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Research Article

PHYSICAL AND CHEMICAL PROPERTIES OF DRIED FISH SKIN-*PEMPEK* WITH THE ADDITION OF RED AND BLACK RICE FLOURS

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ABSTRACT

The research aimed to determine the physical and chemical properties of fish-skin *pempek* with the addition of red and black rice flours. *Pempek* is one of traditional foods in Indonesia that is made of minced fish-filled and starch. This research used a Factorial Randomized Block Design with two factors. The first factor consisted of the kinds of pigmented rice flours (red and black rice flours) and the second factor was the concentration of rice flours (10%, 20%, 30%, 40%, w/w). The analysis of variance showed that the kinds and the concentrations of pigmented rice flours added, as well as their interactions had a significant effect on antioxidant activity, moisture, ash, fat and protein contents of dried fish skin-*pempek*. The highest antioxidant activity was found in the treatment of the addition 40% of black rice flours with the value of IC50 of 1,045.83 ppm.

INTRODUCTION

Pempek is a traditional food of Palembang, one of cities in Indonesia. *Pempek* is also known fish cake from Palembang. The major ingredients in *pempek* are minced fish fillet and tapioca starch. Other kind of starch might use by some producers, such as sago starch, however the most used starch is tapioca starch. There are several kinds of *pempek* such as curly *pempek*, cylindrical *pempek*, egg *pempek*, and fish skin-*pempek*. The ratio between minced fish-fillet to tapioca starch had and an effect on the physical and chemical properties of *pempek*. The common ratio of minced fish-fillet to tapioca starch in *pempek*'s formulation is 1:2. The main ingredient in *pempek* not only minced fish-filled but also fish skin. Modification had been done on the traditional made of *pempek* in order to increase the nutritional composition and appearance of *pempek*. The addition of pigmented rice flours (red and black rice) could increase the nutritional value of fish-skin *pempek*, particularly antioxidant activity. The antioxidant activity in *pempek* could be increased by adding the natural sources of antioxidants from vegetable's extract. In general, the color of *pempek* is starchy white except for the fish-skin *pempek*. Fish-skin *pempek* had a dark appearance of its surface which is due to the natural color of fish skin; therefore the addition of antioxidant sources from vegetables into fish-skin *pempek* might not visually affect the color on fish-skin *pempek*.

Red and black rice flours are added into the dough of fish-skin *pempek* in order to increase the nutritional contents of *pempek* particularly its antioxidant activity. The addition of red and black rice flours in fish skin-*pempek* might have a minor effect on the color of *pempek* due to the dark appearance on the surface of the fish skin *pempek*. Red and black rice contain higher nutritional values compared to that of white rice. The dark color deposited in red and black rice is due to anthocyanin pigment (Chaudhary, 2003; Sompong *et al*., 2011). Widyawati *et al*. (2014) reported that black rice contained higher amount of anthocyanins (2.42×10^{-2}mg/g, dry basis) than that of in red rice (2.42×10^{-2}mg/g, dry basis). Natural antioxidant is able to protect human body from free radicals as well as lipid oxidative. Yang *et al*. (2006) reported that the anthocyanin content in rice could be determined by the intensity of the color. The addition of red and black rice flours in the *pempek* would increase the antioxidant activity.

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The freshly prepared *pempek* contains 40% to 60% of moisture content, and therefore it had a short shelf life. One of alternatives to prolong its shelf life is to reduce the moisture content; however, drying might have an impact on the physical and chemical properties of *pempek*. Thus, the current study focused on the analysis of the physical and chemical properties of dried fish-skin *pempek*.

MATERIALS AND METHODS

Rice materials

The pigmented rice used were red and black rice varieties were derived from lowland swamp land at the village of Pemulutan, Ogan Ilir district, South Sumatera, Indonesia. Those rice grains were ground and passed through an 80 mesh sieve. The red and black rice flours were denoted as A1 and A2, respectively.

Formulation of fish skin-pempek

Fish skin-*pempe*k was denoted as FSP. The fillet and skin of mackerel were separated. The fillet and the skin of mackerel were separately minced and kept in a refrigerator (10^{o}C for two hours). The formulation for the dough of *pempek* consisted of minced fish fillet (125 g), minced fish skin (25 g), table salt (15 g), sugar (5 g), ground red onion (15 g), ground garlic (15 g), mixed yolk and egg white (20 g) and ice water (30 g), 150 g of the total weight of tapioca starch and pigmented rice flours. The ratios of pigmented rice flours and tapioca starch were 1:10 (B1); 2:10 (B2); 3:10 (B3) and 4:10 (B4).

