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Development of high-protein and micro-mineral food products as an alternative snack for pregnant women in East Nusa Tenggara

Meirina S Loaloka[1], Anak Agung Ayu Mirah Adi[2], Santa Luciana Da Costa[3], Santi Lestaluhu[4], Oktavia Soumokil[5]

[1,2,3]Nutrition Study Program, Poltekkes Kemenkes Kupang, Indonesia
[4,5]Nutrition Study Program, Poltekkes Kemenkes Maluku, Indonesia

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ABSTRACT

The World Health Organization (WHO) reports that the prevalence of CED in pregnant women globally is 35-37% which is significantly higher in the 3rd trimester compared to the first and second trimesters of pregnancy. Efforts to develop food ingredients are very necessary. This research was conducted to prove the impact of providing high protein food made in the form of sokateri milk pie which was substituted for anchovy flour, peanuts, green beans and sorghum. This research used a completely randomized design, namely with 5 treatments with 1 standard treatment. Total Energy from the five milk pie treatments, namely P0 465.02%, P1 462.36%, P2 463.22%, P3 428.80%, P4 423.35%, and vitamin C levels in treatments P0 to P4 were not there is Vitamin C content in the product, the Fe content is 3.42%, and the calcium content is 126.91%, pie milk has met SNI 01-42701996 standards, for the best acceptability of milk pie in terms of color, taste, aroma and texture, namely with milk pie in the P2 treatment.

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Corresponding Author:

Meirina S Loaloka,
Nutrition Study Program,
Poltekkes Kemenkes,
Jl. Piet A. Tallo, Liliba, Kec. Oebobo, Kota Kupang, Nusa Tenggara Tim. 85111, Indonesia,
Email: mey.loaloka@gmail.com

INTRODUCTION

The World Health Organization (WHO) reports that the prevalence of Chronic Energy Deficiency (CED) among pregnant women globally is 35–37%, with significantly higher rates observed in the third trimester compared to the first and second trimesters of pregnancy (Ningrum, 2022)(Multazam et al., 2023). CED is a condition of calorie and protein deficiency that lasts for a long time or is chronic. SEZ is a type of malnutrition that can cause health problems (Lestari et al., 2023). In Indonesia, many cases of Chronic Energy Deficiency are mainly caused by an imbalance in nutritional intake, so that the nutrients needed by the body are not fulfilled (Zaidah & Maisuroh, 2022)(Palimbo et al., 2014). Pregnancy is a natural process in a woman's life phase (Lathifah & Dewi, 2021)(Aisyah & Prafitri, 2024). During this phase, women undergo physical and mental changes, requiring every pregnant woman to maintain good health and meet optimal nutritional

needs. Optimal nutritional intake significantly influences the nutritional status of pregnant women and is a crucial prenatal factor affecting fetal growth and development (Nasriyah & Ediyono, 2023)(Sari et al., 2020). The nutritional intake of pregnant women is determined by macronutrients (carbohydrates, fats, proteins) and micronutrients (vitamins and minerals) (Hariawan et al., 2023)(Harti et al., 2016). Data from the 2023 SKI (Indonesian Health Status Survey) shows that 17.3% of pregnant women experience Chronic Energy Deficiency (CED), with the highest prevalence in East Nusa Tenggara (NTT) at 36.8%, the highest in Indonesia. Pregnant women with CED are likely to give birth to babies with a higher risk of low birth weight (LBW) and short birth length (Husna et al., 2020)(Agustina & Fathur, 2022). To address this, it is important to ensure balanced nutritional intake, not only from main meals but also from snacks. As part of the Healthy Living Community Movement, providing supplementary food is crucial for improving nutrition (Kemenkes RI, 2016). The production of supplementary food (PMT) is usually still made using wheat flour. Therefore, in this study, the author attempts to create a snack in the form of a milk pie traditionally made with wheat flour, by substituting it with sorghum flour, anchovy flour (Stolephorus commersoni), peanut flour, and mung bean flour. The flours used are major local products in the East Nusa Tenggara (NTT) province. The objective of this study is to determine the effect of substituting sorghum flour, anchovy flour, peanut flour, and mung bean flour on the acceptability, nutritional content, and micro-mineral levels of the milk pie as an alternative snack for pregnant women with Chronic Energy Deficiency (CED).

