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Diversification of Healthy Chicken Nugget Rich in Antioxidants and Dietary Fiber with Substitution of Green Bean Flour (*Phaseolus radiatus L.*) dan Red Bean Flour (*Phaseolus vulgaris L.*)

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Abstract

Nuggets have the disadvantage of low dietary fiber and antioxidant activity, then the use of tapioca flour in making nuggets results in a low protein product. So the substitution of tapioca flour with red beans and green beans is needed. This study aims to analyze and identify the substitution of tapioca flour with green bean flour and red bean flour on antioxidant activity and physicochemical characteristics of chicken nuggets. The research design used a fully randomized 2x5 factorial pattern with substitution levels of 0, 15, 30, 45 and 60 (%). The Parameters measured were antioxidant activity, protein content, dietary fiber content and L* color. The results showed that the content of antioxidant activity and protein content was higher in the substitution of red bean flour at the 60% level with a value of 65.6%, The highest dietary fiber content was observed in the substitution of green bean flour at the 60% level with a value of 10.7%. then the substitution of red bean flour and green bean flour can reduce the color value of L* in nugget products. There was an interaction between the type of treatment and the degree of substitution on the dietary fiber content. It was concluded that substitution at 60% level was the best treatment in flour substitution in chicken nugget products.

Keywords: Antioxidant activity, Protein content, Dietary fiber, Red bean flour, Green bean flour

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1. Introduction

A nugget is a processed ground meat product that is *filled* and seasoned, coated with egg whites (*batter*) and flour (*breading*) prefried and then packaged and frozen [1]. The production of chicken nuggets requires the addition of flour. Flour acts as a filler and binder. Tapioca flour is one of the fillers used to make the nuggets and its function is to improve the texture, making the nuggets chewy and soft. According to [2], the use of tapioca flour as a binder will produce chicken nuggets with a softer texture but a low protein content below the SNI 01-6683-2002 standard, this is because tapioca has a low protein content of 0.5 g and a high carbohydrate content of 86.9 grams [3].

In generally, the nuggets on the market are perishable, low in antioxidants, low in dietary fiber and vitamins, and the processing process tends to cause oxidation, which shoertens the shelf life of the nuggets. According to [4], One way to prevent oxidation is to add ingredients that contain antioxidants.

In order to increase the prevention of oxidation, and to increase the dietary fiber, protein and vitamin content in the nuggets, it is necessary to diversify the nugget products by using local flours that have antioxidants, dietary fiber, vitamins and high protein content. A potential local ingredient with antioxidant properties and high nutritional value is the red bean (*Phaseolus vulgaris L.*) and the green bean (*Phaseolus radiatus L.*). Based on the research by [5], on the formulation of chicken nuggets using red bean flour as a source of fiber and protein, the study concluded that the formulation of 20% red bean flour: 80% chicken meat produced acceptable proximate quality, physicochemical and sensory properties. Meanwhile [6], on the formulation of nuggets using green bean flour as a source of protein and fiber, The incorporation of green bean flour at levels up to 100% has been demonstrated to enhance the protein, fiber, and acceptability profiles of nugget products. The objective of this study was to examine and ascertain the impact of substituting tapioca flour with red bean flour and green bean

flour on the protein content, dietary fiber content, and antioxidant activity of chicken nuggets.

2. Materials and methods

2.1 Materials

The materials used were fresh broiler breasts obtained from broiler slaughterhouse mitra usaha jayaYusuf Bauty street, Paccinongan village, Somba Opu subdistrict, Gowa Regency. red beans obtained from farmers in Pao village, Tombolopao subdistrict, Gowa Regency. Green beans were obtained from farmers in Malakke village, Belawa subdistrict, Wajo district. Salt (R), garlic, pepper powder (R), chicken eggs, tapioca flour (R), DPPH (*Diphenyl picryl hisrazyl*) powder, methanol, distilled water, 0,3 N H_2SO_4, N_aOH solutions dan 95% alcohol. Tools used *Spectrophotometer* (UV-VIS SHIMADZUUV-1800), *food processor* (Cosmos Blenz CB-802), vacuum pump, food dehydrator (GETRA ST-02 capacity 100 L), exiccator, digital balance (SF 400 capacity 1000 g), stove, test tube, tube rack and refrigerator.

