Chemical, textural, and sensory properties of eastern little tuna fish ball (*Euthynnus affinis*) with rice bran flour (*Oryza sativa*) substitution

D R Affandi, E Purnama, B Yudhistira and A P Sanjaya

Department of Food Science and Technology, Faculty of Agriculture, Sebelas Maret University, Surakarta, Indonesia

Email: adhit.sanjaya@staff.uns.ac.id

Abstract. The aim of this study was to investigated the characteristic of chemical, physical, functional, and sensory properties of the fish balls with substitution rice bran flour. Substitution of rice bran flour and tapioca as fish ball fillers used in this research were 25:75, 40:60, 55:45, and 100:0 as a control. The result showed that the substitution of rice bran affected the chemical, functional, physical and sensory characteristics of eastern little tuna fish balls. The substitution of tapioca flour with rice bran flour as fillers in eastern little tuna fish ball could increase moisture, ash, fat, and protein content. In this study, antioxidant activity, vitamin E, and WHC of eastern little tuna fish balls were also increased. Texture properties (cohesiveness, chewiness, springiness) of eastern little tuna fish ball affected by the substitution of rice bran flour. Substitution of 25% rice bran and 75% tapioca flour as fillers in eastern little tuna fish ball was more acceptable than another formula. The moisture, ash, fat, protein, and total starch content of the eastern little tuna fish ball substituted 25% rice bran and 75% tapioca flour were 68.07%; 6.53%; 1.47%; 38.12%; and 41.51%, respectively. Sensory analysis of the eastern little tuna fish ball substituted 25% rice bran and 75% tapioca flour formula showed that it had a brownish color, not-strong-fishy aroma, a slightly weaker fishy flavor, a rather strong rice bran flavor, and slightly weak texture.

1. Introduction

Eastern little tuna (*Euthynnus affinis*) has a high-productivity sea catch and also has a high market value of fish. Ministry of Marine Affairs and Fisheries Indonesia in 2015 reported that an average production of 552,410 tons/year. This a huge number of production was not in line with the number of consumption of Eastern little tuna which still limited. In daily consumption, eastern little tuna usually is consumed as a protein source food. According to Intarasirisawat et al [1], the nutritional composition in eastern little tuna which still limited. In daily consumption, eastern little tuna usually is consumed as a protein source food. According to Intarasirisawat et al [1], the nutritional composition in eastern little tuna was 73.03% of moisture content, 18.16% of protein content, 4.26% of fat content, 1.79% of ash content, and 2.76% of carbohydrate. Hernandez et al [2] also mentioned that eastern little tuna contains omega 3 (1.5 g / 100 g) and omega 6 (1.8 g / 100 g) which can prevent heart disease, stroke or high blood pressure. Accordingly, eastern little tuna has good potential as a major ingredient in a food product.

There are several processed fish products that can be produced to increase the consumption number of eastern little tuna, such as nuggets, fish balls, shredded fish, and fish chips. In this study, eastern little tuna was prepared as the main ingredient to produce fish balls product. Fish balls were can be consumed by a varied age range. Holley and Patel [3] described that fish ball is an emulsion of fish meat that is mashed and then added flour as filler, salt, and spices. According to Huda [4], fish balls...
have a brighter color than beef meatballs, fish balls tend to have a white color and elastic properties. The elasticity of fish ball is one of the parameters which are used to determine the textural quality of fish balls. The elasticity of fish balls can be obtained by the addition of texture-forming food additives and fillers. In general, tapioca was used as a filler in fish ball production. In this study, the filler component of the eastern little tuna fish ball was substituted with rice bran flour in order to provide functional value that has a potentially positive effect on health. Rice bran has a higher protein content and antioxidant activity compare to that of tapioca. Moongnarm et al. [5] reported that rice bran contains 13.66% of protein content, 40.63% of carbohydrate content, 18.80% of fat content, and high antioxidant activity of tocoferol as 40.94 mg/g. Due to the potential health of the rice bran flour, eastern little tuna fish balls were prepared using rice bran flour as filler in order to substituted tapioca. The nutritional component, functional characteristics and physical properties of the eastern little tuna fish balls which substituted with rice bran flour were investigated.

2. Materials and Methods

2.1. Materials

Eastern little tuna was obtained from the local fish market, Surakarta (Indonesia). Rice bran flour as filler material was obtained from CV. Kusuka Ubiku, Yogyakarta (Indonesia). Rice bran flour was sifted using an 80 mesh sieved before used and then roasted for 15 minutes. The roasting process of rice bran was aimed to reduce the bad odor of rice bran flour. Chitosan and sodium tripolyphosphate (STPP) food grade was kindly provided by a local shop in Surakarta (Indonesia). The other ingredients such as salt, tapioca flour, sugar, egg, and pepper were purchased from Pasar Gede Solo (Indonesia).

