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# Physiochemical and Sensory Quality Assessment of Frozen Surimi Produced From Some Underutilized Fish Species

**Mohamed Abou-Taleb; Abdelrahman S. Talab; Mohamed A. Ibrahim; Maha E. Genina; Mostafa M. Mahmoud; Shimaa M. Abou-Taleb and Fify R. Anees***

*National Institute of Oceanography and Fisheries (NIOF), Egypt*

**Abstract**

This study aims to determine the chemical composition, physicochemical and sensory properties of surimi processed from common carp, kawakawa tuna and little tuna fish stored at -18°C for 60 days. The results showed that, moisture, protein, lipid and ash of fish surimi were decreased at the end of frozen storage. Moreover the values of pH, total volatile basic nitrogen, trimethylamine and thiobarbeturic acid of little tuna, kawakawa tuna and common carp fish surimi were increased during frozen storage till reached to (7.60, 7.63, 7.40), (29.10, 28.19, 25.81 mg/100g), (7.23, 5.11, 6.04 mg/100g) and (1.62, 1.47, 0.98 mg MDA/kg); respectively at the end of frozen storage. In conclusion, fish surimi gain high nutritional value as a cheap product and according to physicochemical and sensory quality aspects, surimi processed from common carp was the best type and had higher stability during storage followed by kawakawa and little tuna fish.

*Keywords:* Fish surimi, frozen storage, Total volatile bases nitrogen, Trimethylamine .quality attributes, sensory evaluation

## 1. Introduction

Underutilized fish species are commonly discarded and only the latest harvest of the trip on the board is preserved where preservation instruments are mostly used for selected species. Also this means that they are not preserved well, therefore reduction of the quality and the price as a result. This fish species make sundry problems associated with handling, recovery and preservation on board and subsequent on their processing. With regard to fish recovery, many approaches have been tried to reducethe the by-catch. The decrease of fishing time and efforts, the fishing ground region closures, and some management measures are introduced like enforced prohibitions on discharges. Another kind of measurement includes the use of more eclectic tools [1]. Kawakawa tuna (*Euthynnus affinis*) belongs to epipelagic tuna *Scombridae* family and are exceedingly publicized in the tropical and subtropical waters of the Indo–Pacific region [2]. Lately, *E. affinis* has been consideredas a new target species for aquaculture because of its fast growth [3]. Fish surimi is conceder stabled myofibrillar proteins as intermediate product obtained from mechanically deboned fish flesh after heading, gutting, filleting, deboning, washing, dewatering, refining, adding cryoprotectants, and then freezing [4]. In addition, many researches had studied fish surimi, for example the effect of super chilling with cryoprotectants (a mixture of sorbitol and sucrose) on the activity of microorganisms, oxidation of lipid, and proteolytic degradation in surimi obtained from common carp was investigated [5]. The different ratio effect of washing solutions [distilled water, $CaCl_2$ (0.1% and 0.2%, w/v), and $MgCl_2$ (0.1% and 0.2%, w/v)] on chemical changes and gel characteristics of surimi gels obtained from silver carp fillets through processing and heating was evaluated [6]. Little tuna has a high nutritional value which contained 26.2% protein and rich in omega-3 fatty acids, but, the utilization and food processing of little tuna as the major ingredient in food products is still restricted [7]. The cryoprotective effects of γ-polyglutamic acid (γ-PGA) on surimi obtained from grass carp during frozen storage at - 20 °C was investigated [8]. The effect of ultrasound pre-treatment modes on gelation properties of silver carp surimi was studied [9]. The effects of filleting method on yield, composition, gelling properties and aroma profile of grass carp surimi was investigated [10]. Microbiological, rheological, physicochemical and microstructural changes of surimi prepared by pH shift procedure and the

*Corresponding author e-mail: fify_anees@yahoo.com
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traditional water-washing procedure through cold storage was investigated [11]. Therefore, this study aims to evaluate the impact of frozen storage on the physicochemical quality of fish surimi processed from three underutilized fish species namely common carp fish (*Cyprinus carpio*), Kawakawa tuna (*Euthynnus affinis*) and Little tuna (*Euthynnus alletteratus*).

