KARAKTERISTIK KIMIA, FISIK DAN SENSORI KERIPIK SIMULASI BERBAHAN DASAR IKAN BANDENG (CHANOS CHANOS) DAN TEPUNG KACANG MERAH (PHASEOLUS VULGARIS L.) SEBAGAI MAKANAN RINGAN SUMBER PROTEIN

CHEMICAL, PHYSICAL AND SENSORY CHARACTERISTICS OF SIMULATION CHIPS BASED MILKFISH (CHANOS CHANOS) AND KIDNEY BEANS FLOUR (PHASEOLUS VULGARIS L.) AS A PROTEIN SOURCES SNACK

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ABSTRACT
Chips are one of the most popular snack foods in the community. However, chips still have some drawbacks in terms of uniformity of size and made from one type of raw material only, so it has not been able to increase the nutritional value. Protein is needed for growth. Chip needs diversification of food products to meet protein needs for growth. Based on its high protein content, milkfish and kidney bean flour then used as raw material in making simulation chips. This research use Completely Randomized Design (CRD) with one factor that is variation of milkfish and kidney bean flour formulation. The data were analyzed by One Way Anova with 95% significance level. The results of research showed the best formulation on F2 (35% milkfish meat : 65% kidney bean flour). The result of chemical analysis on F2 is moisture 3.44 %wb, ash 3.84 %db, fat 23.22 %db, protein 23.01 %db, carbohydrate 51.01 %db, FFA 0.39 %db, total calories 5.30 kcal/g and crude fiber 4.40 % db. While physical analysis at F3 that is hardness 7.61 N and wholeness 96.74 %. While on sensory analysis the most preferred value is F2.

1. INTRODUCTION
Snacks are foods consumed between main meals. One snack that is popular in the community is chips. In general, chips are made from tubers, fruits or vegetables that are thinly sliced and then fried. Chips sold on the market still have some deficiencies in terms of uniformity in size and are made from just one type of raw material, so they cannot improve nutritional value (Putri, 2011).

Protein is needed by children and adolescents to maintain health, growth and development (Primasoni, 2012). In addition, protein is used to produce hormones, enzymes and hemoglobin, and can be used as an energy source, even though it is not a primary choice (Hoffman and Falvo 2004). According to Regulation of the Head of Food and Drug Supervisor of Republic of Indonesia Number 75 Year 2013 (BPOM, 2013) concerning Angka Kecukupan Gizi (AKG) which is recommended for Indonesians, namely protein needs for children and adolescents at 35–72 grams per day.

Chips as snacks can be used to help meet protein needs for children and adolescents. According to Koswara (2009), chips consist of two types, namely ordinary chips and simulation chips. Ordinary chips are snacks that have a crunchy texture made through a process of stripping and cleaning, thin slices, and frying pans. While the simulation chip is a chip that can be diversified into raw materials for the purpose of increasing the nutritional value of chips. According to Karebet (1998), the advantages of simulation chips compared to conventional chips are that they can be printed in shapes and sizes to taste so that they can be uniform and produce high yields. In addition, simulation chips can be added with
additional ingredients to support flavor and nutritional value.

Milkmilk is one of the fish that is favored by the Indonesian people because it has a fairly tasty and savory taste so it becomes one of the leading cultivation commodities (Fitri, et al, 2016). According to Hafiludin (2015), mkilk is a fish that is rich in protein sources (20-25%), fat (0.7-0.8%) and the highest amino acid content, glutamate, while the highest saturated fatty acids are oleic, mineral macro in milkfish meat, namely Ca, Mg, Na and K and their micro minerals Fe, Zn, Cu, Mn. The vitamin content of milkfish meat includes vitamins A, B1 and B12. According to the Data, Statistics and Information Center of the Ministry of Marine and Fisheries Year 2015 (BPS, 2015), milkfish production in 2010-2014 experienced an increase of 10.84%. Other raw materials that have high protein content come from nuts. One of the nuts that can be used is kidney beans with 22.37% vegetable protein content (USDA, 2007). According to Rakhmawati et al (2014), kidney bean flour has moisture 9.91%, ash 3.04%, protein 20.57%, fat 3.12%, and carbohydrate 70.33%. The addition of kidney bean flour is expected to increase protein nutritional content.

