The utilization of young-harvested purple corn for dodol processed to support functional food diversification

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Abstract. Young-harvested purple corn can be processed to some products, including traditional processed dodol in Indonesia, that very liked by all people until now. The superiority of purple corn dodol is it has component of anthocyanin that has antioxidant activities. The ingredient using young-harvested purple corn. The method using complete randomize design, factor I extractor water P (300ml, 400 ml, 500ml), factor II heating duration L (15 minutes, 25 minutes, 35 minutes), each intervention done by 3 times repeating, cooked in boiled temperature. The data analyze using Anova, and continue with DMRT test. The level of panelists’ acceptance using organoleptic test with display parameter of colour, smells, texture, and taste test. The result of this research showed that the intervention which very liked by panelists was P1L1 500g of corn extracted by 300 ml of water with heating duration about 15 minutes, with component of water 24.86%, ash 0.44%, protein 5.98%, and high relative anthocyanin 4.04 (µg/g). Dodol processed of purple corn can be developed to instant product, with proper packaging can support functional food product diversification that has high sale value.

1. Introduction
One of Indonesia's traditional preparations which are quite popular and remain in demand by consumers and businessmen of processed snacks is Dodol. Dodol is classified as semi-wet food (Intermediate moisture food) which has a chewy texture, has a sweet taste so it can be eaten immediately. The desired functional characteristics of lunkhead are related to the structural properties of processed food products, namely the texture [1, 2]. One of the ingredients that can be processed into lunkhead is purple corn, both young and physiologically ripe. The nutritional and functional content of corn material is influenced by the age of harvest [3].

Pulut purple corn is an alternative functional food that provides many benefits for the body because it has low anthocyanin and amylose content [4]. The low amylose content in purple corn cooked with milk has a characteristic sticky texture so that it is suitable for processing into products that do not require a high level of development and are chewy [5,6]. As with low-amylose glutinous rice starch, when heated at a critical temperature in the presence of excess water, the shape changes from regular to irregular. Starch granules will absorb water, swell, and dissolve in solution which is characterized by loss of birefringence, the change is called gelatinization [7-9].

The purple color in purple rice corn is an anthocyanin compound. Purple corn anthocyanin levels are affected by the variety [10-12]. Purple corn varieties that have a strong free radical scavenging capacity also have strong reducing abilities and this property is influenced by the phenolic and flavonoid components contained in it [13]. Anthocyanin compounds are useful as antioxidants, anti-diabetic, anti-
hypoglycemic, antihypertensive, anticancer, anti-inflammatory, anti-mutagenic, anti-microbial, anti-obesity, prevent liver function disorders and other degenerative diseases [14, 15]. However, the anthocyanin content in food products will be easily damaged or decreased due to heating (temperature), pH, oxygen, light, and sugar. As a result of this process will affect the stability of anthocyanins, so they will be degraded [16]. So it is necessary to have proper heating treatment to produce lunkhead with the best physicochemical characteristics and can minimize anthocyanin degradation. The purpose of this study was to determine the effect of extracting volume and heating time on the physicochemical and organoleptic characteristics of purple corn dodol cooked with milk. It is expected that the resulting lunkhead product can have high economic and functional value.

2. Materials and Methods

The material used in this study was young harvested purple corn obtained from IP2TP Bajeng plantations. Several equipment and additional materials as needed are carried out at the Processing Laboratory of the Cereal Crops Research Institute.

A total of 250 g of purple young corn has been peeled / shaved, added with water (which has been boiled, cooled) as much as 300 ml, 400 ml, 500 ml (according to the treatment) then crushed with a blender. After being crushed, the solution is then filtered using gauze. The extract of the purple corn solution was then added with 400 g of granulated sugar, 50 ml of thick coconut milk, 0.5 tsp of vanilla, stirred until evenly mixed (homogeneous). The next stage the dough is heated for 15 minutes, 25 minutes, 35 minutes (according to the treatment).

The study was conducted using a completely randomized design (CRD). The treatment that was tried consisted of two factors including extracting water (P), namely: 300 ml (P1), 400 ml (P2), 500 ml (P3); heating time (L), namely: 15 minutes (L1), 25 minutes (L2), 35 minutes (L3), each treatment was repeated three times.

