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Development and Nutritional Evaluation of Healthy Pangasius Soup Powder Incorporated with Locally Available Vegetables in VietNam

Nguyen Minh Thuy*; Ngo Van Tai
Department of Food Technology, College of Agriculture, Can Tho University, Vietnam
nmthuy@ctu.edu.vn; ngovantai1509@gmail.com
*Corresponding author email: nmthuy@ctu.edu.vn

Abstract
This study carried out to develop some soup formulas from Pangasius and locally vegetables in Viet Nam. Four formulas were prepared by adding different ratios of dried fish, soybean, moringa leaf and other ingredients (full cream powder, non-dairy creamer, potato starch and some kinds of vegetables). The Pangasius were dried using oven/freeze-drying at temperatures ranging from 60 to 80^{o}C (for oven drying) and 12 to 60 hours (for freeze drying). The results showed that Pangasius quality is best achieved when dried by freeze-drying method, with freezing time of about 24 hours, condensation temperature of -80^{o}C and pressure of 0.001 mBar in 48 hours of freeze-drying. The healthy fish vegetables soup mixture containing 30% freeze-dried fish, 5% moringa powder and other ingredients (2.4% full cream powder, 12% non-dairy creamer, 21% potato starch, 22.7% of vegetable powder, 5.1% seasoning and 1.8% sugar) was the best sensory quality. The water activity, moisture, protein, carbohydrate, lipid and ash content of this formula were 0.245, 5.54%, 27.34%, 49.82%, 8.74% and 6.35%, respectively. The total energy of this product was 387.3 kcal/100 g with the acceptable macronutrient distribution ranges for protein (28.84%), carbohydrates (51.45%) and lipid (20.31%). The highest sensory value of soup mix was recorded at 4 minutes of cooking. The final product quality was maintained in the aluminum bag with zipper, a little change in moisture content and low water activity (<0.3) during four months of storage.

Keywords: Pangasius, formulation, healthy soup mix, quality characteristics, sensory evaluation.

1. Introduction
Viet Nam today is a developing country and the demand for convenient food is increasing. Many food groups have made good progress, of which soups are also one of the top foods of interest. Instant soup can become an alternative food because it could fulfil the adequacy of energy and nutrient required by the body, very practical in preparation and taking only a short time to serve.
Pangasius (*Pangasianodon hypophthalmus*) has the native to the river of Southeast Asia, more common in the Mekong such as Myanmar, Cambodia, Laos, Thailand and Viet Nam (Tasnuba *et al*., 2012). In recent years, the prices of Pangasius have dropped to the lowest level in 10 years due to export difficulties, according to the Ministry of Agriculture and Rural Development's Agricultural Market Development and Processing Department. This rapid expansion in the market for Pangasius arises due to its relatively low price. Pangasius contain desirable quality attributes, including its white flesh, delicate texture, clean taste and lack of horizontal bones. The low-fat and high protein with abundant essential amino acids, also make Pangasius become a favorite choice as a fish food source (Wang and Hsieh, 2016). In Viet Nam, Pangasius used increasingly in food service, now its products also can be found in restaurant menus and food stores, where one may see it called "tra". Besides, moringa trees are widely distributed in Viet Nam, it is considered as the kind of most useful trees, moringa leaves are the excellent source of proteins (essential sulfur containing amino acid which rarely found in daily dried vegetables), beta-carotene, minerals and tocopherols (Mohajan *et al*., 2016).

Potatoes, soybeans and other ingredients such as corn starch, pumpkins, tomatoes, carrots, garlic, onions almost are good vegetables which these component content low in calories and high in fiber contain. They are also the best source of antioxidants and phytonutrients (Niththiya *et al*., 2014). Some important advantages of using dehydrated vegetables due to its convenient in local, low cost and safely for storage. All ingredients were mentioned above are suitable and conveniently to produce an instant soup mix. The objective of this study is to develop an enriched protein soup mix with dried fish (Pangasius), moringa leaf and other ingredients as a complete dense nutrients instant food.

2. MATERIALS AND METHODS

2.1 Materials

Pangasius, moringa leaves, potato, soybean, corn starch, pumpkins, tomato, carrot, purple onion, garlic, sugar, seasoning, coriander, black pepper, non-dairy creamer, and full cream milk powder were purchased in the supermarket in Can Tho city, Viet Nam.