Limited amino acids in kidney bean protein are methionine and cysteine with relatively low content of 0.105% and 0.084%. However, legumes contain high levels of amino acids leucine and phenylalanine which are 0.761% and 0.522% (Astawan, 2009). Milkfish have the advantage of providing all types of essential amino acids and their adequacy provides amino acids methionine and histidine which is equal to 0.564% and 0.434%, but the lowest essential amino acids are phenylalanine by 0.338% (Hafiludin, 2015). So that with the combination of vegetable and animal protein obtained high protein content and essential amino acids complete. Research is needed to determine the characteristics of milkfish and kidney bean flour simulation chips which include chemical, physical and sensory characteristics with the aim to be acceptable to consumers and have high nutritional value.

2. MATERIALS AND METHODS

Materials

Materials used in making chips are milkfish meat, kidney bean flour, tapioca flour, salt, garlic, onion, margarine, cooking oil and water. While the material for chemical analysis is petroleum ether solvent, filter paper, concentrated sulfuric acid, mercury oxide, potassium sulphate, sodium thiosulfate hydroxide solution, saturated boric saturated acid, 0.02 N hydrochloric acid solution, 95% alcohol, sodium hydroxide system 0.1 N, indicators of PP, sulfuric acid and aquadest.

Methods

Milled milkfish (Chanos chanos) meat

Fresh milkfish is cleaned to separate fish meat from the head, bones, stomach contents, tail, and gills. After that, wash with running water to remove dirt that sticks to the fish. Then the separation fish meat of red, white, skin and thorns is done. Then the steaming process is carried out at a temperature of 100 °C for 15 minutes and milkfish is ground until smooth.

Kidney bean flour

Kidney beans are soaked for 48 hours at room temperature with replacement of water every 12 hours and a comparison of water with kidney beans 10 : 1 (b/v). After being soaked, the beans are washed with running water and drained for 10-15 minutes, then the kidney beans are dried using a cabinet dryer with a temperature of 60 °C for 16 hours. After drying, the kidney beans is peeled manually, then roasted at 80-90 °C for 5 minutes. Then it is milled and sifted with an 80 mesh filter.

Chips simulation

In making these simulation chips using 4 formulations: (1) Control (100 g of wheat flour), (2) F1 (50 g of milkfish meat : 50 g of kidney bean flour), (3) F2 (35 g of milkfish meat : 65 g of kidney bean flour and (4) F3 (20 g of milkfish meat : 80 g of kidney bean flour). The manufacturing process includes milled milkfish and kidney bean flour with a predetermined formula mixed with tapioca flour, onion, garlic, margarine, and salt that has been mashed. Then mixed evenly and given water and kneaded until the dough becomes smooth. The simulation chips dough is then formed into sheets with a thickness of ± 3 mm to make it easy to print. The simulation chip dough sheet is then manually printed in a square shape with a size of 3 cm x 3 cm. Assume that the bates stick to the tool 0.1%. Frying is done by deep frying method. The frying temperature is 176 ± 4 °C for 42 seconds. After the frying process, the simulation chips are then drained to reduce the sticky oil content.

Chemical, physical and sensory analysis

Chemical analysis includes water content from the thermogravimetric method (AOAC, 2005), ash oven method (AOAC, 2005), fat soxhlet method.

Data analysis
This study used a completely randomized design (CRD) with one factor that is variation of milkfish and kidney bean flour formulation. The data obtained were then analyzed statistically with One Way Analyze of Variance (ANOVA) using SPSS 23 application. If the result of the analysis showed a real difference between treatments then continued by using Duncan Multiple Range Test (DMRT) with significance level a = 0.05.

