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The Characteristics of Physico-Chemical and Sensory Properties of Bran and Pumpkin Flours Substitution of Simulation Chips

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ABSTRACT

Snacks are food consumed between the times of the main meal. Indonesian people have a habit of eating a snack, and it is a business opportunity for the snack industry. Most snack on the market contain a lot of monosodium glutamate (MSG), to reduce the use of MSG, it can use local foodstuffs such as bran and fruit pumpkin that has a complete nutritional content, source of dietary fiber, and antioxidants. By processing the bran and pumpkin fruit into flour, it can be used as raw material in the processing of the simulation chips. The purpose of this study was to determine the effect of substitution proportion of TB and TLK to the physico-chemical properties and sensory quality of simulation chips. The design used was completely randomized design (CRD) with four replications for each treatment. Treatment substitution of TB consists of 7 levels: 0%, 5%, 10%, 15%, 20%, 25%, and 30% of the total flour, whereas substitution of TLK consists of 7 levels, namely 10%, 20 %, 30%, 40%, 50%, 60% of the total flour. The best results obtained on substitution treatment of F4 with TB were as much as 15% and 30% of TLK which has a water content of 3.71%, ash content of 5.09%, the protein content of 10.67%, fat content of 16.94%, carbohydrate content of 63.58%, β-carotene with 2.81 µg/g, vitamin E of 0.59 mg / 100 g, TDF of 10.64% db, the antioxidant capacity of 668.52 ppm GAEAC, and IC 50 amounted to 145.19 mg / mL. Sensory acceptance is based on the overall quality attributes of a score of 4.13 (quite like to like).
Keywords: Flour, Bran, Pumpkin, and Chips Simulation

I. INTRODUCTION

Indonesian people have a habit of eating a snack. Snacks are light meals consumed between main meals. Snack consumption is generally more or less 2-3 hours between main meal times, which are at 10 am and 4 pm. The habit of eating snacks is one of the business opportunities for the snack industry, as evidenced by the increasingly diverse types of snacks that have flooded the market, based on wheat flour, soy flour, chocolate, fruit, and nuts.

Snacks on the market is still dominated by dense foods contain a lot of calories and *monosodium glutamate* (MSG) (Pajajaran University, 2012). Eating snacks with high MSG content in large quantities and on an ongoing basis can cause health problems. To address this, now healthy snack began much talked about, because people began to realize the importance of the quality of food consumed to maintain health. The criteria of healthy snacks are to contain vitamins, protein, and fiber food (Kompas, 2009). Consumption of healthy snacks can provide extra energy to move, and help meet the energy needs until the main meal.

Chips are generally made in an intact form in accordance with the raw materials, such as banana, cassava, and potato chips. Besides the chips processed products, there are also other types of product chips, known as the simulated chips. Simulated Chips are a snack that is processed by shaping the dough, made of thin sheets, sliced, dried and fried (Matz, 1984). Processing chips in dough forms possible using raw materials that have high nutritional value, containing dietary fiber, and antioxidants to produce a healthy snack. To get healthy snack products, it is preferably using raw materials derived from nature without using additional materials made from chemicals. One type of local food that can be used are rice bran and fruit pumpkin. Bran and pumpkin contains a complete nutrient (carbohydrate, protein, fat, minerals and vitamins) as a source of dietary fiber and antioxidants. To facilitate the consumer in processing chips, rice bran, and pumpkin fruit can be processed into flour.

Bran is rice mill waste, which is generally used as cattle feed, while rice bran can be used as a food ingredient, they are natural healthy foods and as sources of antioxidants (Ramezanzadeh *et al*., 1999 and Iqbal *et al*., 2005). Components of essential substances in bran is a food fiber, as a source of calcium mineral of 500-700 mg/100g and magnesium at 600-700 mg/100g, contains vitamin B complex, vitamin E, essential fatty acids and amino acids (Astawan, 2009; Damayanthi *et al*., 2010; and Pasha *et al*., 2002).

Pumpkin including types of vegetables that can be grown in the lowlands to high, between 0-1500 m above the sea level (Hendrasty, 2003), generally the fruit of pumpkin can be grown in the tropics and sub-tropics (Kulkarni *et al*., 2013). Pumpkin is a source of carotenoids, pectin, mineral salts, vitamins and other bioactive substances, such as phenolic compounds (Cerniauskiene *et al*., 2014). The yellow color of pumpkin showed β-carotene compound that can be used as a food ingredient alternatives to increase the amount of β-carotene which the body needs daily (Usmiati *et al*., 2005).

