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EFFECT OF PARTIALLY SUBSTITUTING WHEAT FLOUR WITH FISH BONES POWDER ON THE PROPERTIES AND QUALITY OF NOODLES

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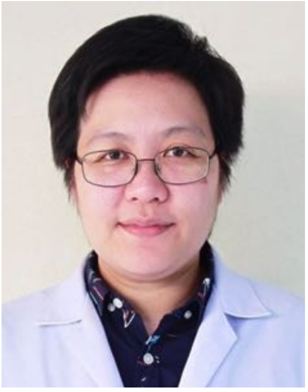

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ABSTRACT

Adding salmon (*Salmo salar*) fish bone powder (SBP), as a partial substitute for refined wheat flour in the production of fresh noodles, was developed as a method of utilizing a waste product from fish industry, reducing the use of wheat flour and enhancing the nutritional quality of the noodles. Refined wheat flour was partially substituted with salmon bone powder at 0, 5, 10, 15 or 20% of refined wheat flour. The noodles, made from these combinations, were then tested for their color, cooking quality, texture, chemical, sensory properties and level of microorganism during storage. The results indicated that as the amount of salmon bone powder increased, the appearance became yellowish and darker, the elasticity and softness of the noodles were decreased. Cooking quality; cooking time and cooking yield decreased while cooking loss was increased. When the noodles made from 15% salmon bone powder plus 85% refined wheat flour were tested their moisture content, protein, total carbohydrate, fat and ash were 36.45, 3.34, 43.60, 3.34, 6.74 g/100g, respectively and their calcium content also progressively increased with increasing levels of salmon bone powder in the refined wheat flour. The calcium content from noodles made from 15% salmon bone powder plus 85% refined wheat flour was 1.84 g/100g. The sensory evaluation in terms of appearance, color, odor, elasticity, softness, smoothness, taste and overall acceptability showed that the cooked noodles containing 15% salmon bone powder had similar characteristics to cooked noodles made from 100% refined wheat flour. Levels of microorganism including total plate count, yeasts and molds remained low, while *Escherichia coli, Staphylococus aureus, Bacillus cereus* and *Samonella* spp. were non-detected. All microorganism levels within acceptable levels and remained within criterion of microbiological quality standardization of foods and tableware announced by Department of Medical Science (No.3/2017) throughout the storage. Overall, the noodles retained acceptable quality for at least 9 days in refrigerator at 4±2°C.

Key words: Calcium, Chemical properties, Salmon bone powder, Noodle, Sensory acceptability ajfand SCHOLARLY, PEER REVIEWED AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT Volume 21 No. 1 January 2021 PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST ISSN 1684 5374

INTRODUTION

Salmon (*Salmo salar*) bones are a waste or by-product of processing fish fillets, frozen fish fillets, smoked salmon, fish sausages and crispy skin snacks. Bones from salmon processing are normally just discarded and can cause environmental pollution. However, salmon bones can be made into salmon bone powder (SBP) for use in food products. Production of SBP is by washing the bones in tap water, then soaking in NaOH solution, boiling in a pressure cooker, drying in an oven and finally grinding into powder [1]. This processing procedure is effective, uncomplicated and inexpensive [2]. Prapasuwannakul [3] reported that the chemical composition of SBP was 14.2% moisture, 40.8% protein, 25.3% total lipids, 18.3% ash, 2,715.9 mg/100 g calcium, 1,132.7 mg/100 g phosphorus and 1.3 mg/100 g iron. Sirichokworrakit [4] reported that tilapia bone flour contained 1.05% moisture content, 22.52% crude protein, 1.24% carbohydrate, 10.18% crude fat, 65.01% ash and 27.75 g/100 g calcium**.** Fish bones are therefore, a valuable natural source of minerals, especially calcium which is a necessary mineral for building up healthy bones and teeth. Chaimongkol [5] compared three sources of calcium, fish bone powder, small freshwater shrimp powder and anchovy powder, that could be used to fortify crisp rice. Their result showed that the fish bone powder had the highest calcium level was 19.21g/100 g, small freshwater shrimp powder 2.48 g/100g and anchovy powder 1.76 g/100g, and fish bone powder was the cheapest. Fong-in *et al.* [6] investigated tilapia bone powder as a partial replacement of wheat flour in cashew nut cookies and found that 20% substitution level due to the acceptable physicochemical and organoleptic qualities and increased their calcium content. Prapasuwannakul [3] investigated substitution of tapioca flour with a range of tilapia bone powder (0-25%) on fish crackers and found that 15% substitution produced acceptable fish crackers and also increased their calcium content.