RESEARCH METHOD

This study is experimental in nature. The design used is a Completely Randomized Design (CRD) with five treatments P0: 100% wheat flour, P1: 80% wheat flour, 5% anchovy flour, 5% sorghum flour, 5% mung bean flour, P2: 60% wheat flour, 10% anchovy flour, 10% sorghum flour, 10% peanut flour, and 10% mung bean flour, P3: 40% wheat flour, 15% anchovy flour, 15% sorghum flour, 15% peanut flour, and 15% mung bean flour, P4: 20% wheat flour, 20% anchovy flour, 20% sorghum flour, 20% peanut flour, and 20% mung bean flour. Each treatment was repeated three times, resulting in 15 experimental samples. The study was conducted from April to October 2024. The panelists consisted of 300 individuals, including students and lecturers from the Nutrition Department. The product preparation was carried out in the Food Science and Nutrition Laboratory at Poltekkes Kemenkes Kupang. The analysis of nutritional content and micro-minerals was conducted at the SIG Laboratory in East Java Province. Data collected included manual processing of acceptability (organoleptic analysis of aroma, texture, taste, and color). The average scores were analyzed to determine whether the data followed a normal distribution using Normality Tests (Kolmogorov-Smirnov and Shapiro-Wilk). If the data were not normally distributed, the Kruskal-Wallis test was applied. For data with a normal distribution, one-way Analysis of Variance (ANOVA) was used, followed by Duncan's multiple range test at a 5% significance level.

RESULTS AND DISCUSSIONS

Panelists' Acceptability

The acceptability test was conducted with 248 students and lecturers evaluating five sample treatments. The assessed aspects included color, aroma, texture, and taste. The results of the acceptability test for the *sokateri* pie showed an average preference score (for color, aroma, texture, and taste) ranging from 4 to 5, indicating a category of "liked" to "very liked." Statistical analysis of each treatment level revealed that the combination proportions of sorghum flour, peanut flour, mung bean flour, and anchovy flour influenced the acceptability (organoleptic quality) of the pie susu used in this study. This was due to differences in acceptability

(organoleptic quality) between the control pie susu (using the standard recipe) and the pie susu with the combination of sorghum flour, peanut flour, mung bean flour, and anchovy flour.

Colour

The organoleptic test on color, conducted with 248 students and lecturers from the Nutrition Department at Poltekkes Kemenkes Kupang, revealed that the acceptance level for pie susu (both original and formula) was in the "liked" to "very liked" category, with scores ranging from 4 to 5. Differences in color among treatments were attributed to the varying proportions of sorghum flour, peanut flour, mung bean flour, and anchovy flour used (NUR RAHMADITA, 2020)(Rulaini, 2022). The more anchovy flour added, the darker the pie became, with the pie in treatment P4 appearing darker than those in other treatments due to higher amounts of anchovy and other flours compared to P0, P1, P2, and P3. It was concluded that substituting these flours influenced acceptance, particularly regarding color.

This finding aligns with research by (Hestin Rahmawati & Rustanti, 2013) on cookies made with tempeh flour and anchovy flour substitutions, where cookies without substitutions or with minimal substitution (25% tempeh flour and 10% anchovy flour) were the most preferred. Statistical analysis using the Kruskal-Wallis test confirmed that treatment formulations significantly affected color ($p=0.000$). The darker hues of peanut and anchovy flours overshadowed the lighter colors of mung bean and sorghum flours (Annisa et al., 2019). Formulas P0 and P1 were more preferred in color due to their inclusion of only 10 g of anchovy flour, resulting in a less dark product.

Aroma

Aroma is a critical parameter in acceptability evaluation. The organoleptic test by trained panelists showed that the aroma of pie susu P3 and P4 carried a distinctive anchovy smell (Susianti et al., 2021). The acceptability test by 248 panelists indicated that pie susu *sokateri* (both original and formula) fell within the "liked" to "very liked" range, scoring between 4 and 5. Differences in aroma were due to varying proportions of sorghum flour, peanut flour, mung bean flour, and anchovy flour, with higher quantities enhancing the aroma. Treatment P4 had the strongest anchovy scent due to the higher amount of anchovy flour used.

It was concluded that substituting these flours affected acceptability, particularly in aroma. Statistical analysis confirmed a significant effect on organoleptic quality for aroma ($p=0.000$). Larger substitutions were still acceptable, with phospholipids such as trimethylamine oxide (TMAO) in marine fish contributing to the distinct aroma. If the reaction continues, excessive fishy odors may occur (Arumsari et al., 2014).

Texture

The texture evaluation showed that 248 panelists rated pie susu (original and formula) as "liked" to "very liked," scoring between 4 and 5. Differences in texture arose from the proportions of sorghum flour, peanut flour, mung bean flour, and anchovy flour. Increasing anchovy and peanut flour made the pie crispier, with treatment P4 being the crispiest due to its higher flour substitution levels.

It was concluded that the substitution influenced texture acceptability. Pie crust texture was assessed by breaking and biting to determine flakiness. According to Beranbaum (1998) on (Faroj, 2019), ideal pie crusts should be soft, light, and flaky. Treatment P0, using only wheat flour, was most preferred, while P4, with the most substituted flours, had a slightly harder texture. This hardness resulted from reduced gluten, which provides elasticity and creates airy textures during baking. The lower gluten levels in substituted flours led to less aeration, resulting in a denser texture (National Food Service Management Institute, 2009; Beranbaum, 1998). Statistical tests confirmed a significant effect on texture ($p=0.000$).

