

# Physical, Textural and Sensory Properties of Noodles Supplemented with Tilapia Bone Flour (*Tilapia nilotica*)

Supatchalee Sirichokworrakit

**Abstract**—Fishbone of Nile Tilapia (*Tilapia nilotica*), waste from the frozen Nile Tilapia fillet factory, is one of calcium sources. In order to increase fish bone powder value, this study aimed to investigate the effect of Tilapia bone flour (TBF) addition (5, 10, 15% by flour weight) on cooking quality, texture and sensory attributes of noodles. The results indicated that tensile strength, color value ( $a^*$ ) and water absorption of noodles significantly decreased ( $p \leq 0.05$ ) as the levels of TBF increased from 0-15%. While cooking loss, cooking time and color values ( $L^*$  and  $b^*$ ) of noodles significantly increased ( $p \leq 0.05$ ). Sensory evaluation indicated that noodles with 5% TBF received the highest overall acceptability score.

**Keywords**—Tilapia bone flour, Noodles, Cooking quality, Calcium.

## I. INTRODUCTION

CALCIUM is one of the important minerals for human growth and prevention of osteoporosis in aged persons. According to Thai RDI, Thai people should have an intake of 800 mg of calcium per day. Calcium is generally obtained from dairy products, broccoli, tofu, oysters, sardines and similar soft sources of bone [1]. Fishbone ash consists of 34 - 36% calcium, particularly calcium phosphate [2]. Fishbone of Nile Tilapia (*Tilapia nilotica*), available as waste from a fish leather factory, should be a potentially good source of calcium. Reference [3] found that the fishbone flour of Nile Tilapia consists of 14.20% moisture, 40.80% protein, 25.30% total lipid, 18.30% ash and mineral (100 g) was 2,715.90 mg (calcium), 1.3 mg (iron) and 1,1327 mg (phosphorus). Therefore the utilization of fishbone in human food might be a good way to enhance the value of itself.

Noodles are very popular in Thailand. They are made from simple ingredients (wheat flour, water and salt) and are claimed to lack other essential nutritional components, such as dietary fiber, vitamins and minerals, which are lost during wheat flour refinement [4]. Researchers have tried to use various composite flours with added value are growing rapidly. For noodle and the similar food type like pasta, numerous natural additive sources, such as cereal starches [5], banana flour and  $\beta$ -glucan [4], purple yam flour [6], protein from lupine [7], green tea powder [8], broccoli powder [9], konjac glucomannan [10], sweet potato, colocasia and water

Sirichokworrakit S., is with the Faculty of Science and Technology, Suan Sunandha Rajabhat University, 1 U-Tong Nork Road, Dusit Bangkok 10300, Thailand (e-mail: supatchalee.si@ssru.ac.th).

chestnut flours [11] have been studied so as to improve the nutritional value and functional properties of the product.

The objectives of this research were to make noodles with the addition of fishbone flour of Nile Tilapia at different levels in order to increase calcium content. The effect of wheat flour replacement with fishbone flour was investigated in terms of physical, cooking quality, texture and sensory attributes of the noodles.

## II. MATERIALS AND METHODS

### A. Fishbone Flour Preparation

Fishbone of Nile Tilapia from a local market in Nonthaburi province, Thailand was prepared by removing head and tail. TBF was prepared by method of [1] that fishbone was washed, boiled at 95°C for 10 minutes, soaked in 10 ppm chlorine for 90 minutes, soaked in 0.8% sodium hydroxide for 90 minutes, heated 121°C for 90 minutes under high pressure (15 lb.in<sup>-2</sup>) and dried at 90°C for 60 minutes. Then it was blended and sieved through an 80 – mesh screen. TBF was kept in sealed container at room temperature.

### B. Preparation of the Fresh Noodles

The basic noodle formula consisted of 100 g of wheat flour, 50 ml of distilled water, 1 g of salt and 1 g of sodium carbonate. Four additional noodle samples were prepared by substituting wheat flour with 0 g, 5 g, 10 g and 15 g TBF. The different formulations were processed into noodles using a kitchen Aid mixer (Kitchen Aid, St. Joseph, MI). The prepared dough was placed to rest in a plastic bag for 30 min. The dough was passed through a small noodle machine for several times with the rollers gap reduce gradually, to get dough sheets. The dimensions of the resultant noodle strands were 2 mm in width and 1 mm in thickness.

### C. Chemical Analysis

The chemical proximate compositions and calcium content of TBF were analyzed according to AOAC method [12]. The chemical proximate compositions of Thai fresh noodle were analyzed according to AACC method [13].