2.2. Preparation of Eastern Little Tuna Fish Balls

Fish balls were produced according to the following traditional recipe. In this study, fresh eastern little tuna fish was prepared as the main ingredient on fish balls production. The first step, the internal organs and another part of fish by product of fresh eastern little tuna fish was removed and separated from the meat part. After that, eastern little tuna meat was washed and then fish meat was minced at cold temperature. Ice cube was added during the mincing process in order to maintain the temperature at 4°C. The minced fish was weighted and added STPP, chitosan, spices (salt, sugar, pepper, garlic) and flour. The fish meat and other ingredients were kneaded for 30 min, by hand, to obtain a homogeneous dough. The fish balls dough was shaped into ball form with 2 cm diameter. Fish balls dough was cooked for 15 minutes at 100 ˚C. In this study, the fish balls formula was prepared in four ratios (w/w) of tapioca : rice bran flour which was F0 (100: 0) as a control, F1 (75:25), F2 (60:40), F3 (45:55). A preliminary study was done in order to determine the basic formula of the fish balls dough and then to obtain ratios of tapioca : rice bran flour (w/w) on the fish balls dough. All experiments were performed in triplicate.

2.3. Analytical Methods

The moisture and ash content were determined according to the methods no. 971.28 and no. 940.26 of AOAC by drying the samples using a convection drying oven at 105°C to achieve a constant weight, and burning the samples at 575°C [6]. Fat content was analyzed using soxhlet extraction method and protein content was determined according to the Micro-Kjedahl method [6]. Antioxidant activity was determined using DPPH method, described by Gow-Chin [7]. Water holding capacity (WHC) analysis was performed using a centrifuge to remove the water content in the sample [8]. Texture profile analysis was determine according to the method described by Bourne [9] using Analyzer merk Brookfield model LFRA 4500. Determination of sensory evaluation was investigated using scoring [10,11]. In this study, thirty untrained sensory panels have been used to evaluate the acceptence test of little tuna fish balls product. The selected of the untrained panel has an age range between 19 and 21 years and has the interest to consume the fish product. Consumer evaluation was performed according to an hedonic scoring from 1 (like very much) to 7 (dislike very much) for cohesiveness, chewiness, springiness, and overall parameters. Samples were carried out under similar conditions (temperature
and quantity) for all panelists. Analysis of Variance (ANOVA) that followed by the Duncan Multiple Range Test (DMRT) with a significance level of 0.05 (P<0.05) was used to analyze the significance of the means differences of each sample. This test was performed using the Statistical Package for the Social Sciences version 19 (SPSS).

3. Results and Discussion

3.1. Chemical and Functional Properties of Eastern Little Tuna Fish balls

Eastern little tuna fish balls were analyzed chemical composition in order to determine the chemical characteristic of each rice bran substitution treatment. Chemical properties of eastern little tuna fish balls are shown in Table 1. The moisture content of eastern little tuna fish balls increased significantly different (P<0.05) due to the difference concentration of rice bran substitution. The highest moisture content of eastern little tuna fish balls was achieved by eastern little tuna fish balls with 55% rice bran substitution. The corresponding value was 69.65%. The moisture content of eastern little tuna fish balls can be affected by the chemical composition of eastern little tuna, rice bran flour, tapioca flour, and other ingredients. The increasing of eastern little tuna fish balls moisture content was caused by the increasing WHC of eastern little tuna fish balls (Table 2). The moisture content of eastern little tuna fish balls can be affected by starch gelatinization which is content in tapioca and rice bran flour. During the boiling process, the water is gradually absorbed in the amorphous space of starch, which leads to a swelling phenomenon [12]. Standard Nation of Indonesia (SNI) 01-3819-1995 reported that the water content level of fish balls has maximal 80%. Previous study reported that the moisture content of fish ball which was made from alburnus fish was 71.3% [13]. Poernomo et.al. [14] also reported that fish ball from the indo-Pacific sailfish has 79.11% of moisture content.

Table 1. Chemical and Functional Properties of Eastern Little Tuna Fish balls

| Rice Bran Substitution | Moisture (%wb) | Ash (%db) | Fat (%db) | Protein (%db) | Antioxidant (%) | Vitamin E (mg/100g) |
|------------------------|----------------|-----------|-----------|---------------|----------------|---------------------|
| 0% (control)           | 68.31<sup>a</sup> | 5.70<sup>a</sup> | 0.67<sup>a</sup> | 38.98<sup>a</sup> | 2.37<sup>a</sup> | 0.85<sup>a</sup> |
| 25%                    | 68.07<sup>b</sup> | 6.53<sup>b</sup> | 1.47<sup>b</sup> | 38.12<sup>b</sup> | 10.88<sup>b</sup> | 0.91<sup>b</sup> |
| 40%                    | 68.26<sup>a</sup> | 7.13<sup>c</sup> | 1.57<sup>c</sup> | 41.37<sup>b</sup> | 15.51<sup>c</sup> | 1.06<sup>b</sup> |
| 55%                    | 69.65<sup>b</sup> | 8.52<sup>d</sup> | 2.02<sup>d</sup> | 47.43<sup>c</sup> | 16.45<sup>d</sup> | 1.15<sup>c</sup> |

