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Nutrient Content and Shelf Life of Best Fortified 'Enbal' From Kei Islands Added with Fish Meal and Sweet Potato Leaf Flour

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Abstract : *Enbal* formulation was made using fortified fish of several species at different concentration and obtained the best formulation at the treatment of 15% mackerel scad, *Decapterus spp*. Flour. This study was aimed at knowing the nutrient composition and the self life of the best fortified enbal product obtained from the best treatment of 15% fish flour and 5% cassava flour. The study utilized experimental/descriptive method and nutrient composition used standard method. The fortified enbal product composition consisted of 15% fish meal, 5% sweet potato leaf flour, and 80% enbal flour. The analysis found the moisture content of 12.3%, protein of 16.69%, fat of 1.09%, vitamin A of 0.28%, and carbohydrates of 10.73 %, respectively. The best self life was 36 days based on Total Plate Count value. Thus, the fortified enbal product could be developed tobe am instant functional food product and emergency food product.
Keywords : Diversification, protein, fat, vitamin, carbohydrate

Introduction

Enbal is the local name of bitter cassava (*manihot esculenta crantz*) that becomes traditional food of people in Kei Islands. Raw enbal processing is done through gratting, pressing for water removal, fermentation, sun-drying, and milling using very simple tool, then made a variety of processed products, such as sangrai (fried

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enbal) [1,2,3]. Besides, the enbal milled and sieved can also printed on the printer and roasted at 60 ^{o}C, then sun-dried up to drought [4,5].

In line with the policy of Indonesian Government to promote local food-based food diversification, many researches have indicated the use of cassava as a variety of processed products [6,4]. Since, enbal is source of good carbohydrate, despite very low nutritive content, the fortification of protein and vitamin source of the processed products has been done [1,2].

One of the pelagic fish utilizations is to make the fish be protein source of low protein food product, such as enbal, and it at the same time promotes the eating fish and its processed product program**.** Sweet potato is one of the local food materials of Malluccas people, in which the root is used as calory source and the leaves as vegetable. The leaf of sweet potato is source of vitamin, protein, mineral, and fiber [7,8] and can be repeatedly harvested along the year.

Riry *et al*. [9] have formulated the enbal product with fortification treatment of fish meal of different fish species and at different concentrations, and found the best treatment concentration of 15% mackerel scad. The best mean preference level of panelist's appraisal is 4.03 for color, 4.20 for taste, 3.93 for texture, 3.70 for aroma, and 3.67 for crispness, respectively. This paper is the next step of the study to know the nutrient composition and the durability of the enbal product fortified with mackerel scad meal of 15%.

Materials and Method

Materials

Materials used in this study were fresh scad, *Decapterus macrosoma*, enbal, sweet potato leaves, and seasoning (lemon grass, jinger, galangal) for steaming water. The fish were collected from fishermen's village, Selayar, Kei-Kecil district, Southeast Maluccas, while enbal and sweet potato leaves were bought from the local market. Materials used for proximate analysis (water content, ash, protein, fat) were H_2SO_4 pa, NaOH 30-33%, H_3BO_3 3%, HCl 0.1M, bromcresol green, red metal indicator, and aquadest for protein, hexane for fat, and $CaCO_3$, 80% alcohol for carbohydrate. Vitamin A analysis needed chloroform and trichloride. Microbilogical observation used total plate count (TPC) method, while mold analysis required nutrient agar, aquadest, bufferfield phosphate buffered solution, PCA, and (PDA).

The equipment used in the fortified enbal production were MK-G1350P Panasonic-typed meat separator, steaming pan, blender (Phillips), Camry-typed balance, OVL-12-typed electrical drying oven, polyethylene (PE) plastic, alumimum pan, and 70-mesh sieve. For chemical analysis, this study used pH meter (Orion), *stirrer*, oven, distillator, a_w meter (Shibaura), spectrophotometer (Shimadzu). For microbiological analysis, an incubator (Binder) and oven were used.

