The Quality of Corned Chicken with the Addition of Red Beet (*Beta vulgaris* L.) Flour as Natural Food Coloring

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Abstract. Corned chicken is a processed meat product that is processed using restructuring technology. Corned chicken is made by mixing meat, sugar, pepper, and flour. This study uses chicken meat as the main ingredient. Processed meat products, especially corned chicken, have several disadvantages such as pale color and low fiber content. The use of red beet flour can be a natural food coloring and a source of fiber to improve the color and quality of corned chicken. The purpose of this study was to determine the effect of serving the right addition of red beet flour to the corned chicken and to determine the quality of the corned chicken with the addition of red beet flour. The research material used was chicken meat, sugar, salt, milk powder, vegetable oil, pepper, shallots, nutmeg, and isolate soy protein (ISP), which were treated with the addition of red beet flour. The method used is a laboratory experimental method with a completely randomized design with 4 treatments and 5 replications. Phase 1 research treatment consisted of without the addition of red beet flour as a control, and adding red beet flour 1%, 3%, and 5% of the total ingredients used. The variables measured were pH, water holding capacity (WHC), cooking loss, and color L*a*b*. The results showed that the use of red beet flour on corned chicken gave highly significant effect on pH, water holding capacity (WHC), cooking loss, and color L*a*b*. The conclusion of the study was that using 5% red beet flour produced the best corned chicken.

Keywords: Corned Chicken · Natural Food Coloring · Red Beet Flour

1 Introduction

Fresh food products such as meat are included in perishable foods so they require handling due to their short shelf life. Further handling needs to be done to protect food quality and safety [1]. Restructuring meat technology can be used to produce fast food such as patties, ham, surimi, and corned chicken so as to facilitate serving and increase consumer desire to consume the product [2]. Corned chicken in Indonesia is commonly used as a side dish or a mixture of dishes such as noodles, fried rice. Corned chicken made from chicken has various disadvantages including low fiber content, pale color, short shelf life, and easy to go rancid. The food processing industry usually uses synthetic additives to improve the shortage of processed chicken meat products. The use of

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synthetic materials can have an impact on health in the long term. Various efforts have been made to create processed food products that are healthy and safe for consumers. Natural ingredients that have functional potential when added to food products are red beets.

Red beets have strong antioxidant and radical scavenging properties as well as chemoprotective activity. Beets are rich in various nutrients such as fiber, carotenoid folic acid, glycine, betalain, saponins, polyphenols, flavonoids and various minerals [3]. Red beets contain betaine, phenolic compounds, and ascorbic acid. Red beet is included in 10 plants with high antioxidant content [4]. Red beet flour is commonly used as a natural food coloring because it contains betalain compounds. Betalain is a red pigment contained in red beets. Betalain is usually used as a natural colorant in food products such as tomato sauce, dessert, jam, ice cream, and other food products [5]. The addition of red beet flour with different percentages as natural food coloring can improve the color and improve the quality of corned chicken in terms of physical characteristics.

2 Materials and Methods

2.1 Materials

The material of this research is broiler chicken meat. Additional ingredients in making corned chicken include sugar, salt, powdered milk, vegetable oil, pepper, shallots, nutmeg, isolated soy protein (ISP). The red beet undergoes a flouring process at the UPT. Materia Medica Batu City. Materials and equipment needed for pH testing include buffer solution 4, buffer solution 7, distilled water, and pH meter. Materials and equipment used for testing the water holding capacity include Mettler Toledo digital scale, glass plate, 35 kg load, whattman 42 filter paper, pencil and mm paper. Materials and equipment used for cooking shrinkage testing include water baths, digital scales, plastic, and tissue. Equipment and used for L*a*b* color testing include OEM CHNSPEC CS-10 Colorimeter Color Reader and samples.

2.2 Methods

The research method is a laboratory experiment using a completely randomized design (CRD). This design consisted of 4 treatments and 5 replications. If there are results that show a significantly different or highly significant effect between treatments, it is continued with Duncan's Multiple Range Test (DMRT).

2.3 Red Beet Flour Preparation

The process to make red beet flour begins with washing the red beet with water and then peeling it, after being skinned, the red beet is cut into thin slices and then dried at 60oC for 24 h. Red beetroot which already has a water content of about 12% is then mashed with a food processor and sifted on an 80mesh sieve to obtain a fine red beet flour.

