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Physicochemical Properties and Consumer Preference of Fish Burgers Produced from Black Tilapia Surimi Paste and Potato Flour

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***Abstract*—This study was conducted to evaluate the physicochemical characteristics and to determine the degree of consumer preference of fish burgers produced with different level of Black Tilapia surimi paste and potato flour. Five formulation of fish burgers with different percentage of Black Tilapia surimi paste to potato flour were formulated as follows: Control=70:10; A=62:18; B=66:14; C=74:6; D=78:2. The fish burgers were analysed for their colour, cooking loss, texture, pH, water holding capacity, and folding test as well as the proximate composition. Hedonic test was also carried out to evaluate the consumer preference of the fish burgers. In term of colour, raw fish burgers of formulation A was the highest (P<0.05) in the value of whiteness (L*), redness (a*), and yellowness (b*). In addition, both raw and cooked fish burger of formulation A was also significantly the highest (P<0.05) in the hardness between all formulations. However, proximate composition of raw and cooked fish burger of formulation D which contained the highest of percentage of Black Tilapia surimi paste to potato flour was significantly highest (P<0.05) in moisture and protein content. The preference of panellists within formulations were not significantly differed (P>0.05) in attributes of appearance, fish aroma, texture, taste, and overall acceptance except for juiciness (P<0.05). Thus, this study concluded that fish burgers produced from Black Tilapia surimi paste combining with potato flour at different level affected physicochemical properties of fish burgers but did not affect consumer acceptability.**

***Keywords*—Freshwater Fishes: Fish Burgers; Black Tilapia Burger; Consumer Preference**

I. INTRODUCTION

Malaysia is one of the few countries in the world where by per year, a person would consume more than 50 kg of fish. In 2013, there was an increase of profit (0.23%) in the fisheries sector which contributed RM11,466.53 million to the nation's economy. The national production from freshwater fish culture has also contributed 132,892.42 tons valued at RM880.45 million. Indeed, Black Tilapia contributed as one of the highest production of freshwater fish with a total of 9,337.33 metric tons valued at RM59,874.41 [1]. This shows that Malaysia has a stable production of freshwater fish especially for Black Tilapia fish.

Several researchers obtained that freshwater fishes can be used as an alternative of using marine fishes in surimi production due to easy capture and low price. Furthermore, intermediate foodstuffs derived from surimi made from freshwater fishes such as Silver Carp, Big Head Carp, and Chinese snake head have been developed in China [2]. The ability of gel-forming of surimi from freshwater fishes such as Carp, Rainbow Trout, and Silver Crucian Carp were also studied by Chang et al. [3]. In Malaysia, several researchers found that local species of freshwater fishes have potential to be used for surimi processing. For example, surimi was also successfully produced from Lizardfish [4] and Catfish [5].

The increment of freshwater fishes harvesting had led to the production of surimi from freshwater and brackish water fishes such as from Common Carp and Black Tilapia. Several researchers reported that Black Tilapia and Red Tilapia could be used as raw material for surimi-based products [6]-[7] such as fish burger [8] and spring roll [9]. Some of the major factors that influence the final acceptance of surimi-based products by consumers are texture and colour [10]. Indeed, surimi made from freshwater fishes have a moderate gel forming ability when compared to surimi made from marine fishes [11]. Thus, ingredients such as starch and flour could modify and improved the textural properties of surimi-based products [12]-[13].

Fish burgers are one of the fast food products that are popular in food industry and this might be due to a rapid increase in working population and urbanization in most countries [14]. In order to produce a better quality products, the use of extenders, binders, and fillers in the formulation of food products is very important [13]. For example, fish fingers made from surimi with addition of potato flour are better in terms of their quality than the fish fingers made only from minced fish. Furthermore, the colour was also lighter, better odour, and are more attractive for the consumers [15].

