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RESEARCH ARTICLE

Variable Parameters Affecting to Nile Tilapia (*Oreochromis Niloticus*) Fish-Paste Production

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Abstract

Tilapia has emerged as one of the most cultivated and marketed species in Vietnam. There is not much research mentioned to processing of fish-paste of this valuable fish. In order to improving the added value of this fish, we investigated a production of fish-paste from Nile tilapia *(Oreochromis niloticus)*. By investigation different parameters probably affecting to gelation, the results was noticed that the best physicochemical properties and sensory characteristics of fish-paste would be obtained by the addition of modified starch 1.5%: guar gum 1.5%. These results demonstrated that the addition of modified starch and guar gum in the formulation of Nile tilapia fish-paste increased the nutritional value of the product without reducing its sensory preference.

Keywords: *Nile tilapia (Oreochromis niloticus), fish-paste, Modified starch, Guar gum, Physicochemical properties.*

Introduction

Nile tilapia (*Oreochromis niloticus*) belongs to the family of Cichlidae. It has been introduced and spread in the world where there is warm water appropriate for their growth and reproduction. Most tilapia species are suitable for aquaculture. The growth rate varies depending on the nature of the food. It feed mainly on phytoplankton, algae, aquatic plants, remaining of decaying organic material and insect larvae [1].

Currently, there are many products available in the supermarket, which are made by binding comminuted meat products along with spices, seasonings, and stabilizer in to one cohesive product. Various binders are available to meat processors. Some binders are proteins, such as soy protein isolate, pea protein, wheat protein, milk casein ate, gelatin, and egg protein.

Some binders are derived from enzymes, such as transglutaminase and beef fibrin. Some binders contain little or no protein, such as fibers, flours, and starches [2]. It's one of the excellent sources of protein, fat, polyunsaturated fatty acids, vitamins and minerals.Fish paste was the most preferred product, followed by salted-cold smoked, then surimi while cured-cold smoked tilapia was the least preferred [3].

There were sevaral studies mentioned to Nile tilapia (*Oreochromis niloticus*) processing and utilization. Fish glue from tilapia scale and skin and its physical and chemical characters was evaluated [4]. Development of a fish paste with *Oreochromis mossambicus* and *coccina grandis* as a natural blood glucose reduction food was also mentioned [5].

A study was to evaluate the shelf life of minced tilapia to replace synthetic preservatives with Hijiki and Nori seaweeds extract [6]. A study was to determine performances of cold-set binders, food hydrocolloids, and commercial meat binder on the physical and chemical characteristics of tilapia fish balls [2]. The by-products generated from industrial filleting of tilapia surimi can be used for the manufacture of surimi [7].

Thermal and physicochemical properties of red tilapia (*Oreochromis niloticus*) surimi gel incorporated with different levels of microbial transglutaminase (MTGase) were investigated [8]. A ready to serve sandwich paste was developed from the meat of tilapia (*Oreochromis mossambicus*) with peeled potato by thermal processing in retortable pouches [9]. A research evaluated the effect of the addition of flaxseed flour to sensory acceptance and nutritional status of Nile tilapia croquettes [10]. A study was to optimise the mixture of different flours in the development of a freeze-dried mixture of fish croquette using Nile tilapia [11].

In this research, they used Nile tilapia *(Oreochromis niloticus)* as a material for examining. We focused on examining different aspects affecting to Nile tilapia *(Oreochromis niloticus)* cake production such as modified starch, guar gum concentration supplemented into fish paste, mixture of modified starch and guar gum.

Material & Method

Material

We catched Nile tilapia *(Oreochromis niloticus)* from Dong Thap province, Vietnam.After harvesting, they must be kept in ice chest (< 4°C) and conveyed to laboratory within 4 hours for experiments. Besides Nile tilapia, we also used other materials such as NaCl, monosodium glutamate (MSG), pepper, sugar, garlic, Modified starch, Guar gum. Lab utensils and equipments included grinder, weight balance, thermometer, autoclave, ice chest, texture analyzer. We evaluated moisture content, texture, color in fish-paste.