Method

This study applied experimental and descriptive methods. This study was carried out in two phase: **1. Flour processing**. Fish meal processing followed [2, 9], respectively. The fish were washed and filleted, then squashed using a MK – G1350P Panasonic-typed meat separator. The pulverized fish meat was then steamed in the steaming pan containing seasoning as lemon grass, jinger, and galangal, and steaming was carried out for 30 minutes after the water had boiled, then dried in the oven at 50^{0}C. The dry pulverized meat was blended and sieved through a 100 mesh-sieve until the fish meal was produced. Enbal flour processing also used method described [2,9] starting from purchasing the squeezed enbal (processed by the seller from the root of bitter cassava squeezed for the liquid, left one night and wind-dried. It is round-shaped with 30 cm diameter and 7 cm thick and chopped to small size and sieved through 70 mesh-sieve to yield fine enbal meal. The leaves of sweet potato were also cleansed, air-dried, and put on bamboo shelf to dry under the sunlight for 9 to 10 hours. The dry leaves were then destructed to fine size using a blender. **2. Best fortified enbal processing**. Fish meal was prepared at the concentration of 15%, put into a brass filled with enbal meal, then added with sweet potato leaf flour of 5%. All materials were mixed together up to be homogenous, and roasted for about 8 minutes until the mixture turned to brownish yellow color, agglomerated, and slightly dry. The fortified enbal product was then removed from the cast and placed on the bamboo basket to season under the sunlight, and eventually obtained enbal product of complete nutrition derived from enbal flour, fish meal, and sweet potato leaf flour.

Analyzed Parameters

Parameter analyses covered water content (oven), protein (Kjedhal method), fat (Soxhlet method), ash (blasting method), vitamin A (spectrophotometer), carbohydrate (spektrofotometer), and Total Plate Count (TPC) (pouring method). The nutritional content was done in the Chemistry Laboratory, FMIPA, Pattimura University, and TPC in the integrated laboratory of Bogor Agriculture Institute.

Water content

Water content analysis started with drying the porcelene cup at 105°C for 1 hour [10]. The cup was put in a desicator for about 15 minutes and left to dry, then weighed. It was reweighed up to constant weight was obtained, and 5 g of sample was put and dried in the oven at 105°C for 5 hours. Afterwards, the cup was inserted into a desicator and left to cool, then reweighed.

Weight loss (g) = initial weight of sample (g) – weight after dried (g) (1)

$$\text{Water content (wet weight)} = \frac{\text{weight loss (g)}}{\text{initial sample weight (g)}} \text{ x } 100\% \quad (2)$$

Protein

Protein analysis consists of 3 phases, destruction, distillation, and titration. It used Kjeldahl method. Sample of 2 g was put into 50 ml-Kjeldahl tube, added with 7 g of K_2SO_4, 0.005 g of HgO-kjeltab, 15 mL of concentrated H_2SO_4 and 10 mL of H_2O_2 gradually added into the tube and left for 10 minutes in acid room. The sample was destructed at 410°C for about 2 hours or until the solution turned to clear green. The kjeldahl tube was then washed in 50 mL-75 mL of aquadest, the water was inserted into a distillator. The distillate was held in a 125 mL-erlenmeyer containing 25 mL of 4% boric acid with 0.1% bromcherosol green indicator and 0.1% methyl red at 2:1 ratio. Distillation was conducted by adding 50 mL of NaOH-$Na_2S_2O_3$ solution into the distillator up to 100-150 mL of green-colored distillate in the erlenmeyer. The distillate was titrated with 0.2N HCl up to turning to pale red, and number of titrant was recorded. Protein content was calculated as follows:

$$\% \text{ N} = \frac{(\text{mL HCl} - \text{mL blank}) \text{ x N HCl x } 14.007}{\text{sample Mg (g)}} \text{ x } 100\% \quad (3)$$

% Protein = % N x conversion factor* (4)

*) conversion factor = 6.25

Fat

Sample of 5 g (W_1) was put in the filter paper wrapper in which both edges were closed with far free-cotton and inserted into a fat cover, then the wrapped sample put into a fat flask of known constant weight (W_2) and connected to *soxhlet* flask. The fat flask was put in the extractor room of *soxhlet* flask and flushed with benzene as fat solvent, then refluxed for 6 hours. The fat solvent in the fat flask was distilled up to all solvent evaporated.

In distillation, the solvent was kept in the extractor room and released. The fat flask was dried in the oven at 105 °C, then cooled in the desicator until the constat weight (W_3) was gained.

$$\% \text{ fat content} = \frac{W3 - W2}{W1} \text{ x } 100\ \% \quad (5)$$

where W_1 = weight of scad (g), W_2 = weight of fat flask without fat (g), and W_3 = weight of fat flask and fat (g).