3. RESULT AND DISCUSSION
Chemical characteristics of simulation chips based milkfish (Chanos chanos) and kidney beans flour (Phaseolus vulgaris L.)
There are 8 parameters observed in chemical characteristics. Table 1. shows that the concentration of milkfish meat and kidney bean flour used has an effect for all parameters, but the kind of effect is different for each parameter. The highest water content value was found on simulation chips F1 3.74 (%wb) or 3.83 (%db). This is because the protein content in milkfish is 24.17 (%wb) able to bind water. Protein can bind to water because of the presence of polar amino acid groups in which the peptide chain contains some polar groups so that the protein will be hydrophilic (Triyono, 2010).

The ash content ranged from 1.70–3.83 (%wb) or 1.75–3.97 (%db). The value of ash content in all simulation chips formula (F1, F2 and F3) except Control is higher than the maximum ash content for fried tempeh chips in SNI 01-2602-1992, which is 3 (%wb). This is because ash content in milkfish is 3.53 (%db) (Widyarini, 2014), while kidney bean flour is 3.04 (%db) (Rakhmawati, 2014). According to Sudarmadji et al. (1997), the ash content in a food product is very dependent on its constituent ingredients. If the constituent material has high ash content, the product also has a high ash content.

Fat content ranged from 21.16–21.15 (%wb) or 21.98–26 (%db). The higher the addition of kidney bean flour to the simulation chips, the higher the fat content value. According to Charles et al. (2005), starch has the ability to absorb oil, during the frying process the starch will undergo a gelatinization process so that the swelling process occurs and forms a cavity or pore causing oil to enter and replace the evaporated water. All formula of simulation chips have fulfilled SNI 01-2886-2000, the value of fat content with the maximum frying process for extrudate food that is 20 (%wb).

Table 1. Chemical characteristics of simulation chips based milkfish (Chanos chanos) and kidney beans flour (Phaseolus Vulgaris L.)

<table>
<thead>
<tr>
<th>Chemical analysis</th>
<th>Unit</th>
<th>Control</th>
<th>F1</th>
<th>F2</th>
<th>F3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture content (%)</td>
<td>(wb)</td>
<td>3.74±0.0</td>
<td>3.74±0.0</td>
<td>3.74±0.0</td>
<td>3.74±0.0</td>
</tr>
<tr>
<td>Ash content (%)</td>
<td>(wb)</td>
<td>0.11±0.0</td>
<td>0.13±0.0</td>
<td>0.12±0.0</td>
<td>0.13±0.0</td>
</tr>
<tr>
<td>Protein content (%)</td>
<td>(wb)</td>
<td>7.75±0.0</td>
<td>22.15±0.0</td>
<td>20.86±0.0</td>
<td>17.77±0.0</td>
</tr>
<tr>
<td>Carbohydrate content (%)</td>
<td>(wb)</td>
<td>64.03±0.0</td>
<td>49.10±0.0</td>
<td>49.55±0.0</td>
<td>50.33±0.0</td>
</tr>
<tr>
<td>FFA (%)</td>
<td></td>
<td>0.31±0.0</td>
<td>0.41±0.0</td>
<td>0.57±0.0</td>
<td>0.35±0.0</td>
</tr>
<tr>
<td>Total calories</td>
<td>(kcal/g)</td>
<td>5.48±0.0</td>
<td>5.19±0.0</td>
<td>5.30±0.0</td>
<td>5.56±0.0</td>
</tr>
<tr>
<td>Crude fiber (%)</td>
<td>(wb)</td>
<td>2.79±0.0</td>
<td>3.67±0.0</td>
<td>4.24±0.0</td>
<td>4.66±0.0</td>
</tr>
</tbody>
</table>

a = subset a, b = subset b, and a and b in one column show a significant difference at a = 0.05. Control = 100 % wheat flour, F1= 50 % milkfish meal : 50 % kidney bean flour, F2= 35 % milkfish meal : 65 % kidney bean flour, F3= 20 % milkfish meal : 80 % kidney bean flour.