Research Method

Investigate the Effect of Modified Starch to Physicochemical Properties and Sensory Characteristics of Fish-paste

Nile tilapia *(Oreochromis niloticus)* was kept under 4°C in 2 hours before being grinded thoroughly. Salt 1.0%, MSG 0.1%, sugar 0.5%, pepper 1.0% and garlic 1.5% were used as food ingredients. It was grinded into paste in 2 minutes at 0-4°C. Then we added different Modified starch concentration (1.0, 2.0, 3.0, 4.0 and 5.0%) into fish paste. Fish-paste was then formed and sterilized at 121°C in 10 minutes. Texture, color, and moisture were tested to identify the optimal Modified starch concentration.

Investigate the Effect of Guar Gum to Physicochemical Properties and Sensory Characteristics of Fish-paste

Nile tilapia *(Oreochromis niloticus)* was kept under 4°C in 2 hours before being grinded thoroughly. Salt 1%, MSG 0.1%, sugar 0.5%, pepper 1.0% and garlic 1.5% were used as food ingredients. It was grinded into paste in 2 minutes at 0-4°C. Then we added different Guar gum concentration (1.0, 2.0, 3.0, 4.0 and 5.0%) into fish paste. Fish-paste was then formed and sterilized at 121°C in 10 minutes. Texture, color, and moisture were tested to identify the optimal Modified starch concentration.

Investigate the Effect of Mixture (Modified Starch: Guar gum) to Physicochemical Properties and Sensory Characteristics of Fish-paste

Nile tilapia (Oreochromis niloticus) was kept under 4°C in 2 hours before being grinded thoroughly. Salt 1%, MSG 0.1%, sugar 0.5%, pepper 1.0% and garlic 1.5% were used as food ingredients. It was grinded into paste in 2 minutes at 0-4°C. Then we added different carragenan: Guar gum ratio (3.0%:0%, 0:3.0%, 1.5%:1.5%, 2.0%:1.0, 1.0%:2.0%, respectively) into fish paste. Fish-paste was then formed and sterilized at 121°C in 10 minutes. Texture, color, and moisture were tested to identify the optimal Modified starch concentration.

Statistical Analysis

Data were statistically summarized by Statgraphics.

Result & Discussion

Effect of Modified Starch to Physicochemical Properties and Sensory Characteristics of Fish-paste

Hydrocolloids are widely used in many food formulations to improve quality attributes and shelf-life.

The two main uses are as thickening and gelling agents. Hydrocolloids with their unique characteristics are of great interest in processed meat due to their abilities to bind water and form gels [12].

Table 1: Effect of modified starch concentration to texture firmness of fish-paste

Modified starch concentration (%)	Texture firmness of fish-paste (g/mm^2)
Control	8.69±0.02^d
1.0	9.81±0.01^c
2.0	11.73±0.01^b
3.0	**12.09**±0.03^{ab}
4.0	12.20±0.04^a
5.0	12.22±0.02^a

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

Table 2: Effect of modified starch concentration to color of fish-paste

Modified starch concentration (%)	Color of fish-paste (a value)
Control	57.41±0.01^c
1.0	58.70±0.01^{bc}
2.0	59.94±0.02^b
3.0	**62.16**±0.03^{ab}
4.0	62.60±0.03^a
5.0	62.62±0.03^a

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

Table 3: Effect of modified starch concentration to moisture content of fish-paste

Modified starch concentration (%)	Moisture content of fish-paste (%)
Control	65.08±0.01^c
1.0	66.72±0.02^b
2.0	66.93±0.03^b
3.0	**69.25**±0.03^a
4.0	69.58±0.01^a
5.0	69.62±0.00^a

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

From table 1, 2 and 3 we will get the best physicochemical properties and sensory characteristics of fish-paste by the addition of modified starch 3.0%. A study was to develop a value added product from these fishes by incorporating kovakka leaves which can be used for diabetes patients. Paste was prepared after boiling the fish until internal temperature become 70 °C for 15 minutes and mixing with minced fish with relevant amount of spices.

