Physical Quality of Chicken Corned Using Flaxseed Flour (*Linum usitatissimum*) as a Filler

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Abstract. Flaxseed flour (*Linum usitatissimum*) is known as a functional ingredient rich in dietary fiber, antioxidants, and fatty acids that support digestive health and improve food quality. Flaxseed flour is used as a filler to enhance texture and physical properties chicken corned. This study aimed to determine the optimal level of flaxseed flour addition in chicken corned, evaluated through pH, yield, water holding capacity (WHC), cooking loss, and color (L*, a*, b*). The materials used was corned from the meat of spent laying hens, formulated with different levels of flaxseed flour. The method used was a laboratory experiment using a Completely Randomized Design (CRD) with 4 treatments and 5 replications. The treatments were T0 (control), T1 (2% flaxseed flour), T2 (4% flaxseed flour), and T3 (6% flaxseed flour). The data were analyzed using Analysis of Variance (ANOVA), and then the significant difference continued with Duncant Multiple Range Test (DMRT). The results showed that flaxseed flour addition had a very significant effect ($P<0.01$) on all measured parameters. Increased flaxseed flour levels improved yield, WHC, and redness (a*) color, while reducing pH, cooking loss, lightness (L*) and yellowness (b*) color. It was concluded that the addition of 6% flaxseed flour gave the optimal chicken corned based on physical quality.
Keywords: Corned, filler, flaxseed flour, spent laying hens

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1 Introduction

Spent laying hen meat is derived from hens that are approximately 96 weeks old and have an egg production rate of less than 70%, indicating that these hens are no longer efficient at producing eggs. However, spent laying hens still have the potential to be utilized as a source of meat that is suitable for consumption. Spent laying hen meat is still underutilized among the public due to its tendency to be tougher in texture. Despite this weakness, spent laying hen meat is high in protein, containing 25.4 – 31.5%, and low in fat, containing 1.3 – 7.3% [1]. Therefore, efforts to diversify processed products based on spent laying hen meat are needed to increase added value and consumer acceptance. One processing technique that can be applied is restructured meat technology.

Restructured meat technology is a method to enhance the use of materials and improve economic efficiency while also prolonging the shelf life of meat products [2]. Restructured meat products have added value because they create food that is more palatable, practical, and nutritious. Corned is one meat product that uses restructured meat technology. Corned is usually consumed as a side dish or mixed ingredient in various dishes such as noodles and fried rice [3]. However, most corned products on the market still tend to have low fiber content and poor texture, thus requiring new modifications in corned processing through the addition of natural ingredients to enhance both the nutritional value and physical quality of corned products.

Flaxseed (*Linum usitatissimum*) is a plant species belonging to the *Linaceae* family. Flaxseed is classified as a "superfood," a term for foods derived from nature that contain many bioactive components beneficial to health. Flaxseed contains beneficial bioactive components such as lipids, gum, α-linolenic acid, and phytochemicals in the form of lignans, phenolic acids, flavonoids, and tocopherols. In addition, flaxseed also contains 28% dietary fiber and approximately 20%–25% protein [4]. The dietary fiber component of flaxseed mainly consists of mucilage compounds, which are hydrocolloid heteropolysaccharides composed of neutral monosaccharides and acids with varying ratios. Mucilage has diverse functional characteristics, namely emulsifying, thickening, gel-forming, and water and oil binding properties [5]. Flaxseed flour with its various functional properties, has the potential to serve as a functional agent in chicken corned to improve physical quality.

Previous studies have reviewed the use of various natural ingredients such as red beet pulp [3], rice bran oil [6], and angkak [7] in corned processing innovations. However, research on the use of flaxseed flour as an innovation in corned processing has not been conducted previously. This study aims to evaluate the effect of adding flaxseed flour on the physical quality of corned made from spent laying hens. The parameters observed include pH, yield, Water Holding Capacity (WHC), cooking loss, and color value (L a*b*).

2 Materials and methods

2.1 Materials

The materials used in this study were fresh meat from spent laying hens, flaxseed flour, tapioca flour, canola oil, skim milk powder, sugar, salt, pepper, soy protein isolate, ice cubes, garlic, and shallots. The equipment used in the chicken corned production process included baking pans, spoons, spatulas, cuttingg boards, choppers, basins, stoves, knives, analytical scales, steaming pots, and sieves.

