The Effect of Adding Green Spinach Flour (*Amaranthus tricolor*) on Chicken Liver Nuggets in Terms of Yield Quality, Organoleptic Preference, and Color Using a Color Reader

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Abstract. The purpose of this study was to know the effect of addition green spinach flour (*Amaranthus tricolor*) to chicken liver nuggets in terms of yield quality, oraganoleptic, and color using a color reader. The materials in this research are broiler chicken liver and green spinach flour (*Amaranthus tricolor*). The research method used four treatments with different concentration of green spinach flour (*Amaranthus tricolor*) namely P0 (0%), P1 (5%), P2 (10%), and P3 (15%). The experimental design used the Analysis of Variance (ANOVA) and de garmo method for the best treatment. The results showed had no significant effect ($P > 0.05$) on the yield and color test, however organoleptic quality on each parameter gave significant effect ($P < 0.01$). The conclusion obtained was the making of chicken liver nuggets with green spinach flour (*Amaranthus tricolor*) the best treatment was obtained P0 (0%) with an average yield value of 146,76%, organoleptic (color, taste, flavor) respectively 3,68; 4; 4; and color (L*, a, b) respectively 58,97, −0,04; 20; 28. The results further suggested that replacing use of vegetable flour other than green spinach (*Amaranthus tricolor*) in broiler liver nuggets for the diversity of food products and testing the same variables to find out optimal results.

Keywords: chicken liver nuggets · green spinach flour · yield quality · oraganoleptic · color reader

1 Introduction

Food processing technology is growing in line with people's mindsets that encourage the diversity of food products, no doubt processed products from livestock. Meat is an animal protein that comes from livestock, its availability is important to meet needs. Indonesian people's consumption interest in chicken meat. According to Putra et al. [1], especially broiler chicken meat reached 3.8 kg per capita per year, increasing to 22.19 percent from 2009. When compared with other livestock meat consumption, the total consumption of boiler chicken meat reached 84.07 percent of the total consumption of other livestock meat. Chicken meat has a relatively affordable price with abundant availability, chicken

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meat can be used as an innovative product using processing technology into an efficient product without reducing its nutritional value. One of the processed chicken meat products that people are interested in is nuggets. Processed chicken product made from a mixture of chicken meat with or without the addition of other food ingredients, with or without the addition of permitted food additives, printed (steamed or frozen molded), coated with or without frying according to the National Standardization Agency [2]. The purpose of making nuggets is to increase the added value of meat, processing nuggets into processed products that are practical and can be stored properly.

The use of meat for nuggets has been modified a lot, namely by replacing meat with the liver. This is a food product innovation that utilizes by-products or by-products of cutting. The Liver is one of the organs of livestock that is easily processed and accepted by the community. Chicken liver contains mineral vitamin A as much as 21,676.18 g RE/100 g raw sample, vitamin B1 0.23 mg/100 g, vitamin B2 0.74 mg/100 g, vitamin B3 6.57 mg/100 g, vitamin B5 4.16 mg/100 g, and vitamin B6 0.01 mg/100 g, and mineral iron (Fe) 79.29 mg/kg [3]. Study by Krismaputri et al. [4] stated that the use of chicken liver which contains vitamin A and iron (Fe) provides a different taste so and will increase consumer preferences.

Nugget processing requires fillers or fillers that can determine the characteristics of the resulting nugget product, in the manufacture of nuggets the fillers that can be used include wheat flour, tapioca flour, and cornstarch [5]. Tapioca flour is a starch extracted from cassava (*Manihot utilisima crantz*) which has amylopectin content so that products with tapioca flour tend to have a crunchy texture, are soluble in water, usually used as fillers and binders which produce an elastic, and compact texture [6]. Research by Kusumaningrum et al. [7] the use of tuber flour by 10% as an addition to filler and binder serves to increase emulsion stability, reduce shrinkage during cooking, improve cut characteristics, improve taste, and reduce formulation costs. The use of tapioca flour in making chicken nuggets was carried out by Gumilar et al. [8] in a study of differences in the use of filler nuggets using tapioca flour as much as 10% of the weight of chicken meat.

