuna fish bone flour (thunnus sp.) on the organoleptic properties of crackers which says that sorghum seeds have a dim (brown) seed coat which produces a creamy colour (13). Sorghum is known to have a high carbohydrate content; the utilization of sorghum flour in the manufacture of sorghum and anchovies occurs the Maillard response, specifically the response between starch, especially reducing sugars, and the collection of essential amines called the Maillard response. The product of this reaction is a brown-coloured substance.

Aroma

Based on the results of the organoleptic test, the most favourable aroma for panellists was P2, with a value of 3.48 (somewhat like) substitution of 20% sorghum flour and 15% anchovy flour. This means that the addition of anchovy flour concentration affects the aroma of biscuits. However, an error occurred during the roasting process of product P1 (30% sorghum flour and 10% anchovy flour), which resulted in a slightly charred product that affected the results of the product organoleptic test, namely panellist acceptance in terms of aroma. This causes panellists to accept the product with treatment 2 more than treatment 1, which has less anchovy concentration. Other studies have shown that by adding anchovy flour, the aroma of bagea cake loses some of its hedonic value (14). The highest value was found in treatment A (0%) with a value of 8.20 in the very like recognition model, and the lowest value was found in treatment D (35%) with a value of 5.40 in the neutral recognition model.

Based on the ANOVA test, the results showed an effect of sorghum flour substitution and anchovy flour on the organoleptic properties of biscuit aroma with a P value of 0.000 (<0.05). The tukey test results show that the significantly different treatment is the P0 treatment. Another study showed that the average panellists' preference for aroma decreased proportionately to the amount of anchovy meal added to the biscuit formulation. When fishmeal is added to a product, the result is a strong fishy aroma influenced by the dominant fishy taste in fishmeal (15).

Texture

Based on the results of the organoleptic texture test, the most preferred texture by panelists was P1 with a score of 4.1 (like) with a substitution of 30% sorghum flour and 10% anchovy flour. This means that the higher the addition of sorghum flour concentration, the crunchier the texture of the biscuits. Panelist assessment in terms of biscuit texture in all treatments had the same texture. This means that by adding the concentration of sorghum flour and anchovy flour, there is no difference in the texture of the biscuits. This research is in line with the research of Hermeni et al. (2023), about the acceptability, hedonic quality and nutritional value profile of sorghum flour substitute cookies (sorghum bicolor) said that judging from the results of the assessment of the suitability of sorghum flour substitute treats on the treat surface, the most preferred detail is F2 (50%) with an average slope value of 4.7 (12). Cookies become crumblier and crunchier the more sorghum is present in the recipe. The texture of cookies is influenced by the protein, amylose, and amylopectin content of the flour. During the frosting and unglazing process, the texture of the biscuits or cookies is affected by the sorghum flour, which lacks the gluten protein that aids in cookie formation. The type of starch and protein in flour and its texture are closely related. During the baking process, the gluten protein's ability to hold gas helps the dough rise.

This research is also in line with the research of Rahman & Naiu, (2021), on the characteristics of sago flour bagea cookies (Metroxylon sp) which are substituted for anchovy flour (Stolephorus Indicus) saying that because the proportion of sago flour used is still a lot, the texture of bagea cookies in treatment A (0%) and treatment B (15%) received a texture panel score of 8 with the criteria of liking it very much. (14). While treatments C (25%), and D (35%) have a low value of 5-6 with a fairly good non-partisan standard, this is due to the level of sago flour which is assumed to be an important part in surface formation. In addition to anchovy flour also decreased, it does not contain gluten which is very important for texture formation.

Based on the results of statistical analysis, the P value of 0.000 was obtained, which means that there is a difference between control biscuits and biscuits substituted with sorghum flour and anchovy flour. This shows that the addition of sorghum flour and anchovy flour to biscuits affects hardness. This research is in line with the research of Mariza Rosniar, (2016) on the difference in hardness and acceptability of biscuits from sorghum flour which is shredded and not shredded, namely the hardness value of biscuits increases proportional to the amount of substitute ingredients present. (16). Biscuits with 30% sorghum flour replacement had the most significant hardness. Because the sorghum flour used to make biscuits does not contain gluten, the dough contains less protein and is less fluffy.

Taste

Based on the organoleptic test results, the most preferred taste by the panelists was P3 with a score of 3.76 (liked) with a substitution of 10% sorghum flour and 30% anchovy flour. The taste of food products is influenced by the natural characteristics of the raw materials and during processing, the taste can change due to various factors such as the duration and conditions of the roasting process. This research is in line with the research of Rahmat et al. (2020), about spinach cookies and sorghum flour rich in iron as additional food for pregnant women with anaemia said that cookies formula 1 was enjoyed by as many as 90% of samples (10%: 90%), while cookies formula 2 (20%: 80%) and cookies formula 3 were enjoyed by 46.7% and 40% of samples, respectively. (17). This research is also in line with the research of Rahman & Naiu, (2021), on the characteristics of sago flour bagea cookies (Metroxylon sp) which are substituted for anchovy flour (Stolephorus Indicus) saying that the taste of bagea treats produced using sago flour with anchovy flour substitutes creates an alternative taste. (14). The difference in taste of the bagea treats was due to the influence of the various groupings of anchovy meal substitutes. The biscuit formulation contained a lot of anchovy flour, which lowered the hedonic mean value of taste. The higher the anchovy content in the rolls, the more the taste tended to be less preferred by the panelists. This research is in line with the research of Wael et al. (2023) on the effect of anchovy flour substitution on the hedonic quality of kamplang, namely the substitution of anchovy flour in Kamplang products has a significant effect on taste. In addition, the results of additional tests showed that each treatment was significantly different (18). The addition of anchovy flour which gives a salty taste with different degrees in each treatment is thought to be the cause of the variation in the taste parameters of Kamplang products between treatments.