2.2 Methods

This research method used in this study was a laboratory experiment using a completely randomized design (CRD) with four treatments and five replicates. The treatments used were the use of flaxseed flour in spent laying hen meat corned with different percentages. The treatments consisted of 2%, 4%, and 6% flaxseed flour. The control treatment (P0) was chicken corned without the supplementation of flaxseed flour. The formulation of the chicken corned with the incorporation of flaxseed flour is shown in Table 1.

Table 1. Formulation of chicken corned

Ingredients (%)	T_0	T_1	T_2	T_3
Fresh spent laying hen meat	70	70	70	70
Flaxseed flour	0	2	4	6
Tapioca flour	5	5	5	5
Ice cube	10	10	10	10
Powdered skim milk	3	3	3	3
Salt	2	2	2	2
Sugar	1.5	1.5	1.5	1.5
Soy protein isolate	2	2	2	2
Canola oil	2	2	2	2
Garlic	2	2	2	2
Shallots	2	2	2	2
Ground pepper	0.5	0.5	0.5	0.5

Note : % of total ingredients used 100 g while treatment % of total spent laying hen meat used

2.3 Preparation of chicken corned

The breast meat from spent laying hens is cut into small cubes measuring 2 x 2 x 2 cm and subsequently minced finely. This minced meat is combined with soy protein isolate, skim milk, and some ice water, then put into a food processor and blended for 20 seconds. Salt and seasonings such as shallots, garlic, and pepper are added to the blend, along with flaxseed flour, based on the designated treatments: control (without flaxseed flour), 2%, 4%, and 6%. The mixture is then processed again in the food processor for 2x20 seconds. The next step is to press the dough into corned molds and store them in the refrigerator for 30 minutes. After that, the dough is steamed for 30 minutes at a temperature of 90 ± 2 °C. After cooking, the product is cooled, and the quality of the chicken corned product is analyzed.

2.4 Parameter measurements

The pH value was analyzed in 1 g of sample dissolved in distilled water using a calibrated pH meter [8]. Water Holding Capacity (WHC) was analyzed using the press method with 0.3 g of sample on Whatman No. 42 filter paper [8]. Cooking loss was analyzed using 25 g of sample by comparing the difference in sample weight before and after cooking with the sample weight before cooking [8]. Yield was calculated by comparing the weight of the sample dough before and after cooking [8]. Color parameters (L*, a*, b*) were analyzed using a color reader on 5 g of sample [8].

2.5 Data analysis

Data were analyzed using analysis of variance (ANOVA). If there were significant or highly significant differences in the data, Duncan's Multiple Range Test was performed.

3 Results and Discussion

3.1 pH Value

The inclusion of flaxseed flour at varying levels significantly influenced ($P<0.01$) the pH value of the chicken corned. The average pH values of the chicken corned, which contained added flaxseed flour, are shown in Table 2.

Table 2. The average pH values of chicken corned with the inclusion of flaxseed flour

Treatment	pH ± SD
T0	6.5 ± 0.04^{a}
T1	6.4 ± 0.04^{b}
T2	6.2 ± 0.04^{c}
T3	6.1 ± 0.07^{d}

Note : ^{a,b,c,d} Different superscripts in the column indicate a highly significant difference ($P<0.01$)

The results showed that there was a decrease in the average pH value of chicken corned with an increase in the percentage of flaxseed flour added. The decrease in the average pH value of chicken corned may be due to the phenolic acid content in flaxseed flour, including ferulic acid, p-coumaric acid, 4-hydroxybenzoic acid, o-coumaric acid, secoisolariciresinol, vanillic acid, resveratrol, sinapic acid, rutin, enterolactone, chlorogenic acid, and enterodiol [9]. These phenolic acid compounds have weak acidic phenolic groups and are capable of releasing hydrogen ions (H^{+}), thereby lowering the pH when added to the chicken corned. In addition, flaxseed flour with a high total phenolic content of 3164 mg GAE/g has strong antioxidant activity, which is closely related to the presence of these phenolic acid compounds [9]. Thus, the addition of flaxseed flour can cause a decrease in the pH value of chicken corned due to the release of protons and reactions between phenolic acid compounds, protein components, and fats in chicken corned. Another study also reported a decrease in pH from 6.6 to 3.3 in mutton patties due to the addition of flaxseed flour at a supplementation level of 2 – 8% [10]. Previous studies on chicken corned with the addition of rice bran oil had pH values ranging from 6.24 to 6.57 [6].

3.2 Yield

According to the research conducted, the findings indicate how the inclusion of flaxseed flour influences the yield value of chicken corned. The average yield value of chicken corned that includes flaxseed flour is displayed in Table 3.