The lowest protein content in the Control formula is 7.75 % (wb) or 7.97 (%db), while the highest protein content in formula F1 is 22.15 (%wb) or 23.01 (% db). The more milkfish used causes the increase of protein contains in the simulation chips. This is because the protein content of milkfish is higher at 24.17 (%wb) (Hafiludin, 2015), compared to kidney bean flour, which is 17.24 (%wb) (Verawati, 2015). Amino acids in milkfish include glutamic acid, aspartic acid, leucine, alanine, lysine, methionine, threonine, valine, isoleucine, phenylalanine, tyrosine, arginine, histidine and cysteine with the highest amino acid glutamic acid 1.27 (%wb).
(Hafiludin, 2015). While in kidney beans there are amino acids including leucine, isoleucine, arginine, phenylalanine, alanine, methionine, tyrosine, tryptophan, valine, histidine, cysteine and lysine with the highest amino acid, leucine at 0.76 (%wb) (Kay, 1979), so that with the combination obtained complete essential amino acid content. The protein content in Control and F3 simulation chips formula was lower than SNI 01-2602-1992, the minimum protein content for fried tempeh chips was 20 (%wb). This is because the material control used is wheat flour with medium protein which is 10.5% (Bogasari, 2012), while in F1 formula milkfish is used too little. In addition, the addition of tapioca flour to the formulation can reduce protein levels in the simulation chips. if children and adolescents consume 100 g of these simulated chips, there is a protein content of 20–22 g.

Carbohydrate levels ranged between 49.10–64.03 (%wb) or 51.01–65.85 (%db). In the Control formula the carbohydrate content is higher than the formula F1, F2 and F3 because the ingredients used are wheat flour. According to the USDA (2007), the level of carbohydrates in wheat flour is 74.48 (%db). Meanwhile, according to Rakhmawati et al. (2014), carbohydrate levels in kidney bean flour are 70.33 (%db). According to Sugito and Hayati (2006), the higher the component of other nutrients, the lower the carbohydrate content.

Free fatty acid (FFA) levels ranged between 0.31–0.41 (%wb) or 0.32–0.43 (%db). All simulation chips formulas have fulfilled SNI 01-2602-1992, the level of free fatty acids (FFA) is calculated as the maximum lauric acid for fried tempeh chips of 1 (%wb). The higher the water content in the simulation chips, it can increase FFA levels. According to Apendi et al. (2013), the presence of water content in the material can occur hydrolysis reactions that cause damage to fat when frying lasts, causing an increase in free fatty acids (FFA).

The highest total calorie at F3 is 5.56 kcal/g, while the lowest in F1 is 5.19 kcal/g. The total calories in the simulated chips formula increased as often as the addition of more kidney bean flour, namely the formula F1, F2 and F3. At F3 it shows greater total calories compared to Control. This is supported by the calculation of total calories based on the chemical composition of each simulation chip formula that is at the F3 formula of 5.1565 kcal/g, greater than the Control of 5.1509 kcal/g. Based on the serving size of 20 g/serving of simulated chips there is energy of 103.95–111.29 kcal with a protein content of 3.67–4.60 g, fat content of 4.39–5.20 g and carbohydrates of 10.20–13.17 g.

The highest crude fiber value in F1 simulation chips formula is 4.66 ± 0.03 (%wb) or 4.80 (%db), while the lowest chips formula is 2.79 (%wb) or 2.87 (%db). All formulas (F1, F2 and F3) except Control is higher than the maximum crude fiber content for fried tempeh in SNI 01-2602-1992, amounting to 3 (%wb). This is due to the difference in raw materials which in the Control formula uses wheat flour, while in the formula F1, F2 and F3 using kidney bean flour and milkfish. Fiber content in wheat flour was 0.40–0.50 (%db) (Ardiyanti, 2001), lower than that of kidney bean flour 3.93 (%wb) (Permana dan Widya, 2015).