Noodles are a popular food, not only in Thailand, but throughout Asia and many other parts of the world. Noodles are normally made from wheat flour, eggs, salt, alkali solution and water by a process of mixing, rolling into sheets and cutting into lines [7]. There are many types of noodles in Thailand including egg noodles, fried noodles, rice noodles, instant noodles and even crispy noodles. However, fresh noodles are generally low in nutrients, dietary fibre and minerals, which are often supplemented during commercial processing [8]. Noodles have been fortified or substituted with various ingredients including oat flour [9], green tea powder [10] banana flour [11] and tamarind seed flour [12].

Greater utilization of fish bone powder could give improved nutritional content of food products, give consumers options in the organoleptic properties for several food products and decrease environmental pollution by reducing industrial waste. Development of healthy noodles could be achieved by reducing wheat flour through substitution with salmon bone powder, which is a natural source of minerals especially calcium. The objectives of this research were to evaluate the effects on cooking quality, chemical composition, physical analysis, sensory acceptability and shelf life evaluation of partially substitute wheat flour with salmon bone powder at different concentrations.

MATERIALS AND METHODS

Material preparation

Salmon fish bones (*Salmo salar*) that had been produced from waste at a processing industry in Bangkok of Thailand was purchased. Salmon bone powder (SBP) was prepared by subjecting the bones to alkaline treatment, according to the method of Suwansakornkul and Jongrittiporn [1], where the fish bones were washed thoroughly in tap water, soaked in 0.4% NaOH solution for 12 h, boiled in 100ºC water for 40 min, wash again in tap water carefully separated from leftover flesh and cooked in a pressure cooker (Tefal Secure 5 Neo, Thailand) at 121ºC for 60 min. After cooking the bones were washed again at room temperature and dried in hot air oven at 100ºC for 60 min, then ground in a hammer mill and winnowed using 30 mesh sieves, packed in aluminum foil bags and kept in a refrigerator prior to analyses.

Noodle preparation

The dough for the noodles was prepared using the method described by Uthai *et al.* [13], where 200 g of refined wheat flour (United Flour Mill, Thailand), 3 g salt (Prung Thip, Thai Refined salt, Thailand), 70 g pasteurized egg (CP brand, Thailand), 3 g sodium carbonate (Merck KGaA, Darmstadt, Germany) and 70 g of drinking water (Crystal, Sermsuk, Thailand) were used as the standard formula. For noodle preparation, salmon bone powder (SBP) was used to replace refined wheat flour at 0 (control), 5, 10, 15 or 20%. After mixing the wheat flour and the SBP, the dough was left for 30 min then placed in a noodle maker (Marcato Atlas 150, Italy) to make the noodles, removed and boiled in water at 100°C for 80 to 120 sec (Table 1).

Determination of chemical composition and calcium of SBP and SBP noodles

Samples of the SBP and SBP noodles were analyzed for moisture content, protein, fat and ash using the methods described by Association of Official Analytical Chemists (AOAC) [14]. For carbohydrate the method described by Darryl *et al.* [15] was used. Calcium was analyzed by the method described by AOAC method [14] using sub component 984.27. Analyses were performed in triplicate.