Fish burgers could be made from freshwater fishes surimi paste of Rainbow Trout [16], Silver Catfish [17], and Grass Carp [14]. However, addition of other ingredients such as flour or starch should be added to improve the textural properties of fish burger produced from freshwater fishes surimi. Therefore, the objectives of this study was to evaluate the physicochemical characteristic of fish burgers and its consumers' preference produced with different level of Black Tilapia surimi paste and potato flour.

II. MATERIALS AND METHODS

A. Raw Materials

Black Tilapia was purchased from supermarket in Nilai, Negeri Sembilan, Malaysia. The fish was kept in an ice container (4ºC) before immediately processing to surimi paste in the Food Processing Laboratory in order to produce a good quality of surimi paste. Other ingredients such as potato flour, garlic powder, and black pepper for production of fish burgers were purchased from supermarket in Nilai, Negeri Sembilan, Malaysia.

B. Preparation of Surimi Paste

The Black Tilapia fishes were scaled, cleaned, headed, eviscerated, and skinned before producing fish fillets. Then, the fish fillets were washed properly to remove all traces of blood and followed by draining the excessive water for 20 seconds [18]. The fillets were then directly washed and grinded with cold water approximately at 10ºC using a ratio of water and fillet of 5:1. At the final step, 0.5 % of sodium chloride solution was added to make the process of water removal easier in further processing steps. The washed mince was partially dewatered using small spores layered cloth and were pressed gently in a screw press to produce very whitish meat fish. The surimi paste was kept in frozen condition at -18ºC in block forms.

C. Preparation of Fish Burgers

Five formulations of fish burgers were formulated in this study with different level of surimi paste and potato flour (Table 1). A control sample with the percentage of surimi paste and potato flour (70:10) was formulated according to Haq et al. [14] with slight modification. Fish burger preparation started by preparing the isolated soy protein (ISP) and textured vegetable protein (TVP). Then, ISP was dissolved and TVP was soaked with cold water using 1:4 ratio [19]. After one minute of soaking, the TVP was pressed using dry tissue to remove excessive water. Both of these ingredients were put aside for later usage. Then, surimi paste was mixed thoroughly with potato flour using a mixer for one minute. Next, the dissolved ISP and TVP were added and mixed together for one minute followed by addition of sugar, garlic, salt, and white pepper. Finally, the batter mixture was pressed manually using burger press [20] and were packed and stored at -18ºC before analysis. Table 1 shows the formulations of fish burger in this study.

Table 1: Fish burger formulations in this study

Ingredients (%)	**Control**	**A**	**B**	**C**	**D**
Surimi paste	70	62	66	74	78
Potato Flour	10	18	14	6	2
ISP	9	9	9	9	9
TVP	5	5	5	5	5
Sugar	2.5	2.5	2.5	2.5	2.5
Garlic	1.5	1.5	1.5	1.5	1.5
Salt	1.5	1.5	1.5	1.5	1.5
White pepper	0.5	0.5	0.5	0.5	0.5
TOTAL	100	100	100	100	100

Adapted from Haq et al. [14]

D. Colour

The colour of fish burger samples were measured using a colourimeter (Minolta Spectrophotometer CM-3500D Model, Osaka, Japan). Initially, the samples were cut into small pieces and approximately, 15 g of fish burger sample was placed within a plastic Petri dish with the lid on and the colour was measured according to manufacturer's instruction.

E. Cooking Loss

Prior to cooking loss evaluation, the fish burgers were weighed and read before and after frying. The fish burgers were fried for three minutes and the cooking loss were measured using the following equation:

$$\% \text{ Cooking loss} = [m_a - m_b] / m_a * 100$$

Notes: m_a = weight before frying; m_b = weight after frying

F. Texture Profile Analysis

Texture of fish burgers were measured using texture analyser (TA-XT Plus Model, Stable Micro System). Initially, the fish burgers were placed into the cylinder approximately 25 mm diameter and 25 mm length. Each cylinder was compressed using probe 75 (P.75) compression platen with the distance of 35 mm and trigger force 5 g for six seconds.