Products of simulated chips that have been researched are simulated chips of low fat bran flour substitution by Damayanthi and Listyorini (2006), the addition of 10% low fat bran flour is the best formula of simulated chips, but from the tests of sensory to the flavor of low fat bran flour simulated chips has left slightly bitter taste. To improve the taste of simulated chips, it can be done with pumpkin flour substitution that has flavor and sweeter aroma than the bran flour.

Utilization of bran flour (TB) and pumpkin flour (TLK) with other supporting materials produce healthy snacks that contain dietary fiber and antioxidants. Research on the substitution of bran flour with pumpkin flour in food products has not been widely conducted. The purpose of this study was to determine the influence of the proportion of the addition of bran flour (TB) and pumpkin flour (TL) to the physical properties (yield, hardness, and color), chemical (proximate, amylose, vitamin E, β-carotene, dietary fiber, and total antioxidant), and sensory quality of the simulated chips.

II. METHODS AND MATERIAL

A. Materials

Bran used was obtained from farmers in Tabanan regency, while the pumpkin fruit is obtained from farmers in the Sub-district of Petang, Badung Regency, Bali. Additional materials used consisted of flour, green beans, onions, garlic, salt, refined sugar, baking powder, and margarine.

Chemicals used consisting of sulfuric acid (H_2SO4), boric acid (H_3BO_3), HCL 0.02 N, hexane, Na-phosphate 0.1M, 0.1 ml of the enzyme amylase, the enzyme pepsin, pancreatic enzyme, 4M HCL, NaOH, 1,1-diphenyl-2-2picrylhydrazyl (DPPH), petroleum ether, ascorbic acid, ethanol, alcohol, methanol, potassium hydroxide, α-tocopherol, methyl alcohol, and nitrite. All chemicals used for the analysis was obtained from Merk (Darmstadt, Germany).

Equipment used in the oven (with the brand of Shellab-USA, Type: 1370 FX), microwave oven with Kris brands with specification: 230V-50 Hz, 1400 W with a frequency of 2450 MHz, and the Genesys spectrophotometer 10S UV-VIS.

B. Methods

This study was conducted in January through March 2014. The processing of simulated chips was conducted at the Laboratory of the Institute for Agricultural Technology (BPTP) Bali, while the chemical analysis was conducted at the Laboratory of Food Technology of Agriculture, University of Udayana, the Center for Postharvest Laboratory Testing Bogor, and the Laboratory of Food and Nutrition Faculty of Agricultural Technology of UGM.

Sample Preparation

Rice bran is derived from paddy varieties of Cigeulis. The drying of the rice bran was conducted by using microwave oven (OM) on the power of 200 watt for 15 minutes. Fruit pumpkin originated from the species of

Cucurbita moschata (yellow squash or pumpkin), dried using OM to the power of 300 watt for 4 hours.

The processing of the simulated chips was made by mixing all the ingredients into doughs that can be formed. Subsequently made of thin sheets and molded round. The drying of simulated chips using an oven at 60°C for 2 hours (until dry). Simulated chips that have been dried were fried at a temperature of 190°C for 21 seconds.

Substitution treatment of TB and TF on simulated chips is the addition of TB consists of seven levels: 0%, 5%, 10%, 15%, 20%, 25%, and 30% of the total flour. While the addition of TLK consists of seven levels: 0%, 10%, 20%, 30%, 40%, 50%, and 60% of the total flour. The design used in this research is CRD (completely randomized design) which is repeated four times in each treatment.

C. Chemical Analysis

1. Proximate Analysis

Proximate analysis was conducted on water content and ash content using the oven method (Apriyanto, 1989), protein content using the Micro-Kjeldahl (Apriyanto, 1989), fat content using Soxhlet (Apriyanto, 1989), and the carbohydrate content using carbohydrate by difference (Apriyantono , 1989).

2. Analysis of Food Fiber

Analysis of dietary fiber content was conducted by using the Multi-Enzyme (Asp *et al*, 1983). The analysis was conducted using three types of enzymes, the amylase enzyme, the enzyme of pepsin and the pancreatic enzymes.