Food innovation with the addition of flour from green spinach (*Amaranthus tricolor*) aims to increase the nutritional value of nugget products. The utilization of green spinach (*Amaranthus tricolor*) in the form of flour is a way to reduce the distinctive taste of spinach and maintain the spinach content. Components of green spinach (Amaranthus tricolor) described by Rauf [9] Fe levels ranged from 1.67–6.78 mg/100 g and the constituent components of vitamin A were 9,420 mg/100 g and vitamin C 59 mg/100 g. The Fe in green spinach (*Amaranthus tricolor*) is non-heme Fe in the presence of vitamin C, vitamin A, and beta carotene can increase the absorption of non-heme Fe. The use of green spinach flour (*Amaranthus tricolor*) with broiler liver will increase the nutrition of liver nugget products, supported by Santosa et al. [10], iron in chicken liver is heme iron. The form of heme iron is more absorbable by the body than non-heme iron found in vegetables and fruits.

Based on the description above, it is necessary to conduct research to determine the effect of the quality of chicken liver nuggets with the addition of green spinach flour (*Amaranthus tricolor*) in terms of yield quality, organoleptic preferences (color, taste, and flavor), and color using a color reader.

2 Materials and Methods

The research was conducted in the Division of Meat Processing, Laboratory of Animal Products Technology, Faculty of Animal Science, Universitas Brawijaya.

2.1 Research Material

The research material is nuggets made from fresh broiler liver obtained from Best Meat, Malang City, and green spinach flour (*Amaranthus tricolor)* brand Omah Tepung produced from Omah Tepung e-commerce, Sleman, Yogyakarta.

2.2 Research Substance

Other supporting substances are Cap Kapal salt, Ladaku brand pepper, garlic, broiler eggs, yellow bread flour, Rose Brand tapioca flour, and Bimoli brand oil which can be found at grocery stores in Malang City.

2.3 Research Equipment

The equipment used in the making and processing of liver nuggets is stainless steel pots and pans, Mitochiba food processor for grinding liver, Weston brand digital scales, aluminum concrete measuring 20 cm long × 10 cm wide × 7 cm high, gas stove, gas stove LPG green tube container, spatula¸ knife, tablespoon, and stopwatch timer from a cellphone. Color testing using a color reader brand OEM type CHNSPEC CS-10.

2.4 Research Method

This research method uses a completely randomized design (CRD) experimental method with 4 treatments and 4 replications. The treatment was the addition of green spinach flour (*Amaranthus tricolor*), namely: P0 (without addition), P1 (addition of 5%), P2 (addition of 10%), and P3 (addition of 15%). The variables tested included yield quality (%), preference organoleptic, and color using a color reader.

2.5 Variable Test

Research variables include:

1. Testing the yield of chicken liver nuggets with the addition of green spinach flour (*Amaranthus tricolor*) was carried out by weighing the weight of the nugget product and the weight before the nugget product with the formula [11]:

$$\text{Yield (\%)} = \frac{\text{Processed weight}}{\text{Weight before processing}} \times 100\%$$

2. Organoleptic testing (color, taste, and flavor) on chicken liver nuggets with the addition of green spinach flour (*Amaranthus tricolor*) was carried out by testing the panelists' preferences for color, taste, and flavor. Sensory testing is carried out using the hedonic method (Likeness Test) where the assessment is by scoring. The level of preference with a hedonic scale on color, taste, and flavor is 1: Very Dislike, 2: Disliked, 3: Moderately Liked, 4: Liked, 5: Very Liked [12]. The test involved 7 trained panelists to provide an assessment by filling out the Organoleptic Test Worksheet provided to assess based on the level of preference and write down responses and impressions on the color, taste, and flavor of chicken liver nuggets with the addition of green spinach (*Amaranthus tricolor*) that had been presented.
3. Color testing on chicken liver nuggets with the addition of green spinach flour (Amaranthus tricolor) with a color reader reading parameter L* stating the brightness (lightness) value from 0–100 (black-white), parameter a* chromatic color of the red-green mixture for the + a* (positive) value from 0–100 for red and the –a* (negative) value of 0–(–80) for green, and the b* parameter represents the mixed chromatic color of blue and yellow for the + b* value (positive) from 0–70 for yellow and –b* (negative) value from 0–(–70) for blue [13].