After preparation of the paste it was pasteurized at 85 °C for 15 minutes in a water bath. Tilapia fish was selected as the best fish type for the preparation of the fish paste. The proximate analysis revealed that fish paste contains higher amount of protein showing that it is a better source of protein and also it contains 71.77 ± 1.32% of moisture, 2.60 ± 0.20% of fat and 0.93 ± 0.25% of fiber as the other nutrients [5]. In another research, the by-products generated from industrial filleting of tilapia surimi can be used for the manufacture of surimi. This study found that the optimal formulation for producing the best surimi using the by-products of tilapia filleting in manufacturing fish burger were the addition of 10% tapioca starch and three minced fish washing cycles [7].

Effect of Guar Gum to Physicochemical Properties and Sensory Characteristics of Fish-paste

Gel formation is the phenomenon involving the association or cross-linking of the polymer chains to form a three dimensional network that traps or immobilises the water within it to form a rigid structure that is resistant to flow. The formation of gel involves the association of randomly dispersed polymer segments in dispersion in such a way so as to form a three-dimensional network that contains solvent in the interstices.

Table 4: Effect of Guar gum concentration to texture firmness of fish-paste

Guar gum concentration (%)	Texture firmness of fish-paste (g/mm²)
Control	7.70±0.02^{d}
1.0	8.88±0.01^{c}
2.0	10.51±0.01^{b}
3.0	**10.90**±0.02^{ab}
4.0	11.07±0.03^{a}
5.0	11.13±0.03^{a}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

Table 5: Effect of Guar gum concentration to color of fish-paste

Guar gum concentration (%)	Color of fish-paste (a value)
Control	56.42±0.01^{c}
1.0	57.65±0.01^{bc}
2.0	58.22±0.02^{b}
3.0	60.94±0.00^{ab}
4.0	61.14±0.01^{a}
5.0	61.21±0.03^{a}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

Table 6: Effect of Guar gum concentration to moisture content of fish-paste

Guar gum concentration (%)	Moisture content of fish-paste (%)
Control	64.05±0.01^{c}
1.0	65.56±0.03^{b}
2.0	65.65±0.01^{b}
3.0	68.15±0.02^{a}
4.0	68.23±0.03^{a}
5.0	68.29±0.01^{a}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

From table 4, 5 and 6 we will get the best physicochemical properties and sensory characteristics of Fish-paste by the addition of Guar gum 3.0%. A study was to evaluate the shelf life of minced tilapia to replace synthetic preservatives with Hijiki and Nori seaweeds extracts. The application of the extracts had no effect on the chemical composition of the minced tilapia.

The seaweed extracts had inhibitory effect on total volatile base nitrogen. The minced tilapia with added seaweed extracts were within quality standards during frozen storage [6].

Thermal and physicochemical properties of red tilapia (*Oreochromis niloticus*) surimi gel incorporated with different levels of microbial transglutaminase (MTGase) were investigated. Surimi samples mixed with various concentrations of MTGase were subjected to two-stages heating (at 45^{o}C followed by 90^{o}C) to prepare surimi gel. Samples formulated with 0.30 MTGase (units/g surimi) showed the highest breaking force and deformation, and lowest expressible water content among treatments. Highest storage modulus was found in the gels mixed with 0.30 MTGase (units/g surimi).

Compared with control surimi gel, addition of microbial transglutaminase to levels 0.10, 0.20 and 0.30 (units/g surimi) increased the enthalpy and maximum transition temperature of myosin. Results suggest that up to 0.30 MTGase (units/g surimi) could improve texture, colour, water-holding capacity, elasticity and thermal stability of red tilapia surimi gel [7].