Cooking analysis

Optimum cooking time

The optimum cooking time of noodle samples was determined according to the American association of cereal chemists (AACC) method [16] with slight modifications. Briefly, 15g of noodles were boiled in 500 mL water and noodles were checked at random while boiling by squeezing them between two glass plates until they were considered completely cooked or without white or opaque wen. The determinations were based on triplicate analyses.

Cooking yield

The cooking yield was determined by the method described by Chin *et al.* [17] using 10g of noodles cooked in 200 mL boiling water for 5 min, draining them for 15 min then weighing. The cooking yield was calculated in a percentage of noodles after cooking using the following equation. The determination was conducted in triplicate analyses.

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$$\textbf{Cooking yield}\ (\%)\ = \frac{\textbf{weight of noodle after cooking} \times \textbf{100}}{\textbf{weight of noodle before cooking}} \qquad \textbf{(1)}$$

Cooking loss

Cooking loss of noodle samples was determined according to the method described by AACC method [16]. 10 g of noodles were place in a measured beaker together with 200 mL of water and boiled 5 min, removed from the beaker and left for 15 min. The noodles together with the beaker with the water after boiling was put into air oven, at 105^{o}C until the water had evaporated then all were weighed and the cooking loss during cooking was calculated as a percentage of the noodle before cooking using the following equation. The determination was based on triplicate analyses.

$$\textbf{Cooking loss}\ (\%)\ = \frac{\textbf{Residue in cooking noodle} \times \textbf{100}}{\textbf{weight of noodle before cooking}} \qquad \textbf{(2)}$$

Determination of color

The color of both the uncooked and cooked noodle from the different wheat flour SBP combinations were measured using a calorimeter (Minolta CR-400, Konica Minolta, Japan) using the CIE L^* a^* b^* system. The readings were obtained directly from the instrument and provided measurements of lightness L^* (100=white; 0=black), redness a^* (+, red; -, green) and yellowness b^* (+, yellow; -, blue). Determination for color values was performed in triplicate.

Determination of texture

The texture of uncooked and cooked noodles from SBP were analyzed using a Texture Analyzer (TA-XT plus, England) following the method described by Uthai *et al.* [13], The calibration was performed using a 5 kg load cell before measurement using spaghetti tensile grips (A/SPR). For dough a Kieffer dough and gluten extensibility rig at a speed test of 3 mm/sec, a distance of 100 mm and 30 mm and 5 g auto-trigger type was used. Uncooked and cooked noodles were measured for tensile strength and elasticity. Test mode of for tensile strength at a post-test speed of 5 mm/sec, return to start distance of 100 mm, pre-test speed of 3 mm/sec, trigger type 5 g, and test speed of 3mm/sec. The analysis was repeated 5 times on each sample.

Sensory evaluation

Sensory acceptability of noodle samples, made from the wheat flour blended with 0, 5, 10, 15 or 20% SBP was carried out by an evaluation panel of 100 members (untrained panels) selected from university and companies (50 females, 50 males, age ranges 22-60 years) who were all familiar with eating noodles (2-3 times per week). Before testing, each sample of noodles (200 g), was cooked for 10 min in 1000 mL of boiled drinking water and drained. 15g of noodles samples each portion were random labeled with 3-digit codes and served to panelists 5 samples at a time then the panelists evaluated them in the general lighting room. Unsalted bread, a spit cup, napkins and drinking water at room temperature were given to each panelist for palate cleansing in-between samples. The panelists were asked to score the cooked noodle in terms of appearance, color, odor, elasticity, softness, smoothness, taste and overall acceptability using 9 point hedonic scale (9 = extremely like, 8 = very much like, 7 = moderately like, 6 =slightly like, 5 =

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neither like nor dislike, 4 = slightly dislike, 3 = moderately dislike, 2 = very much dislike, 1 = extremely dislike).