2.2 Method

This research was conducted experimentally using a Completely Randomized Design (CRD) 2x5 factorial pattern research method as follows:

Factor A is the flour type substitution treatment:

A_1 = Red Bean Flour (RBF)

A_2 = Green Bean Flour (GBF)

Factor B is the treatment of flour level:

B_1 = 0%

B_2 = 15%

B_3 = 30%

B_4 = 45%

B_5 = 60%

2.3 Preparation for Making Red Bean Flour and Green Bean Flour

The production of red bean flour refers to the research of [7], 1 kg of red beans was washed and soaked in water at room temperature for 24 hours. Then steamed for 20 minutes at medium heat. Then dried in an oven 60 ° C for ± 12 hours. The dried red beans are crushed and sieved with a 100 mesh sieve for uniform and fine size.

The production of green bean flour refers to the research of [8], namely sorting is done to select good quality green beans to be used as flour, 1 kg of green beans are washed and soaked for 20 minutes. The soaked mung beans were washed again and then boiled at 100°C for 20 minutes, then peeled to remove the epidermis and then dried in an oven at 60°C for 30 minutes. The green beans were ground and sieved through a 100 mesh sieve.

2.4 Preparation of Chicken Nugget Dough

Chicken breast meat is first cleaned and then cut into small sizes to facilitate the process of grinding the meat. After the meat is ground and smooth, it is mixed with red bean flour with the treatment and then given spices.

Once the shaping process is complete, the dough should be steamed for a period of 30-40 minutes. Following this, the dough should be cooled and cut. It should then be coated with a mixture of wet flour and panir flour and placed in the freezer for a period of 15-30 minutes. After this, the nuggets can be fried and tested.

2.5 Variabel Analysis

2.5.1 Antioxidant Activity

The antioxidant test refers to the method of [9], DPPH was weighed to a precision of 0.008 g and subsequently dissolved in 50 mL of methanol. The control absorbances were obtained by diluting the DPPH solution to achieve a series of concentrations. The dilution was conducted by adding the DPPH solution at concentrations of 60 ppm, 70 ppm, 80 ppm, 90 ppm, and 100 ppm to 9 mL of methanol. The absorbance was then measured using a UV-VIS spectrophotometer at a wavelength of 515 nm.

One gram of the test sample was diluted in nine milliliters of methanol and homogenized by vortexing at concentrations ranging from 104 ppm to 103 ppm. For each dilution, 0.2 mL of the sample solution was added to a test tube, followed by the addition of 3.8 mL of the DPPH solution and 0.2 mL of methanol. The test sample mixture was homogenized by vortexing and incubated with 3.8 mL of DPPH preparation and 0.2 mL of methanol for 30 minutes in a dark room. After that, the absorbance was measured using a UV-VIS spectrophotometer at a wavelength of 515 nm. The formula for calculating the value of antioxidant activity is as follows:

$$\text{DPPH Radical scavenging Effect (\%)} = \frac{A\,(DPPH) - A(Sampel)}{A\,(DPPH)} \times 100\%$$

2.5.2 Dietary Fiber

Dietary fiber testing is conducted in accordance with standard [10] using the enzymatic gravimetric method (18-8-6-2/MU/SMM-SIG), as performed by PT Saraswanti Indo Genetech at Rasamala Street NO. The address is 20, Taman Yasmin, Bogor, West Java 16113.