Ash

Blasting cup was dried in an oven at 105°C for 1 hour then cooled for 15 minutes in a desicator and wighed up to constant weight obtained. Sample of 5 g was put in blasting and blazed over the Bunsen fire up to having no smoke. The caup was then inserted into blast furnace at 400^{o}C for 1 hour and weighed up to constant weight gained.

Ash weight (g) = final weight of sample and cup (g) – empty cup (g) (6)

$$\% \text{ ash content} = \frac{\text{ash weight (g)}}{\text{sample weight (g)}} \text{ x } 100\ \% \quad (7)$$

Total plate count (TPC)

Total plate count analysis followed BAM (2003) [11]. Agar media was prepared by mixing 23 g of nutrient agar with 1 L of aquadest in the glass cup. The solution was heated while stirred up to boiling and all agar was dissolved. Sterilization (121 $^{\circ}$C, 1 atm) was done on agar solution and all equipment used, such as pippet and blender in an autoclave for 15 min. Agar solution was then stored in a 45°C-water heater. Dilluting solution was made by putting 8.5 g of NaCl into 1000 mL of aquadest. The dilluting solution was then sterilized.

Sample solution was made by mixing 1 g of material and crushed in 9 mL of dilluting solution up to homogenous. Dillution was done by taking 1 mL of the homogenous sample with sterile pipette and inserting it into a test tube containing 9 mL of diluting solution yielding 10^{-1} dilution and then shaken up to homogenous. The dillution was done with research needs. Pippetting was carried out as much as 1 mL of sample solution and moved into a sterile petridisc using sterile pipette in duplo.

Agar media was poured into a petridisc as much as 20 mL and stirred up to homogenous. The petridisc (frozen agar) was incubated at upside down position for 48 hours in an incubator of 37 $^{\circ}$C. Bacterial colony on the incubated disc was calculated based on countable numbers, 30-300 colonies. Total number of bacteria/g can be obtained by considering the number at the diluting level and the petridisc using colony counter or hand counter.

Data Analysis

Nutrient composition and durability data of the selected treatment of 15% fish meal and 5% sweet potato leaf flour were descriptively analyzed using Microsoft office Excel (Microsoft Inc., USA).

Results and Discussion

Previous study using fish meal of different species, mixture of fish meal and different enbal concentration, and 5% fortified sweet potato leaf meal [9]. The fortified enbal product has a rectangular shape of 8 x 4 cm^2, thin, fine compact texture, very crispy, typical fish savory flavour, brownish color. Based on this specification, the organolecptic test of fortified enbal product could physically compared with biskuit and commercial crackers. It was found that the fortified enbal product using mixture of 15% fish meal of *Decapterus* sp. and 5% sweet potato leaf meal had the highest preference level [9]. The panelist's value was 4.03 (like) for color, 4.20 (like) for taste, 3.93 (neutral) for texture, 3.70 (neutral) for aroma, 3.67 (neutral) for crispness, respectively. In general, the panelist's acceptance to the fortified enbal product occurs at normal/neutral preference.

Nutritional composition of fortified enbal product

The fortified enbal is a very practical fast food because it can directly be consumed**.** Hence, having the fortified enbal product could meet the nutritional needs It means that consumption of the fortified enbal product could supply balanced enough nutrition for human body. The chemical composition of the best fortified enbal is presented in Table 1.

Table 1. Chemical analysis of the best fortified enbal.

Chemical Composition of Best Fortified Enbal		
Parameters	**Best Fortified Enbal**	**Fish Enbal***
Water content (%)	12.3%	10.46%
Protein (%)	16.69%	20.16%
Fat (%)	1.09%	1.10%
Ash (%)	5.18%	1.54%
Vitamin A (%)	0.28%	-
Carbohydrate (%)	10.73%	-

* Source : Tapotubun [2]

Fortification of fish meal and sweet potato leaf flour in enbal product (fortified enbal) is a new breakthrough to supply the need of carbohydrate, protein, vitamin, mineral and fibers for human body. Recent trend of people consumption to the fast food is well developed in various industries under nutritional composition and service consideration [12]. The water content of the fortified enbal is higher than that reported in [2], 10.46%. Fish fortification and sweet potato leaf could possibly affect the product water content due to water content of the fish and the sweet potato leaf.