G. pH

The pH of the fish burgers were measured using a digital pH meter (Model 420A, Orion, MA, USA). Initially, fish burgers samples were homogenised using homogeniser (Model Yellow Line D125 basic). Approximately, 10g of fish burgers were weighed and were added with 50mL of deionised water [21]. The mixture was homogenised within 60 seconds to ensure the mixture mix well, and the pH was measured directly from homogenised samples.

H. Water Holding Capacity

Prior to the analysis, one gram of fish burgers were added with 40mL distilled water in centrifuge tube. The samples were weighed before centrifuging process for 10 minutes at 7500rpm. Then, the supernatant was removed while the pellet was weighed and measured. Water holding capacity of fish burger was calculated using this formula [22].

I. Folding Test

Folding test was only done on cooked fish burgers. Initially, cooked fish burgers were sliced into 3 mm thick portions and were analysed and given scores using the parameters as follows: (1) Breaks by finger pressure; (2) Cracks immediately when folded in half; (3) Cracks gradually when folded in half; (4) No cracks showing after folding in half; and (5) No cracks showing after folding time.

J. Proximate Analysis

Analysis of moisture, crude protein, fat, and ash of fish burgers were carried out according to the methods of Association of Official Analytical Chemists (AOAC) [23]. Moisture content was determined by drying the samples overnight at 105°C while the ash content was determined by ashing the samples overnight at 550°C. The crude protein content was determined using Kjeldahl method and the fat content was determined using soxhlet method. Finally, the carbohydrate content was calculated by the difference of moisture, ash, protein, and fat. All analysis of proximate composition was done in duplicate.

K. Sensory Evaluation

Sensory evaluation was conducted using hedonic test by hundred panellists to determine the preference of fish burgers between the five formulations studied. The age of panellists ranged from 19 years old to 67 years. The attributes that were evaluated by the panellists were appearance, fish aroma, texture, taste, juiciness, and overall acceptance. The score was based on a 9-point hedonic scale ranging from 1 (extremely dislike) to 9 (extremely like) [9]. The sensory analysis was conducted in sensory laboratory in Universiti Sains Islam Malaysia (USIM). Each fish burger was cut into a triangle pizza shaped coded with 3-digit number and presented to each panellist using random permutation number.

L. Statistical Analysis

All data was analysed using one-way analysis of variance (ANOVA), followed by Tukey's Test to compare the means between obtained datas and was analysed using Minitab® software, Release 16 (2011) and the significance difference was established at (P<0.05) [24].

III. RESULTS AND DISCUSSION

A. Colour

Results on colour of raw and cooked fish burgers are shown in Table 2. The colour of raw and cooked fish burgers changed with different level of surimi paste and potato flour. The value of *L** (darkness to whiteness), a* (green to red), and *b** (blue to yellow) of raw fish burgers of formulation A which contained the highest potato flour was significantly (P<0.05) the highest of *L** (65.29), *a** (1.66), and *b** (21.08). Indeed, potato flour is a white colour while fish surimi contains variety of nitrogenous compunds such as myoglobin, hemoglobin, and hemocyanins that contribute to the colour of the fish [25]. Thus, this could explain why the pattern of *L**, *a**, and *b** value in raw cooked burgers decreased with decreasing percentage of potato flour or increasing the surimi paste.

In cooked fish burgers, the values of *L** decreased (52.35 to 60.33) compared to in raw fish burgers (63.19 to 65.29). A similar trend was also reported by Nurul et al. [26] that the *L** value or lightness of fried Dori fish loss after frying process. The high temperature in frying process contributes to the denaturation and oxidation of fish protein which lead to the darker colour of the meat product. The formation of coloured compounds during frying process might also be related with removal of water from amino acid and Maillard reactions [27] as well as caramelisation in food products [28]. However, the *a** and *b** value of cooked fish burgers slightly increased compared to in raw fish burgers and was in accordance to report by Nurul et al. [26].