3. Analysis of Vitamin E

Analysis of the levels of vitamin E was calculated using HPLC. 2 g sample was weighed, ethanol and saponified with KOH, then extracted with petroleum ether. Results of concentrated sample was vaporized in the evaporator, the rest of the concentrates was dissolved in 2 ml of methanol. Chromatography using the mobile phase methanol : water (97:3) with a flow rate of 1.2 ml/min. Quantitative determination of vitamin E using UV at a wavelength of 295 nm, the column at a temperature of 24^{o}C.

4. Antioxidant Capacity

Test of antioxidant capacity was conducted by using the DPPH (Blois, 1985). Antioxidants of gallic acid are used as a comparison. The crude extract sample was dissolved in methanol P.A. to obtain a concentration of 200, 400, 600, and 800 ppm. Extract solution and the solution antioxidant of Gallic acid derived respectively 4.50 ml and treated with 500 mL of 0.1 mM DPPH solution in a different test tube. The reaction reached at 37°C for 30 minutes and then the measure of the absorbance was measured using a spectrophotometer at a wavelength of 517 nm. Antioxidant capacity is determined by a standard curve of gallic acid in reducing free radical DPPH 0.1 mM by the formula of:

$$\text{Antioxidant capacity (ppm)} = \frac{X\ (\text{mg/L}) \times fp \times TV\ (\text{L}) \times 1000000}{w\ (\text{mg})}$$

Notes : X = concentration of gallic acid standard regression equation
fp = dilution factor
TV = total volume
w = sample weight

Absorbance of the reference solution is measured to perform the calculation of percent inhibition. The reference solution prepared by reacting 4.50 ml of methanol with 500 mL of 0.1 mM DPPH solution in a test tube. IC 50 value searched by using a standard curve equation of % inhibition as the y-axis and the concentration of antioxidants as a fraction of the x-axis. IC 50 is calculated by entering a value of 50% inhibition in a standard curve equation as the y-axis is then calculated the value of x as the concentration of IC 50. IC 50 value declared the concentration of the sample solution needed to reduce DPPH free radicals by 50%. Inhibition of the sample extract against 0.1 mM DPPH radical is determined by the formula of :

$$\%\ \text{inhibition} = \frac{\text{absorbance of the blank - sample absorbance}\ \times 100\%}{\text{absorbance of the blank}}$$

5. Sensory Test

The sensory tests used were the test of description, test of preferences (hedonic) and test of ranking methods of Soekarto (1995). The tests were carried out by using 10 panelists on the description of the quality attributes of color, aroma, flavor, texture, taste and the after taste. The rating scale of the simulation chips quality attributes are: grade 1 = very weak; grade 6 = very severe. The preference or hedonic test was performed by using 40 semi-trained panelists to assess the parameters of color, aroma, texture, taste, and overall acceptance of the simulation chips used in the assessment. There are 6 grades in the hedonic test assessment, namely 1 = strongly dislike, 2 = dislike, 3 = somewhat dislike, 4 = somewhat like, 5 = like, and 6 = very like. The ranking test was used to determine the most preferred formulations; rank 1 indicates the most preferred product. Assessment is done by 40 semi-trained panelists. Panelists of semi-skilled and well-trained recruits are students of Food Technology of the Udayana University.

Statistical Analysis

The observed data were analyzed by analysis of variance (ANOVA) using SPSS 16. Results of analysis of variance were significantly different ($p < 0.05$) followed by a further test of Duncan's multiple range test (DMRT).

III. RESULT AND DISCUSSION

Antioxidant capacity and IC 50

Results of analysis of variance of simulation chips substitution of TB and TLK showed significant differences ($p < 0.05$) on antioxidant capacity and IC 50. Increased antioxidant capacity of simulation chips was comparable with the addition of TB and TLK, but the reverse condition occurred in IC 50, in which IC 50 values decreased with the increasing substitution of TB and TLK (Table 1). The high antioxidant capacity in simulation chips was caused by TB contains the antioxidant capacity of 92.13 ppm GAEAC, and TLK contains the antioxidant capacity of 184.40 ppm GAEAC.