## 2.Materials and Methods

### 2.1. Materials

To produce fish surimi, three fish species namely common carp fish (*Cyprinus carpio*), Kawakawa tuna (*Euthynnus affinis*) and little tuna (*Euthynnus alletteratus*) were used. Fish fillets were obtained by using about 200 kg from fresh fish, with average weight 3.5 to 5 kg each and with length 45 to 55 cm each. Fresh fish samples were collected from Alexandria fish market, Alexandria governorate, Egypt and transported in icebox to Fish Processing and Technology Laboratory, Fish Research Station, El-Kanater El-Khiria, Qalubia Governorate, National Institute of Oceanography and Fisheries.

### 2.2. Methods

#### 2.2.1. Preparation of fish samples

Fish samples were prepared for processing under hygienic condition, all fish were rewashed, beheaded, eviscerated, skin removed and filleted. Fish fillets were washed and drained.

#### 2.2.2. Fish surimi processing

Fish surimi was produced according to Liu, et al. [5] method which described as follow: the samples of fish filleted were minced with Kitchen meat mincer (an orifice diameter of 4 mm). The fish mince was washed by cold water (4°C) and the used ratio of mince/water was 1:3 (w/v). Then, the mixture was stirred gently for 5 min, and the washed mince was then filtered through a layer of nylon screen. Repeat the washing step for two times, then the washed mince was centrifuged at 700 RPM for 15 min. Fish surimi was divided into three parts then wrapped these parts in a permeable film of polyethylene and kept in a refrigeration cabinet at a temperature of -18 °C for 60 days [5]. All studied parameters were determined at zero time, 30 and 60 days of frozen storage.

### 2.3. Analytical methods

The proximate chemical composition and pH values were determined according to the methods recommended by AOAC [12]. Total volatile bases nitrogen (TVB-N) content was determined according to the method described by Pearson [13]. Trimethylamine was determined as described by AMC [14]. While, the thiobarbituric acid (TBA) value was measured according to the method described by Tarladgis et al. [15]. The sensory analysis of fish surimi was carried out as described [16]. The results obtained (n=3) were expressed as Mean ± SD.

## 3. Results and discussion

### 3.1. Approximate composition of fish surimi samples as affected by frozen storage.

Chemical components; including moisture, protein, fat and ash contents of surimi product and the alterations in gross as influenced by frozen storage temperature were studied. The obtained data were recorded in Table (1). The moisture % tended to have a downward pattern of change since it started by 80.96, 91.54 and 91.66 % in fish surimi product manufactured from common carp, kawakawa tuna and little tuna fish, and reached 79.55, 90.49 and 90.87 % after 60 days of storage at -18 °C with a loss of 1.41, 1.05 and 0.79 % for the previous treatments respectively. So, these results indicate a reversible relation between moisture content and frozen storage period, a trend which agree with the investigation which found that significant reduction in moisture content of surimi *Nemipterus japonicus* appeared to stay stable through the storage period [17]. This decrease in moisture content was attributed to the sublimation of ice in frozen storage and the loss of drip during thawing process [18]. Additionally, this decrement of moisture content might be due to the decrease in their water holding capacity, as reported [19, 20]. Results of the present work (Table 1) showed that surimi product manufactured by different types fish lead to a similar trend in the tested samples and the highest reduction in values of moisture content was noticed in surimi of common carp samples. The least reduction in moisture content was noticed in surimi product manufactured from little tuna fish.

Data presented in Table (1) show the effect of frozen storage at -18 ºC on protein content (%) of fish surimi processed from common carp, kawakawa tuna and little tuna. From obtained results it was be clear that, protein contents of surimi samples gradually decreased during storage. In common carp fish surimi, there was decrease in protein content during storage and the values of sample ranged from 15.61±0.75 at zero time to 14.15±0.43 after 60 days. Changes in protein contents of fish surimi processed from kawakawa tuna and little tuna showed similar behavior during frozen storage under the same conditions. Protein content changes can be attributed to the leakage of some volatile nitrogenous compounds through the storage period by freezing and hydrolyses of protein which lead loss of some soluble components in separated to the leakage of some water soluble nitrogen with the thawing drip. In the trend of the study which reported that the decrement of crude protein of mackerel fish after 180 days of frozen storage could be mainly due to the liquid through the process of thawing [21]. The higher rate of decrease was observed in surimi produced from kawakawa tuna and little tuna fish.