### D. Cooking Quality

Cooking quality of noodles was analyzed in accordance to the method described by [14]. The noodles (3 g) were boiled in water (200 ml) until completely cooked (2 min), which was achieved when the center of the noodles became transparent.

The cooked noodles were washed with distilled water, drained for 5 min and weighed immediately. Cooking loss was expressed as a percentage of the weight of dry solids in cooking water to the dry noodle weight before cooking. Water absorption was reported as the percent increase in the weight of cooked noodles (weight of cooked noodle minus weight of dried noodle) compared to the dry noodle weight [15]. Cooking time was evaluated by observing the time of disappearance of the core of the noodles strand during cooking (every 30 s) squeezing the noodles between to transparent glass slides [16].

#### E. Noodle Color Analysis

The color of the noodle sheets and the optimally cooked noodle samples were measured with spectrophotometer (Hunter Lab, Color Quest XE, USA) equipped with a D65 illuminant using the CIE L\* a\* b\* system. The L\*, a\* and b\* readings were obtained directly from the instrument and provided measures of lightness, redness and yellowness, respectively. All measurements were performed in triplicate.

#### F. Noodle Texture Analysis

Tensile strength of cooked noodles were measured using texture analyzer (Lloyd Instrument, TA plus, UK). Cooked noodle strip was fixed to arms of tensile grips. Force (tensile strength) at the break point was measured at a speed of 1.0 mm/s. Ten measurements were conducted for each sample.

#### G. Sensory Evaluation

All noodle samples were boiled using tap water for the optimum cooking time. The samples with soup were evaluated for appearance, flavor, softness, Elasticity and overall liking of the samples by 30 untrained panelists using nine-point hedonic scales, where 9 = extremely like and 1 = extremely dislike.

### III. RESULTS AND DISCUSSION

#### A. Chemical Compositions and Color Characteristic of TBF

The chemical composition of TBF is presented in Table I. The TBF prepared contained moisture content, crude protein, carbohydrate, crude fat, ash, and calcium are nearby the report of [1]. The lightness (L\*) of TBF is higher than [1] while the redness (a\*) and yellowness (b\*) are lower than [1].

#### B. Cooking Qualities

Cooking loss and water absorption, which are important characteristics determining the cooking quality of noodles, are presented in Table II. The results indicated that water absorption decreased as the levels of TBF increased from 0-15%, but the cooking times of all noodle samples range 110 to 120 s. The cooking loss increased from 2.95 to 3.31 as the levels of TBF increased. The differences in cooking quality were attributed primarily to the gluten fraction. This is because, by increasing the amount of TBF that is incorporated, the gluten fraction was diluted, leading to less water retention for the noodle. Therefore, increasing the amounts of TBF hindered the functional dough properties and the cooking quality [6].

TABLE I  
CHEMICAL COMPOSITIONS AND COLOR CHARACTERISTIC OF TBF

	This study	[1]
Moisture content (%)	1.05	1.55
Crude protein (%)	22.52	24.51
Carbohydrate (%)	1.24	0.56
Crude fat (%)	10.18	7.63
Ash (%)	65.01	65.75
Calcium (g/100 g)	27.75	25.01
L*	84.08	73.57
a*	0.67	0.88
b*	13.41	18.44

TABLE II  
WATER ABSORPTION, COOKING TIME AND COOKING LOSS OF NOODLES SUPPLEMENTED WITH TBF

Noodles	Water absorption (%)	Cooking time (s)	Cooking loss (%)
0% TBF	104.25 <sup>a</sup>	115 <sup>b</sup>	2.95 <sup>c</sup>
5% TBF	95.74 <sup>b</sup>	110 <sup>c</sup>	3.11 <sup>b</sup> <sup>c</sup>
10% TBF	92.35 <sup>c</sup>	120 <sup>a</sup>	3.23 <sup>ab</sup>
15% TBF	89.85 <sup>d</sup>	120 <sup>a</sup>	3.31 <sup>a</sup>

Different superscript letters in a column indicate significant difference ( $P \leq 0.05$ )

#### C. Color Characteristics

Asian customers prefer bright yellow, alkaline noodles that retain a stable color for 24 – 48 h after preparation and consider red or dull grey noodles as undesirable [17]. Color characteristics of raw sheet and cooked noodles supplemented with TBF are shown in Table III. The results indicated that as the amount of TBF increased, the appearance of raw sheet and the cooked noodles supplement with TBF brighter. The redness (a\*) and yellowness (b\*) values were also significantly different between all samples. The redness values significantly decreased, while the yellowness values significantly increased.