2.2 Preparation of dried fish (oven-drying and freeze-drying method)

The flesh of fish fillet is cut into cubic form (0.5x0.5 cm) and then steaming 5 min in microwave (high power: 800W) before drying. The steamed fish dried in an oven dryer for 6 hours at different temperatures (60, 70 and 80^{o}C). For freeze-drying method, the steamed fish is frozen at -80^{o}C in the freeze-dryer at condenser temperature -80^{o}C, the pressure of 0.01 mBar with time arranging 12, 24, 36, 48, and 60 hours. In all cases, the final moisture content of dried fish was less than 7% (Elavarasan and Shamasundar, 2016). The physical and chemical characteristics of dried fish were determined.

2.3 Preparation of vegetable powder

Pumpkin, potato, tomato, carrot, garlic, purple onion were washed and cut into small pieces. All ingredients (including coriander and moringa leaves) were soaked in solution with sodium metabisulfite ($Na_2S_2O_5$) 300 ppm for 30 minutes, and cooked by microwave 800W for 5 minutes (excepted for garlic, purple onion, moringa leaves and coriander). The ingredients were dried in an oven dryer for 6 hours at 60^{o}C. Dried vegetable was ground then packed in LDPE bag and storage at ambient temperature (28±2^{o}C).

2.4 Preparation of soybean powder

Soybean was prepared by washing and soaking in clean water about 4 hours for removing the hulls and then boiled at 100^{o}C for 30 minutes. Then soybean seed was dried at 65^{o}C for 6 hours (Ishak and Sarbon, 2018) until the obtained moisture content 5-6%. The soybean powder with particle size 0.5 mm was packed in LDPE bag and storage at ambient temperature (28±2^{o}C).

2.5 Formulation of soup mix powder

Four formulations of soup mix were prepared as given in **Table 1**. The water activity, moisture, ash, protein, lipid, total carbohydrate content of the developed soup mix powder were analysed. The percentage of daily value and the energy of selected formula were calculated and the Nutrition Facts was established.

Table 1. Four formulas of soup mix

No	Ingredients (g)	F1	F2	F3	F4
1	Dried fish	30	28	26	24
2	Soy bean	5	7	9	11
3	Moringa leaf	5	5	5	5
4	Potato	21	20	19	18
5	Corn flour	5	5	5	5
6	Pumpkin	3	3	3	3
7	Tomato	4	4	4	4
8	Carrot	3.8	3.8	3.8	3.8
9	Garlic	0.7	0.7	0.7	0.7
10	Onion (Purple)	1	1	1	1

11	Sugar	1.8	1.8	1.8	1.8
12	Seasoning	5.1	5.1	5.1	5.1
13	Black pepper	1.2	1.2	1.2	1.2
14	Non-dairy creamer	12	12	12	12
15	Full cream milk powder	2.4	2.4	2.4	2.4
TOTAL		**100**	**100**	**100**	**100**

2.6 Effect of the cooking time on quality of soup mix

The selected one in four formulas was used for this experiment. The ratio of mix soup and water is 1:10 (1 g of product/10 ml of water). The instant soup prepared by boiling at boiling temperature (100^{o}C) or boiled water at different times (1-4 mins). The sensory characteristics of products were evaluated (by 20 panelists) using QDA (Quantitative Descriptive Analysis) method.

2.7 Effect of different package bags on physical characteristics and microorganisms of dried fish soup

All types of package were used to pack fish soup mix, including aluminum foil ziplock bag 13x18 cm, one side clear resealable zipper stand up mylar aluminum foil bag 13x18 cm and High density polyethylene pouch (HDPE pouch). The samples weighed in 30 g and packed in three types of bags then kept at ambient temperature (28±2^{o}C). The period for storage was four months. Then, the nutritional quality of product (physical characteristics and microorganisms) were analysed.

2.8 Quality analysis

The chemical composition of meat and vegetables such as protein, moisture, fat and crude fiber determined by using standard methods (AOAC, 2005). The total carbohydrate content was determined according to the method of McCseady (1971) and Dubois *et al*. (1956). The determination of calcium, sodium and potassium was carried out by flame photometry, followed the procedure of Arunkumar *et al*. (2015), using FP6410 Flame Photometer. The cholesterol content was determined according to the method of Dinh *et al*. (2008). Vitamin C content was analysed by Indophenol method (Zvaigzne *et al*., 2009). A SP-UV1000 Spectrophotometer 200~1000 nm was used to measure absorbance at 450 nm in glass cuvettes for total carotenoid analysis (Parrish, 1977). The peroxide value determined in correlated with the degree of oxidation of fats (Gray *et al*., 1978).