2.6 Data Analysis

The data obtained were analyzed using Analysis of Variance (ANOVA). Then if there is a difference, it is continued with Duncan's Multiple Range Test (DMRT).

3 Results and Discussion

3.1 Yield (%)

The nugget product yield test analysis showed no significant effect ($P > 0.05$), the data are presented in Table 1. The highest average value of the P3 treatment with the addition of green spinach flour (*Amaranthus tricolor*) was 15%, which was 150.15% and the lowest average value in the addition of 5% is 139.92%. The higher the percentage of addition of green spinach flour (*Amaranthus tricolor*) can increase the yield of the product, this is influenced by the weight of the material increasing after the addition of the formulation of green spinach flour (*Amaranthus tricolor*). Comparable to research by Hidayati et al. [14] the addition of green spinach flour (*Amaranthus tricolor*) to wet noodles with the addition of 0, 10, 20, and 30 resulted in the yield percentage.

Nuggets with the addition of green spinach flour (*Amaranthus tricolor*) the texture obtained from nuggets with the addition of green spinach flour (*Amaranthus tricolor*) is less compact, and the texture of the nugget product can affect the yield. The use of green spinach flour (*Amaranthus tricolor*) in processed meat products, namely sucuk which is a traditional Turkish dry fermented sausage by Salehi [15] that the texture of the sucuk product with the addition of green spinach flour (*Amaranthus tricolor*) with a percentage of 0%: 6.67, 1%: 4.78, and 3%: 4.67 showed insignificant results. Previous research by Firdausi [16] product of chicken liver nuggets, mixed broiler meat nuggets with broiler liver, and broiler meat nuggets resulted in the average yield test not having a significant effect ($P > 0.05$), which was 108.94% to 112, 36% showed the best treatment on 100% chicken nugget treatment of 112.36%.

Table 1. The average yield, organoleptic preference, and color test using a color reader on chicken liver nuggets with the addition of green spinach flour (*Amaranthus tricolor*).

Treatments	Yield (%)	Organoleptic			Color		
		Color	Taste	Flavor	L*	a*	b*
P0	142,97 ± 2,17	3,68 ± 1,23^{b}	4,00 ± 0,96^{c}	4,00 ± 1,10^{c}	58,97 ± 0,34	−0,04 ± 0,02	20,28 ± 0,21
P1	139,92 ± 8,27	2,79 ± 1,08^{a}	2,93 ± 1,10^{b}	3,07 ± 1,07^{b}	58,77 ± 0,07	−0,013 ± 0,08	21,77 ± 3,19
P2	142,78 ± 2,56	2,61 ± 1,14^{a}	2,71 ± 0,84^{ab}	2,61 ± 0,67^{a}	58,79 ± 0,01	−0,007 ± 0,09	19,80 ± 0,75
P3	150,15 ± 13,00	2,43 ± 1,08^{a}	2,32 ± 1,04^{a}	2,82 ± 1,14^{ab}	58,67 ± 0,26	−0,14 ± 0,18	18,85 ± 2,65

Note: $^{a-c}$ different superscripts in the same column show a very significant difference ($P < 0.01$)

3.2 Organoleptic

Color. Based on the results of organoleptic analysis, the color of the nugget product was very significant effect ($P < 0.01$), the data are presented in Table 1. The highest mean value was obtained by the control treatment P0 (without the addition of 0%) namely (3.68 ± 1.25) and P3 (155% addition) with the lowest average being (2.43 ± 1.10). This is comparable to the research by Indraswati et al. [17] namely the catfish nugget (*Clarias batrachus*) with the addition of green spinach (*Amaranthus tricolor*) 0, 20, 30, 40%, the results obtained nugget without the addition of spinach is more acceptable by the panelists with a score of 3.8, the catfish nugget (*Clarias batrachus*) with the addition of spinach by 40% was not accepted by the panelists with a score of 2.88. The addition of green spinach (*Amaranthus tricolor*) in nugget products in research using green spinach flour (*Amaranthus tricolor*) in chicken liver nuggets, the higher percentage of green color produced, the darker it is. In line with the research of Rasyid et al. [18] that the addition of green spinach (*Amaranthus tricolor*) to squid nuggets (*Loligo* sp.) shows a darker color, the higher the percentage, this is because green spinach (*Amaranthus tricolor*) has a green dye, namely chlorophyll which when mixed too much will cause The green color in spinach will affect the color density which gives the food a darker color effect.