2.5.3 Protein content

The protein content is determined according to the SNI 01-2891-1992 method, point 7.1. The protein content can be determined by the Kjeldahl method. This method consists of three steps, namely digestion, distillation and titration [11]. The determination of protein content is performed by grinding the sample with a suitable tool or grinder, then weighing the sample 0.2-0.5 g and placing the sample in the Kjedhal tube, then adding a number of catalysts (Selenium mix) and 6 ml of H2SO4 then homogenizing. Homogenized samples are then deconstructed for ± 1.5 hours until they are clear yellow. After deconstruction is complete, the sample is cooled until completely cold. Samples were analyzed using the Foss instrument (KJELTEC). Protein content test parameters in the proximate analysis using the formula:

$$\text{\% Nitrogen} = \frac{(S-B)\text{X N HCL X } 14}{\text{W X } 1000\text{K}} \text{ X } 100\%$$

Protein content = % Nitrogen x 6,25

Note: S = volume tyrant sample
B = volume tyrant sample
W = dry sample weight
N = normality HCL

2.5.4 Instrument L^* Colour

The measurement of the color value of chicken nuggets refers to the test method of [12], the digital colorimeter (T 135) which measures the color L*. color L = 0 (black) to 100 (white).

2.6 Data Analysis

Data were processed by analysis of variance based on a 2x5 completely randomized design (CRD) using IBM SPSS Statistics 26, followed by Duncan's test if the treatment had a significant effect [13].

3. Results and Discussions

3.1 Antioxidant Activity

This study examines the impact of substituting tapioca flour with green bean flour and red bean flour on the antioxidant activity of chicken nuggets. The results are illustrated in Figure 1. The results demonstrate that the use of red bean flour yields superior outcomes compared to green bean flour, with a notable difference of 1.90%. The analysis of variance revealed a statistically significant effect of tapioca flour substitution on the antioxidant activity of chicken nuggets ($P<0.01$). Red beans and green beans contain phenolic compounds in the form of flavonoids that function as antioxidants, but in the results of the study, the antioxidant content of red beans is higher than that of green beans because red beans contain secondary metabolites, namely anthocyanins, anthocyanins are believed to have excellent antioxidant effects. According to [14], among the various classes of flavonoids, anthocyanins are regarded as the most potent antioxidants. It is postulated that anthocyanin content may inhibit a range of free radicals, including superoxide radicals and hydrogen peroxide. Furthermore, anthocyanins and their derivatives have been demonstrated to inhibit diverse oxidation reactions through a variety of mechanisms. Based on [15], the results of *1,1-Diphenyl-2-Picrylhydrazyl* (DPPH) test of red beans have the highest antioxidant activity compared to soybean and green bean, the antioxidant activity of red bean flour with skin is 98.40%.

Duncan's test results showed that the 60% flour substitution level was significantly different with a higher increase in antioxidant activity content from 0% compared to 15%, 30% and 45%. Each addition of 15% peanut flour resulted in an increase in antioxidants. The observed increase in antioxidant activity is attributable to the varying levels of flour incorporation across the treatment groups. The implication of this increase in antioxidant activity is to reduce rancidity despite the presence of unsaturated fat. According to [16], antioxidant activity can inhibit the rancidity process because antioxidants are more active than oxygen, the active molecules of antioxidants prevent the formation of peroxides by binding oxygen. In addition, the addition of other ingredients to the dough also has antioxidant activity. Red beans and green beans contain bioactive compounds such as flavonoids, coumarins tannins, triterpenoids that act as natural antioxidants. According to [17], beans contain saponins, flavonoids, triterpenoids, coumarins and tannins. These are natural antioxidants that have the capacity to reduce the number of free radicals. The analysis of variance revealed that the interaction between the two factors exhibited no statistically significant effect ($P>0.05$). The absence of interaction between the two factors resulted in a lack of response to antioxidant activity across different types, with a consistent level observed.

3.2 Dietary Fiber

This study examines the impact of substituting tapioca flour with green bean flour and red bean flour on the dietary fiber content of chicken nuggets. The results are illustrated in Figure 2. It can be seen that the results of green bean flour substitution are superior to red bean flour with a difference of 1.28%. The analysis of variance revealed a statistically significant effect of tapioca flour substitution on the dietary fiber of chicken nuggets ($P<0.01$). This phenomenon can be attributed to the high fiber content of red beans and green beans. Research Results [18], Flour derived from legumes exhibits a higher fiber content than tapioca flour.