Total calories (kcal) was calculated by the formula as follows: fat (g) x 9 + protein x 4 + total carbohydrate (g) x 4 (Thompson and Manore, 2017).

The percentage daily value (%DV) on the Nutrition Facts label is a guide to the nutrients in one serving of food. DVs are based on a 2,000-calorie diet for healthy adults. Even if your diet is higher or lower in calories, you can still use the DV as a guide. For example, it tells you whether a food is high or low in a specific nutrient, defined as follows: low: 5% or less of a nutrient and high: 20% or more of a nutrient. The %DV for a nutrient is calculated by dividing the amount of a nutrient in a serving size by its daily value, then multiplying that number by 100 (Thompson and Manore, 2017).

2.9 Physical properties analysis

External color of fish soup mix powder were evaluated in a Hunter-Lab colorimeter uses three values (*L*, *a*, and *b*). The water activity (a_w) was measured using RotronicHygro Palm HP23-AW-A-SET-40 (USA).

Scanning Electron Microscopy (SEM)*:* The dried fish were cut using a razor blade and the sample was mounted onto brass stubs using double-sided carbon conductive adhesive tape. A gold coating (0.5 nanometer thick) was then applied under 8-9 pascalvacuum. Bulk samples were examined at 15 kV, the sample distance to the 7cm ejection glass, 750 and 850x magnification using a JEOL model J550 scanning electron microscope (Japan).

2.10 Microbial analysis

The dried vegetarian soup with some legumes were kept in different types of package bags at ambient temperature (28±2°C) for a period four months. Total viable count, yeast and molds were analysed by using total plate count.

2.11 Sensory evaluation

Quantitative Descriptive Analysis (QDA) were applied for sensory evaluation. Twenty panelists were selected based on the screening criteria including no allergic to food, availability and interest in participating in the descriptive analysis panel. The panelists were tested to determine their ability to discriminate different intensities of basic taste solutions and the intensity rating scale from 0 to 5 (where 0 = attribute not detected and 5 attribute extremely strong). CATA and PCA were applied using XLSTAT (2007, Addinsoft, New York, NY).

2.12 Data analysis

Data analyses were carried out using STATGRAPHICS Centurion XV (U.S.A.). Values were expressed as mean±SD.

3. RESULTS AND DISCUSSION

3.1 Effect of drying method on the quality of dried fish

Physicochemical characteristics of freeze-dried fish

The initial moisture content of fish fillet was 78.28% (fresh weight basis). The moisture content and water activity (a_w) of freeze-dried fish decreased during the drying process (12 to 60 hours) (**Table 2**) from 36.40±0.17 to 3.55±0.09% and 0.75±0.03 to 0.19±0.01, respectively.

Table 2. Effect of drying time on water activity, moisture content of freeze-dried fish

Time (hours)	Moisture (%)	Water activity
12	36.40±0.17	0.75±0.03
24	35.33±0.49	0.68±0.03
36	28.27±0.38	0.62±0.02
48	5.13±0.09	0.21±0.01
60	3.55±0.09	0.19±0.01

Values are expressed as mean±SD.

According to Genin *et al.* (1996), to prolong the preservation time of freeze-dried products, the moisture content of the product must meet the requirement (approximately 5%). Pathogens *et al*. (2013) stated that low water activity able confirm the safety of food for long storage. The time of freeze-dried for fish was selected at 48 hours. The proximate composition of freeze-dried Pangasius by using freeze-drying method at different time (12-60 hours) had been shown in **Table 3**. The protein content of freeze-dried fish increased when drying time increased from 12 hrs (protein content of 25.88±0.34%) to 60 hrs (protein content of 66.77±0.96%). Similarly, the lipid and ash content of the product also increased markedly with respect to increased drying time from 12 (7.04±0.16%, 1.86±0.1%) to 60 hrs (19.81±0.47%, 3.15±0.19%). During drying, heat and moisture transfers are coupled, it is a simultaneous heat and moisture transfer process where moisture leaves the food in the form of vapor, while oil and protein content are not significantly changed, it means that proportion of lipid in fish is stability in the fish, the freeze-dried fish kept fat at higher levels, this findings agree with the observation of freeze-dried of other fish keep fat at high level (Sablani *et al*., 2007). The increase in drying time and loss of moisture leads to denaturation of the protein (Begum *et al.*, 2013). Normally, the stability of ash content in raw material was observed, it means that percent of ash is no change in the fish. These results are quite similar with Kordon *et al*. (2018) in the study on *Pangasianodon hypophthalmus*.