<sup>*Different notations in the same column show a significant difference at α = 0.05.</sup>

Formula of rice bran substitution based on the percentage of the total fish portion in fish balls dough formula. Control was defined as 100% tapioca flour used in fish balls dough formula.

In Table 1, the ash content of eastern little tuna fish balls increased significantly different (P<0.05). In this study, the ash content of rice bran flour used was higher than that of tapioca ash which were 8.01% and 0.13%, respectively (data not shown). The substitution of rice bran could increase the ash content of eastern little tuna fish balls. The highest of ash content of eastern little tuna fish balls was achieved by the 55% rice bran substitution which was 8.52%. The 55% rice bran substitution eastern little tuna fish balls were significantly higher than that of the other rice bran substitution treatment. Bhosale [15] reported that the mineral content contained in rice bran as calcium of 52.10 mg, phosphor 1185.20 mg, zinc at 6.02 mg, and iron of 28.10 mg. In this study, the ash content of eastern little tuna fish balls with rice bran substitution was significantly higher (P<0.05) than that of the control which was from 100% tapioca as filler. Arifin [16] mentioned that the ash content of threadfin bream fish balls made with various flour has various ash content depending on the type of flour. The ash content value of the threadfin bream fish balls which made from wheat flour, banana flour, or ubi badak flour were 2.19%, 2.78%, and 2.45%, respectively.

Fat content of eastern little tuna fish balls increased significantly different (P<0.05). The highest fat content was obtained by the 55% rice bran substitution which was 2.02% (Table 1). The fat content of eastern little tuna was influenced by the composition of the fish balls. Moongngram et al. [5] rice bran flour have a high-fat content which was 2.77%. The rice bran substitution resulted in an increasing of
the fat content of eastern little tuna fish balls. The rice bran substitution of eastern little tuna fish balls also showed an increasing protein content. The highest protein content was achieved by the 55% rice bran substitution, which was 47.43%. The rice bran substitution could increase significantly the protein content of eastern little tuna fish balls.

Antioxidants in food can be defined as a substance that has the capability to prevent the oxidation process in foods. Antioxidants can prevent the formation of free radicals in food that can impair the taste of food [17]. The antioxidant activity of eastern little tuna fish balls with rice bran substitution was presented in Table 1. The highest antioxidant activity of eastern little tuna fish balls with rice bran substitution was obtained by the 55% rice bran substitution and the lowest antioxidant activity was achieved by control. The increasing of antioxidant activity of eastern little tuna fish balls followed by the amount of rice bran substitution on eastern little tuna fish balls. Vitamin E is one of the powerful antioxidants preventing free radicals [18]. Rice bran contains a high level of vitamin E (tocopherol). The result showed that vitamin E of eastern little tuna fish balls was increased significantly (P<0.05). As an antioxidant in rice bran, the increasing of vitamin E level in eastern little tuna fish balls also followed by the amount of rice bran substitution on eastern little tuna fish balls. The highest vitamin E was achieved by the 55% rice bran substitution.

3.2. Physical Characteristic of Eastern Little Tuna Fish balls

Eastern little tuna fish balls were analyzed water holding capacity (WHC), cohesiveness, chewiness, and springiness in order to determine the physical characteristic of each rice bran substitution treatment. Physical characteristic of eastern little tuna fish balls is presented in Table 2. Water holding capacity is one of a physical parameter of food that describes as an interaction of the protein with water in the food [19]. Jideani [20] mentioned that WHC is influenced by several factors namely, amino acid profile, pH, temperature, ionic bond, a hydrophobic, water binding strength increases with the addition of rice bran composition. The highest WHC of eastern little tuna fish balls was obtained by the 55% rice bran substitution. The corresponding value was 8.53%. The eastern little tuna fish balls with 55% rice bran substitution also had the highest protein content, which was 47.43%. In this result, the increasing of WHC properties of eastern little tuna fish balls was caused by the protein content of eastern little tuna fish balls.

Table 2. Physical Characteristic of Eastern Little Tuna Fish balls

| Rice Bran Substitution | WHC (%) | Cohesiveness | Chewiness (gf) | Springiness (mm) |
|------------------------|---------|--------------|----------------|------------------|
| 0% (control)           | 6.08a   | 0.61b        | 19338.27b      | 7.96b            |
| 25%                    | 6.04a   | 0.54a        | 15904.81a      | 7.56a            |
| 40%                    | 6.46a   | 0.54a        | 15416.21a      | 7.54a            |
| 55%                    | 8.53b   | 0.54a        | 15374.19b      | 7.52a            |

*Different notations in the same column show a significant difference at α = 0.05.