Duncan's test results demonstrated that the 0% flour substitution level exhibited a statistically significant difference from the increase in fiber content of 15%, 30%, 45%, and 60%, and vice versa. A notable difference was observed at the 15% substitution level, suggesting that an increase in the level of flour substitution may correspond with a proportional increase in the dietary fiber content of the nuggets. Research Results [19], the fiber content of red beans is 4 g per 100 g while that of green beans is 7.5 g per 100 g.

Both factors were subjected to statistical analysis, the results of which yielded statistically significant results at the ($P<0.01$) level of significance for the interaction of flour type and degree of substitution on the dietary fiber of chicken nuggets. The interaction that occurs in the dietary fiber content parameter shows that the response between the type of treatment and level of flour substitution increasingly converges with the level of flour substitution.

3.3 Protein content

This study examines the impact of substituting tapioca flour with green bean flour and red bean flour on the protein content of chicken nuggets. The results are illustrated in Figure 3. The results demonstrate that the substitution of red bean flour is more effective than that of green bean flour, with a notable difference of 0.9%. The analysis of variance investigating the impact of tapioca flour substitution on protein content in chicken nuggets yielded statistically significant results ($P<0.01$), indicating a noteworthy influence on the protein profile of the chicken nuggets. The protein content of red beans is 23.10 g and the protein content of green beans is 22.90 g. In addition, red beans have a composition of acidic acids that can be absorbed by the body. In addition, red beans have a complete amino acid composition, one of which is a high arginine content of 56.80 mg /g protein [20], red beans contain quite high leucine which reaches 76.16 mg / g protein, thus making red beans one of the food sources that have good quality protein content [21]. The following findings are based on the research conducted by [22], the addition of 30% red bean flour results in a protein content of 20.01%. Protein levels are influenced by the ingredients used in the nugget manufacturing process.

The Duncan test results show that the 0% level is different from the addition of 15%, 30%, 45% and 60% levels. There is an increase in protein content with substitution but there is no visible difference. The disparity in protein content between tapioca flour and red bean flour and green bean flour is the underlying cause of this phenomenon. The resulting different protein levels are also due to the level of flour substitution used. The substitution of red and green bean flour in greater quantities will result in a corresponding increase in protein content.