Table 2: Colour properties of fish burgers

		Control	A	B	C	D
*L**	RFB	64.16^{b}	65.29^{a}	64.77^{a}	63.19^{c}	63.43^{c}
	CFB	56.70^{c}	60.33^{a}	58.28^{b}	54.84^{d}	52.35^{e}
*a**	RFB	1.38^{bc}	1.66^{a}	1.47^{a}	1.24^{c}	0.80^{d}
	CFB	2.04^{c}	3.66^{a}	3.56^{a}	2.48^{b}	1.71^{d}
*b**	RFB	16.86^{a}	17.27^{a}	16.84^{b}	16.10^{b}	16.13^{b}
	CFB	17.08^{b}	21.08^{a}	20.92^{a}	16.18^{c}	15.64^{c}

Different alphabetical letters within rows indicate significant differences (P<0.05) among fish burgers samples. All experiments were carried out in duplicate.

Notes:

RB = raw fish burger; CFB = cooked fish burger

Formulation: Control = 10 % potato flour: 70 % surimi paste; A = 18 % potato flour: 62 % surimi paste; B = 14 % potato flour: 66 % surimi paste; C = 6 % potato flour: 74 % surimi paste; and, D = 2 % potato flour: 78 % surimi paste

B. Texture

Results of texture of raw and cooked fish burgers are shown in Table 3. Different level of surimi paste and potato flour in fish burger's formulation significantly (P<0.05) affected the textural properties (hardness, chewiness, and springiness) in both raw and cooked fish burgers except for cohesiveness. Fish burger with the highest percentage of potato flour to surimi paste (Formulation A) demonstrated the highest hardness but the lowest springiness in both raw and cooked burger (P<0.05) compared to other fish burgers. Raw fish burger of formulation D which contained the highest percentage of surimi paste to potato flour obtained the lowest of chewiness (P>0.05) as well as in cooked fish burger (P>0.05). Results also found that cooking increased all textural attributes (hardness, chewiness, springiness, and cohesiveness) in fish burgers (Table 3). According to Li et al. [29] loss of water during cooking tends to increase hardness, chewiness, springiness and cohesiveness of smoked sausage made with technically separated poultry meat and wheat protein.

Table 3: Texture profile analysis of fish burger

		Control	A	B	C	D
Hardness (N)	RFB	6.64^{ab}	6.73^{a}	6.62^{ab}	5.98^{bc}	5.67^{c}
	CFB	6.83^{ab}	7.20^{a}	6.84^{ab}	6.35^{bc}	6.21^{c}
Chewiness (N/cm)	RFB	4.97^{ab}	4.13^{b}	6.03^{a}	4.13^{b}	4.00^{b}
	CFB	5.28^{a}	5.35^{a}	5.31^{a}	5.15^{a}	5.00^{a}
Springiness (cm)	RFB	1.09^{b}	0.91^{b}	1.54^{a}	0.96^{b}	0.93^{b}
	CFB	1.30^{ab}	0.95^{b}	1.61^{a}	1.07^{b}	1.11^{b}
Cohesiveness (ratio)	RFB	0.80^{a}	0.62^{a}	0.80^{a}	0.73^{a}	0.72^{a}
	CFB	0.83^{a}	0.83^{a}	0.84^{a}	0.78^{a}	0.77^{a}

Different alphabetical letters within rows indicate significant differences (P<0.05) among fish burgers samples. All experiments were carried out in duplicate.