Table 1. The Average antioxidant capacity and IC 50 simulation chips with TB and TLK substitutions

Treatment (TB% : TLK%)	Antioxidant Capacity (ppm GAEAC)	IC 50 (mg/mL)
F1 (Control)	284.21 ±74.04^{a}	393.36 ± 28.46^{e}
F2 (5:10)	428.68 ±51.52^{b}	239.27± 9.81^{d}
F3 (10:20)	545.00± 24.68^{c}	185.83± 7.57^{c}
F4 (15:30)	668.52 ± 80.94^{d}	145.19± 15.16^{b}
F5 (20:40)	685.09± 80.72^{d}	138.45 ± 14.86^{ab}
F6 (25:50)	721.88± 55.43^{d}	126.66± 5.94^{ab}
F7 (30:60)	761.28± 42.50^{d}	120.59± 4.20^{a}
kk (%)	10.56	7.51

Description : Figures followed by the same letter in each column, indicating no different at the level of 5% Duncan test

IC50 value of simulation chips decreases with the increasing of TB and TLK substitutions. The highest IC 50 value was found in the F1 treatment of 393.36 mg/mL and the lowest was for the treatment F7 of 120.59 mg/mL. According to June *et al*., (2003), IC 50 values of simulation chips on the treatment of F2 to F7 at 120.59 mg/mL to 239.27 mg/mL have the ability to moderate antioxidant activity, whereas treatment F1 has the capability of weak antioxidant activity with the value of 393.36 mg/mL. This indicates that the substitution of TB and TLK on simulated chips has the potential of free-radical scavengers, with an average concentration of 120.59 mg/mL have been able to ward off free radicals by 50%.

The contents of the IDF, SDF and TDF

Results of analysis of variance of the simulation chips significantly affect ($p < 0.05$) the insoluble dietary fiber (IDF), soluble dietary fiber (SDF), and total dietary fiber (TDF), as presented in Table 2. The increased levels of IDF, SDF, and TDF of simulation chips were comparable with the addition of TB and TLK. This is because the TB contain the IDF by 30.51% db, SDF 6.31% db, and TDF of 36.82% db while TLK contained IDF of 5.00% db, SDF of 10.21% db, and TDF of 15.22% db.

Table 2. The average of IDF, SDF and TDF simulation chips, with the substitution of TB and TLK

Treatment (TB% : TLK%)	IDF (% db)	SDF (% db)	TDF (% db)
F1 (Control)	3.90± 0.05^{a}	3.09 ± 0.42^{a}	6.77± 0.22^{a}
F2 (5:10)	4.75± 0.37^{a}	3.54± 0.28^{ab}	7.89± 0.10^{b}
F3 (10:20)	6.68 ± 0.35^{b}	3.96± 0.63^{bc}	10.54± 1.03^{c}
F4 (15:30)	6.62± 0.43^{b}	4.02± 0.08^{bc}	10.64± 0.50^{cd}
F5 (20:40)	6.94± 0.74^{bc}	4.07± 0.26^{c}	11.01± 0.89^{cde}
F6 (25:50)	7.49± 0.59^{cd}	4.08 ± 0.15^{c}	11.57± 0.69^{de}
F7 (30:60)	7.76± 0.48^{d}	4.17± 0.06^{c}	11.93± 0.44^{e}
kk (%)	7.57	7.57	6.35

Description : Figures followed by the same letter in each column, indicating no different at the level of 5% Duncan test

The content of TDF of simulation chips from the results of the research can be used as a source of dietary fiber because it contains TDF more than 6 g/100 g, the results of this research is in accordance with the statement of Friska (2002), which said food is the source of fiber if it contains 3-6 g/100 g of TDF.

Vitamin E and β-carotene

The results of the analysis of the simulation chips variant significantly affect ($p<0.05$) on the content of vitamin E and β-carotene. The content of vitamin E and β-carotene increased with increasing addition of TLK for TB and TLK because TB is rich in vitamin E and TLK containing β-carotene (Table 3). The increasing amount of vitamin E and β-carotene was due to TB raw materials of Cigeulis varieties contain vitamin E amounted to 2.05 mg/100 g. The same was said by Pongjanta (2006), that there was an increase in the content of β-carotene on bread, cake, and cookies at 10-50% substitution of TLK.

Table 3. The Average of Vitamin E and β-carotene simulation chips substitution with TB and TLK

Treatment (TB% : TLK%)	Vitamin E (mg/100 g)	β-carotene (μg/g)
F1 (Control)	0.16 ± 0.07^{a}	0.25 ± 3.23^{a}
F2 (5:10)	0.25 ± 0.02^{a}	1.49 ± 36.41^{b}
F3 (10:20)	0.36 ± 0.07^{a}	2.52 ± 23.87^{c}
F4 (15:30)	0.59 ± 0.15^{b}	2.81 ± 17.28^{cd}
F5 (20:40)	0.71 ± 0.18^{bc}	3.06 ± 10.83^{d}
F6 (25:50)	0.80 ± 0.10^{c}	3.71 ± 28.33^{e}
F7 (30:60)	0.88 ± 0.09^{c}	4.13 ± 28.18^{f}
kk (%)	16.68	9.23