Microbial analysis
The noodle sample that had received the highest scores of sensory acceptability were each packed separately in sterile polyethylene bags, sealed and stored at 4±2°C and tested for microbial contamination after 1, 3, 5, 7 and 9 days. Aerobic plate count, yeast and mold, *Staphylococus aureus, Bacillus cereus, Samonella* spp. calculated in CFU/g and *Escherichia coli* calculated in MPN/g, were all analyzed according to U.S. Food and Drug Administration, Bacteriological Analytical Manual (FDA-BAM) [18, 19, 20, 21 and 22]. Each analysis was performed in triplicate.

Statistical analysis
The experimental designs used were the completely randomized designs (CRD) and the randomized completely block design (RCBD). The analyses of the samples were performed in triplicate. Analysis of variance (ANOVA) and statistical protocol used, for mean comparison were tested using a Duncan's New Multiple Range Test at $p \leq 0.05$ using SPSS.

RESULTS AND DISCUSSION

Chemical composition
The chemical composition of SBP was presented in Table 2. The SBP contained 3.86 g/100g moisture content, protein, carbohydrate, fat and ash were 25.96, 0.68, 18.23 and 51.27 g/100g, respectively. Calcium was 10.29 g/100g. Comparing flour made from Tilapia (TBF) [4] with SBP, levels of protein and fat were higher in the SBP, but ash and especially calcium were higher in TBF (Table2). The SBP contained the highest fat level, which may be due to the fat from salmon fish bones being largely unsaturated, containing omega-3. This could be advantageous for consumer's health [23]. When SBP was compared with wheat flour, SBP had considerably higher levels of protein, calcium, fat and ash (Table2).

The chemical composition of the uncooked noodles, including moisture content, protein, total carbohydrate, fat, ash and mineral composition, with added SBP at 0, 5, 10, 15 and 20% are shown in Table 3. Moisture content decreased with increasing SBP, while protein, fat, ash and calcium increased with increasing SBP therefore 20% SBP had the highest levels. Total carbohydrate of 20% SBP was the lowest and 0% SBP was the highest. FoodData Central [24] gave total carbohydrate content of wheat flour as 74.60 g/100g which was higher than levels in SBP (0.68 g/100g). Thus, it was concluded that increasing SBP resulted in increasingly nutritional benefits of noodles.

Cooking quality of noodles
Cooking time, cooking loss and cooking yield of 0, 5, 10, 15 and 20% of SBP noodles were presented in Table 4. A short cooking time and slightly loss of solids in the cooking water was a positive attribute of the noodles, when the cooking quality of noodles was ascertained by water absorption or cooking yield as previously reported [25].

The cooking times of all noodle samples were in the range of 80 to 120 sec. The cooking loss increased from 4.13 to 7.76% as the levels of SBP increased and the cooking yield decreased from 210.73 to 190.20% as the levels of SBP increased. The results indicated that the noodles from refined wheat flour had a longer cooking time which was 120 sec and higher cooking yield which was 210.73% than noodles with 5, 10, 15 and 20% SBP while cooking loss of noodles from SBP were 5.13 to 7.76% which were higher than noodles from refined wheat flour, which was 4.13%. These results were consistent with the findings of Sirichokworrakit [4], who reported that the noodles prepared from wheat flour supplemented with 0-15% fish bone from Nile Tilapia, had increasing cooking loss and decreasing water absorption with increasing levels of fish bones. In addition, Phongramun *et al.* [26] used Amaranth (*Amaranthus lividus*) leaf powder as a supplement in wheat flour to make noodles. They found that with added Amaranth leaf powder, cooking time and cooking yield decreased while cooking loss increased. Also, Sirichokworrakit *et al.* [27] found similar results on cooking loss of noodles when wheat flour was supplemented with 0, 10, 20, 30 or 40% of Riceberry rice flour (non-gluten flour), increasing cooking loss when increasing Riceberry rice flour. Izydorczyk *et al.* [28] reported that there was reducing quality of the protein-starch matrix and increasing cooking loss resulted in noodles when wheat flour was diluted with barley flour. It may, therefore, be concluded that the cooking quality and other qualities of noodles were different with increasing amounts of salmon bone powder since the gluten fraction was diluted, which in turn resulted in less water retention in noodles. Thus, increasing the amounts of salmon bone powder disrupted the practical attributes and the cooking capability of noodles [29].