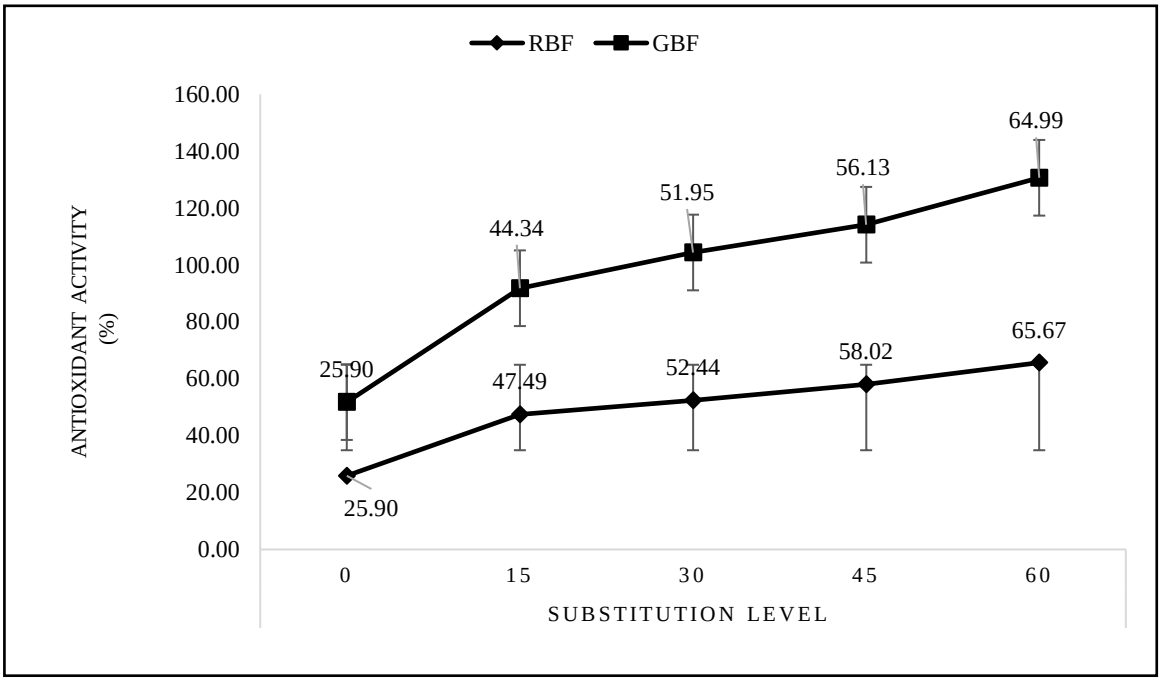

Figure 1. Effect of substitution of tapioca flour with red bean flour (RBF) and green bean flour (GBF) on antioxidant activity (%) of chicken nuggets

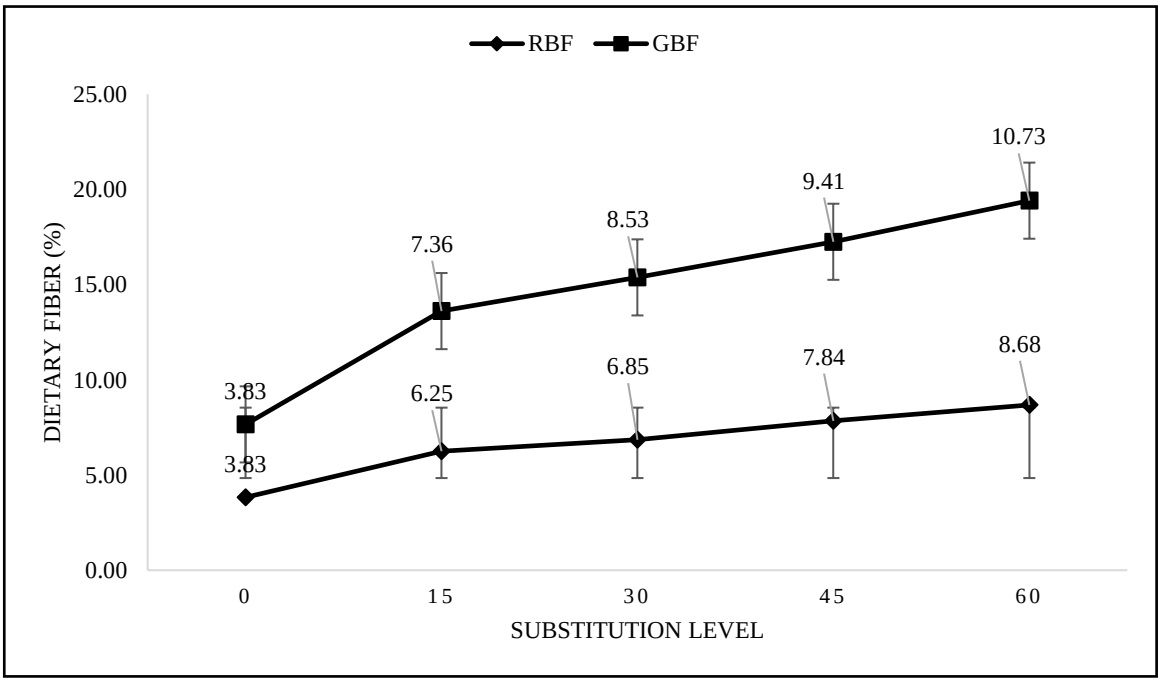

Figure 2. Effect of substitution of tapioca flour with red bean flour (RBF) and green bean flour (GBF) on dietary fiber (%) of chicken nuggets