TABLE III  
COLOR CHARACTERISTIC OF FISHBONE FLOUR NOODLES SUPPLEMENTED WITH TBF

Noodles	Raw sheet noodles			Cooked noodles		
	L*	a*	b*	L*	a*	b*
0% TBF	66.67 <sup>d</sup>	1.00 <sup>a</sup>	22.89 <sup>b</sup>	68.79 <sup>d</sup>	-0.67 <sup>a</sup>	18.36 <sup>c</sup>
5% TBF	68.81 <sup>c</sup>	0.93 <sup>b</sup>	23.42 <sup>a</sup>	69.56 <sup>c</sup>	-0.69 <sup>a</sup>	18.45 <sup>bc</sup>
10% TBF	69.32 <sup>b</sup>	0.88 <sup>c</sup>	23.49 <sup>a</sup>	69.93 <sup>b</sup>	-0.76 <sup>b</sup>	18.61 <sup>b</sup>
15% TBF	71.90 <sup>a</sup>	0.52 <sup>d</sup>	23.74 <sup>a</sup>	70.12 <sup>a</sup>	-0.99 <sup>c</sup>	19.65 <sup>a</sup>

Different superscript letters in a column indicate significant difference ( $P \leq 0.05$ )

#### D. Noodle Texture Analysis

Noodles texture of raw sheet and cooked noodles supplemented with TBF are shown in Table IV. The tensile strength of raw and cooked noodles was significantly different between all samples. The tensile strength decreased when the TBF content increased. The addition of TBF, non gluten flour, in the fabrication of noodles diluted the gluten strength of the wheat flour and interrupted as well as weakened the overall structure of the noodles [18].

### E. Sensory Evaluation

The cooked noodles were evaluated for their sensory quality characteristics of appearance, flavor, softness elasticity and overall liking as show in Table V. It was found that all attributes decreased as the TBF residue content increased. Supplementing noodles with 5% TBF is also observed to have equal all attributes of the control noodles.

TABLE IV  
TENSILE STRENGTH OF NOODLES SUPPLEMENTED WITH TBF

Noodles	Tensile strength (N)	
	Raw sheet noodles	Cooked noodles
0% TBF	0.52 <sup>a</sup>	0.40 <sup>a</sup>
5% TBF	0.40 <sup>ab</sup>	0.30 <sup>ab</sup>
10% TBF	0.30 <sup>b</sup>	0.25 <sup>b</sup>
15% TBF	0.23 <sup>b</sup>	0.17 <sup>b</sup>

Different superscript letters in a column indicate significant difference ( $P \leq 0.05$ )

TABLE V  
SENSORY EVALUATION OF NOODLES SUPPLEMENTED WITH TBF

Noodles	Appearance	Flavor <sup>Ns</sup>	Softness	Elasticity	Overall liking
0% TBF	7.58 <sup>a</sup>	7.67	7.58 <sup>a</sup>	7.46 <sup>a</sup>	8.21 <sup>a</sup>
5% TBF	7.38 <sup>a</sup>	7.42	6.64 <sup>ab</sup>	6.21 <sup>b</sup>	7.25 <sup>a</sup>
10% TBF	5.25 <sup>b</sup>	7.46	5.46 <sup>b</sup>	5.25 <sup>b</sup>	6.25 <sup>b</sup>
15% TBF	5.58 <sup>ab</sup>	7.25	4.67 <sup>c</sup>	3.96 <sup>c</sup>	5.46 <sup>b</sup>

Different superscript letters in a column indicate significant difference ( $P \leq 0.05$ )

<sup>Ns</sup> Non significance

### IV. CONCLUSION

The study revealed that the noodles with good acceptable cooking quality, textural, color and sensory characteristics could be using TBF with a replacement level of 5%. The nutrition of noodles substituted with 5% TBF consisted of 8.66% of protein, 0.98% fat and 0.91 g/100g calcium. The noodles with 5% TBF had calcium content that was adequate for Thai people.

### ACKNOWLEDGMENT

The financial support was provided by the Research and Development Institute, Suan Sunandha Rajabhat University.