Description : Figures followed by the same letter in each column, indicating no different at the level of 5% Duncan test

The Content of Proximate

Results of analysis of variance substitution treatment of TB and TLK of simulation chips significantly affect ($p<0.05$) on moisture, ash, protein, fat, and carbohydrates, as shown in Table 4. The highest water content of the simulation chips was in treatment of F1 (5.26 %), followed by water content dropped with the increasing substitution of TB and TLK. This was due to reduced content of gluten on simulation chips. Gluten is found in wheat flour water served as a binder and forming the dough elasticity. The water content of simulation chips was also affected by the water content of TB and TLK used. The water content of TB that is used has a moisture content of 10.54% and TLK water containing of 7.64%, lower than the water content of wheat flour by 14.5%.

The results of this research are consistent with the results of research by Silvi *et al*., (2011), on a wet noodle products, substitution of wheat flour with 20% TLK has a water content of 32.12% lower compared with controls, at 35.42%. The same thing happened to sausage products, where fortification with TLK can lower the water levels of sausage (Agus *et al*., 2009). According to the SNI, the water content of the chips in general is a maximum of 5-6%, while the moisture content of simulation chips of the study has met the SNI standards.

Table 4. The average content of the proximate of simulation chips with TB and TLK substitution

Treatment (TB% : TLK%)	Water Content (%)	Ash Content (%)	Protein Content (%)	Fat Content (%)	Carbohydrate content (%)
F1 (Control)	5.26 ± 1.14^{c}	4.24 ± 0.19^{a}	9.43 ± 0.92^{a}	14.05 ± 1.76^{a}	67.02 ± 2.94^{c}
F2 (5:10)	4.63 ± 1.08^{c}	4.30 ± 0.32^{a}	10.30 ± 0.92^{ab}	15.74 ± 0.71^{b}	65.02 ± 1.29^{bc}
F3 (10:20)	3.90 ± 0.44^{ab}	4.73 ± 0.21^{b}	10.78 ± 0.74^{b}	16.69 ± 1.13^{bc}	63.89 ± 1.63^{ab}
F4 (15:30)	3.71 ± 0.48^{ab}	5.09 ± 0.19^{c}	10.67 ± 0.51^{b}	16.94 ± 0.96^{abc}	63.58 ± 0.93^{ab}
F5 (20:40)	3.51 ± 0.53^{ab}	5.44 ± 0.20^{d}	11.09 ± 0.60^{b}	17.49 ± 0.81^{cd}	62.48 ± 0.89^{a}
F6 (25:50)	3.52 ± 0.41^{ab}	5.53 ± 0.19^{d}	11.20 ± 0.52^{b}	18.09 ± 0.69^{cd}	61.66 ± 0.88^{a}
F7 (30:60)	3.03 ± 0.61^{a}	5.76 ± 0.21^{d}	11.26 ± 0.52^{b}	18.48 ± 0.57^{d}	61.47 ± 0.72^{a}
kk (%)	18.46	4.46	6.52	6.06	2.37

Description : Figures followed by the same letter in each column, indicating no different at the level of 5% Duncan test

Ash, protein, and fat contents of the simulation chips increased with the increasing substitution of TB and TLK (Table 4). This is because the ash, protein, and fat contents of TB were greater than the wheat flour. The research results of Damayanthi and Listyowati (2006), showed that there was an increase in ash content of 3.01% and amounted to 7.96% protein on the simulation chips with the addition of 20% low-fat TB. The same results were found in biscuit products substitution of wheat flour with TLK by Kulkarini and Joshi (2013), who mentioned that there were increased levels of fat in biscuits with the increasing substitution of TLK. On the contrary the carbohydrate levels dropped with higher substitution of TB and TLK.

Carbohydrate content of the simulation chips decreased significantly, with the increasing substitution of TB and TLK (Table 4). The same results were expressed by El-Demery (2011), stating substitution to 20% of TLK on toast, which contain carbohydrates by 51.38% lower than in the controls (57.03%). Statement of Damayanthi and Listyorini (2006), the low-fat simulation chips are TB control carbohydrate1 content (73.48%) is higher than the carbohydrate content of simulation chips with the addition of 20% of low fat TB, amounting to 71.48%. It is also stated by See *et al*., (2007) in baked goods, with the addition of 15% carbohydrates of TLK by 42.44%, lower than in the controls, at 46.28%.