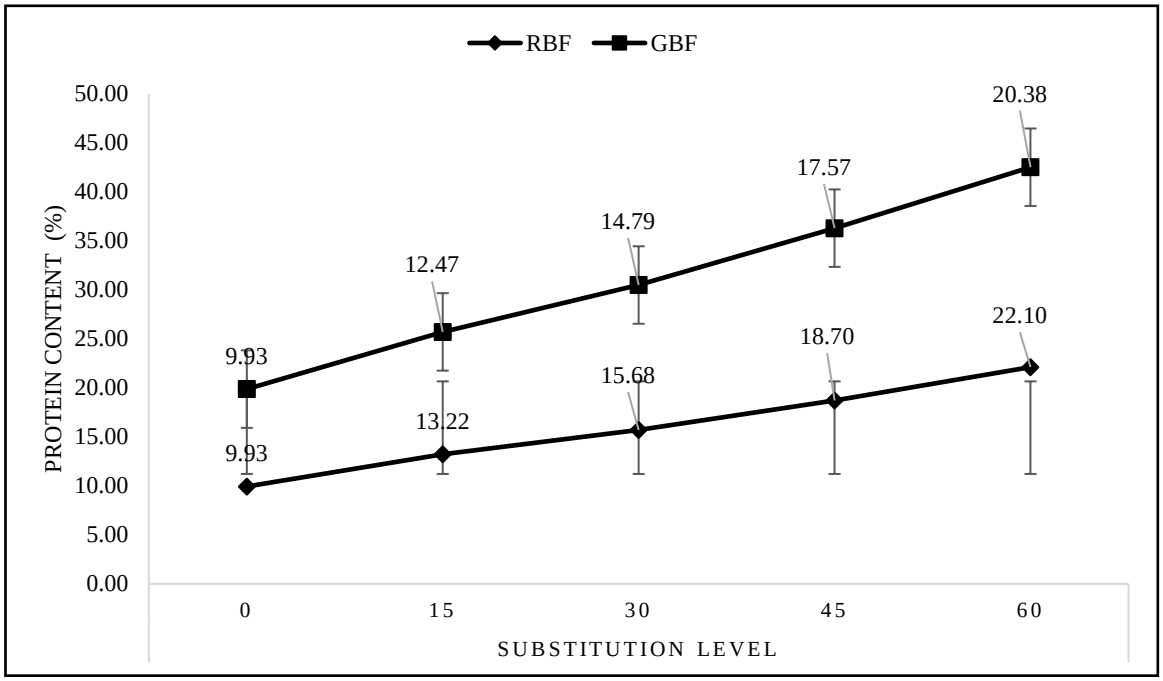

Figure 3. Effect of substitution of tapioca flour with red bean flour (RBF) and green bean flour (GBF) on protein content (%) of chicken nuggets