Color characteristics of noodles

Color characteristics of both uncooked and cooked noodles blended with SBP were shown in Table 5. In a comparison between wheat noodles and noodles blended with SBP (uncooked and cooked noodles), the results indicated that the color of wheat noodles had higher in $L*$ which were 75.16 and 64.80, but lower in $a*$ which were 2.17 and 0.28 and $b*$ which were 24.61 and 18.04 than noodles substituted with SBP, but the color of noodles blended with SBP appeared more yellow. These changes may be as a result of the SBP used for noodle preparation making them darker than refined wheat flour. This effect may be because of the naturally occurring carotenoid pigments of salmon, giving the flour color characteristic of fish bone powder a yellower color than wheat flour. Also, preparation of the noodles by heating may have made the fish bone powder darker as previously reported [30].

Texture of noodles

Texture analysis of dough, uncooked and cooked noodles made from refined wheat flour and substitution with SBP (Table 6) show that the dough extensibility significantly ($p<0.05$) increased with increasing levels of SBP. This shows that the tension force of dough increased from 86.39 to 137.91 g as the levels of FBP increased which were higher hardness and lower softness. Popert and Gawborisut [31] showed that increasing of Tilapia frame meat supplement in noodles also increased the tension force from 11.44 to 19.64 g. For distance of dough, measuring elasticity, it was shown that with increased SBP there was progressively lower elasticity. Tensile strength of uncooked and cooked noodles was significantly decreased ($p<0.05$) with increasing SBP content. The tensile strength of uncooked noodles decreased from 29.40 to 18.22, and 21.80 to 14.32 g for cooked noodles. Noodles containing SBP had significantly (p<0.05) higher hardness and lower elasticity than noodles made from 100% wheat flour. The higher hardness, lower elasticity and less soft attributes could be a concern in terms of consumer acceptability. Sirichokworrakit [4] reported tensile strength of raw sheet and cooked noodles from Tilapia bone flour to decrease with increased Tilapia bone flour diluting the wheat flour in the noodles. It might, therefore, be concluded that the fish bone powder, with its non-gluten content, resulted in an inability to form networks during dough formation that, in turn, affected noodles making them less soft and tearing easily [32]. Diluting gluten strength from noodles by adding SBP, agitation and intruded the noodle structure which could make the noodle easily torn.

Sensory analysis of noodles

The sensory quality characteristics of cooked noodles (Table 7) indicated that all attributes were slightly decreased when SBP added to the flour. When 5, 10 or 15% SBP was added attributes of appearance, odor, elasticity, taste and overall acceptability were not significantly different (p<0.05) from the control, while color was non-significantly different (p<0.05) between all samples. From this finding it might conclude that using the SBP as a proportional substitution for wheat flour up to 15% resulted in similar quality and pleasant appearance as regular noodles (0% SBP) as perceived by the taste panel.

Effect of storage time on microorganism in noodles

Total plate count, yeast and mold increased during storage in refrigerator (4±2^{o}C), as would be expected, but *Escherichia coli*, *Staphylococus aureus*, *Bacillus cereus* and *Samonella* spp. remained at undetectable levels throughout the storage period (Table 8). Criterion of microbiological quality standardization of foods and tableware, announced by Department of Medical Science, Ministry of Public Health, Thailand, guidelines for fresh noodles (No.3/2017) [33] indicates that total plate count should be less than 5x105 CFU/g, yeast and mold should be less than 500 CFU/g, *Escherichia coli* should be less than 10 MPN/g, *Staphylococus aureus*, *Bacillus cereus* should be less than 100 and 1,000 CFU/g, respectively and *Samonella* spp. should be undetectable. Therefore, these noodles conformed to Thai standards for microbiological contamination, even after 9 days storage.