Notes:

RFB = raw fish burger; CFB = cooked fish burger

Formulation: Control = 10 % potato flour: 70 % surimi paste; A = 18 % potato flour: 62 % surimi paste; B = 14 % potato flour: 66 % surimi paste; C = 6 % potato flour: 74 % surimi paste; and, D = 2 % potato flour: 78 % surimi paste

C. Chemical Properties

Table 4 shows the chemical properties of raw and cooked fish burgers include water holding capacity, pH, cooking loss, and folding test. The percentage of water holding capacity of formulation A was the highest (5.83) compared to other formulations (P>0.05). It was also found that increasing the percentage of potato flour to surimi paste was able to increase water holding capacity of fish burgers.

Previously, Ammar [30] reported that water holding capacity values increased with the increasing level of yellow and brown mustard flour in beef burger patties formulation. Water holding capacity in raw fish burgers were higher (4.78 to 5.83) compared to in cooked fish burgers (3.48 to 4.16). According to Coelho [31], water holding capacity of raw fish burgers were higher than cooked fish burger due to protein denaturation during cooking process.

Table 4: Water holding capacity, pH, cooking loss, and folding test of fish burgers

		Control	A	B	C	D
Water holding capacity (%)	RFB	5.78^{a}	5.83^{a}	5.73^{a}	4.91^{a}	4.78^{a}
	CFB	4.16^{a}	3.52^{a}	3.48^{a}	3.80^{a}	3.90^{a}
pH	RFB	6.49^{c}	6.53^{ab}	6.52^{bc}	6.56^{a}	6.52^{bc}
	CFB	6.68^{b}	6.77^{a}	6.73^{ab}	6.74^{ab}	6.70^{ab}
Cooking loss (%)	CFB	23.06^{ab}	17.59^{b}	16.84^{b}	21.82^{ab}	29.93^{a}
Folding test	CFB	4.75^{a}	5.00^{a}	5.00^{a}	4.50^{a}	3.00^{b}

Different alphabetical letters within rows indicate significant differences (P<0.05) among fish burgers samples. All experiments were carried out in duplicate.

Notes:

RFB = raw fish burger; CFB = cooked fish burger

Formulation: Control = 10 % potato flour: 70 % surimi paste; A = 18 % potato flour: 62 % surimi paste; B = 14 % potato flour: 66 % surimi paste; C = 6 % potato flour: 74 % surimi paste; and, D = 2 % potato flour: 78 % surimi paste

The pH values of raw and cooked fish burgers were significantly different (P<0.05) between all fish burger formulations (Table 4). In general, the pH of fish burgers reduced with increasing proportion of surimi paste in fish burger formulation. Previously, Nopianti et al. [32] reported that raw surimi without cryoprotectant obtained the highest percentage of reduction in pH (6.16 %) compared to the surimi added with various cryoprotectant during three months frozen storage. The cryoprotectants were able to protect excessive glycolysis that causes the reduction of pH in surimi. This study also found that the pH range of raw fish burgers was lower (6.49 and 6.56) than the pH range of cooked fish burgers (6.68 and 6.77). The increasing pH in cooked beef patties could be related to the breaking of sulphur or imidazole linking of amino acids content in meat product during cooking [32]. Furthermore, pH of surimi gels was significantly increased (P<0.05) in heat-induced gels compared with pressure induced gels [33].

The highest percentage of cooking loss was significantly the highest (P<0.05) in fish burger of formulation D (29.93 %) which contained the lowest percentage of potato flour to surimi paste. Results obtained that higher content of potato flour in fish burger formulation was able to reduce the percentage of cooking loss. Higher amount of protein in fish burger caused moisture loss during frying and might be associated with the steric effects in the muscle. Upon cooking, proteins in muscle tend to change in shape and conformation, thus, causing them to shift and lost ability to bind water molecule. Products also shrinked after cooking due to valatile and dripping loss. In order to reduce diameter shrinkage and weight loss, fibres, and non-meat protein ingredients could be added in the meat products [34].

