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Hedonic And Physicochemical Quality Test Of Biscuits With Chicken Liver Flour And Pumpkin Flour Substitution As Supplementary Food For Pregnant Women

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Abstract
Pregnancy requires optimal nutrition, but physiological changes increase the risk of Chronic Energy Deficiency (CED). As a solution to the government's supplementary (PMT) biscuit, which is less preferred in terms of aroma and flavor, an innovation of nutrient-dense biscuits was developed by substituting chicken liver flour and pumkin flour. This study aimed to determine the effect of substitution of chicken liver flour and pumpkin flour on the hedonic quality (colour, aroma, taste and texture (crispiness)) and physicochemical (moisture, ash content, and density). This study used an experimental design with 9 formulations of substitute biscuits, containing chicken liver flour levels at 20%, 25%, and 30% and pumkin flour levels at 5%, 10%, 15%. Sensory evaluation was conducted by 36 untrained panelists, and the results were analyzed using Kruskal-Walis and post hoc Mann-Whitney. Laboratory analysis was evaluating moisture content, ash content, and density. Substitution of chicken liver flour and pumpkin flour showed an effect on the color parameter ($p<0.05$). The characteristics of biscuits were yellowish-brown color (3.90), with the chicken liver aroma (3.89) and pumkin aroma (3.70) being almost imperceptible, the taste of chicken liver (3.27) and taste of pumkin (3.35) was faint, and the texture was slightly crispy (3.05). Physicochemical analyzes showed a moisture content of 4.68-4.77%, ash content of 1.77-2.42%, and density of 9.91-35.47 N. Biscuits substituted with chicken liver flour and pumpkin flour were sensory accepted by panelists and had good physicochemical characteristics. Future research should conduct shelf-life testing, evaluate other chemical contents, control during the production process, and sensory evaluation by semi-trained panelists.

Keywords: Biscuit, Chicken Liver Flour, Pumkin Flour, Supplementary Food for Pregnant Women

INTRODUCTION

Pregnancy is an important period marked by increased nutritional needs, both macronutrients and micronutrients, to support fetal development and maintaining maternal health (Afandy et al., 2024).However, physiological changes during pregnancy can cause nausea, vomiting, and decreased appetite. If left untreated, these conditions can lead to Chronic Energy Deficiency (CED) (Ariani et al., 2024).

As an intervention, the Indonesian government has implemented a supplementary feeding program (PMT) in the form of sandwich biscuits specially formulated for pregnant women with CED. PMT biscuits are nutritionally dense, with each serving containing at least 270 kcal, 6 grams of protein, 12 grams of fat, and 11 vitamins (A, D, E, B1, B2, B3, B5, B6, B9, B12, and C) and 7 minerals (iron, calcium, sodium, zinc, iodine, phosphorus, and selenium) (Juliasari et al., 2022). Although the nutritional content has been adjusted, the effectiveness of this program is hampered by its acceptability. Data from the 2023 Indonesian Health Survey (SKI) shows that pregnant women do not finish PMT biscuits due to several factors, including unpleasant taste (45.9%), too sweet (24.6%), dislike of the aroma (18.9%), and insufficient variety of flavors (10.5%).

The issue of acceptability indirectly encourages pregnant women to consume their favorite commercial snacks. However, the snacks on the market are still dominated by products high in sugar, salt, and saturated fat, such as candy, chocolate, chips, wafers, and sweet biscuits. Consuming these snacks can potentially cause health problems if consumed excessively (Nugraha et al., 2025). Therefore, there is a significant opportunity to intervene in the nutritional status of pregnant women through innovative, nutrient-dense snacks.

Biscuits were chosen because of their popularity as a snack that is accepted by the community, with an average consumption of 40.7 grams per week (Ministry of Agriculture, 2023). Furthermore,

biscuits are selected based on their dry characteristics, making them suitable for pregnant women because they do not trigger nausea. Based on the Indonesian National Standard (SNI 2973-2011), biscuits are dry food products with a maximum water content of 5% and an ash content of 1.6%, making them practical, ready-to-eat, and have a long shelf life. The nutritional quality of these biscuits can be improved by substituting local ingredients such as chicken liver and pumpkin.