Formula of rice bran substitution based on the percentage of total fish meat portion in fish balls dough formula. Control was defined as 100% tapioca flour used in fish balls dough formula.

Texture Profile Analysis (TPA) is used to determine the bite size and shape of the food samples placed on the baseplate and pressed twice with the platter. This method was also used to investigate the bite force, i.e. the action of biting and chewing by the teeth, preferably given high pressure [9]. In general, the texture profile analysis of the fish balls is influenced by the elasticity (springiness), chewiness (chewiness), and cohesiveness (cohesiveness). Texture profile analysis of eastern little tuna fish balls with rice bran substitution presented in Table 2. Cohesiveness profile was defined as the ability of fish balls can steady after it is being given a force or pressure by the teeth. Fish balls which can steady after pressure giving process mean that cohesiveness level of fish balls is greater [21]. The increasing level of bran flour substitution leads to decrease the value of cohesiveness. According to
Serdaroglu et al. [22], the gelatinization starch content influences the cohesiveness of fish balls. The total starch content of rice bran flour and tapioca flours are 47.21% and 83.97%, respectively (data not shown). The cohesiveness value of eastern little tuna fish balls with rice bran substitution was higher than that of eastern little tuna fish balls without rice bran substitution (control). This result could be related to the total starch content that was higher in the tapioca than that of the rice bran resulted in the cohesiveness value of tapioca was higher than that of rice bran. Chewiness is described as the energy that is needed to chew fish balls into small sizes [21]. The increasing amount of rice bran substitution on eastern little tuna fish balls caused a decreasing of the chewiness value of fish balls. The higher the starch content in fish balls, the chewiness is greater. The higher the chewiness value was indicated a good texture quality of fish balls. Szczesniak [21] defined springiness as the ability of the fish balls to be able to return to their original shape after the first emphasis until the second emphasis will begin. According to Serdaroglu et al. [22], springiness is influenced by the amount and type of starch used for the produce of fish balls. In Table 2, the increasing amount of rice bran substitution could affect to a decreasing of springiness profile. Springiness is influenced by the amount and type of starch used for the fish balls production.

3.3. Sensory Properties of Eastern Little Tuna Fish balls

Sensory properties of eastern little tuna fish balls were determined using an acceptance test (Figure 1). In this study, acceptance test of eastern little tuna fish balls was performed using a scoring method. The score in Figure 1 presented the panelist acceptance and preference level of eastern little tuna fish balls with rice bran substitution compare to control. The scale consists of seven labeled categories which range from ‘dislike very much’ to ‘like very much, and have a neutral category in the middle which the score levels are 1= like very much; 2= moderately like much; 3= slightly like; 4= slightly like; 5= slightly dislike; 6= moderately dislike; 7= dislike very much. The acceptance test of cohesiveness, chewiness, springiness, and overall parameters showed that panelists most like eastern little tuna fish balls with the 25% rice bran substitution (Figure 1). Sensory analysis of the eastern little tuna fish ball substituted 25% rice bran and 75% tapioca flour formula showed that it had a brownish color, not-strong-fishy aroma, a slightly weaker fishy flavor, a rather strong rice bran flavor, and slightly weak texture.

Figure 1. Sensory properties of eastern tuna fish balls with 25% (■), 40% (▲), or 55% (●) rice bran substitution.

3.4. Determination the Best Formula of Eastern Little Tuna Fish Balls

Best formula of rice bran substitution on eastern little tuna fish balls was determined according to the method described by De Garmo and Sullivan [23] using score compensatory method. The method was carried out to determine the score from each parameter on each sample, and then the samples which have the highest score would be chosen as the best formula of rice bran substitution on eastern little tuna fish balls. The eastern tuna fish balls with 25%, 40%, or 55% rice bran substitution had a total
score as 0.526, 0.428, and 0.421, respectively. The best formula had been determined, i.e. eastern little tuna fish balls with the 25% rice bran substitution.

4. Conclusions
The chemical composition (moisture, ash, fat, and protein content) of eastern little tuna fish balls were increased by the substitution of tapioca flour with rice bran flour. In this study, antioxidant activity, vitamin E, and WHC of eastern little tuna fish balls were also increased. Texture properties (cohesiveness, chewiness, springiness) of eastern little tuna fish ball affected by the substitution of rice bran flour. Due to the sensory characteristics of the eastern little tuna fish balls with rice bran substitution, the panelists provide high values for eastern little tuna fish balls with 25% rice bran substitution.

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