Changes occurred in lipid content were given in Table (1). During storage at - 18 °C, the fat content values of surimi product samples processed from common carp were ranged from 3.28±0.32 at zero time to 2.97±0.10 after 60 days of frozen storage and it showed slowly decrement during the storage period. In the same trend the decrement of lipid content was noticed in surimi samples processed from kawakawa tuna and little tuna. The decrement of fat content values may be attributed to hydrolysis and oxidation of lipids which lead to the formation of some volatile component as aldehydes and ketones. This trend agree with the study which found that the significant decrease in protein and fat for surimi *Nemipterus japonicus* from 18.38± 0.39% to 15.5±0.23% and 1.0±0.03 % to 0.75±0.03%, respectively [22]. The decrement of minerals and protein content on water leaching can be basically attributed to the leakage of water soluble proteins through the process of thawing.The high decreasing in fat content was observed in surimi samples processed from kawakawa tuna and little tuna fish which were 0.66 and 0.38% after 2 months of frozen storage, the lowest values of fat content were recorded in the same treatments at 0 day of storage. These results might be due to the strongly effect of washing and highly content of the red muscles to a removing partially of fat and exhibited the autoxidation of unsaturated double bonds as well as enzymatically oxidation to transitory intermediate compounds. The results obtained are in agreement with those found by Janak Kamil et al., Fan et al. and Duan et al. [23, 24 and 25].

Moreover, ash content changes of fish surimi through storage at -18°C for 60 days as influenced by a washing steps and frozen storage are given in Table (1). During storage, the ash content increased after 30 days of storage under freezing conditions and the continued of the ash content in increasing for the all tested samples with extended the storage period. The ash content values of the tested surimi products were 0.39, 0.30 and 0.17% at zero time. Then these values increased to 0.64, 0.53 and 0.24% after 60 days for surimi produced from common carp, kawakawa tuna and little tuna fish, respectively. The increase in ash contents of fish products during frozen storage might be attributed to the loss recorded in the concentration of protein and fat content which reflected the increasing found in ash contents. On the other hand some studies showed a decreasing in ash content of fish during frozen storage which was attributed to the drip loss during thawing process [26].

**Table (1). Changes in chemical composition (on wet weight basis) of fish surimi as affected by frozen storage.**

| Storage period (days) | Fish surimi | | |
|---|---|---|---|
| | Common carp | Kawakawa tuna | Little tuna |
| | Moisture content (%) | | |
| 0 | 80.96±0.42 | 91.54±0.67 | 91.66±0.12 |
| 30 | 80.73±0.25 | 90.52±0.37 | 91.38±0.22 |
| 60 | 79.55±0.28 | 90.49±0.32 | 90.87±0.36 |
| | Protein (%) | | |
| 0 | 15.61±0.75 | 8.30±0.47 | 7.99±0.47 |
| 30 | 15.28±0.92 | 8.16±0.30 | 7.84±0.82 |
| 60 | 14.15±0.43 | 7.99±0.37 | 7.72±0.81 |
| | Fat (%) | | |
| 0 | 3.28±0.32 | 0.87±0.32 | 0.84±0.39 |
| 30 | 3.24±0.25 | 0.67±0.38 | 0.66±0.33 |
| 60 | 2.97±0.10 | 0.66±0.27 | 0.38±0.12 |
| | Ash (%) | | |
| 0 | 0.39±0.42 | 0.30±0.61 | 0.17±0.14 |
| 30 | 0.58±0.23 | 0.37±0.49 | 0.21±0.33 |
| 60 | 0.64±0.13 | 0.53±0.31 | 0.24±0.57 |

Data are expressed as means ± standard deviation (n=3).

### 3.2. Physicochemical quality parameters of fish surimi samples as affected by frozen storage

Effect of different types of fish and frozen storage at -18 °C on the changes of pH, TVBN, TMA and TBA values of fish surimi samples during storage under freezing condition are presented in Figures (1, 2, 3 and 4).