Chicken liver is a food source with a relatively high protein and iron content. According to the Indonesian Food Composition Table (TKPI), chicken liver contains 27.4 g of protein per 100 g of food, higher than chicken eggs (12.4 g), chicken meat (18.2 g), and beef (17.5 g). Meanwhile, chicken liver contains 15.8 mg of iron per 100 g, significantly higher than beef liver (6.6 mg) and beef (2.6 mg). The heme iron from chicken liver is absorbed 37% higher than that from plant-based sources such as green vegetables and nuts (Nurul et al., 2022). However, chicken liver has a distinctive fishy smell and a dark color (Paramita et al., 2025). Research by Rotua et al., (2024) The results of the chicken liver flour substitution levels (0%, 25%, 35%, and 50%) showed that the higher the chicken liver flour substitution, the lower the panelists' preference for color, aroma, and taste, with the lowest rating at 50%. Furthermore, the higher the substitution, the higher the water and ash content.

Pumpkin has a bright yellow color and sweet flavor, making it suitable for masking the fishy aroma and dark color of chicken liver. Pumpkin contains higher levels of beta-carotene (1569 mcg/100 g) than sweet potatoes (794 mcg/100 g). Furthermore, pumpkin has a milder, less bitter taste than carrots. Pumpkin also contains vitamin C, which helps absorb iron, B vitamins, minerals, and fiber, which are good for supporting the immune system and digestive health (Aulia et al., 2024). The use of pumpkin flour as a substitute ingredient in biscuits will also affect the physicochemical characteristics. Research by (Subaktilah et al., 2021) shows that substitution of 20% chicken liver flour can increase water content and ash content.

Despite the nutritional potential of both ingredients, developing products for sensitive populations such as pregnant women requires sensory acceptance testing (hedonic quality) that encompasses color, aroma, texture, and taste. Furthermore, the physicochemical quality of the biscuits is also important to consider. Physicochemical parameters such as moisture content, ash content, and texture are factors that influence product stability, food safety, and compliance with applicable biscuit quality standards.

In relation to the explanation that has been described, this study aims to determine the hedonic quality value and physicochemical characteristics (water content, ash content, and texture (density)) of biscuits with chicken liver flour and pumpkin flour substitutes as supplementary food for pregnant women. The results of this study are expected to provide information on the level of acceptance and quality of these substitute biscuits, as well as serve as a basis for consideration in developing PMT that is effective and accepted by the community.

RESEARCH METHODS

This research is an experimental research with a factorial Completely Randomized Design (CRD) approach, which consists of two factors, namely the level of substitution of chicken liver flour (20%, 25%, and 30%) and the level of substitution of pumpkin flour (5%, 10%, and 15%), so that 9 biscuit formulations are formed.

This research procedure consists of three main stages, namely, making chicken liver flour, making pumpkin flour, and making biscuits.

Making Chicken Liver Flour

The chicken livers are sorted and soaked in lime solution (10 minutes), then boiled with bay leaves, lime leaves, lemongrass, and ginger (5 minutes), crushed, dried (60oC for 4 hours), ground, and sieved using an 80 mesh sieve.

Making Pumpkin Flour

The pumpkin is peeled and seeds are removed, washed, cut into 2-3 mm thick pieces, dried (60oC for 8 hours), mashed, and sieved using an 80 mesh sieve.

Biscuit Making

Powdered sugar, egg yolks, margarine, and butter are beaten, then mixed with chicken liver flour, pumpkin flour, low-protein flour, soy protein isolate, powdered milk, baking powder, and vanilla until a dough forms. It is then molded into squares and baked at 160°C for 20 minutes.

The hedonic quality test data collection involved 36 untrained panelists (females of childbearing age) who assessed the attributes of color, aroma, taste, and crispness using a hedonic quality scale of 1-5. Laboratory physicochemical testing included analysis of water content using the drying method, ash content using the dry ashing method, and texture density level using the Perten TVT 6700 Texture Analyzer tool expressed in Newton (N).

Sensory test data were analyzed statistically using the non-parametric Kruskal-Wallis test. If a significant effect ($p<0.05$) was found, the analysis was continued with a post-hoc Mann-Whitney test to determine significant differences between treatment groups. Physicochemical data were analyzed descriptively and presented graphically.