Table 3. The average yield values of chicken corned with the inclusion of flaxseed flour

Treatment	Yield (%) ± SD
T0	91.44 ± 0.23^{a}
T1	93.32 ± 0.19^{b}
T2	95.11 ± 0.47^{c}
T3	96.80 ± 0.55^{d}

Note : ^{a,b,c,d} Different superscripts in the column indicate a highly significant difference ($P<0.01$)

The addition of flaxseed flour at different percentages significantly affects (P<0.01) the yield value of chicken corned. Based on Table 3, an increase in the concentration of flaxseed flour was directly proportional to the rise in the yield value of chicken corned. Several factors influence yield, including ingredient composition, water-holding capacity, and product fiber content. Flaxseed flour is a good source of fiber, containing about 20–25% fiber consisting of soluble and insoluble fiber, where the soluble fiber is in the form of mucilage (approximately 8% of flaxseed's dry weight), which includes sugars, gums, and pectin [11]. This mucilage content is essential in increasing yield because it has a high water-retention capacity and good emulsifying properties. Research that has been carried out reports that the mucilage contained in flaxseed flour has a high water-binding capacity, besides that it also has foaming, amphipathic, and emulsifying properties [12]. Mucilage contains complex polysaccharides such as arabinoxylan and rhamnogalacturonan, which can form a viscoelastic gel, enabling it to retain water and fat during the cooking process, improving product texture, and reducing cooking loss. The soluble sugar and amphiphilic protein content in mucilage also functions as a natural emulsifier that supports fat and water retention in the meat matrix, increase in the yield value of processed chicken meat. This research aligns with previous research on chicken corned with the supplementation of rice bran oil, which produced an increasing yield value ranging from 92.35 to 95.25% [13].

3.3 Water Holding Capacity (WHC)

The addition of flaxseed flour at various percentages had a highly significant influence (P<0.01) on the Water Holding Capacity (WHC) of chicken corned. The average values of WHC for chicken corned with added flaxseed flour are shown in Table 4.

Table 4. The average WHC values of chicken corned with the inclusion of flaxseed flour

Treatment	WHC (%) ± SD
T0	42.37 ± 0.29^{a}
T1	43.39 ± 0.40^{b}
T2	44.15 ± 0.44^{c}
T3	45.40 ± 0.35^{d}

Note : ^{a,b,c,d} Different superscripts in the column indicate a highly significant difference (P<0.01)

The results showed an increasing trend in WHC values as the percentage of flaxseed flour added to the formulation increased. The increased average water holding capacity values in chicken corned can be attributed to the reaction between meat protein and the soluble components of flaxseed flour. The reaction that occurs causes the ability to bind water and fat to increase, thereby strengthening the stability of the emulsion during the product restructuring process. In addition, the hydrophilic properties of mucilage in flaxseed flour cause water molecules and muscle proteins to bind, forming a more complex and dense protein structure [14]. A denser and more compact tissue structure will be more effective in retaining water, so that the WHC value can increase as the proportion of flaxseed flour increases. Based on previous research, it was reported that mucilage is a hydrocolloid heteropolysaccharide consisting of neutral and acidic monosaccharides. This compound has various functional properties such as emulsifying, thickening, and water/oil binding properties, making it effective as a functional agent to improve physical parameters such as water holding capacity in food products [5]. This study aligns with previous research that produced increasing WHC values ranging from 14.06 - 22.65% in chicken corned with the addition of red beet flour [3].

3.4 Cooking Loss

Based on the research conducted, the findings regarding the impact of adding flaxseed flour on the cooking loss of chicken corned were determined. The average cooking loss values for chicken corned incorporating flaxseed flour are shown in Table 5.

Table 5. The average cooking loss values of chicken corned with the inclusion of flaxseed flour

Treatment	Cooking loss (%) ± SD
T0	15.49 ± 0.10^{d}
T1	12.25 ± 0.08^{c}
T2	11.54 ± 0.09^{b}
T3	9.63 ± 0.02^{a}

Note : ^{a,b,c,d} Different superscripts in the column indicate a highly significant difference ($P<0.01$)

The addition of flaxseed flour at different percentages had a significant effect ($P<0.01$) on the cooking loss of chicken corned. As the percentage of flaxseed flour added increased from 0-6%, the cooking loss of chicken corned gradually decreased from 15.49 to 9.63%. The cooking loss results in chicken corned are related to the WHC value obtained, whereas a higher WHC value results in a lower cooking loss. This decrease in cooking loss is likely due to the high protein content in flaxseed flour. Higher protein content can lead to a higher ability to bind water, thus resulting in lower cooking loss [7]. Low cooking loss indicates that water and other nutrients are lost in smaller amounts during cooking. This shows that flaxseed flour can improve the water-binding capacity of chicken corned. This study is in line with previous research, which found that the addition of rice bran oil significantly reduced cooking loss in chicken corned, ranging from 3.79 to 6.67% [13].