Table 3. Effect of drying time on the content of protein, lipid, and ash of the freeze-dried fish

Drying time (hrs)	Nutrients (%)		
	Protein	Lipid	Ash
12	25.88±0.34	7.04±0.16	1.86±0.10
24	32.27±0.48	8.20±0.36	2.39±0.22

36	39.77±0.60	10.81±0.60	2.75±0.28
48	59.66±0.40	17.87±0.34	3.01±0.13
60	66.77±0.96	19.81±0.47	3.15±0.19

Values are expressed as mean±SD.

Physicochemical characteristics of oven-dried fish

The moisture content and water activity of dried fish were ranging from 2.63-5.57% and 0.35-0.43, respectively (**Table 4**). The high temperature can remove water from the raw material, due to the water in the fish evaporated and the moisture from drying food released from the oven. The reduction in moisture level reduced the water activity of the dehydrated sample. As the moisture content of dried fish is low, the water activity is also low, made it is safety food a long storage (Pathogen *et al*., 2013). A relatively low value of water activity of dehydrated sample (less than 0.6) is the recommended level for safe and long-term storage. The lower value of water activity prohibits the microbial activity and thereby prevents the oxidative and enzymatic degradation of the sample (Kaur and Singh, 2014).

The proximate composition of oven dried Pangasius samples were presented in Table 5. As the drying temperature increased from oven drying 60 to 80^{o}C, crude protein decreased significantly (57.45% to 56.73%, respectively). Men *et al*. (2003) reported that, the protein content of Pangasius was 58.6% by air-drying. The lipid content of samples were reduced as increased drying temperature, at high temperature, the lipid is removement from the fish mass (Begum *et al*., 2012). As drying temperature increased, there was corresponding increase in protein denaturalization resulting to significant decrease in both protein and fat. These results are in agreement with the report of Gernah and Sengev (2011) and Sengev *et al*. (2013) in their similar studies.

Table 4. Effect of drying temperature on moisture content and water activity of oven-dried fish

Drying temperature (℃)	Moisture content (%)	Water activity
60	5.57±0.41^{b}	0.43±0.02^{b}
70	3.10±0.08^{b}	0.40±0.03^{b}
80	2.90±0.53^{a}	0.35±0.02^{a}

Values are expressed as mean ± SD. Values with different superscripts are significantly different (P<0.05).

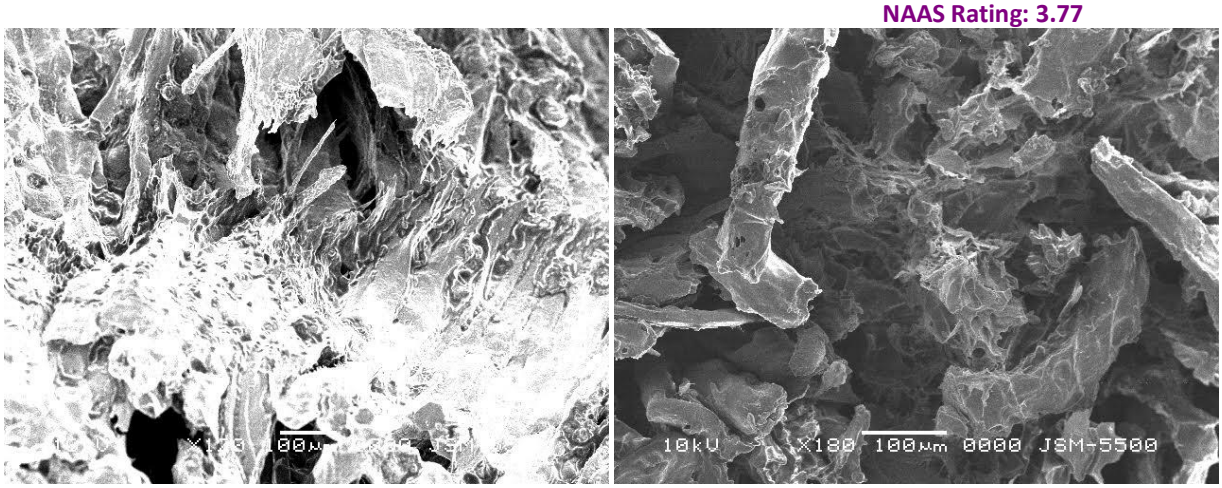
Table 5. The chemical composition of dried fish by oven-drying

Drying temperature (^{o}C)	Protein (%)	Lipid (%)	Ash (%)
60	57.45±0.65^{b}	17.22 ±0.98^{b}	2.82±0.12^{a}
70	57.44±0.36^{b}	17.08±0.62^{b}	2.92±0.09^{a}
80	56.73±0.59^{a}	15.24±0.85^{a}	2.90±0.12^{a}

Values are expressed as mean ± SD. Values with different superscripts are significantly different (P<0.05).