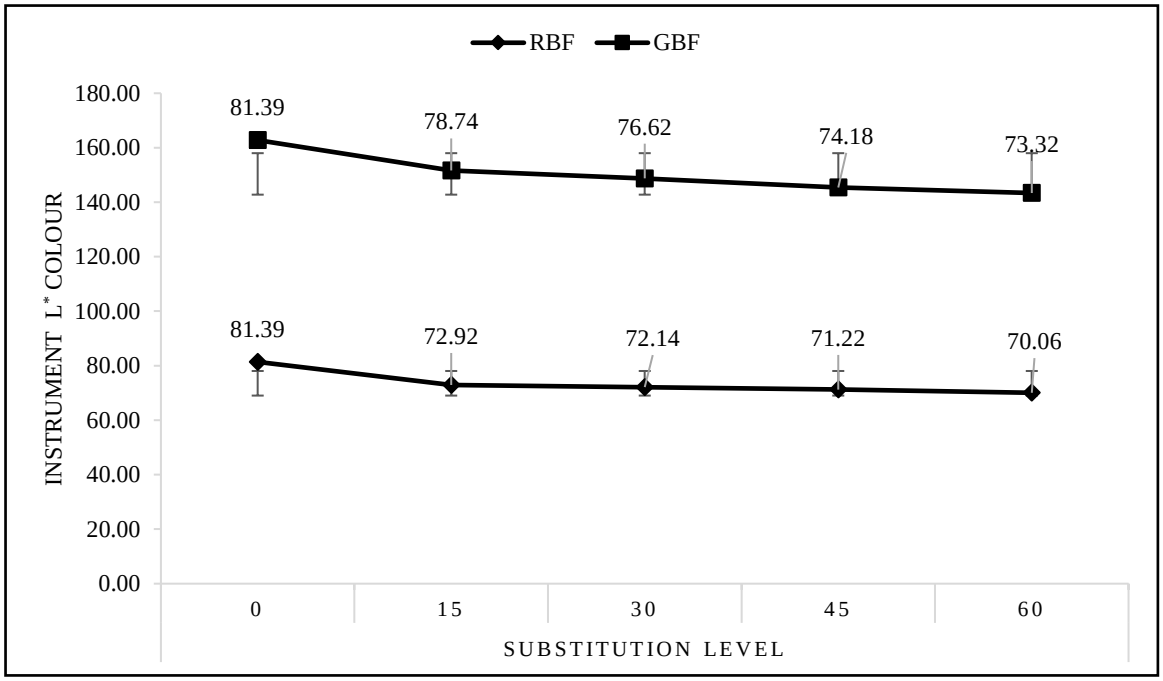

Figure 4. Effect of substitution of tapioca flour with red bean flour (RBF) and green bean flour (GBF) on instrument L^* colour (%) of chicken nuggets

According to SNI (2002), the minimum standard for the protein content of chicken nuggets is 12% [23]. When compared with the Indonesian national standard, chicken nuggets with red bean flour and green bean flour substitutions met SNI 01-6683-2002 for protein content. The analysis of variance revealed that the interaction between the type and level of substitution had no significant effect (P>0.05). Therefore, it may be concluded that there is no interaction between the two factors, which results in the absence of protein content response across the various types at the identical level.

*3.4 Instrument L*colour*

This study examines the impact of substituting tapioca flour with green bean flour and red bean flour on the L* color of chicken nuggets. The results are illustrated in Figure 4. It can be seen that the results of red bean flour substitution are different. The objective of this study was to analyze the impact of tapioca flour substitution on the L* color of nuggets. To this end, an analysis of variance was conducted. yielded statistically significant results (P<0.01), and there was no significant interaction (P>0.05) between the two factors on the L* color of chicken nuggets.

Duncan's test results showed that the 0% substitution level exhibited a statistically significant difference (P<0.05) in L* color compared to the nuggets at varying substitution levels 15, 30, 45 and 60%, the 15% and 60% levels were significantly different from the 3 treatments while the 30% and 45% levels were not significantly different. The results demonstrated that the average value of the substitution level of red bean flour had the greatest impact on the L* color of the nuggets. at 0% (81.39) and the lowest at 60% (70.06), then at the substitution of green bean flour the highest was 0% (81.39) and the lowest was 60% (73.32). The higher the degree of flour substitution, the higher the Maillard reaction that occurs, causing the lightness value of the nuggets to decrease. Research Results [24], anthocyanin compounds in products are unstable when heated so that they are easily degraded in conjunction with the presence of sugar and protein groups, which can cause Maillard reactions. Maillard reactions can cause food to turn brown. The analysis of variance of the interaction between the two factors revealed no statistically significant effect (P>0.05). Therefore, it may be concluded that there is no interaction between the two factors, which results in the absence of a L* color response across the various types at the identical level.

4. Conclusions

Substitution of red bean flour in chicken nuggets produces antioxidant content, high protein content of 65.67% and 22.10%, respectively, then for the highest dietary fiber content obtained from the substitution green bean flour with a value of 10.73%. Substitution at the 60% level is the best treatment in flour substitution in chicken nugget products.

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