RESULTS AND DISCUSSION

Product Results

The product produced in this study was biscuits with chicken liver flour and pumpkin flour substitutes, with nine different treatment formulations. Visually, the nine samples had distinct colors, as seen in the following image:

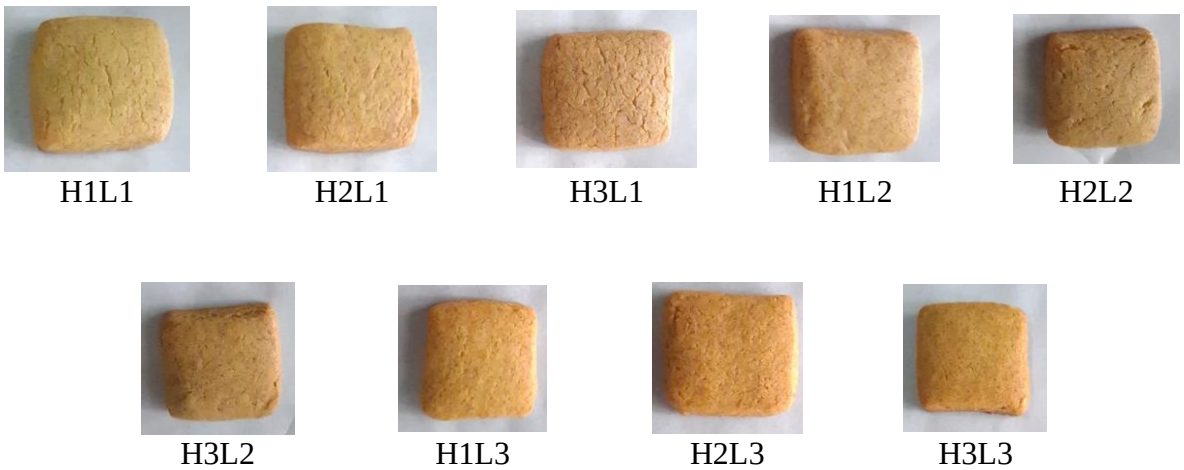


Figure 1. Visual appearance of biscuits with chicken liver flour substitution (H1 = 20%, H2 = 25%, and H3 = 30%) and pumpkin flour (L1 = 5%, L2 = 10%, and L3 = 15%)

Hedonic Quality Test Results

The results of the hedonic quality test are listed in the following table:

Parameter	Mean	p-value
Color	3.90	<0.001*
Chicken Liver Aroma	3.89	0.570
Yellow Pumpkin Aroma	3.70	0.734
Chicken Liver Flavor	3.27	0.086
Pumpkin Flavor	3.55	0.929
Crispness	3.05	0.833

Note: (*) indicates a statistically significant effect based on the Kruskal-Wallis test ($p < 0.05$).

Color

Food colors that have a deviant impression from the color they should have tend to be rejected by consumers, even though they have good nutritional value (Annisa & Suryaalamsah, 2023). The results of the Mann-Whitney test showed that the substitution of chicken liver flour and pumpkin flour had a significant effect on color parameters.

Treatment	Mean ± SD
H1L1	4.36 ± 0.762 a
H1L2	4.31 ± 0.710 ab
H2L2	3.94 ± 0.715a
H3L2	4.03 ± 1,000bc
H2L1	4.00 ± 0.894abc
H1L3	3.89 ± 0.887c
H3L3	3.58 ± 1.156d
H2L3	3.56 ± 0.998cd
H3L1	3.39 ± 0.994bcd

Description: numbers followedfollowed by different notations (a,b,c,d) in the column indicates a significant or real difference based on Mann-Whitney test ($p<0.05$)

The H1L1 formulation produced the highest mean value (4.36^{a}), which was not statistically significantly different from H1L2, H2L2, and H2L1. However, H1L1 was significantly different from the highly substitutable formulations such as H1L3, H3L3, H2L3, and H3L1. The H3L1 formulation had the lowest mean (3.39^{bcd}), which was not significantly different from the H3L2, H2L1, H1L3, and H2L3 treatments. However, it was significantly different from H3L3.

The color changes to a browner color as the concentration of chicken liver flour increases, due to the heme iron content (hemoglobin and myoglobin), which imparts a dark red to dark brown color. These results align with research (Tyas et al., 2025) This indicates that the higher the concentration of chicken liver flour substitute, the darker the resulting color. The color of the biscuits is also influenced by the high carotenoid content in pumpkin, resulting in a yellow color (Moron et al., 2025). The combination of the two ingredients to a certain extent is able to balance the product's visuals into an attractive golden brown.

In addition to raw material factors, the formation of dark brown color is also caused by a non-enzymatic browning reaction (Maillard reaction) during roasting. The Maillard reaction is a reaction caused by amino groups with reducing sugars that form hydroxymethyl furtufural compounds which then become furtufural which polymerizes to produce melanoidin, resulting in a brown color (Marsita et al., 2024). The higher the substitution level of the two ingredients, the faster the Maillard reaction rate will be, resulting in biscuits with a deep dark brown color.