Folding test related to the texture of fish burgers. Results also found that fish burger of formulation D which contained the lowest percentage of potato flour to surimi paste was significantly lowest (P<0.05) in folding test with the value 3.00. The values of folding test of control sample, formulation A, B, and C were 4.75, 5.00, 5.00, and 4.50, respectively. Folding test scores scale was linearly related with gel strength, thus, higher scores indicate higher gel strength [35]-[36]. Myofibrillar proteins from meat product contributed to good folding test, but, by adding cryoprotectant it will avoid protein denaturation in meat product [37]. Thus, this finding found that addition of high amount of potato flour enhance the texture of fish burger as indicated with no crack after folding time.

D. Proximate Analysis

Proximate composition of raw and cooked fish burgers are shown in Table 5. The increasing percentage of surimi paste to potato flour in fish burgers formulation were significantly increased (P<0.05) the moisture, and ash content of raw and cooked fish burgers, but, the moisture and ash content in raw fish burgers found to be higher than in cooked fish burgers. During cooking process, moisture in meat products will loss and evaporate [13], thus, moisture content of cooked fish burgers was lower than that in raw fish burgers. The ash content decreased in cooked fish burgers due to some minerals were affected by cooking method [38]. Previously, Elyasi et al. [15] also reported that ash content in cooked fish finger produced from mince and surimi fish decreased (6.50 and 4.47 %) compared to raw products (6.66 and 5.63 %).

Table 5: Proximate analysis of fish burgers

		Control	A	B	C	D
Moisture	RFB	75.29^{c}	71.51^{e}	73.04^{d}	77.69^{b}	79.15^{a}
	CFB	61.29^{b}	58.45^{c}	63.14^{b}	67.77^{a}	66.46^{a}
Ash	RFB	5.01^{a}	2.52^{c}	3.74^{b}	5.90^{a}	6.06^{a}
	CFB	2.24^{a}	2.00^{a}	1.64^{a}	2.10^{a}	2.23^{a}
Protein	RFB	12.95^{b}	12.57^{b}	12.43^{b}	13.34^{ab}	13.99^{a}
	CFB	16.56^{c}	14.40^{d}	15.87^{c}	17.37^{b}	19.39^{a}
Fat	RFB	0.35^{a}	0.54^{a}	0.38^{a}	0.61^{a}	0.54^{a}
	CFB	5.86^{a}	4.34^{a}	5.12^{a}	4.23^{a}	4.27^{a}
Carbohydrate	RFB	6.41^{c}	12.86^{a}	10.41^{b}	2.45^{d}	0.35^{e}

CFB	14.06^{b}	20.79^{a}	14.24^{b}	8.54^{c}	7.65^{c}

Different alphabetical letters within rows indicate significant differences (P<0.05) among fish burgers samples. All experiments were carried out in duplicate.
Notes:
RFB = raw fish burger; CFB = cooked fish burger
Formulation: Control = 10 % potato flour: 70 % surimi paste; A = 18 % potato flour: 62 % surimi paste; B = 14 % potato flour: 66 % surimi paste; C = 6 % potato flour: 74 % surimi paste; and, D = 2 % potato flour: 78 % surimi paste

Increasing the level of surimi paste to potato flour in fish burgers formulation were significantly increased (P<0.05) the protein content of raw and cooked fish burgers as predicted. However, the protein content in cooked fish burgers found higher than in raw fish burgers. Protein content in cooked fish burgers ranged between 14.41 and 19.39 %, while protein content in raw fish burgers ranged between 12.43 and 13.99 %. In meat product, the protein content in cooked product increased due to the cooking process will coagulate the protein content in product where the tightly coiled polypeptide chains unfold and form large aggregates [39]. This could be explained why cooked fish burgers were higher in protein content than in raw fish burgers in this study. Furthermore, Elyasi et al. [15] reported that the protein content in fish fingers increased after deep frying process.