The making of FSP

The ingredient of minced fillet, minced fish skin, table salt, sugar, ground onion, ground garlic, minced yolk and egg white, and ice water were mixed thoroughly. The pigmented rice flour was added and mixed followed by tapioca starch. The dough as amount of 20 g was shaped into a cylindrical with the length of 65 mm and height of 5 mm. The uncooked of cylindrical *pempek* was steamed for 5 minutes (after water boiled), then it was cooled at room temperature for an hour. The steamed *pempek* was kept in a freezer (-17^{o}C) for 24 hours prior to drying at 60^{o}C in an oven for 24 hours. The dried FSP was further analyzed for its physical and chemical properties. The data obtained were statistically analyzed by using analysis of variance (ANOVA) and honestly significant difference test (HSD) at the 5% level.

The physical and chemical analysis

The physical analysis included rehydration time and redness (*a**). The rehydration time was defined as the length of time for a sample to absorb water until the sample achieved a constant weight (± 0.02 g). The redness (*a**) of dried FSP was measured by using a Konica Minolta CR-10 Chromameter. The chemical analysis of water, ash, fat and protein content followed the methods in AOAC (2006). The measurement of antioxidant activity which was indicated by the IC_{50} value used a DPPH (1,1 Diphenyl-2-Picryl-Hydrazil) method as described by Pengkumsri *et al*. (2015) and Garcia *et al*. (2012). IC_{50} is the half maximal inhibitory concentration that shows the effectiveness of a substance in inhibiting a specific biological or biochemical function (Abe *et al*., 2012).

RESULTS

The physical and chemical properties that were examined in dried FSP included moisture, ash, fat and protein content as well as antioxidant activity as tabulated in Table 1 and the rehydration time and redness (*a**) as shown in Table 2.

Table 1 Moisture, ash, fat and protein content; and IC_{50} of dried FSP

Treatments	Water content (%)	Ash content (%)	Fat content (%)	Protein content (%)	IC_{50} (ppm)
A1B1	9.46 ± 0.07^{a}	1.25 ± 0.07^{d}	2.33 ± 0.13^{c}	8.26 ± 0.10^{d}	3048.51^{a}
A1B2	8.29 ± 0.12^{ab}	1.28 ± 0.08^{d}	2.55 ± 0.02^{b}	8.33 ± 0.10d	2815.85^{b}
A1B3	7.88 ± 1.35^{ab}	1.34 ± 0.13^{cd}	2.60 ± 0.02^{b}	8.48 ± 0.08^{bcd}	2292.35^{c}
A1B4	7.18 ± 1.18^{ab}	1.43 ± 0.04^{cd}	2.69 ± 0.01^{b}	8.64 ± 0.10^{bc}	1983.00^{d}
A2B1	8.18 ± 0.45^{ab}	1.26 ± 0.03^{d}	2.38 ± 0.01^{c}	8.46 ± 0.06^{cd}	1564.72^{e}
A2B2	7.13 ± 0.38^{ab}	1.46 ± 0.01^{bc}	2.63 ± 0.03^{b}	8.67 ± 0.10^{bc}	1400.85^{f}
A2B3	6.70 ± 0.97^{ab}	1.57 ± 0.03^{b}	2.70 ± 0.02^{ab}	8.70 ± 0.09^{b}	1203.07^{g}
A2B4	6.02 ± 1.75^{b}	1.77 ± 0.03^{a}	2.85 ± 0.03^{a}	8.90 ± 0.09^{a}	1045.83^{h}

Value followed by the different letter is significantly different, according to Tukey's at the probably level of 5%

Statistical analysis shown that factor A (kinds of pigmented rice varieties), factor B (concentration of pigmented rice flours) and their interactions had a significant effect on IC_{50}, moisture, ash, fat and protein contents of dried FSP. The higher amount of pigmented rice flours added, the lower of moisture content in the dried FSP. Unlike the parameter of moisture content, there was a positive correlation between the amount of pigmented rice flours added and the contents of ash, protein, fat and the antioxidant activity in dried FSP.

Table 2 The rehydration time and redness (*a**) of dried FSP

Treatments	Rehydration time (minutes)	*a**
A1B1	171.33^{a}	6.37 ± 0.21^{ab}
A1B2	164.33^{bc}	6.53 ± 0.51^{ab}
A1B3	156.33^{de}	6.77 ± 0.76^{ab}
A1B4	152.66^{e}	7.10 ± 0.53^{a}
A2B1	168.33^{ab}	5.97 ± 0.21^{abc}
A2B2	160^{cd}	5.60 ± 0.53^{bc}
A2B3	146.66^{f}	4.73 ± 0.31^{cd}
A2B4	141.33^{g}	3.93 ± 0.06^{d}

Value followed by the different letter is significantly different, according to Tukey's at the probably level of 5%

Statistical analysis showed that the addition of pigmented rice flours, the concentration of rice flours added and their interactions had a significant effect on the rehydration time and redness (*a**) of dried FSP. The higher amount of pigmented rice flours added, the higher values of *a** and the shorter of rehydration time.