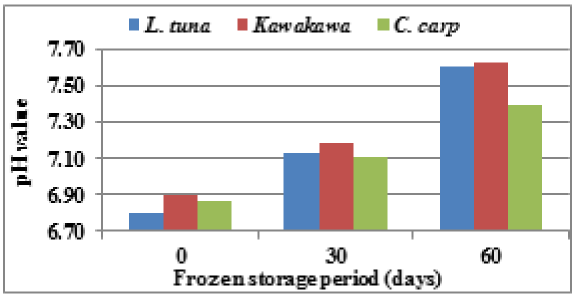


Figure (1). Changes in pH values of fish surimi during frozen storage at -18°C for 60 days.

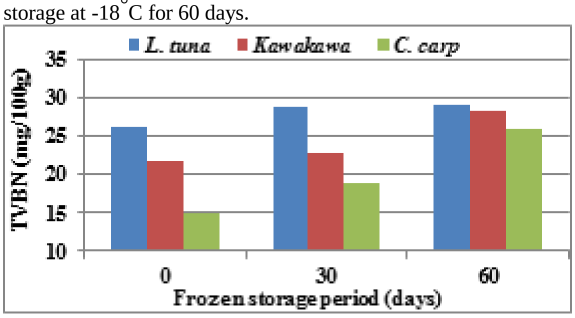


Figure (2). Changes in total volatile bases nitrogen (TVBN) values of fish surimi during frozen storage at -18 °C for 60 days.

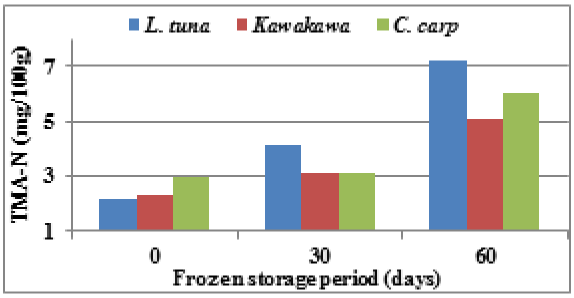


Figure (3). Changes in trimethylamine nitrogen (TMA-N) values of fish surimi during frozen storage at -18 °C for 60 days.

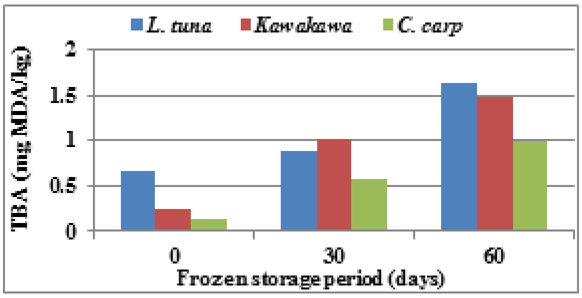


Figure (4). Changes in thiobarbituric acid (TBA) values of fish surimi during frozen storage at -18 °C for 60 days.

The values of pH, TVBN, TMA and TBA of little tuna, kawakawa tuna and common carp fish surimi increased during frozen storage tile reached to (7.60, 7.63, 7.40), (29.10, 28.19, 25.81 mg/100g), (7.23, 5.11, 6.04 mg/100g) and (1.62, 1.47, 0.98 mg MDA/kg); respectively at the end of frozen storage (Fig.1, 2, 3 and 4). While, the corresponding values for the common carp fish surimi samples which had the lowest pH, TVBN, TMA and TBA content at the beginning of frozen storage (6.86, 14.93, 2.96 mg/100g and 0.120 mg MDA/kg respectively), to the end of frozen storage period after 60 days. It was concluded that, there was an increment of pH, TVBN, TMA and TBA values with extended of frozen storage period.