Effect of Mixture (Modified Starch: Guar Gum) to Physicochemical Properties and Sensory Characteristics of Fish-paste

Table 7: Effect of mMdified starch: Guar gum ratio to texture firmness of fish-paste

Ratio of Modified starch: guar gum	Texture firmness of fish-paste (g/mm²)
Modified starch 3.0%	11.05±0.01[c]
Guar gum 3.0%	10.93±0.03[c]
Modified starch 1.5%: Guar gum 1.5%	13.20±0.02[a]
Modified starch 2.0%: Guar gum 1.0%	12.13±0.01[b]
Modified starch 1.0%: Guar gum 2.0%	12.09±0.02[b]

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

Table 8: Effect of Modified starch: Guar gum ratio to color of fish-paste

Ratio of Modified starch:Guar gum	Color of fish-paste (a value)
Modified starch 3.0%	61.11±0.01[cd]
Guar gum 3.0%	60.93±0.01[d]
Modified starch 1.5%: Guar gum 1.5%	63.22±0.00[a]
Modified starch 2.0%: Guar gum 1.0%	62.27±0.04[b]
Modified starch 1.0%: Guar gum 2.0%	61.59±0.02[c]

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

Table 9: Effect of Modified starch: Guar gum ratio to moisture content of fish-paste

Ratio of Modified starch:Guar gum	Moisture content of fish-paste (%)
Modified starch 3.0%	68.21±0.01[d]
Guar gum 3.0%	68.09±0.01[d]
Modified starch 1.5%: Guar gum 1.5%	72.11±0.02[a]
Modified starch 2.0%: Guar gum 1.0%	71.32±0.03[b]
Modified starch 1.0%: Guar gum 2.0%	70.24±0.01[c]

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

Firmness and tenderness for optimum texture, as well as the retention of moisture for optimum juiciness were strongly affected by these hydrocolloids. From table 7, 8 and 9 we will get the best physicochemical properties and sensory characteristics of Fish-paste by the addition of Modified starch 1.0%: Guar gum 1.0%. The blending of different polysaccharides (carragenan and Guar gum) offers an alternative route to the development of new textures. The major interest lies in the development of synergistic mixtures with improved or induced gelation.

A study was to determine performances of cold-set binders, food hydrocolloids, and commercial meat binder on the physical and chemical characteristics of tilapia fish balls [2]. A ready to serve sandwich paste was developed from the meat of tilapia (*Oreochromis mossambicus*) with peeled potato by thermal processing in retortable pouches at a temperature of 121.1oC with different F0 values of 6, 7, 8 and 9.

Based on the evaluation of samples for texture, colour, commercial sterility, biochemical and sensory analysis all the samples were found to be acceptable based on the quality. The samples processed at 121.1oC at F0 value 8.08, Cook value 75.02 and total process time 32.23 min were found to be the best. Thermally processed ready to serve tilapia sandwich paste was developed and its keeping quality was studied at ambient temperature. During storage, there was no significant change in the contents of Moisture, Protein, Fat and Ash. The TBA values of tilapia sandwich paste slightly increased during storage. Tilapia sandwich paste processed at 121.1oC for F0 value 8.08 was fit for consumption even after a period of 1 year storage in retort pouch [9]. A research evaluated the effect of the addition of flaxseed flour to sensory acceptance and nutritional status of Nile tilapia croquettes.

The basic formulation of tilapia croquette was enriched with different contents of flaxseed flour, and a ranking preference test was used to determine which formulation did not differ from the basic product. The enrichment of croquettes with flaxseed flour significantly improved the nutritional value, even though they had been subjected to deep fat frying [10].

Conclusion

Nile tilapia (*Oreochromis niloticus*) is an introduced low-value freshwater fish. Nile tilapia (*Oreochromis niloticus*) cultivation has expanded during the last decade as a result of technological advances associated with the intensification of cultivation practices. We have successfully investigated the effect of modified starch and guar gum to *Nile tilapia (Oreochromis niloticus)* fish-paste production. Utilisation of this cultured fish may aid in alleviating food security.

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