Chicken Liver Aroma and Yellow Pumpkin Aroma

Aroma is a sensory attribute that can be assessed using the sense of smell based on the stimulation of volatile compounds in nasal receptor cells (Tarwendah, 2017). The results of the Kruskal-Wallis test showed that the substitution of chicken liver flour (p = 0.570) and pumpkin flour (p = 0.734) did not affect the aroma of biscuits.

Chicken liver has a distinctive, fishy aroma due to volatile compounds in the aldehyde, ketone, and sulfur compounds. Meanwhile, pumpkin has a distinctive sweet aroma due to volatile compounds in the aldehyde and short-chain alcohol groups. The lack of difference between treatments is likely due to volatile compounds being less heat-stable. In this study, both ingredients underwent a double heating process: during flour production and biscuit baking. High heat causes volatile compounds to evaporate (Ramadhania et al., 2025).

The biscuit-making process also involves standard ingredients that can influence the biscuit's aroma. The use of fat (margarine and butter) provides a distinctive bakery aroma, while the caramelization of refined sugar during baking produces a sweet caramel aroma. Coupled with vanilla's function as a flavoring agent, this ingredient can also disguise the fishy aroma of chicken liver and

pumpkin. Another factor contributing to the panelists uniformity in assessment was the relatively narrow range of substitution levels, making it difficult for the panelists to identify the aromas of chicken liver and pumpkin (Muhlishoh et al., 2024).

Chicken Liver Flavor and Yellow Pumpkin Flavor

Taste is a major factor in the acceptance of food products, which involves the sense of taste for chemical components in food ingredients.(Khasanah & Mumpuni, 2021)The Kruskal Wallis test results showed that the substitution of chicken liver flour (p = 0.086) and pumpkin flour (p = 0.929) did not have a significant effect (p > 0.05) on taste parameters. Panelists perceived a uniform taste across all treatments.

The absence of this difference is thought to be influenced by the roasting process, high temperatures can trigger the Maillard reaction which then produces a savory caramel aroma so that it is able to disguise the original taste of chicken liver which is fishy and has a metallic aftertaste (Budhi et al., 2023).

Furthermore, the interaction between the characteristics of the raw materials can also balance the flavor. The natural sweetness of pumpkin flour can mask the metallic taste of chicken liver (Diang et al., 2022). This masking effect is enhanced by the use of standard raw materials such as refined sugar and milk, which have dominant flavors, thus masking the taste of substitute ingredients (Muhlishoh et al., 2024).

Texture (Crispyness)

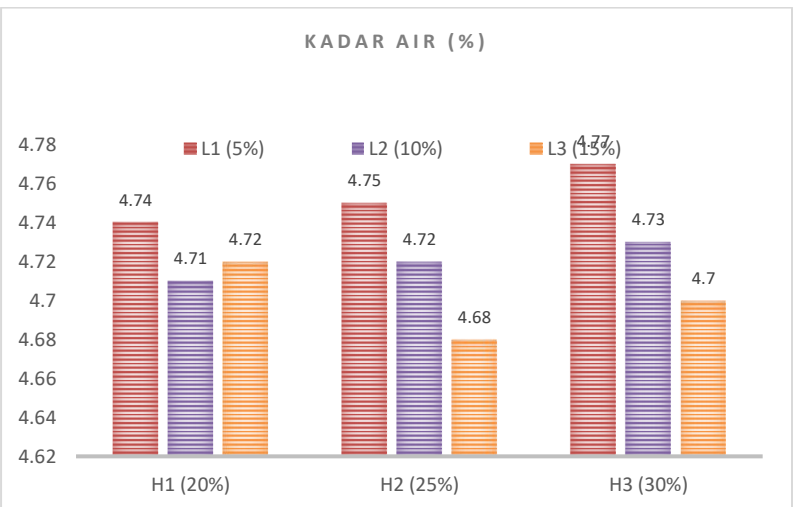
Texture is a quality attribute that determines consumer acceptance, in biscuits it is usually assessed based on the level of crispiness (Priyono, 2018)The Kruskal-Wallis test results showed that the substitution of chicken liver flour and pumpkin flour had no significant effect (p = 0.833) on texture parameters. Panelists did not perceive any difference in texture across all treatments. The total mean value indicated that the biscuits had slightly crunchy characteristics.