2.4 Corned Chicken Preparation

The processes of making corned chicken begin with preparing all the ingredients, then weighing all the ingredients including chicken, potatoes, skim milk, ice water, salt, broth, pepper, and shallots. The weighed chicken is cut into small pieces and then finely chopped. The minced meat is mixed with the skim milk, potatoes, ice cubes, shallots, pepper, salt, and red beet flour in a food processor for about 20 s. The homogeneous dough is stored in the refrigerator for 30 min. The next step is to print the corned chicken dough on the corned chicken mold and then boil it for 10 min at a temperature of 85 °C.

2.5 Data Analysis

Data were analyzed statistically using analysis of variance (ANOVA). If there are results that show a difference in influence between treatments, it is followed by Duncan's Multiple Range Test.

3 Results and Discussion

3.1 pH Value

The results of the analysis of variance showed that the addition of red beets with different concentrations gave a highly significant effect on the pH of corned chicken ($P < 0{,}01$). Table 2 shows the average pH value of corned chicken with the addition of red beet flour (Table 1).

The pH value of corned chicken with the addition of red beet flour ranged from 6,49% to 7,63%. As the percentage increase in the addition of red beetroot decreased the pH value of corned chicken, this was due to the low pH value of red beet flour, which was 5.94 [6]. Betalains have the ability to maintain their structure over a wide pH range from pH 3 to pH 7 [7, 8]. This ability causes betalains to be applied to foods that have an acidic pH and foods that have a neutral pH [9].

Other advantages of betalains are compounds that are more soluble in water, have the power to provide color, stronger antioxidant properties than anthocyanins [10, 11],

Table 1. Experimental design and research experimental.

Treatments	Descriptions
Control	Corned chicken without red beet flour addition
P1	Corned chicken with 1% red beet flour addition
P2	Corned chicken with 3% red beet flour addition
P3	Corned chicken with 5% red beet flour addition

Table 2. The average pH value of corned chicken with red beet flour addition.

Perlakuan	Nilai pH
P3	$7,63 \pm 0,26^{b}$
P2	$7,38 \pm 0,10^{b}$
P1	$7,32 \pm 0,20^{b}$
P0	$6,49 \pm 0,26^{a}$

$^{a, b, c, d}$ Several superscripts in the same column showed a highly significant difference ($P < 0.01$) from the pH value of corned chicken.

Table 3. The average water holding capacity of corned chicken with red beet flour addition.

Perlakuan	Nilai pH
P0	$14,06 \pm 0,70^{a}$
P1	$15,29 \pm 0,55^{a}$
P2	$19,45 \pm 0,93^{b}$
P3	$22,65 \pm 1,39^{c}$

$^{a, b, c, d}$ Several superscripts in the same column showed a highly significant difference ($P < 0,01$) from the water holding capacity of corned chicken.

and have a high molar extinction coefficient compared to synthetic dyes so that they can provide a higher color power than synthetic dyes.[12] and anthocyanins because they are color stable over a wider range of pH and temperature [13]. The disadvantages of betalain pigments include vulnerability to light, enzymatic activity, metal ions, oxidation, and heating and food storage processes [14]. The thermostability of betalains is between pH 4 and 5 [15]. Other studies have shown that betacyanins are more heat-resistant than betaxanthins [10, 15]. Other authors reported that betacyanins decreased while betaxanthins increased with increasing processing temperature. Processing and storage techniques can affect the physical characteristics of the product [16].

3.2 Water Holding Capacity

Water holding capacity is the ability of protein to prevent water from being released from the product [17]. The results of analysis of variance showed that the addition of red beets with different concentrations gave a highly significant effect on the water holding capacity of corned chicken ($P < 0,01$). Table 3 shows the average value of water holding capacity of corned chicken with the addition of red beet flour.

The water holding capacity of corned chicken with the addition of red beet flour ranged from 14,06% to 22,65%. As the percentage of red beet flour increased, it was shown to increase the water holding capacity of corned chicken, this was because red beet

Table 4. The average cooking loss of corned chicken with red beet flour addition.