CONCLUSION

The results of partial substitution of refined wheat flour with salmon bone powder (SBP) in noodles showed that increasing levels of SBP resulted in increasing levels of protein, fat, ash and calcium but deceasing carbohydrate levels. Increasing the levels of SBP resulted in the noodles requiring shorter cooking times, lower cooking yield and higher cooking loss compared to the noodles made from 100% refined wheat flour. In addition, increasing the level of SBP in the noodles gave them a yellowish color and a darker appearance, while the wheat flour noodles appeared bright yellowish color. The textural properties of the SBP noodles showed a weaker structure than the noodles made from 100% refined wheat flour. Sensory evaluation indicated showed that adding up to 15% SBP resulted in the noodles having similar quality as regular noodles as perceived by the taste panel. Also, noodles containing SBP could be successfully stored in refrigerator at 4±2°C and remained acceptability for at least 7 days and possibly 9 days. Overall, it was concluded that diluting wheat flour with up to 15% SBP could enhance the nutritional characteristics of noodles, without detracting from their acceptability by consumers and their storage life. The slight changes in appearance and cooking requirements did not appear to detract from consumer acceptance. Adding SBP to noodles could also benefit the commercial fish processing industry by providing a possible lucrative outlet for a waste product.

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Table 1: Noodle formulation

Pasteurized liquid egg (g)	Sodium bicarbonate (g)	Salt (g)	Water (g)	Wheat flour (g)	SBP (g)
				200	0
				190	10
55	3	3	70	180	20
				170	30
				160	40

SBP = Salmon bone powder

Table 2: Chemical compositions of salmon bone powder (SBP), Tilapia bone flour (TBF) and wheat flour (g/100g)

Chemical compositions	SBP (This study)	Tilapia bone flour [4]	Wheat flour [24]
Moisture content	3.86	1.05	11.10
Protein	25.96	22.52	12.00
Carbohydrate	0.68	1.24	74.60
Fat	18.23	10.18	1.70
Ash	51.27	65.01	0.56
Calcium	10.29	27.75	0.02

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Table 3: Chemical compositions of 0, 5, 10, 15 or 20% of noodles substituted with SBP

SBP substitute wheat flour (%)	Uncooked noodles substituted with SBP					
	Moisture content (%)	Ash (g/100g)	Protein (g/100g)	Fat (g/100g)	Total carbohydrate (g/100g)	Calcium (g/100g)
0	39.93	1.96	7.00	2.53	48.58	0.19
5	38.26	3.98	7.96	2.86	46.94	0.61
10	37.26	4.77	8.89	3.12	45.96	1.22
15	36.45	6.74	9.87	3.34	43.60	1.84
20	35.54	8.04	10.13	4.01	42.28	2.44

Table 4: Cooking time, cooking loss and cooking yield of 0, 5, 10, 15 or 20% noodles substituted with SBP

SBP substitute wheat flour (%)	Cooking quality		
	Cooking time (sec)	Cooking loss (%)	Cooking yield (%)
0	120	4.13 ± 0.42^{c}	210.73 ± 0.83^{a}
5	110	5.13 ± 1.86^{bc}	206.47 ± 0.64^{b}
10	100	6.47 ± 0.50^{bc}	196.33 ± 0.81^{c}
15	90	6.53 ± 0.50^{ab}	194.87 ± 0.95^{c}
20	80	7.76 ± 0.90^{a}	190.20 ± 1.06^{d}

$^{a-d}$ Mean ± SD The different letters in each column indicate significant difference (*p*<0.05)

Table 5: Color characteristics of 0, 5, 10, 15 or 20% uncooked noodles and cooked noodles substituted with SBP