The crispiness of biscuits is greatly influenced by the gluten content of the flour which provides an elastic and dense texture after the baking process (Baihaqi, 2025)Substituting chicken liver and pumpkin flour for gluten content will reduce gluten content. However, in this study, formulations H1L1 through H3L3 had similar characteristics. This is likely due to the substitution level being too small to make a significant difference.

The highest average and crispiest texture was found in sample H1L1. This aligns with research showing that biscuits with low substitution tend to have organoleptic values closer to those of control biscuits (China et al., 2020).

Physicochemical Test Results

Water content



Water content is a critical parameter in food ingredients which indicates the amount of water contained in an ingredient, which functions to determine freshness and shelf life. High water content

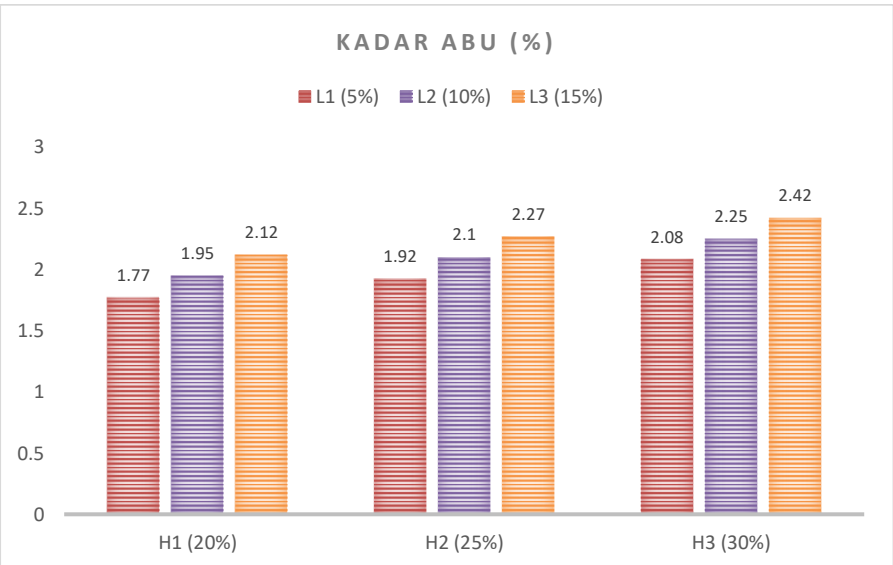
will cause bacteria, yeast and mold to grow easily (Normilawati et al., 2019). The test results showed that the water content of the biscuits ranged from 4.68% to 4.77%, all treatments have met the biscuit quality requirements based on SNI 2973:2011 which stipulates a maximum water content of 5%. The water content value below this standard limit indicates that the biscuits have good shelf life potential, because the water content is effective in suppressing microbial activity and preventing damaging chemical reactions (Seftiono et al., 2019; Zaddana et al., 2022).

Increasing the concentration of chicken liver flour tends to increase the water content in biscuits with the same concentration of pumpkin flour. This increase in water content is due to the hydrophilic nature of animal protein in chicken liver. Protein compounds have polar groups that can form strong bonds with water molecules. During the baking process, the water trapped in the gel matrix becomes more difficult to evaporate (Widiantara et al., 2018), so biscuits with high chicken liver flour substitution tend to retain a lot of water.

However, the water-retaining properties can be suppressed as the pumpkin flour concentration increases. This is because the dietary fiber in pumpkin forms hydrogen bonds with the protein components rather than binding free water (Damayanti et al., 2020). In addition, increasing the concentration of chicken liver flour and pumpkin flour substitutes will reduce the proportion of wheat flour in the asonan, thereby decreasing the gluten content. This reduction in gluten will weaken the water-binding capacity. This condition facilitates the release of water molecules during the baking process, resulting in a lower water content (Ira et al., 2019).

The fluctuating patterns observed in some treatments are thought to be influenced by technical factors in the processing. Uneven oven heat distribution and variations in biscuit thickness can affect the rate of water evaporation.