Structure of freeze-dried fish and oven-dried fish by Scanning Electron Microscopy (SEM)

The physical structure of hot air drying and freeze-drying fish samples as viewed under scanning electron microscope (**Figure 1**). It was observed that there was clear different between them, the structure of hot air dried samples were irregularly broken pieces or had a flake like structure. Freeze-dried samples had shrunken with porous or honey comb like structure. The porous structure is due to sublimation of ice in the freeze-dried samples, the sublimation process is likely to result in the formation of voids. The dried fish prepared by freeze drying showed smoother microstructure and the morphology was relatively dense (**Figure 1b**) than the dried fish under hot air drying (**Figure 1a**) with large porous.



a. SEM photographs of oven dried fish ***b. SEM photographs of freeze-dried fish***

Figure 1. Scanning electron microscopic (SEM) photographs of (a) hot air dried fish at 60°C and (b) freeze dried fish at 48 hours (X180)

The pore development after hot air drying is presumably because of tissue expansion from the internal water evaporated. During freeze-drying, the original dimensions of the product are maintained first by freezing. The ice is then sublimed, usually under high vacuum. Since there is no aqueous phase, there is no migration of water to the surface but instead a receding interface of frozen and layer. The effect of shrinkage and concentration of water soluble components due to the mobility of the aqueous phase are thereby prevented and the resulting product is not shrunken but has a small porous (Li and Jelen, 1987).

Comparing the physicochemical and sensory characteristics between freeze-dried and hot air dried samples, it was observed that the freeze-dried samples had higher protein and lipid content than oven dried samples and the color was also brighter.

3.2 Formulation of soup mix powder

A healthy diet is a diet that helps to maintain or improve overall health. A healthy diet provides the body with essential nutrition: fluid, macronutrients, micronutrients and adequate calories.

Moisture content and water activity

The moisture content and water activity (aw) of the products produced by four formulas showed no significant difference, ranging from 4.17±0.34 to 4.87±0.36% and 0.245±0.04 to 0.249±0.04, respectively (Table 4). Moisture content is an important factor in maintaining food quality because increase moisture facilitates the growth of microbes and ultimately destroy quality. The minimum aw at which microorganisms can grow is 0.60. The minimum a_w for growth of most bacteria is approximately 0.87, although halophilic bacteria can grow at a_w as low as 0.75 (Beuchat *et al.*, 2013). According to the International Commission on Microbiological Specifications for Foods (1996), under optimal conditions, *S. aureus* can grow at a_w as low as 0.83. Moreover, the moisture content of the newly developed soup was lower than the reports of other studies (Singh & Chaudhary, 2015).

Table Error! No text of specified style in document.**. Moisture content and water activity of fish soup powder**

Formula	Moisture content (%)	Water activity
F1	4.54±0.17	0.246±0.05
F2	4.87±0.69	0.249±0.04
F3	4.17±0.34	0.245±0.02
F4	4.37±0.03	0.245±0.04

Values are expressed as mean±SD.

Carbohydrate, protein and fat content

The proximate composition of the different soup formulas were given in **Table 5**. The protein content ranged from 26.58-27.34%. The soya bean, moringa leaf and fish enhance the protein content in all soup formulas. Soybean is a good source of protein (40–45%) (Garg *et al.*, 2014), hence, this is the basis for using soy flour as an economical protein supplement in soup (Hegstad, 2008). Moringa leaf is also a good source of protein (26.2%) (Dachana *et al*., 2010). There was no statistical difference among lipid/carbohydrates contents of soup formulas, ranged from 8.60-8.74% and 49.82 to 51.89%, respectively in different formulas.

Dietary sources of essential elements are important for correct physiological functions of human body. A deficient intake of certain minerals can produce diseases and lead to abnormal development (Fellows, 2000). The ash content of all soup mix (in different formula) were between 6.09 to 6.88%.