Treatments	Cooking Loss
P0	$18,27 \pm 4,32^{b}$
P1	$17,32 \pm 2,08^{b}$
P2	$15,44 \pm 1,59^{ab}$
P3	$13,05 \pm 1,16^{a}$

$^{a, b, c, d}$ Several superscripts in the same column showed a significant difference ($P < 0.05$) from the cooking loss of corned chicken.

Table 5. The average color L*a*b* of corned chicken with red beet flour addition.

Treatments	L*	a*	b*
P0	$63,84 \pm 2,73^{d}$	$-0,60 \pm 0,39^{a}$	$12,96 \pm 0,59^{b}$
P1	$58,82 \pm 1,16^{c}$	$2,55 \pm 0,32^{b}$	$14,71 \pm 0,67^{b}$
P2	$53,07 \pm 3,13^{b}$	$4,28 \pm 0,59^{c}$	$13,73 \pm 1,55^{ab}$
P3	$47,13 \pm 1,84^{a}$	$6,84 \pm 1,49^{d}$	$10,83 \pm 1,46^{a}$

$^{a, b, c, d}$ Several superscripts in the same column showed a highly significant difference ($P < 0,01$) from the color L* a* b* of corned chicken.

flour had a larger particle size than tapioca flour, thereby increasing the water holding capacity [18]. The pH value can affect the water holding capacity. The pH value needed to bind water is above the isoelectric point of 5.0 to 5.2. Water holding capacity (WHC) relates to the ability of meat to retain water during processing and storage. Low WHC in meat products causes a decrease in consumer interest because low WHC has an impact on visual appearance and low palatability properties related to juiciness and tenderness. Increased WHC in meat products leads to better protein functionality, greater processing and cooking yields [19]. Water holding capacity is influenced by the amount of protein contained in the product. Increasing the pH causes the protein to have a more negative charge so that it can increase the water holding capacity [20].

3.3 Cooking Loss

Cooking loss is needed to determine the amount of weight lost during the cooking process. Cooking loss occurs due to protein denaturation due to heat treatment during the cooking process, thereby reducing the binding capacity between water and protein molecules [21]. The results of the analysis of variance showed that the addition of red beets to corned chicken had a significant effect on the cooking loss of corned chicken ($P < 0,05$). Table 4 shows the average cooking loss value of corned chicken with the addition of red beet flour (Table 5).

Cooking loss on corned chicken with the addition of red beet flour ranged from 13,05% to 18,27%. Table 4 shows that as the percentage of red beet flour increases the

cooking loss of corned chicken, this is because the water holding capacity has increased. The increase in the product's ability to bind water causes the water that comes out during the cooking process to decrease. Cooking loss is affected by the use of temperature and cooking time. Temperatures that are too high and cooking times that are too long cause protein denaturation which results in a decrease in water holding capacity so that the unbound water increases causing an increase in cooking loss [22].

3.4 Color L*a*b*

Color plays an important role in processed food products. The addition of dyes is used to improve the sensory quality of food products that may undergo changes during processing or with the aim of creating products with colors that consumers prefer [23]. L*a*b color is a color space that is used to classify colors so that it is possible to achieve color accuracy [24].

The results of the analysis of variance showed that the addition of red beets with different concentrations gave a highly significant effect on the color of L*a*b* corned chicken ($P < 0.01$). The L* color of corned chicken with the addition of red beet flour ranged from 47,13% to 63,84%. The results showed that as the percentage of red beet flour decreased the L* color of the corned chicken, this was because as the percentage of red beet flour increased, the product became darker.

The a* color of corned chicken with the addition of red beet flour ranged from -0,60% to 6,84%. The results showed that as the percentage of red beet flour increased the a* color of the corned chicken, this was due to the presence of betalain pigments contained in the red beetroot. Red beets contain betalain pigments as a source of reddish and yellowish pigments. Betalains consist of betaxanthins (yellow) and betacyanins (red) [25].

The color of b* on corned chicken with the addition of red beet flour ranged from 10,83% to 14,71%. The results show that as the percentage of red beet flour in corned chicken causes the color of b* tends to decrease, this is due to a thermal process that can change the color of the product [25].

4 Conclusions

Red beet flour has potential as a natural food coloring in corned chicken because it contains betalain compounds which are color pigments contained in red beets. The addition of red beetroot flour (Beta vulgaris L.) improved the quality of corned chicken in terms of pH, cooking loss, water holding capacity, and L*a*b* color.

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