Physical Analysis

The results of the analysis of the physical properties of simulation chips significantly effect ($p<0.05$) on the color parameters of L, a, and b, as shown in Figure 1. Color L means brightness that indicates the value of L decreases with the increasing substitution of TB and TLK. Values of L simulation chips ranged from 53.79 to 69.89 that show the brightness range from 0-100. L color change is proportional to the reduction in the moisture content of the simulation chips. Chips with low water content has a dense texture and hard, so that when the frying process uses high temperatures, the water in the material and the surface is out in the form of water vapor and simultaneously hardening occurs on the surface of the material that causing the dark color (Jamaluddinet *et al*., 2011 and Wibawa *et al*., 2006). The color L decreased is allegedly due to the mailard reaction at high temperature (Jamaluddinet *et al*., 2011 and Norfezah, 2013) and because TLK has a high sugar content (Norfezah, 2013).

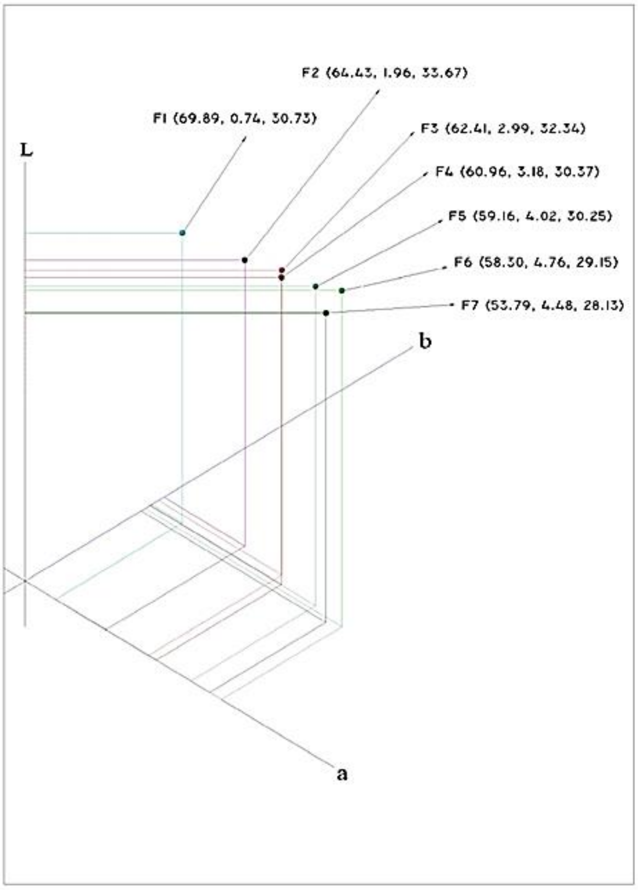

Figure 1. Graph Values of L, a, and b of simulation chips by substitution of TB and TLK

The a value of simulation chips increased with increasing addition of TB and TLK. The value of a, is the dimension of red-to-green. Simulating chips product has a positive value between 0.74 to 4.76 which is denoted by the red color. Simulating chips have a value of b, between 28.13 to 33.67 which have a positive value between 0-70 so it is denoted as the yellow color (Figure 1).

Sensory Test

Sensory tests used in products of simulation chips are description test, test of preferences (hedonic), and test of ranking. The test results description of sensory attributes to determine the effect intensity of each attribute of the experiment, as presented in graphical form of Spider web (Figure 2).

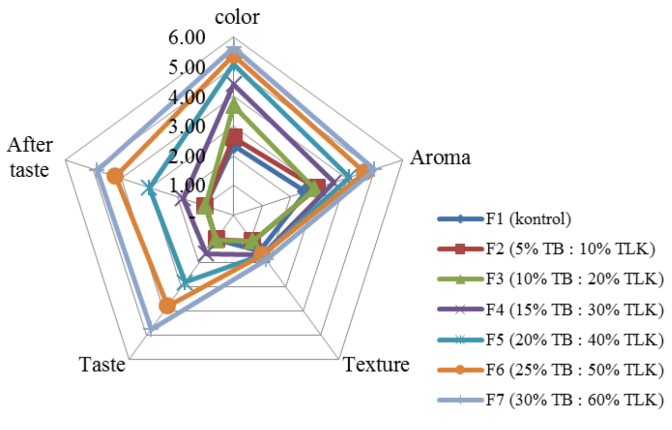

Figure 2. Spider web graph description assessment of simulation chips with the addition of TB and TLK