The water content of the product highly influences the texture and the taste of the processed enbal product. Based on the panelist's appraisal, fairly low water content of the fortified enbal has got good enough acceptance and preference level "like" [9]. Tremendously low water content could make the product schorched flavor and the color turn to too dark, while very high water content could make its structure be not intricate, easily broken, and the taste quickly change during the storing process [13]. Water content of a food material affect the durability in which the lower the water content is tha longer the durability of the food product.

The ash content of the fortified enbal product was higher than that previously recorded [2], 1.54%. Increased ash content could result from addition of bone meal and cassava flour in the formulation of fortified fish enbal. The ash content of *D. Macrosoma* could reach 3.98% [2], that of cassava is 0.15% [14], while calcium content is 0,32 mg/kg and iron is 7.31 mg/kg [15,16]). Ash content of fish meal ranges from 20 to 30 % [17].

Protein content of the best fortified enbal was 16.69%, and it was slightly lower than that found by Tapotubun [2], so that protein content obtained in this study still met the protein standard established by the National Standardization Board [17], at least 9%. Protein content of biscuits and commercial crackers varies from 3 to14%. Protein content of the best fortified enbal comes mainly from the proten of mackerel *D. macrosoma* meal, because fish are source of high protein content. Protein content of fish meal is 45 – 65 % [17], the fish meal of *D. macrosoma* is 78.62 % [18]. Enbal flour gives very small contribution to the fortified enbal protein. The protein content of cassava is 0.9% [15], and sweet potato is 0.13 % [14]. High protein content of the fortified enbal product reflects that this product could meet the community's protein suppy. In addition, fish protein contains sufficiently complete essential amino acids and therefore, it is very good for protein need fulfilment.

The fat content of the fortified enbal product obtained in this study is lower than the fat standard established by the National Standardization Board [19], at least 9.5% and that of biscuit and commercial crackers, 11.1 - 29% [20]. This low fat content could result from increased low fat content of all composing components of the fortified enbal product. The fat content of peeled root of cassava after processing is 0.1 % and flour 0.04 to 0.12 [21], flour from five genotype *Manihot esculanta* is 0.1 to 0.8 (g 100 g^{-}1) [22], mackerel fish meal is 2.64% [18]. Low fat-fortified enbal product is good enough to be consumed, particularly for fat diet. Heating process at roasting and sun-drying also influence the fat content of the fortified enbal.

Carbohydrate content of the best fortified enbal product was high enough for the fast food product to meet human's daily carbohydrate needs. It is starch-rich tubers but contains low glucose. With high starch content, low glucose, and filling effect, this product is good for diabetics or those who are on a diet so that it diserves to be functional food [23]. Thus, the fortified enbal product of sufficiently complete composition could be developed to be a functional food and emergency food as well due to its long shelf life.

Nevertheless, sufficient amount of vitamin A lost if compared with vitamin A content in the sweet potato leaf, 3,5 µg, and declined to 0.28% product. This loss could occur due to roasting process and san-drying. Vitamin A is highly needed for the health of eye, but it is very sensitive (unstable) to acid, air, light, and heat. Vitamin A in a roasted product will experience shrinkage in the roasting process [24]

The fortified enbal product was done at the storage temperature of 30-35°C. These results reveal that the durability of the fortified enbal product is 36 days based on TPC value. This condition is supported with the acceptable product sensory features. The finding is better than that reported by Tapotubun [2], in which the durability of fish enbal product reaches only 18 days. Long durability of the fortified enbal product could result from relatively low water content and the use of good packaging in vacumn condition and controlled storing temperature so that the bacterial growth could be pushed.

Enbal made of cassava is ”twins” of sago material-originated food called sago plate [25]. Enbal or embal will be a very appropriate food type for famine food material if it is stored in good and dry condition [23].

Conclusion

This study concluded that the best fortified enbal contained water content of 12.3%, protein of 16,69%, fat of 1.09%, ash of 59.18%, vitamin A of 0.28%, and carbohydrate of 64.46%. The best shelf life of the fortified enbal made from fish meal and sweet potato leaf flour was 36 days based upon the TPC value. Considering the nutrient composition of the product and its durability, the fortified enbal product could be developed as fast functional food and emergency food products.

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