**Physical characteristics of simulation chips based milkfish (Chanos chanos) and kidney beans flour (Phaseolus Vulgaris L.)**

<table>
<thead>
<tr>
<th>Table 2. Physical characteristics of simulation chips based milkfish (Chanos chanos) and kidney beans flour (Phaseolus Vulgaris L.)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Formulation</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Control</td>
</tr>
<tr>
<td>F1</td>
</tr>
<tr>
<td>F2</td>
</tr>
<tr>
<td>F3</td>
</tr>
</tbody>
</table>

*a = subset a, b = subset b, a and b in one column show a significant difference at α = 0.05, Control = 100 % wheat flour, F1= 50 % milkfish meat : 50 % kidney bean flour, F2= 35 % milkfish meat : 65 % kidney bean flour, F3= 20 % milkfish meat : 80 % kidney bean flour.*

Physical characteristic of simulation chips determined by the value of hardness and wholeness. The physical characteristics of simulation chips are determined by the value of hardness and wholeness. The hardness value of simulation chips increases with the concentration of milkfish meat larger. This can be seen in Table 2, that the highest hardness value is in F1 (8.97 N). High hardness values indicate that the quality of the simulation chips produced is low. The control formula has the lowest hardness value. This is because using raw materials containing wheat flour, while in the formula F1, F2 and F3 is gluten free. According to Turisyawati (2011), the main component contained in wheat flour which affects texture is protein. Protein in flour can form gluten when added to water. Gluten can cause the dough to be elastic and able to withstand gas so that the pores are formed in large dough. As a result the mixture is able to expand well after the heating process so that it will produce a product that is not hard.

The highest wholeness value in F1 simulation chips formula was 97.18%, while the lowest in the
Control simulation chips formula was 95.12%. The more use of kidney bean flour in the simulation chips formula can reduce the wholeness value. Decrease in total values indicates that simulation chips are crispy. According to Suseno et al. (2004), starch content in materials will be able to form hydrogen bonds with more water, causing water to evaporate and increase empty space in the material when heating and making the product crispy and fragile. In all formula the simulation chips have fulfilled SNI 01-2602-1992, the minimum wholeness value is 95%.

**Sensory characteristics of simulation chips based milkfish (Chanos chanos) and kidney beans flour (Phaseolus Vulgaris L.)**

Table 3. Sensory characteristics of simulation chips based milkfish (Chanos chanos) and kidney beans flour (Phaseolus Vulgaris L.)

<table>
<thead>
<tr>
<th>Formula</th>
<th>Color (±0.82)</th>
<th>Aroma (±0.82)</th>
<th>Flavor (±0.82)</th>
<th>Texture (±0.82)</th>
<th>Overall (±0.82)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>3.60a±0.59</td>
<td>3.18ab±0.71</td>
<td>3.35b±0.92</td>
<td>3.75b±0.89</td>
<td>3.40b±0.70</td>
</tr>
<tr>
<td>F1</td>
<td>2.95±0.95</td>
<td>3.10ab±0.92</td>
<td>3.00b±0.98</td>
<td>2.73ab±0.84</td>
<td>2.93b±0.76</td>
</tr>
<tr>
<td>F2</td>
<td>3.68a±0.91</td>
<td>3.53ab±0.71</td>
<td>3.78b±0.69</td>
<td>3.40b±0.74</td>
<td>3.63b±0.62</td>
</tr>
<tr>
<td>F3</td>
<td>3.30ab±0.91</td>
<td>3.48b±0.78</td>
<td>3.65bc±0.80</td>
<td>3.55bc±0.78</td>
<td>3.48b±0.59</td>
</tr>
</tbody>
</table>

a = subset a, b = subset b, and a and b in one column show a significant difference at α = 0.05.

Scoring Test: The largest number shows the highest level of preference by panelists. Value scale: 1 = really dislike, 2 = dislike, 3 = neutral, 4 = like, 5 = really like.

Control = 100 % wheat flour, F1= 50 % milkfish meat : 50 % kidney bean flour, F2= 35 % milkfish meat : 65 % kidney bean flour, F3= 20 % milkfish meat : 80 % kidney bean flour.