Description about the yellow color and aroma increases with the increasing addition of TB and TLK, this was due TLK has a stronger color and aroma than TB. The texture of simulation chips hardened with the increasing addition of TB and TLK. While the increase in TB and TLK additions can increase the intensity of flavor and the after-taste of the simulation chips to bitter taste. It is associated with a color change of b toward yellow-brown due to high frying temperatures, so that the water at the surface and inside the material evaporated in large quantities and the remain is hard solids that can affect the taste of the product (Figure 2).

Results of analysis of hedonic test on the variants of simulation chips significantly affect (p<0.05) on color, aroma, texture, taste, and overall acceptance (Table 5). Assessment of the panelists using hedonic test (preference) of the color, aroma, texture, taste, and overall acceptance of simulation chips was even lower with the increasing addition of TB and TLK. Panelists did not like the dark color of simulation chips; it is because there was damage of carotenoids, and because of the reaction of mailard due to high sugar levels of TLK.

Table 5. The average of hedonic test of simulation chips with TB and TLK substitution

Treatment (TB% : TLK%)	Color	Aroma	Texture	Taste	Overall Acceptance
F1 (Kontrol)	5.05 ± 0.98^{e}	4.80 ± 1.02^{cd}	4.73 ± 1.19^{c}	4.83 ± 0.96^{d}	4.85 ± 0.89^{d}
F2 (5:10)	4.55 ± 0.84^{d}	4.88 ± 0.84^{cd}	4.83 ± 0.81^{c}	4.50 ± 0.99^{cd}	4.68 ± 0.76^{d}
F3 (10:20)	4.85 ± 0.83^{de}	4.88 ± 0.72^{d}	4.98 ± 0.73^{c}	4.95 ± 0.88^{d}	4.93 ± 0.71^{d}
F4 (15:30)	3.63 ± 0.92^{c}	4.33 ± 0.89^{bc}	4.50 ± 0.99^{bc}	4.28 ± 1.06^{c}	4.13 ± 1.02^{c}
F5 (20:40)	3.18 ± 1.03^{b}	4.15 ± 1.07^{bc}	4.10 ± 1.08^{ab}	3.15 ± 1.00^{b}	3.38 ± 0.98^{b}
F6 (25:50)	2.78 ± 1.02^{ab}	3.88 ± 1.32^{ab}	3.88 ± 1.26^{ab}	2.75 ± 1.23^{ab}	2.93 ± 1.12^{a}
F7 (30:60)	2.38 ± 1.25^{a}	3.48 ± 1.55^{a}	3.68 ± 1.44^{a}	2.43 ± 1.28^{a}	2.63 ± 1.21^{a}
kk (%)	26.36	25.19	25.05	27.75	24.70

Description : Figures followed by the same letter in each column, indicating no different at the level of 5% Duncan test

Panelists overall assessment is strongly influenced by the flavors of the simulation chips, because the taste plays an important role whether the food product is accepted by the panelists. Winarno (1992), stating that the preference and overall acceptance of the food in the mouth is the chemical interaction with the receptor through a process that is complicated and complex, so through this process a favorite food can be known through perception.

The results of test analysis on ranking of simulation chips of TB and TLK substitutions can be seen in Figure 3. Treatment of F2 was based on assessment of the panelists that achieved the first rankings, but not significantly different (p>0.05) from treatment with F3. The second ranking is the treatment of F3 and not significantly different (p>0.05) from treatment with F1. Treatment F4 achieved the fourth ranking that significantly affect (p<0.05) on the treatment of F1, F2, F3, F5, F6, and F7. While treatment F5, F6, and F7 are not preferred by the panelists because it tends to be dark in color, hard texture, and taste bitter.