DISCUSSIONS

The treatment of A2 (addition of black rice flour) has a lower moisture content than the moisture content in the treatment of A1 (addition of red rice flour). Dried FSP of A2B4 (40% of black rice flour) has the lowest moisture content than other treatments. It might be due to differences in amylose and amylopectin content in red and black rice flours added. Hartono (2013) stated that the amylose content of brown rice and black rice were 8.31 mg/g and 9.05 mg/g, respectively. The differences of amylose and amylopectin content in rice flour had an effect on the moisture content of the product. The higher amylose content in the rice flour resulted in a lower moisture content of dried FSP. Amylose consisted of a linear chain of glucose molecules so that amylose is easier to release water, as a result, the moisture of dried FSP would be lower. Unlike amylose, water that was trapped in amylopectin molecule was maintained longer in the product due to the branched molecular chains of amylopectin, therefore the moisture content in the product would be higher.

The treatment of A1 (addition of red rice flour) has a lower protein content than that of protein content in A2 treatment (addition of black rice flour). The differences in protein content in the products might be due to the different protein content in the red and black rice flours. Protein analysis showed that the protein content in red rice flour was 8.37%, while the protein content in black rice flour was 9.83%. The similar reason for the differences in fat and ash content in the dried FSP. The fat content in red rice flour (2.25%) was lower than the fat content in black rice flours (2.63%), therefore the fat content in dried FSP with the addition of red rice flours was lower. The ash content in red and black rice flours were 1.77% and 1.80%, respectively. The ash content in the samples of dried FSP with the addition of black rice flours was higher than dried FSP with the addition of red rice flours.

The antioxidant activity of the product was stated as IC_{50}. Lower IC_{50} value indicates a stronger antioxidant activity than those with higher IC_{50} values. The treatment of A2 (addition of black rice flour) has lower IC_{50} value than IC_{50} value in the treatment of A1 (addition of red rice flour). The difference in IC_{50} value in dried FSP was due to the effect of antioxidant activity of the type of pigmented rice flour being added. The IC_{50} values of red and black rice flour were 481 ppm and 360 ppm. The lower IC_{50} value of black rice indicates that black rice antioxidant activity is stronger than brown rice. Our results were closed to Maharni (2015) who stated that the antioxidant activity of black rice by DPPH method was 388 ppm. In addition, Fidrianny (2016) also stated that black rice has a stronger antioxidant activity than brown rice.

As shown in Table 1, the treatment of A1B4 (40% black rice flour) had the highest antioxidant activity than other treatments. The phenolic compounds in black rice were as the potential source of antioxidants (Sutharut and Sudarat, 2012). Vichapong *et al*. (2010) further stated that the phenolic compound in black rice might be gallic acid, procatal acid, p-hydroxybenzoic acid, guaiacol, p-cresol and 3.5-silenol (Vichapong *et al*, 2010). When viewed from the pattern of substitution, anthocyanins belong to the family of flavonoids (Ghosh *et al*., 2009). Flavonoid compounds such as anthocyanins (glycons of anthocyanidins) act as natural antioxidants present in plants (Pietta, 2000). Widyawati *et al*. (2014) stated that the types of anthocyanin compounds detected in brown rice and black rice were cyanidin-3-glucoside and peonidine-3-glucoside.

The results showed that the treatment of A1 (addition of red rice flour) and A2 (addition of black rice flour) was significantly different. The color of dried FSP with the addition of red rice flour was reddish, while the color of dried FSP with the addition of black rice flour was blackish. Therefore, the treatment of A1 (addition of red rice flour) has a higher value of a^* than that of the a^* value A2 the addition of black rice flour). The different redness intensity of the products was due to the different color of red rice flour and black rice flour caused by anthocyanin pigment. In accordance with the statement of Yang *et al*. (2006), the anthocyanin content in rice determined the intensity of the color. According Chaudari (2003), the color of red, brown and black rice varieties was determined by the content of anthocyanin pigment in the rice.

The rehydration time of dried FSP with the addition of red rice flour (A1) was longer than that of the rehydration time in dried FSP with the addition of black rice flour. The differences in the duration of rehydration could be due to some factors such as different moisture content of products as well as the different amylose content in the pigmented rice flours being added. According to Kurniasari (2015), high water content of the product would result in lower water absorption than the products with low moisture content. The moisture content of A2B4 (addition of 40% black rice flour) was the lowest (6.02%), and it had the shortest rehydration time (141.33 minutes) among others. Black rice flour contained higher amount of amylose content. According to Winarno (2004), amylose depolymerized causes the resulting amylose molecules to be simpler or there is a short straight chain, making it very soluble in water. Drying of FSP caused the water component in the products to easily evaporate leaving the matrix so that it is porous and easy to re-absorb water and as a result, the rehydration time would be shorter.

CONCLUSIONS

The addition of red and black rice flours into dried FSP had a significant effect on the physical and chemical properties of the products. The addition of black rice flour in dried FSP resulted in higher antioxidant activity, lower values of redness (a^*), lower rehydration time and moisture content and higher content of ash, fat and protein in the products.

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