The aroma parameter showed that the comparison of the use of milkfish meat and kidney bean flour did not give a real difference in the formula F1 and F2, but gave a real difference in the Control and F1 formulas. The average score based on panelist assessment ranges from 3.10 to 3.53, panelist judgments related to aromas tend to be neutral. The formula that panelists like is F2, while the formula that panelists don't like is F1. Simulation chips with the most use of milkfish meat caused a decrease in the level of panelist preference.

The taste parameters based on panelist assessment ranged from 3.00 to 3.78, panelist judgments related to tastes tend to be neutral leading to likes. The formula most preferred by panelists is F2, while the formula that most panelists don't like is F1. Panelists prefer simulation chips with less milkfish meat. According to Fitri et al. (2016), the addition of milkfish gives a savory taste typical of fish. While according to Bestari and Pujonarti (2013), the addition of kidney bean flour provides a distinctive taste from peanuts, thus affecting the panelist's assessment.

The texture parameters showed that the comparison of the use of milkfish meat and kidney bean flour did not give a significant difference in the Control, F2, and F3 formulas, but gave a real difference in F1. The average score based on panelist assessment ranges from 2.73 to 3.75, panelist judgment related to texture with a wide range that is not like leads to likes. The formula that most panelists like is Control, while the formula most panelists don't like is F1. In the F3 formula or the use of more kidney bean flour results in an increase in preference by panelists. The level of panelists preference on texture parameters is related to the moisture content of the simulation chips. According to Putri (2011), the lower the moisture content in a food product will produce a low hardness value so that crispy chips have a more crispy and fragile appearance. In all formula the simulation chips are crispy. According to Suseno et al. (2004), the addition of kidney bean flour provides a crispy and fragile texture. According to Bestari and Pujonarti (2013), the addition of kidney bean flour has caused a decrease in the level of panelist preference.
The results of sensory analysis on overall parameters showed that the comparison of the use of milkfish and kidney bean flour did not give a significant difference in the control chips formula F2, F2, and F3, but gave a significant difference in formula F1. The average value based on panelist assessment ranges from 2.93 to 3.63. The most preferred simulation chips formula based on color and flavor parameters is F2 with 35 % milkfish meat : 65 % kidney bean flour and and F3 (20 g of milkfish meat : 80 g of kidney bean flour). Formula F2 and F3 for each color, aroma, taste, and texture parameters are relatively not significantly different.

**Determination of the best formula of simulation chips based milkfish (Chanos chanos) and kidney beans flour (Phaseolus vulgaris L.)**

The best formula determination of chips simulation based milkfish and kidney bean flour is done by compensatory model or weighted test (De Garmo et al., 1993). Thus, after passing the organoleptic test in determining the panelist's preference for the product, we then conduct a weighted test to select the preferred formula of the organoleptics parameters as well as the chemical and physical characteristics. The best formula is the treatment with the highest value score of the degree of product interest expected by the consumer. The best formula with the highest yield value is F2. Therefore, Formula F2 with 35 % milkfish meat : 65 % kidney bean flour is the right combination in simulation chips formula of milkfish and kidney bean flour.

**CONCLUSION**

The simulation chips formula has a significant effect on all chemical analyzes. The more use of milkfish increases the moisture content (2.76–3.74 %wb), ash content (1.70–3.83 %wb), protein content (7.75–22.15 %wb), FFA (0.31–0.41 %wb) and reduce fat content (21.16–25.15 %wb), carbohydrates (51.01–65.85 %wb), total calories (5.19–5.56 %wb) and crude fiber (2.79–4.66 %wb). Hardness value (6.17–8.97 N) and wholeness value (95.12–97.18 %) simulation chips increased with the increasing use of milkfish. The formula of the simulation chips that the panelists like most is F2 (35 % milkfish meat : 65 % kidney bean flour). The best formula for milkfish based chips and kidney bean flour in formula F2 (35 % milkfish: 65 % kidney bean flour). Based on the results of sensory analysis, the best formula is F2 (35 g of milkfish meat : 65 g of kidney bean flour and F3 (20 g of milkfish meat : 80 g of kidney bean flour), F2 and F3 where the two formulas as a whole are not significantly different.

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