Table 5. Proximate analysis of four fish soup powder

Formula	Protein (%)	Lipid (%)	Carbohydrate (%)	Ash (%)	Energy provided (kcal)
F1	27.34±0.73	8.74±0.02	49.82±2.99	6.88±0.10	387.30
F2	27.14±0.06	8.64±0.06	50.82±3.07	6.09±0.02	389.60
F3	26.94±0.38	8.66±0.41	51.77±4.56	6.35±0.02	392.78
F4	26.58±0.06	8.60±0.05	51.89±7.66	6.56±0.02	391.28

Values are expressed as mean±SD.

Sensory characteristics

According to cluster analysis, positive value of the first dimension that comprise formula F1 and was explained with terms of lightness and chalky. It was obviously found that in term of swallow ability and lightness correlated to overall liking. The trend of liking showed that formula F1 received excellent appreciation by the panelists. PCA explained 80.95% of variance (**Figure 2**). The soup powder formula F1 was characterized by overall quality. The results of this study are in agreement with Thuy *et al.* (2019) examined the sensory attributes of the soup products prepared with a combination of vegetable and chicken. The preference mapping also shown the similar result (**Figure 3**).

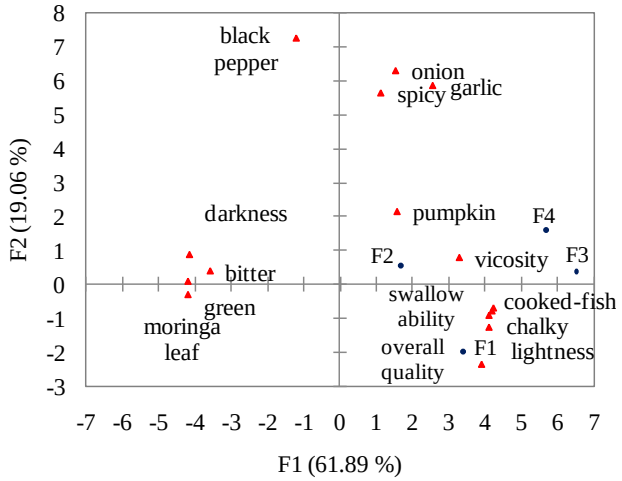


Figure 2. Principle component analysis (PCA) of dried fish soup supplemented with others vegetable

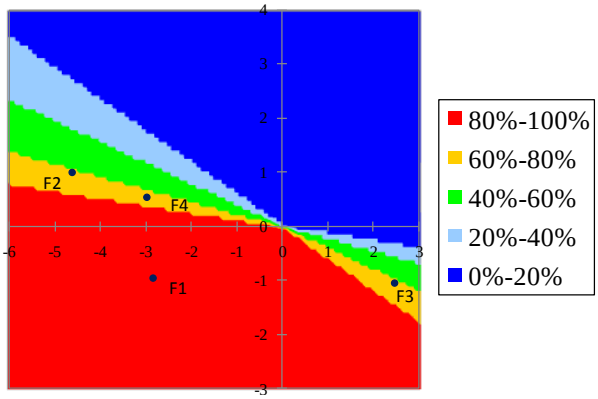


Figure 3. The Preference Mapping of soup product

Percentage of daily value

The percentage of energy supplied from major nutrients in formula 1 (F1) is presented in **Table 6**. A diet that balanced in its macronutrient distribution can help reduce the risk of disease and foster lasting weight loss. Acceptable macronutrient distribution ranges (AMDR) for a particular energy source that is associated with reduced risk of chronic disease while providing intakes of essential nutrients. An intake outside of the AMDR carries the potential of increased risk of chronic diseases and/or insufficient intakes of essential nutrients. Food sources that provide carbohydrate, protein & fat also provide other essential nutrients. A balance of the macronutrients can help ensure adequate intakes of micronutrients as well. Our obtained results showed that the percent of Calories from macronutrients in this formula were within the AMDR, with Calories percentages from carbohydrates, proteins and lipids are 51.45, 28.24, 20.31%, respectively. A diet that is balanced in its macronutrient distribution is recommended for lasting weight loss because unbalanced nutrient profiles may increase the risk of adverse health consequences.

Table 6. Macronutrients content, yielding-energy and percentage of energy that provided from 100 g of mixed fish vegetable soup

Nutrients	Content (g)	Energy-yielding nutrients (kcal)	Percent of energy providing from nutrients (%)
Carbohydrate	49.82	199.28	51.45
Lipid	8.74	78.66	20.31
Protein	27.34	109.36	28.24
Total		**387.30**	**100**

The Nutrition Facts label was established (**Figure 4**). The product also has a relatively high fiber content (%DV is 45.5%), calcium (17.58%) and iron (21.87%), so a formulation rich in vegetables and grain products that contain dietary fiber, calcium and iron. The Footnote in the lower part of the nutrition label tells you "%DVs are based on a 2,000 calorie diet". This statement must be on all food labels. With the energy and nutritional value provided, this product can be used to meet a part of the energy requirement for breakfast or lunch. The healthy fish vegetable soup could be used well in any meal of the day to support and supplement precious nutrients for humans. This is also a convenient product and quick preparation.