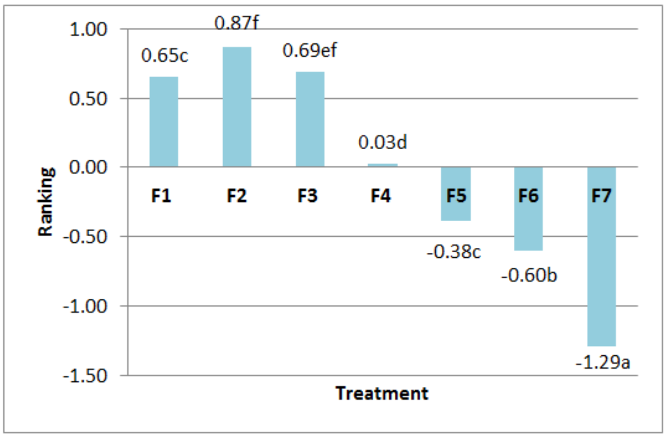

Figure 3. Test chart ranking of simulation chips with the treatment of TB and TLK addition

Description : TB treatment (%): TLK (%); where F1 (0: 0); F2 (5:10); F3 (10:20);
F4 (15:30); F5 (20:40); F6 (25:50); and F6 (30:60)

The Best Method Selection

The decision-making was to determine the best treatment by using the method of Effectiveness Index. The principle of this method is to compare the measured parameters, namely proximate, antioxidant capacity, IC 50, dietary fiber, β-carotene, objective color, and sensory testing. The best alternative is to compare the value of chemical analysis and sensory test by looking at the value corresponding to the desired goal in this research.

Effectiveness Index analysis of the chemical analysis of simulation chips that have the highest Total Value of Products (TVP) was on F7 treatment followed by treatments of F6, F5, F4, F3, F2 and F1. While on the TVP that based on sensory testing, treatment F3 has the highest TVP, followed by treatments of F1, F2, F4, F5, F6 and F7 (Table 6). By comparing the TVP chemical analysis, sensory testing and the expected goals, the F4 treatment is selected as the best treatment. This is because the F4 treatment contains antioxidants, β-carotene, dietary fiber, and high nutrient content and by sensory was acceptable by the panelists. Although the real value of TVP chemical analysis of 0.64 (the fourth ranking) and the sensory value of TVP 0.62 (the fourth ranking), with the assumption that if the treatment of F7 with a value of the highest TVP of 0.67 which was selected but not accepted by the panelists because it has the lowest TVP of 0.00.

Table 6. Selection of the best methods of simulation chips with TB and TLK substitution

Treatment (TB% : TLK%)	Total Value of Product (TVP)	
	Chemical Analysis	Sensory Test
F1 (Control)	0.34	0.92
F2 (5:10)	0.45	0.88
F3 (10:20)	0.57	0.98
F4 (15:30)	0.64	0.62
F5 (20:40)	0.63	0.34
F6 (25:50)	0.66	0.17
F7 (30:60)	0.67	0.00

IV. CONCLUSION

The conclusions of this research are :

1. The best formula of characteristics of physico-chemical properties of simulation chips is on the F4 treatment, with the addition of TB by 15%, and TLK by 30%. Chemical characteristics of the simulation chips have a water content of 3.71%, ash content of 5.09%, the protein content of 10.67%, fat content of 16.94%, and the carbohydrate content of 63.58%.
2. Simulation chips with the best formula contains β-carotene of 2,81 g, vitamin E of 0.59 mg/100 g, the IDF amounting to 6.62% db, SDF 4.02% db, TDF of 10.64% db, antioxidant capacity amounted to 668.52 ppm GAEAC, and IC 50 amounted to 145.19 mg/mL.
3. Characteristics of the physical properties of the best formula simulation chips is based on objective measurement of color, that it has value of L of 60.96 (brightness range 0-100), value of a of 3.18 (as the red color), and the value of b 30.37 (as a yellow-to-blue).
4. Sensory characteristics of simulation chips best formula is based on test description of the color with the intensity of 4.40 quality attributes (light yellow to yellow), the intensity of the aroma quality attributes at 3.55 (weak to strong aroma), the intensity of the texture quality attributes at 1.65 (hard to crisp texture), the intensity of flavor quality attributes of 1.60 (a savory to bitter taste), and quality attributes mouth-feel intensity of 1.80 (kind of like to like).
5. The panelists assessment of the hedonic test on simulation chips on the F4 treatment, on the color of 3.63 (somewhat like, to like), on aroma of 4.33 (somewhat like to like), on the texture of 4.50 (somewhat like to like), on the taste of 4.28 (somewhat like to like), and the overall acceptance of 4.13 (somewhat like to like). The assessment of the panelists was based on the ranking test shows that the F1, F2, F3, and F4

formulas are preferred by the panelists compared with F5, F6 and F7 formulas.

6. Treatment F4 is the best treatment with TVP on chemical analysis of 0.64 and sensory analysis of 0.62.

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