Fat content of fish burgers increased after frying process. The fat content of cooked fish burgers ranged between 4.23 and 5.86 % while in raw fish burgers ranged between 0.35 and 0.54 %. Fat content in cooked fish burgers was due to the oil absorption during cooking process [10]. Increasing the level of surimi paste to potato flour in fish burgers formulation did not significantly affect the (P>0.05) the fat content of raw and cooked fish burgers. In production of surimi, washing process extracted fat and therefore its amount decreased in the products [40]. Furthermore, fat content in fish is influenced by intrinstic and extrinsic factors such as types of fish, age, sex, and diet [41].

Carbohydrate content in raw and cooked fish burgers formulation decreased with the increasing level of surimi paste to potato flour (P<0.05) as predicted. The range of carbohydrate content in raw fish burgers were from 0.35 to 12.86 % (P<0.05) while in cooked fish burgers, the range of carbohydrate content were from 8.54 to 14.24 % (P<0.05). Surimi pastes are considered to have low amounts of carbohydrate in muscles. Furthermore, the higher amounts of carbohydrates in fish burger were due to addition of potato flour and sugar in ingredient. Thus, formulation A which contained the highest percentage of potato flour (18 %) compared to other fish burger formulation obtained the highest carbohydrate percentage in raw (12.86 %) and cooked (20.79 %) form. The high amounts of carbohydrate in fish fingers produced from mince and surimi fish might also be associated with the coating materials such as flour, starch, and bread crumbs [15].

E. Consumer preference

Table 6 shows the mean score of consumer preference of fish burgers formulated with different percentage of surimi paste and potato flour. The increasing percentage of surimi paste to potato flour in fish burgers formulation did not significantly affect (P>0.05) consumer preference of attributes of appearance, fish aroma, texture, taste, and overall acceptance between all fish burgers formulation. The mean score of all the attributes ranged between 5.88 and 6.35. However, the increment ratio of surimi paste to potato flour in fish burgers formulation was significantly affect (P<0.05) consumer preference in term of juiciness. Perhaps, this might be associated to the moisture and fat content in surimi paste which provide juiciness in fish burger than potato flour. Serdaroglu and Değırmencioğlu [42] reported increasing fat level to oat flour increased the juiciness's score of beef patties by consumers.

Table 6: Sensory analysis of fish burgers

Attributes	**Control**	**A**	**B**	**C**	**D**
Appearance	6.22^{a}	6.36^{a}	6.31^{a}	6.24^{a}	6.05^{a}
Fish Aroma	5.88^{a}	5.92^{a}	5.88^{a}	6.11^{a}	5.93^{a}
Texture	6.13^{a}	5.93^{a}	6.26^{a}	6.17^{a}	6.10^{a}
Juiceness	6.00^{ab}	5.68^{b}	6.08^{ab}	6.33^{a}	6.30^{ab}
Taste	6.19^{a}	6.00^{a}	6.17^{a}	6.23^{a}	6.11^{a}
Overall	6.27^{a}	6.20^{a}	6.35^{a}	6.32^{a}	6.29^{a}

Different alphabetical letters within rows indicate significant differences (P<0.05) among fish burgers samples. All experiments were carried out in duplicate.
Notes:
RFB = raw fish burger; CFB = cooked fish burger
Formulation: Control = 10 % potato flour: 70 % surimi paste; A = 18 % potato flour: 62 % surimi paste; B = 14 % potato flour: 66 % surimi paste; C = 6 % potato flour: 74 % surimi paste; and, D = 2 % potato flour: 78 % surimi paste

IV. CONCLUSIONS

The physicochemical properties of fish burgers produced from Black Tilapia surimi paste and potato flour varied and depending on the different amount of surimi paste and potato flour in the formulation. The fish burgers contained higher percentage of potato flour than surimi paste provide lighter, more green, and yellow in color in both raw and cooked fish burgers as well as provided harder texture. The fish burger also contained high in carbohydrate compared moisture, ash, protein, and fat. All fish burgers formulation did not significantly (P>0.05) affect consumers preference among the samples except the juiciness.

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