Nutrition Facts		
1 serving per container Serving size 30 g		
Amount per serving Calories Calories from fat 23.58		116.19
		% Daily Value*
Total fat *Trans* fat	2.62 g 0 g	4.03%
Cholesterol	5.94 g	1.98%
Sodium	68.94 mg	2.87%
Total Carbohydrate Fiber	14.95 g 11.38 g	4.98% 45.50%
Protein	8.20 g	
Vitamin A	5.78 mcg	0.58%
Calcium	193.36 mg	17.58%
Vitamin C	6.04 mg	10.06%
Iron	3.06 mg	21.87%
Potassium	549.29 mg	15.69%
*The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2000 calories a day is used for general nutrition advice.		

Figure 4. Nutrition facts of healthy fish soup powder

3.3 Effect of cooking method on sensory characteristics of fish soup mix

The obtained result was unpleasant for soup with boiled water, the panelists indicated that was very bitter. Cooking time had a remarkable influence on the quality of soup. When the soups were prepared at long cooking time (5 min), the proteins on the surface of soup coagulated, leading to the decrease of flavor and taste compounds extracted from flesh. As a result, the soup did not taste well. Furthermore, an extended cooking time caused a breakdown of protein structure, which brought to a bad soup pattern and color of the soups. On the other hand, when the cooking time were shorter (1-2 min), the denaturation of protein in the soup might not complete and the soluble protein hydrolysates had not been dissolved sufficiently, thus the flavor and taste were also lower in the soups.

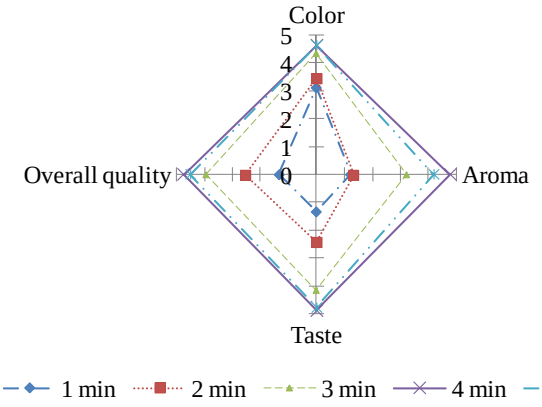


Figure 5. Effect of cooking time on sensory profile of fish vegetable soup

Figure 5 showed the results of sensory evaluation of fish soups mix with different cooking times. The scores of color, aroma, taste and overall quality of the fish soups had relationship with the cooking time. The fish soup obtained at cooking time of 4 minutes had the most favorable appearance: the soup color was white green. The soup obtained at cooking time of 5 minutes got a similar good appearance, and its score was next to the

samples of 3 minutes of cooking. The sample was cooked at 1 minutes showed the lowest scored in the item of color, aroma and overall quality. The sample was cooked after 4 and 5 minutes got the highest grade of taste scores (4.86 and 4.76, respectively), especially its specific fish soup aroma. The samples obtained at 4 minutes of cooking also got relatively high values in aroma evaluation test. The soup cooked at 4 minutes, had the best quality in color, aroma, taste and overall quality.

3.4 Effect of different package bags on physical and microorganisms characteristics of healthy fish soup during storage time

The initial moisture content of the soup mix in Zipper of PA bags (4.24%) increased to 5.55% after two months and no the change so much at the 4th month. The initial moisture content of soup mix in zipper of Aluminum Bag (4.21%) increased to 4.24% after two months and at the fourth month it was increased to 4.75% (**Table 7**). The moisture content did not exceed 5% within four months, and this moisture content is acceptable for dehydrated vegetables products to avoid spoilage. Luh and Woodroof (1975) stated that when the moisture content of dehydrated food is below 8% microorganisms do not grow while when moisture content is above 18% some microorganisms may be reproduced gradually. In addition, El Wakeel (2007) declared that when the moisture content of dried materials was less than 10% such materials are considered as more proper for keeping quality of soup ingredients.