### REFERENCES

- [1] K. Techochatchawal and N. Therdthai, "Development of calcium supplement from the bone of Nile Tilapia (*Tilapia nilotica*)," *J. Food Ag-Ind*, vol. 2, no. 4, pp. 539-546, 2009.
- [2] M. Hamada, T. Nagai, N. Kai, Y. Tanoue, H. Mae, M. Hashimoto, K. Miyoshi, H. Kumagai and K Saeki, "Inorganic constituents of bone of fish," *Fisheries Science*, vol. 63, no. 3, pp. 517-520, 1995.
- [3] M.E. Petenuci, F.B. Stevanato, J.E. Visentainer, M. Matsushita, E.E. Garcia, N. Evelazio de Souza and J.V. Visentainer, "Fatty acid concentration, proximate composition, and mineral composition in fishbone flour of Nile Tilapia," *Archivos Latinoamericanos de Nutricion*, vol. 58, no. 1, pp. 87-90, 2008.
- [4] C.L. Choo and N.A. Aziz, "Effects of banana flour and  $\beta$ -glucan on the nutritional and sensory evaluation of noodles," *Food chemistry*, vol. 119, pp. 34-40, 2010.
- [5] Y.C. Huang and H.M. Lai, "Noodle quality affected by different cereal starches," *J. Food Eng*, vol. 97, pp. 135-143, 2010.

- [6] P.H. Li, C.C. Huang, M.Y. Yang and C.C.R Wang, "Textural and sensory properties of salted noodles containing purple yam flour," *Food Research International*, vol. 47, pp. 223-238, 2012.
- [7] E.A.M. Mahmoud, S.L. Nassef and A.M.M. Basuny, "Production of high protein quality noodles using wheat flour fortified with different protein products from lupine," *Annals of Agricultural Science*, vol. 57, no. 2, pp. 105-112, 2012.
- [8] M. Li, J.H. Zhang, K.X. Zhu, W. Peng, S.K. Zhang, B. Wang and Y.J. Zhu, "Effect of superfine green tea powder on the thermodynamic, rheological and fresh noodle making properties of wheat flour," *LWT-Food Science and Technology*, vol. 46, pp. 23-28, 2012.
- [9] E. Silva, L.M.C. Sagis, E. Van der Linder and E. Scholten, "Effect of matrix and particle type on rheological, textural and structural properties of broccoli pasta and noodles," *J. Food Eng*, vol. 119, pp.94-103, 2013.
- [10] Y. Zhou, H. Cao, M. Hou, S. Nirasawa, E. Tatsumi, T.J. fister and Y. Cheng, "Effect of konjac glucomannan on physical and sensory properties of noodles made from low-protein wheat flour," *Food Research International*, vol. 51, pp.879-885, 2013.
- [11] B.S. Yadav, R.B. Yadav, M. Kumari and B.S. Khatkar, "Studies on suitability of wheat flour blends with sweet potato, colocasia and water chestnut flours for noodle making," *LWT-Food Science and Technology*, vol. xxx, pp. 1-7, 2014.
- [12] Official methods of analysis, *The Association of Official Analytical Chemists (AOAC)*, ed. 18<sup>th</sup>. 2005.
- [13] Approved Method of the American Association of Cereal Chemists, *American Association of Cereal Chemist (AACC)*, ed. 10<sup>th</sup>. 2000.
- [14] T. Takahashi, M. Miura, N. Ohisa, K. Mori and S. Kobayashi, "Heat treatments of milled rice and properties of the flours," *Cereal Chemistry*, vol. 82, pp.228-232, 2005.
- [15] H.J. Chung, A Cho and S.T. Lim, "Effect of heat-moisture treatment for utilization of germinated brown rice in wheat noodle," *LWT-Food Science and Technology*, vol. 47, pp. 342-347, 2012.
- [16] P. Ritthiruangdej, S. Parnbankled, S. Donchedee and R. Wongsagonsup, "Physical, chemical, textural and sensory properties of dried wheat noodles supplemented with unripe banana flour," *Kasetsart J. (Nat. Sci.)*, vol. 45, pp. 500-509, 2011.
- [17] R.E. Asenstorfer, Y. Wang and D.J. Mares, "Chemical structure of flavonoid compounds in wheat (*Triticum aestivum* L.) flour that contribute to the yellow color of asian alkaline noodles," *J. Cereal Sci* vol. 43, no. 1, pp. 108-119, 2006.
- [18] M.I.P. Kovacs, B.X. Fu, S.M. Woods and K. Khan, "Thermal stability of wheat gluten protein: its effect on dough properties and noodle texture," *J. Cereal Sci* vol. 39, no. 1, pp. 1-9, 2004.