While, it was noticed that the pH values of surimi processed from Alaska Pollock showed a slight variation ranged from 7.0 to 7.3 and there was no increment or decrement with extended of storage period [27]. The obtained results were in good accordance with those recorded in other studies which attributed the increases in pH values to proteolysis, derived from the action of microorganisms, resulting in formation and accumulation of basic compounds such as ammonia [28, 29]. The increasing in TVB-N during frozen storage of fish surimi may be due to the breakdown of some nitrogenous components by microbial activity. These data are in parallel with those recoded by Huidobro et al. [30]. On the other hand, the initial and the final TVB-N values of common carp samples did not exceed the upper acceptability limit after 60 days of storage under freezing conditions. These samples (common carp fish surimi) had good levels TMA-N for accepting after the storage period. The increasing in TMA-N values might be due to the increasing of microbial content and enzyme activities specify to fresh samples. These results are in harmony with those obtained by Qing et al. [31].

Results presented in Figure (4) revealed a slight increase in thiobarbituric acid (mg malonaldhyde/ kg sample) for common carp surimi product during storage, but the most increase was in surimi manufactured from kawakawa and little tuna fish. Thiobarbituric acid values were 0.120, 0.249 and 0.654 (mg MDA/kg sample) at zero time of storage period for common carp, kawakawa and little tuna, respectively. The values of TBA were 0.986, 1.479 and 1.623 (mg MDA/kg sample) for the same treatments, respectively, at the end of storage period. Acceptable levels for these samples were still constant after 60 days of storage.

The increment of (TBA) values can be mainly due to the effect of lipolytic enzymes action which specific for kawakawa and little tuna fish surimi samples. These results are in coincidence with those given by Bennour et al. [32].

### 3.3. Sensory evaluation of fish surimi as affected by frozen storage

Effect of different types of fish and frozen storage on the changes of sensory attributes of fish surimi samples during storage under freezing condition are presented in Table, 2.

**Table (2). Sensory evaluation of different type of fish surimi as affected by frozen storage.**

| Sensory parameters | Storage period (days) | Fish surimi | | |
|---|---|---|---|---|
| | | Common carp | kawakawa tuna | Little tuna |
| Appearance | 0 | 8.80 | 8.90 | 9.00 |
| | 30 | 8.60 | 8.80 | 8.90 |
| | 60 | 8.10 | 8.30 | 8.50 |
| Flavor | 0 | 8.20 | 8.60 | 8.80 |
| | 30 | 8.15 | 8.30 | 8.40 |
| | 60 | 8.10 | 8.19 | 8.10 |
| Taste | 0 | 8.30 | 8.50 | 8.70 |
| | 30 | 8.10 | 8.20 | 8.50 |
| | 60 | 8.05 | 8.10 | 8.20 |
| Tenderness | 0 | 8.30 | 8.44 | 8.75 |
| | 30 | 8.25 | 8.35 | 8.30 |
| | 60 | 7.79 | 7.90 | 8.00 |
| Juiciness | 0 | 7.70 | 7.90 | 8.00 |
| | 30 | 7.10 | 7.20 | 8.20 |
| | 60 | 7.10 | 7.20 | 8.20 |
| Overall acceptability | 0 | 7.60 | 7.80 | 8.00 |
| | 30 | 7.40 | 7.50 | 7.90 |
| | 60 | 7.10 | 7.20 | 7.50 |

Generally, the score of sensory evaluation presented by the panel of judges to appearance, flavor, taste, tenderness, juiciness and overall acceptability varied between common carp, kawakawa tuna and little tuna fish surimi. The sensory attributes of fish surimi recorded by the assessors decreased as the storage interval extended. The results indicated that little tuna fish surimi was the best type followed by kawakawa tuna and common carp fish surimi (Table, 2). In addition, no clear changes occurred in taste, flavor, tenderness, and appearance of surimi after 30 days of frozen storage. Moreover, the tenderness of fish surimi got stiff and get lower score in flavor, appearance and overall acceptability at the end of frozen storage.

## 4. Conclusions

This study recommended that the frozen surimi product manufactured from common carp, kawakawa, and little tuna fish gain high nutritional value as a cheap product and according to approximate composition and physicochemical quality criteria, fish surimi processed from common carp was the best type and higher stability during storage followed by kawakawa and little tuna fish. Effect of freezing at -18°C for two months on the fish surimi quality properties varied between fish species and depended on the functional properties of fish muscles.

## 5. Conflicts of interest

**The authors declare that they have no conflicts of interest.**

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