Table 7. Effect of type of package on moisture content, water activity and peroxidation value of healthy fish soup mix

Type of package	Storage time (month)	Moisture content (%)	a_w	Peroxide value (mqe/kg)
Zipper of PA	0	4.24±0.127	0.226±0.004	0.162±0.012
	2nd	5.55±0.093	0.232±0.003	0.163±0.021
	4th	5.58±0.166	0.237±0.005	0.165±0.014
Zipper of Aluminum	0	4.21±0.127	0.226±0.004	0.162±0.061
	2nd	4.24±0.099	0.228±0.003	0.162±0.021
	4th	4.75±0.111	0.231±0.004	0.164±0.031
Zipper of PA and Aluminum	0	4.22±0.117	0.226±0.004	0.162±0.018
	2nd	4.54±0.019	0.229±0.002	0.163±0.024
	4th	4.95±0.131	0.233±0.001	0.166±0.064

The physicochemical state of water is related to water activity, which is a measure of water availability for the growth of various microorganisms. Water activity is a major issue in relation to chemical stability of dry food products and has already been identified as an intrinsic factor in determining shelf-life. The low level of water activity content may have restricted the growth rate of microorganisms. Almost all microbial activity is inhibited below a_w 0.6, while between most fungi are inhibited below a_w 0.7, most yeast are inhibited below a_w 0.8 and most bacterial growth below a_w 0.9 (Garcia *et al*., 2005). Very low values of a_w are related to high lipid oxidation rates. Water activity values of 0.2 and 0.4 lipids have been suggested to have optimal stability and oxidation rates increase with increasing a_w (Raitio *et al*., 2011). From the above mentioned data about moisture content and a_w it could predict the chemical stability (minimum oxidation velocity) and keeping safety and quality of the dried fish soup mixtures (lower the moisture content by a food stuff, the longer the shelf life). Water may accelerate both enzymatic and non-enzymatic browning by enhancing mobility of the reactants. On the other hand, an increase in water content may decrease browning rate by diluting the reactive components (Labuza and Saltmarch, 1981).

The primary products of fat oxidation is hydroperoxides, which are not harmful to food quality. These hydroperoxides are, however, unstable and undergo scission to form volatile carbonyl compounds, such as aldehydes and ketones. Malondialdehyde, a major secondary product of fat oxidation, is the principal factor involved in protein cross-linked reactions. The peroxidation value of soup mix was ranging from 0.162 to 0.166 meq/kg after 4 months of storage.

Soup mix samples in three types of package showed negative results for the yeast and mold at 10^{-1} dilution. No molds and yeast growths were detected in all samples. Heat treatment would have prevented the growth of yeast and mold. The growth of yeast and mold was not observed after four months. Aerobic plate count of the

soup mix in zipper of Aluminum Bag was 2.1×10^1 cfu/g, soup mix in zipper of PA and aluminum (in each sides) was 2.2×10^1 cfu/g and soup mix in zipper of PA bags was 2.9×10^1 cfu/g. As light increase in aerobic plate count was observed in three samples at four months. Jay (1992) reported that the product is microbiologically safe if the total microbial count of dehydrated soups is less than 10^4 cfu/g. Therefore, the developed soup mixes contained the total microbial count within acceptable limit for safe use for a period of four months.

There was no significant difference in the sensory scores of soup powder samples stored at room temperature (25 ± 2^oC) in zipper of PA bag (in the both sides), zipper of PA and aluminum (in each sides), and zipper of Aluminum bag (in both sides) for four months. Therefore, the developed soup mix samples (**Figure 6**) have acceptable sensory character up to four months. However, in general, in the three storage conditions, aluminum packaging was the only one to preserve the initial soup powder color throughout four months of storage.

Figure 6. Healthy fish vegetable soup

4. CONCLUSIONS

Freeze drying is recognized as the best method to produce high-quality dried fish. The final moisture content of dried product was less than 7% that were convenient for the preservation or combination with other ingredients. In order to adequate and balance the nutritional in soup products, the mixing formulas were calculated. The healthy fish vegetables soup mix containing 30% freeze-dried fish, 5% moringa powder and other ingredients (2.4% full cream powder, 12% non-dairy creamer, 21% potato starch, 22.7% of vegetables powder, 5.1% seasoning and 1.8% sugar) was the best sensory quality among the four formulas evaluated. The highest sensory value was obtained at the cooking time of 4 minutes for fish soup. Products contained in aluminum bag with zipper was showed maintain nutrition, little change moisture and low water activity (<0.3) content during a month storage. The product color is unchanged; no strange taste occurs when they were stored under storage temperature.

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