Nutritional Content

The lower the sorghum flour substitution and the higher the anchovy flour substitution, the higher the energy content of the biscuits. This is because the higher the concentration of anchovy flour and the concentration of sorghum flour causes a decrease in the concentration of wheat flour. This research is in line with the research of Rahman N (2021) on the characteristics of sago flour bagea cookies (*Metroxylon sp*). which is substituted for anchovy flour (*Stolephorus Indicus*) said that as the amount of anchovy flour increases, the energy value of the food becomes lower (14). This is because the protein content of the meal tends to increase as the price of anchovy meal increases. As the amount of anchovy meal increases, the amount of energy produced also increases.

The lower the sorghum flour substitution and the higher the anchovy flour substitution, the higher the protein content of the biscuits. This is because the protein content decreases when the proportion of sorghum flour is higher in cookies because wheat flour has a higher protein content than sorghum flour. The effect of the decrease in protein nutrient content in cookies is the baking or drying process carried out. According to Farrah SD (2022) (19)**, h**igh temperatures can increase active energy which can make particles or protein constituents move quickly so that they can damage the bonds that make up the protein, this causes protein damage. Hermeni et al., 2023 (12), on the acceptability, hedonic quality and nutritional value profile of sorghum flour substitution cookies (sorghum *bicolor*) said that sorghum substitute cookies still meet SNI quality standards which require a minimum protein content of 6%. Cookies with lots of protein can be a good food for children's growth.

This research is in line with the research of Rahman N (2021) (14) about the characteristics of sago flour (*Metroxylon sp*) bagea cookies. which is substituted for anchovy flour (*Stolephorus Indicus*) said that the amount of protein in bagea cookies increases proportional to the amount of anchovy flour replaced. The protein content of dried anchovies at 68.7% has an impact on this. In addition, the protein of bagea cake comes from eggs which are an added ingredient as they contain all the essential amino acids, a high-quality egg protein.

The lower the sorghum flour substitution and the higher the anchovy flour substitution, the higher the fat content of the biscuits. This research is in line with the research of Hermeni H (2023), on the acceptability, hedonic quality and nutritional value profile of sorghum flour substitution cookies (*sorghum bicolor*) said that the amount of fat in the cookies increased when sorghum flour was used (12). Cookies made with sorghum flour may have a higher overall fat content than cookies made with wheat flour due to the higher fat content of sorghum flour. Cookies formulation F2 of this study had a fat content of 33.230% which is quite high. This research is also in line with the research of Rahman N (2021) (14), on the characteristics of sago flour (*Metroxylon sp*) bagea cookies. which is substituted for anchovy flour (*Stolephorus Indicus*) said that the amount of fat in bagea cookies increased along with the amount of anchovy flour replaced. This is influenced by the fat content in dried anchovies, which is 4.2%.

Based on the results of organoleptic tests and identification of nutritional values, the best product to be given to toddlers with nutritional problems of Protein Energy Deficiency (PEM) as a snack is

biscuits with sorghum flour substitution and anchovy flour with treatment 3, namely biscuits with the addition of 10% sorghum flour and 20% anchovy flour. According to Kemenkes RI (2022) (20)**,** it is known that for children aged 12 to 23 months, PMT requires 225 to 275 Kcal of energy, while for children aged 24 to 59 months, it requires 300 to 450 Kcal of energy. Snacks are the intended use of these foods. To fulfill these requirements, the number of biscuits made from sorghum flour and anchovy flour should be limited to 10 to 12 pieces per day for children aged 12 to 23 months with PEM nutrition problems and 14 to 20 pieces per day for children aged 24 to 59 months with PEM nutrition problems.

The weakness of this research lies in researchers who are less careful in the process of making products and in the flour making process. During the anchovy flouring process, the researcher did not marinate the anchovies, which resulted in a lack of fishy odour in the anchovies. During the roasting process, the researcher also made a mistake in the process of using fire which resulted in the product burning quickly.

Conclusion

The study demonstrated that substituting sorghum flour and anchovy flour significantly affected the organoleptic properties of biscuits, including color, aroma, texture, and taste. The effects varied across the three substitution levels tested: 30% sorghum flour and 10% anchovy flour (P1); 20% sorghum flour and 15% anchovy flour (P2); 10% sorghum flour and 20% anchovy flour (P3). Statistical analysis revealed significant differences in organoleptic properties between the control (P0) and the substituted samples. Specifically: Color: P3 was most preferred, with a mean score of 4.04 (like). Aroma: P2 was most preferred, with a mean score of 3.48 (somewhat like). Texture: P1 was most preferred, with a mean score of 4.1 (like). Taste: P3 was most preferred, with a mean score of 3.76 (like). Nutritional analysis showed that P3 had the highest protein content and energy value, containing 1,111.6 Kcal of energy, 41.75 g of protein, 50.74 g of fat, and 123.51 g of carbohydrates per serving.

These findings suggest that substituting wheat flour with sorghum and anchovy flour can produce biscuits with acceptable organoleptic properties and enhanced nutritional value, particularly in terms of protein content. Further research is recommended to optimize the formulation and assess shelf life and detailed nutritional composition through proximate analysis.

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Conflicts of Interest: The authors declare no conflict of interest.

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