The color of the nugget product can also be influenced by frying because of the non-enzymatic browning reaction of the reducing sugar contained, this refers to the starchy filler material, namely tapioca flour. Previous research by Talebe et al. [19] that the color of the nugget with the difference in filler flour has a significant effect on the color of the nugget because the product from starch gives a brownish color when heated, the brown color is due to starch dextrins containing dextrin when heated will polymerize to form a brown color.

Taste. Based on the results of organoleptic analysis, the taste of nuggets was very significant effect ($P < 0.01$), the data are presented in Table 1. The highest mean value was obtained by the control treatment P0 (without the addition of 0%) resulting in the highest average (4.00 ± 0.98) and P3 (15% addition) with the lowest average being (2.32

± 1.06). This is reinforced by the results of research by Indraswati et al. [17] the catfish nugget (*Clarias batrachus*) with the addition of green spinach (*Amaranthus tricolor*) 0, 10, 20, 30, 40%, the results obtained are the taste of the nugget with the addition of spinach 30% more acceptable to the panelists with a score of 3.84, the catfish nugget (*Clarias batrachus*) with the addition of 40% spinach was not accepted by the panelists with a score of 2.88 because the greater the proportion of green spinach (*Amaranthus tricolor*) added, the lower the panelist's preference level, the taste of spinach tends to be unpleasant, so that the more spinach is added to the ingredients, the more unpleasant the taste of the catfish nugget (*Clarias batrachus*) will be. The study of broiler liver nuggets with broiler liver substitution conducted by Yuliana et al. [20] showed a difference in the percentage level of broiler liver substitution of 0, 10, 20, 30, and 40% giving an average value ranging from 3.32–4, 1 which shows the delicious-very good parameter, broiler chicken liver affects the taste more than the use of spices and the processing and cooking process causes a significant effect ($P < 0.05$) on the taste of the nuggets.

The taste of chicken liver nuggets with the addition of green spinach flour (*Amaranthus tricolor*) in addition to the influence of the basic ingredients of chicken liver and green spinach flour (*Amaranthus tricolor*), other added ingredients such as garlic, pepper, and salt can affect the taste. In line with the research of Awaliah et al. [21] large amounts of spice extract with a large surface area penetrate perfectly into the product, resulting in a dominant and same taste.

Flavor. Based on the results of organoleptic analysis, the flavor of nuggets was very significant ($P < 0.01$), the data are presented in Table 1. The control treatment P0 (without the addition of 0%) obtained the highest mean value (4.00 ± 1.12) and P2 (10% addition) had the lowest average value (2.61 ± 0.69). Previous research on squid nuggets (*Loligo* sp.) the addition of green spinach (*Amaranthus tricolor*) with a percentage addition of 5, 10, and 15% showed a decrease in hedonic value as the concentration of spinach used increased, the panelist assessment results showed the most disliked scent, value the percentage of 15% is 24.0 [18].

The distinctive flavor of green spinach (*Amaranthus tricolor*) is reduced due to the addition of flour, but the nuggets are still dominantly flavored with chicken liver. This is reinforced by a previous study by Ramadhani [22] where chicken nuggets were added with broiler liver with a presentation of adding 20, 30, and 40% of the weight of chicken meat, showing the best percentage of adding 20% of chicken liver, panelists (100%) assessed the flavor Not fishy, the distinctive flavor of chicken liver is influenced by volatile compounds and water vapor released during cooking and the added spices.