3.5 Color (L*, a*, b*)

The addition of flaxseed flour at different percentages had a highly significant influence ($P<0.01$) on the color of chicken corned. The average color (L*, a*, b*) values of chicken corned with the addition of flaxseed flour are presented in Table 6.

Table 6. The average color (L*, a*, b*) values of chicken corned with the addition of flaxseed flour

Treatment	Lightness (L*) ± SD	Redness (a*) ± SD	Yellowness (b*) ± SD
T0	78.47 ± 0.08^{d}	5.82 ± 0.03^{a}	18.38 ± 0.04^{d}
T1	75.67 ± 0.05^{c}	9.52 ± 0.05^{b}	15.92 ± 0.03^{c}
T2	72.20 ± 0.06^{b}	15.61 ± 0.03^{c}	12.74 ± 0.09^{b}
T3	69.60 ± 0.06^{a}	18.39 ± 0.04^{d}	11.58 ± 0.05^{a}

Note : ^{a,b,c,d} Different superscripts in the column indicate a highly significant difference ($P<0.01$)

The study results show a downward trend in lightness (L*) values as the percentage of flaxseed flour added to the formulation increases. This decrease may be due to the high fiber content in flaxseed flour. The fiber content in flaxseed flour has the ability to absorb water, which can cause the surface of the corned to become denser. The accumulation of absorbed water in the corned product matrix can reduce light reflectance, thereby decreasing the lightness (L*) value of the chicken corned. This is in line with previous studies reporting that particle shape and size, homogenization rate, and material structure type are the main factors determining the color appearance of the final product [15]. In addition, the decrease in L* color in chicken corned is related to the Maillard reaction and non-enzymatic browning process during heating. Flaxseed flour contains complex carbohydrates in polysaccharides, where about 28% of flaxseed consists of polysaccharides that can degrade into reducing

sugars when exposed to high temperatures [4]. These reducing sugars can react with free amino groups from chicken meat proteins to form Maillard intermediate compounds, which then degrade into brown pigments. Thus, the higher the addition of flaxseed flour, the greater the possibility of browning pigment formation during the cooking process, which contributes to the decrease in L* value in chicken corned.

Based on Table 6, an increase in the percentage of flaxseed flour is directly proportional to an increase in the redness (a*) value of chicken corned. The increasing redness value is due to the antioxidant content in flaxseed flour. Previous studies have reported that flaxseed flour contains bioactive components such as lignans, phenolic acids, and tocopherols that function as antioxidants [4]. These bioactive components can inhibit the oxidation of myoglobin to metmyoglobin (brown/gray). With reduced myoglobin oxidation, the pigment fraction that gives red color is relatively higher, increasing the a* color value of the chicken corned.

The addition of flaxseed flour at different percentages had a significant effect ($P<0.01$) on the yellowness (b*) color value of chicken corned. As the percentage of flaxseed flour added increased, the b* color value of chicken corned decreased from 18.38 to 11.58. The decrease in the yellowness color value of the chicken corned was likely caused by fat loss and oxidation that occurred during the cooking process. The addition of flaxseed flour to chicken corned as a natural antioxidant can increase oxidative stability, thereby inhibiting lipid peroxidation and pigment oxidation. This can suppress the formation of oxidative products and result in a decrease in the b* value of chicken corned, which is richer in antioxidants. The results of this study are in line with previous studies, which found that when red beet flour was added to chicken corned samples, there was a decrease in L* value (47.13 – 63.84) and b* value (10.83 – 14.71) and an increase in a* value (-0.60 – 6.84) [3].

4 Conclusion

The addition of flaxseed flour (*Linum usitatissimum*) to chicken corned from spent laying hens had a very significant effect on all observed physical quality parameters, including pH, yield, Water Holding Capacity (WHC), cooking loss, and color (L*, a*, b*). Increasing the percentage of flaxseed flour reduced the pH and cooking loss in chicken corned and consistently increased the WHC, yield, and color. The best treatment was obtained with the addition of 6% flaxseed flour, which produced the optimal physical quality of chicken corned and thus has the potential to be applied as a natural functional ingredient in meat product processing.

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