Physicochemical and functional properties were water content (oven method 105°C), ash content (furnace method 550°C), fat content (extraction method with ether solvent/Kyltex apparatus), protein content (Kyeldahl micro method), carbohydrates (by difference), anthocyanin levels and organoleptic parameters including color, aroma, texture, and taste. The organoleptic test was carried out by 15 panelists by giving a score of 5 (very much like), 4 (liked), 3 (somewhat like), 2 (slightly disliked), 1 (disliked).

The observed data were then analyzed using the F 5% test and if it showed a significant difference, it was continued with the DMRT test.

3. Results and discussion

3.1 Chemical Parameter

The components of thick coconut milk in the dough affect the proximate composition of the resulting dodol. Coconut milk contains fat, water, protein, carbohydrates, and ash, with the main ingredients of coconut milk being water and fat [17, 18]. The chemical composition of coconut milk will affect the composition of the protein, fat, and carbohydrates produced.

Based on the results of the analysis of scales of variance in Table 2 shows that there are significant differences in the chemical composition of purple corn lunkhead harvested with cooked milk which includes water content, ash content, and protein content. The average water content of purple corn lunkhead ranged from 8.03-35-38%. According to SNI 01-2986-1992 regarding the quality standards of a lunkhead, it has a maximum water content of 20%. The lower water content of dodol will increase its shelf life because it is used for microorganism activity. According to [19], the high water content causes the shelf life of dodol to be relatively shorter, ranging from 4-5 days.

The ash content of purple corn dodol shows the mineral content contained in these foodstuffs. According to SN1 01-2986-1992 regarding the quality standard of lunkhead, it has a maximum ash content of 1.5%, so that all treatments of purple corn dodol have met the standard. Based on Table 2, it shows that the ash content of dodol ranges from 0.42-0.65%, with the highest values in the P3L3 and P2L3 treatments, while the lowest ash content in the P1L1, P2L1 and P3L1 treatments. This shows that
the longer the cooking process causes the ash content to increase. Furthermore, brown seaweed lunkhead contains relatively high minerals [20].

Table 1. Chemical composition of purple corn lunkhead harvested with milk

| Treatment | Water (%) | Ash (%) | Protein (%) | Anthocyanins (µg/g) |
|-----------|-----------|---------|-------------|---------------------|
| P1L1      | 24.86 c   | 0.44 c  | 5.98 a      | 4.04                |
| P1L2      | 14.24 d   | 0.57 b  | 5.64 b      | 2.80                |
| P1L3      | 8.03 e    | 0.55 b  | 4.97 c      | 2.04                |
| P2L1      | 35.38 a   | 0.47 c  | 4.88 c      | 2.05                |
| P2L2      | 25.44 c   | 0.46 c  | 4.59 d      | 1.46                |
| P2L3      | 9.37 e    | 0.64 a  | 4.07 e      | 1.35                |
| P3L1      | 30.36 b   | 0.45 c  | 4.59 d      | 1.59                |
| P3L2      | 30.09 b   | 0.42 c  | 4.27 e      | 1.46                |
| P3L3      | 16.64 d   | 0.65 a  | 3.95 f      | 1.24                |

Note: The number of the same row is not significantly different in the 0.05 DMRT test difference

The average value of protein content of purple corn lunkhead cooked in milk ranged from 4.27-5.98%. According to SNI 01-2986-1992 regarding the quality standard of lunkhead, it has a minimum protein content of 3%. So that all treatments in Table 1 have met the SNI standard, which is above 3%. The highest protein content was in the P1L1 treatment (300 ml of extracting water and 15 minutes of heating), then followed by the P1L2 and P2L3 treatments. The use of extracting water volume of 300 ml, has the highest protein content when compared to the use of volumes of 400 ml and 500 ml. This change in protein structure usually causes irreversible changes in the physicochemical properties of the protein such as loss of solubility properties and biological activity [21].

Table 1 shows that the range of anthocyanin content in the purple corn lunkhead is between 1.24-4.04 g/g. The highest anthocyanin content in the P1L1 treatment (300 ml of extracting water with a heating time of 15 minutes) was 4.04 g/g, then followed by the P1L2 treatment. While the P3L3 treatment had the lowest anthocyanin content, namely 1.24 g/g. The longer heating will cause damage to the anthocyanin content whether there is the use of extracting water volumes of 300, 400, and 500 ml. In the treatment of extracting volume of 300 ml, it showed a decrease in the anthocyanin content from heating 15 minutes to 25 minutes by 30.69%, and until heating, for 35 minutes it decreased by 40.59%. According to research results from [10], the heating treatment caused a significant decrease in antioxidant content and antioxidant activity. According to [22, 23], the instability in the anthocyanin structure causes this compound to easily undergo hydrolysis at the glycosidic bond and the aglycone ring becomes open, thus forming various labile aglycones, as well as carbinol groups and colorless chalcones. The anthocyanin content is still maintained in dodol products, although it has decreased due to the effect of dilution and cooking time.