3.3 Color Using a Color Reader

Lightness (L*). Based on the results of the lightness analysis on nuggets, the effect was not significant ($P > 0.05$), the data are presented in Table 1. The control treatment P0 (without the addition of 0%) obtained the highest average value of lightness (L*) (58.97 ± 2.34) and the lowest average P3 (15% addition) value (58.67 ± 2.00). The decrease in the average value of lightness (L*) is strengthened by previous research by Syuhairah et al. [23] that the addition of green spinach (*Amaranthus tricolor*) to chicken sausage

products with a percentage difference of 30%, the value is 49.32 ± 0.02, the percentage of 40% the value of 49.06 ± 0.01, and the percentage of 50% the value of 45.98 ± 0.01, the higher the percentage the addition indicates a decrease in the lightness value (L*).

The color of the nuggets produced looks dark, this is because the color of the chicken liver tends to darken after steaming. Research by Agustia et al. [24] showed that mocaf-garut biscuit products with chicken liver substitute darkened because chicken liver contains iron, and products fortified with the iron will have a dull color as a result of complex changes between iron and polyphenols. The use of tapioca flour as a binder and bread flour as a bettering can affect the color during frying due to the Millard reaction. Research by Amertaningtyas et al. [25] that in the manufacture of chicken liver and beef liver nuggets with different additions of flour does not affect the lightness color, the color of the nuggets may become slightly brown due to the frying process and changes in the color of chicken and beef liver. Due to the steaming and frying process.

Redness (a*). Based on the results of the redness analysis on nuggets, the effect was not significant (P > 0.05), the data are presented in Table 1. The treatment P2 (with the addition of 10%) obtained the highest average value of the redness degree (a*) (−0.007 ± 1.09) and the lowest average P3 (with the addition of 15%) value (−0.14 ± 1.03). The decrease in the average value in the treatment showed the greener the color the more the percentage of addition of green spinach flour (*Amaranthus tricolor*). In line with the results of the study, sausages with the addition of green spinach (*Amaranthus tricolor*) with a difference in the level of addition of 30%: 0.18 ± 0.01, 40%: −0.14 ± 0.01, 50%: −0.10 ± 0.02 the acquisition value of –a* is green in sausage due to the addition of the spinach [23].

The negative value is because the chlorophyll content in spinach is not all lost in the extraction process. This is confirmed in the study of processed klepon with the addition of green spinach (*Amaranthus tricolor*) flour compared to suji leaf flour (*Dracaena angustifolia*) and pandan (*Pandanus amaryllifolius*) with additional levels of 30, 60, and 90% by Salim et al. [26] shows a dark green color the higher the presentation.

Yellowness (b*). Based on the results of the yellowness analysis on nuggets, the effect was not significant (P > 0.05), the data are presented in Table 1. The treatment P1 (with the addition of 5%) obtained the highest average value of yellowness degree (b*) (21.77 ± 4.55) and the lowest average was P3 (with the addition of 15%) value (18.85 ± 1.82). Comparable to the research by Palamutoğlu et al. [27] on the addition of spinach in traditional Turkish sucuk or sausage products showed a decrease in the addition of 10% and 30% treatment, namely 19.43 ± 1.82 to 16.99 ± 2.31 in the study. It states that the higher the addition of green spinach (*Amaranthus tricolor*) will decrease the value of L* and b*.

The use of starchy flour and coating of nuggets using bread flour (bettering) can cause a maillard reaction or browning during frying, this can affect the yellowness value (b*) in the nugget product. Research by Kusuma et al. [28] states that the yellowness value (b*) in celery crackers (*Apium graveolens*) is influenced by the pigment in flour, adding flour and maillard reaction during the frying process.

4 Conclusions

The results showed that the use of green spinach flour (*Amaranthus tricolor*) on chicken liver nuggets with a different percentage of each treatment 0, 5, 10, and 15% did not affect yield and color tests with a color reader, but did affect the organoleptic preference test. It is recommended to compare the use of vegetable flour other than green spinach (*Amaranthus tricolor*) in broiler liver nuggets for the diversity of food products and test the same variables to determine optimal results.

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