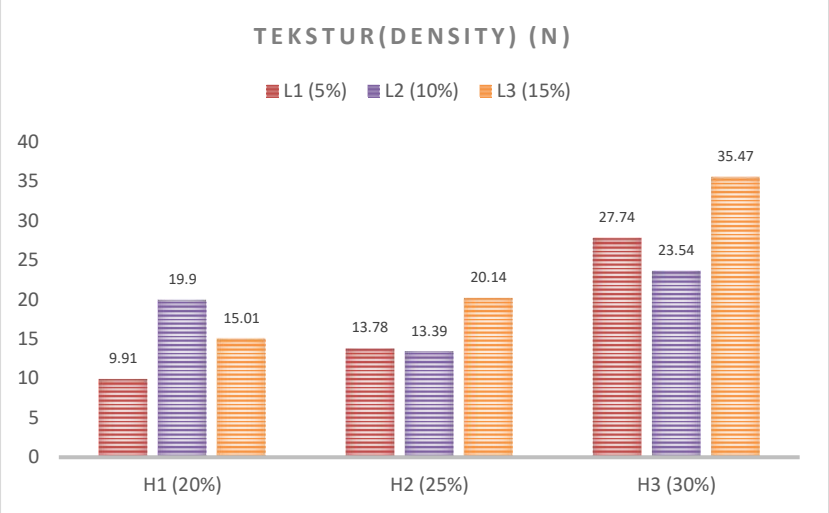
Ash Content



Ash content is closely related to the mineral content of a food ingredient. Ash content is an inorganic substance left over from the combustion of organic materials. Furthermore, ash content also indicates the purity and cleanliness of the resulting food ingredient. Test results show that the higher the concentration of chicken liver and pumpkin flour substitutes, the higher the ash content. This increase is due to the mineral content of the substitutes. Chicken liver is rich in essential minerals such as iron, zinc, and copper, which contribute to the high ash content (Andania, 2023). Pumpkin is also a good source of minerals, including potassium, calcium, phosphorus, and magnesium (Suhaji, 2022).

Since the biscuits in this study are intended as supplementary foods with a deliberately enhanced mineral content, the standards used may refer to specific functional food standards that provide a higher mineral tolerance. Compared to SNI 2973:2011, which has a maximum of 1.6% for commercial biscuits, the overall biscuit formula does not meet the standard, falling within the range of 1.77% to 2.42%.

Texture (Density)



Density is a physical parameter to describe the maximum force required to break a product. Test results using a texture analyzer (load cell capacity 50 N) show values ranging from 9.91 N to 35.47 N, where increasing the substitution concentration tends to produce a firm and difficult to break texture.

The increase in density with increasing levels of chicken liver flour substitution is likely due to the characteristics of animal protein which forms a solid dough matrix through hydrogen bond interactions with starch components during the baking process, thereby increasing the density of the product and requiring greater force to break (Suryaningrum et al., 2025) On the other hand, increasing the level of pumpkin flour substitution also results in a harder texture. Fiber has a high water-binding capacity, which limits the complete gelatinization of starch during baking and results in a denser and stiffer network. Fiber serves as a dough reinforcement, increasing the biscuit's resistance to pressure (Arshad et al., 2025).

CONCLUSIONS

This study shows that the substitution of chicken liver flour and pumpkin flour in biscuits as supplementary food for pregnant women only has a significant effect on the hedonic quality of color, while aroma, taste, and crispiness do not differ significantly between formulations. In general, the biscuits have a characteristic brownish yellow color, almost undetectable aroma of chicken liver and pumpkin, a faint taste of both ingredients, and a slightly crunchy texture so that it is acceptable by the panelists. The results of the physicochemical test showed that the water content ranged from 4.68 to 4.77 percent and has met the requirements of SNI 2973:2011, while the ash content was in the range of 1.77 to 2.42 percent so that it exceeded the standard limit due to the high mineral content of chicken liver flour and pumpkin flour. In addition, increasing the concentration of both substitution ingredients tended to increase the density of the biscuits so that it produced a firmer texture.

This study still has several limitations, namely the lack of a comprehensive analysis of nutritional content such as protein, iron, beta carotene, and antioxidant activity, no shelf life testing, and sensory assessment only involving untrained panelists so it does not fully reflect the preferences of target consumers. Therefore, further research is recommended to optimize the formulation to achieve a balance between sensory quality and nutritional content, test storage stability, iron bioavailability, and product acceptance by pregnant women as the main target. Practically, the results of this study indicate that the combination of chicken liver flour and pumpkin flour has the potential to be developed as an alternative supplementary food based on local foods that are rich in nutrients to support programs to improve the nutritional status of pregnant women, while still paying attention to formula refinement to meet all applicable food quality requirements.

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