3.2 Organoleptic Parameters

This organoleptic parameter is very useful to see the extent of consumer preference for the resulting product. Thus future product development can be accepted by the community and can compete with products that are already widely circulated. The organoleptic test results of cooked corn dodol showed that there were significant differences in all variables, both color, taste, aroma, and texture of lunkhead.
The highest color of processed purple corn dodol when cooked with milk was seen in the treatment with an extracted volume of 300 ml for 15 minutes (P1L1) with a score of 4.00 (like). Then followed by treatment P3L1, P3L2, P3L3 with a score of 3.67 (close to like). While the lowest treatment in P1L2 and P2L3 treatment with a score of 1.67 approached somewhat disliked. It can be seen that the heating time affects reducing the color score of processed dodol so that the P1L1 treatment with a heating time of 15 minutes is favored by the panelists. The increase in the volume of the extractor tends to increase the panelists' preference for color, namely the use of 500 ml.

Figure 2 shows that the aroma of purple corn dodol varies in the range of 2.33-4.67 with the criteria of moderate to close to every liking. The difference in the aroma of the corn dodol is strongly influenced by the addition of the extractor volume and the length of heating time. The highest preference for aroma was seen in the treatment of extracting volume of 300 ml with a heating time of 15 minutes (P1L1) showing a score of 4.67 (the criteria was close to liking very much), and the treatment of extracting volume of 500 ml with a heating time of 15 minutes (P3L1) a score of 4.00 (criteria for liking), while the lowest aroma score in the treatment (P1L2) and (P2L3) with a score of 2.33 with the criteria of
somewhat dislike. Likewise, concerning taste, the panelists most liked the purple corn dodol in the P1L1 (4.67) and P3L1 (4.33) treatments with a category close to very like. This shows that the panelists prefer the aroma and taste of dodol with the shortest heating time of 15 minutes. The longer the heating time of dodol causes a lot of volatile compounds to evaporate so that which affects the aroma and taste of the resulting dodol. The cooking of purple corn dodol dough cooks milk rather quickly because the basic ingredients are low in amylose (pulut).

Panelists’ preference for dodol texture is in the range of 1.33-4.33 (disagree to like category). The highest preference for texture was in the treatment of extracting volumes of 300 ml and 500 with a heating time of 15 minutes (P1L1) and (P3L1), namely 4.33 and 4.00 (like category). While the treatments that have the lowest level of preference for texture are P1L2 and P2L3 with a value of 1.33 (somewhat dislike category). According to [24] the amount of water content can affect the texture, where the higher the water content in the food, the softer the food will be. The formation of texture on this dodol is the result of the starch of glutinous rice flour and corn being heated (gelatinized).

**Figure 3.** Radar Diagram of Organoleptic Characteristics of Purple Corn Dodol Cooked Milk

The radar diagram in Figure 3 shows that the overall taste, aroma, color and texture indicated that the panelists preferred the purple corn dodol which was cooked with a volume of 300 ml of extracting water for 15 minutes. This shows that the treatment can be used as a potential alternative in the development of processed food diversification into dodol form to be widely applied. In addition, it has a chewy texture that is just right, not too soft, so that panelists can like this product with an overall score of 17.67 and an average of 4.42 with a category of like to close to very like. Then followed by treatment with 500 ml extract volume with a heating time of 25 minutes (P3L2) with a total preference level of 15.99 and an average of 3.99 (close to liking). According to the statement (25, 26), that young harvested purple corn with lunkhead products that are acceptable to panelists contains anthocyanins that can support traditional functional food products.

4. Conclusion

Young harvested purple corn can be processed into dodol processed products because it has sticky characteristics. From the parameters of color, aroma, texture, and taste, the panelists received 300 ml of extract, 15 minutes of cooking according to the preparation of young harvested purple corn lunkhead. The water content is 24.86%, the ash is 0.44%, the protein is 5.98% and the anthocyanin content is 4.04
(µg/g). The content of anthocyanins which have antioxidant activity in processed can support functional food diversification, the dodol formulation can be developed according to consumer tastes.

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