Flavor

Flavor is influenced by chemical compounds, temperature, concentration, and interactions with other taste components (Winarno, 2018) on (Nilakrisna et al., 2024). The acceptability test showed that panelists rated the flavor of pie susu *sokateri* (original and formula) in the "liked" to "very liked" range, with scores between 4 and 5. Differences in flavor were attributed to varying proportions of the substituted flours. Higher amounts of sorghum, peanut, mung bean, and anchovy flours enhanced the savory flavor. Treatment P4 had a more savory and sweet flavor due to higher substitution levels.

It was concluded that substituting these flours influenced flavor acceptability. Similar findings were reported by (Zulfahmi et al., 2014), who found that varying anchovy meat concentrations in cookies influenced organoleptic values for flavor. Baking is a critical stage where batter converts into pie, affecting the final taste (Priyanto, 2017). Panelists preferred the flavors in treatments P1 and P2, with modified formulas (P2, P3, P4) showing a sweet-savory combination due to substitutions. This result aligns with (Pitunani et al., 2016), who observed declining preference with higher anchovy flour substitution in cookies.

Carbohydrate Content

Carbohydrates are a primary energy source in foods, primarily from plants, found as starch and sugar. Analysis of carbohydrate content in pie susu *sokateri* samples revealed the highest content in treatment P4 (48.38 g per 100 g), followed by P3 (39.75 g), and the lowest in P1 (34.71 g). Treatment P0, dominated by wheat flour without substitution, had the lowest carbohydrate content (29.28 g).

High temperatures during processing can degrade carbohydrate molecules, reducing nutritional value. Caramelization (non-enzymatic browning) also contributes to carbohydrate breakdown. Martunis (2012) and Akmal (2014) observed that higher temperatures lead to significant carbohydrate degradation. The findings support this conclusion, highlighting the impact of substitution and processing on carbohydrate content.

Protein Content

Protein consists of organic elements similar to carbohydrates and fats, including carbon, hydrogen, and oxygen. However, proteins also contain nitrogen and may include minerals. Protein molecules are composed of 12 to 18 types of interconnected amino acids. Protein is essential for the body to function as a building block for growth and tissue maintenance, a regulator of bodily processes, and a source of energy.

Based on the analysis of protein content in the fruit pie samples, the highest protein content was found in Treatment P4, with a nutritional protein level of 14.58%, while the lowest protein content was observed in Treatment P1 at 6.44%. Wheat flour contains 10 grams of protein per 100 grams, but protein content varies due to processing techniques. During the production of pie susu, protein undergoes denaturation at temperatures between 55°C and 77°C. Since pie susu is baked at a high temperature of 160°C, this process reduces the protein content.

Although the protein content in pie susu is relatively low, it can still serve as an alternative or supplementary food. Its protein levels can be complemented with other dietary sources to fulfill its role as a building block for growth and tissue maintenance. (Kartasapoetra & Marsetyo, 2008) stated that protein functions as a building block for growth and maintenance of body tissues, regulates bodily processes, and serves as an energy source when carbohydrates and fats are insufficient.

Fat Content

The main ingredients in pie susu include anchovy flour, mung beans, peanuts, and sorghum flour, which are naturally low in fat, containing only 1 gram of fat. However, the increased fat content in pie susu is influenced by the baking process and the use of additional high-fat ingredients such as margarine, butter, and milk.

Consuming fat in the range of 15–30% of total energy requirements is considered healthy. This amount fulfills the need for essential fatty acids and aids in the absorption of fat-soluble vitamins. Of the daily fat intake, it is recommended that no more than 10% of total energy comes from saturated fats, and 3–7% comes from polyunsaturated fats.

Micro Minerals

The highest micro mineral content in Treatments P0–P4 was found in Treatment P4, which had the highest levels of iron (Fe) and calcium. This was due to the higher substitution of anchovy flour, mung beans, peanuts, and sorghum compared to other treatments. Vitamin C was not detected in any of the treatments (P0–P4), with a value of 0.01%. This is attributed to the minimal vitamin C content in the ingredients used.

CONCLUSION

The total energy content of the five pie susu treatments was as follows: P0 465.02%, P1 462.36%, P2 463.22%, P3 428.80%, and P4 423.35%. The vitamin C content in treatments P0-P4 showed no detectable levels of vitamin C in the product. The Fe content was 3.42%, and the calcium content was 126.91%. The pie susu met the SNI 01-4270-1996 standard. The best sensory acceptance in terms of color, taste, aroma, and texture was observed in the P2 treatment. Recommendations based on the research findings include further studies on product packaging testing..

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