SBP substitute wheat flour (%)	Uncooked noodles			Cooked noodles		
	*L**	*a** ns	*b**	*L**	*a** ns	*b**
0	75.16±0.85a	2.17±0.25	24.61±1.03b	64.80±0.39a	0.28±0.11	18.04±1.10b
5	73.48±0.52b	2.40±0.41	25.02±0.31ab	63.90±0.34b	0.36±0.09	19.43±0.24a
10	73.13±0.66bc	2.45±0.39	25.73±0.26ab	63.45±0.21bc	0.39±0.12	19.97±0.41a
15	72.81±1.05b	2.56±0.48	25.86±0.32a	63.01±0.54bc	0.49±0.15	20.46±0.76a
20	71.22±0.90c	2.73±0.23	26.13±0.78a	62.74±0.73c	0.51±0.16	20.59±0.97a

a-c Mean ± SD The different letters in each column indicate significant difference (p<0.05)
ns = The letters in each column indicate non-significant difference (p>0.05)

Table 6: Texture characteristics of 0, 5, 10, 15 or 20% cooked noodles substituted with SBP

SBP substitute wheat flour (%)	Texture analysis			
	Dough		Uncooked noodles	Cooked noodles
	Tension force (g)	Distance (mm)	Tensile strength (g)	Tensile strength (g)
0	86.39±4.33e	32.74±3.51a	29.40±2.79a	21.80±2.22a
5	95.92±4.62d	28.12±2.45b	25.02±4.45b	18.68±3.06ab
10	105.61±3.69c	24.53±1.78c	22.86±2.37bc	17.23±3.55bc
15	117.19±1.95b	21.50±1.56c	19.81±2.59cd	16.67±2.46bc
20	137.91±5.19a	17.44±3.24d	18.22±3.04d	14.32±1.14c

a-d Mean ± SD The different letters in each column indicate significant difference (p<0.05)

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Table 7: Sensory evaluation of 0, 5, 10, 15 or 20% noodles substituted with SBP

SBP substitute wheat flour (%)	Appearance	Color* [ns]	Odor	Elasticity	Softness	Smoothness	Taste	Overall acceptability
0	7.94±0.93[a]	8.06±1.01	7.18±1.03[a]	8.08±0.63[a]	7.58±0.96[a]	7.46±1.04[a]	7.76±1.16[a]	8.18±0.86[a]
5	8.02±1.05[a]	7.98±0.91	7.06±1.12[a]	7.96±0.72[a]	7.38±1.21[ab]	7.28±1.17[ab]	7.72±1.08[a]	8.16±1.03[a]
10	7.96±0.69[a]	7.94±0.81	7.00±1.08[a]	7.88±0.89[a]	7.18±1.14[bc]	7.12±1.01[b]	7.54±0.88[a]	8.08±0.74[a]
15	7.78±0.76[a]	7.82±0.62	6.92±0.98[a]	7.74±1.07[a]	7.06±1.10[c]	7.02±0.93[b]	7.42±1.12[a]	8.02±0.91[a]
20	6.56±0.85[b]	7.76±0.99	6.18±0.91[b]	6.40±1.02[b]	5.82±1.03[d]	5.68±0.95[c]	6.48±0.98[b]	5.98±0.97[b]

[a] Mean ± SD The different letters in each column indicate significant difference (*p*<0.05)
[ns] The different letters in each column indicate non-significant difference (*p*>0.05)

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Table 8: Total plate count, yeast and mold, *Escherichia coli*, *Staphylococus aureus*, *Bacillus cereus* and *Samonella spp*. of noodles made from 15% SBP substitute wheat flour during storage at 4±2°C for 1, 3, 5, 7 and 9 days

Storage time (days)	Total plate count	Yeast and mold	*Escherichia coli*	*Staphylococus aureus*	*Bacillus cereus*	*Salmonella spp.*
1	$2.8x10^2$	$1x10^1$	ND	ND	ND	ND
3	$4.2x10^2$	$1x10^1$	ND	ND	ND	ND
5	$4.9x10^2$	$2x10^1$	ND	ND	ND	ND
7	$7.1x10^2$	$2x10^1$	ND	ND	ND	ND
9	$1.03x10^3$	$7x10^1$	ND	ND	ND	ND

ND = non detected

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