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Frozen fish chips properties processed from some economic underutilized fish species

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ABSTRACT

The Egyptians have experienced rapid changes in food habits in the present day. Light food is an interesting food, but its food contribution has been negligible. The main objective of this investigation was to produce fish chips from some economic underutilized fish species e.g. common carp, kawakawa and little tuna and evaluate the physiochemical, microbiological and sensory quality properties for these products during frozen storage for three months at -18°C. Obtained results indicated that the values of pH, TVBN, TMA and TBA were increased during storage period at -18°C in all samples. *Staphylococcus aureus*, and *E. coli*, were not detected during storage and both of the total bacterial count and total coliform values were decreased till the end of storage period of fish chips samples. Sensory evaluation show didn't significantly change ($p>0.05$) in all different types of fish chips samples until the end of storage period. Concluded from this study that the frozen fish chips produced from common carp, kawakawa and little tuna fish gain high organoleptic acceptance as a cheap product and can help to solve the problems of malnutrition and protein deficiency especially in pre-school children and adolescents. According to sensory evaluation results, fish chips processed from kawakawa was the best type followed by common carp and little tuna fish.

INTRODUCTION

Egypt has a valuable heritage of a well-established and balanced diet which persisted practically unchanged for the best part of 5000 years. Nowadays there are notably increased worldwide for production and consumption of snacks food which become popular with all ages and social groups (Hassan, 2004). Development of novel products from new sources becomes imperative to capture the flavor of different people with different food habits. Light and crunchy foods rich in nutrition and healthy for the body is desired by consumers (Rohani, *et al*., 2010). Fish chips are popular snack foods in the world which are usually processed from marine and freshwater fish minces with starch or flour, water, salt, sugar and monosodium glutamate as flavor enhancer, then they are shaped, boiled or steamed to gelatinize, sliced, dried and packed in polyethylene bags till consumption after frying (Siaw, *et al*., 1985, Huda *et al*., 2009; Latip *et al*., 2013 and Zzaman, *et al.*, 2017).

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There are many studies on the production of fish chips from different fish species, but there is no one produced fish chips from kawakawa and little tuna fish. Shaltout (1993) prepared fish chips from wheat flour and minces of cod (*Gadus morbua*) at a flour to fish ratio of 90-10, 80-20 and 70-30. İzci, *et al.*, (2011) studied the changes in some quality parameters of fish chips produced from sand smelt (*Atherina boyeri*) stored at -18°C for 6 months. Neiva, *et al*., (2011) developed sensory acceptable, high nutritional value fish crackers stored for 180 days at room temperature. Duman, *et al.*, (2012) used 5, 10 and 15% surimi powder in processing fish chips and determined chemical composition and sensory quality. Netto, *et al*., (2014) concluded that, the inclusion 20-40% of Nile tilapia fish mince in snacks didn't affect their physicochemical quality, while, the inclusion of 40% caused a decrease in the overall acceptance of the snacks, but the absolute values indicate that the product is acceptable by consumers. Chen, *et al*., (2016) investigated the quality and acrylamide content of deep-fried and microwave-puffed shrimp chips fortified with 0.1%, 0.5%, or 1.0% calcium salts (calcium lactate, calcium carbonate, calcium citrate, or calcium acetate). Ikasari and Hastarini (2016) investigated the utilization of shrimp shell powder in the production of lindur fruit-potato simulation chips. Justen, *et al*., (2016) developed extruded snacks including flour obtained from Nile tilapia carcasses, and then evaluated the chemical composition, colorimetry, thiobarbituric acid reactive substances, and microbiology. İzci and Bilgin (2016) produced fish chips using *Carassius gibelio* and investigate the fatty acid profile and sensory quality of the fish crackers. Mahmoud, *et al*, (2016) produced silver carp fish chips and stored it at -18±2ºC for three months. Zzaman, *et al.*, (2017) processed fish chips from frozen bighead carp (*Hypophthalmichthys nobilis*), Rohu (*Labeo rohita*) and Dory (*Pangasius hypothalamus*). The aims of this study were to produce fish chips from some economic underutilized fish species e.g. common carp, kawakawa and little tuna and evaluate the physiochemical, microbiological and sensory quality properties of these products during frozen storage for three months at -18°C.

MATERIALS AND METHODS

Materials

Fish samples were collected from fish market in Sharqia and Alexandria Governorate, and transported in icebox to Fish Processing and Technology Laboratory, El-Kanater El-Khiria Fish Research Station, National Institute of Oceanography and Fisheries within 3 hours. About 300 kg of common carp fish (*Cyprinus carpio L.*), Kawakawa (*Euthynnus affinis*) and little tuna (*Euthynnus alletteratus*) with mean weights and lengths values (±SE) were (3856.67±218.80g and 55.83±0.83cm); (175.83±8.00g and 25.83±0.27cm) and (1194±59.71g and 45.70±0.79cm), respectively. Fish samples were prepared for processing under hygienic conditions, all fish samples were rewashed, beheaded, eviscerated, skin removed and filleted. Fish fillets were washed, drained, and subjected to chemical and physical analysis to determine the freshness parameters. Garlic and onion powder, black pepper, and red pepper were obtained from local market in Cairo.

Methods

Fish chips processing

Fish fillets samples were rewashed and minced using mincer machine Model TORNADO MG-2000- meat grinder. Minced Fish meat were put in polyethylene bags and stored at 4±1°C till processing. Fish chips were prepared by mixing minced fish meat with mashed potato and starch in different percentages depending on diagram shown in Fig. (1). The other ingredients added in same percentage for all formulas were 1.85% salt, 0.65% mono sodium glutamate, 0.5% sucrose, 1% spices mixture (black pepper and red pepper), garlic powder and onion powder and water was added in small amount.

Fig. 1: Processing steps of fish chips

All ingredients were mixed by electric stirring device for 2 minutes to obtain smooth dough, which shaped through packing in plastic bottles (4-5cm diameter length and 10 cm depth) filled with the produced dough manually were placed into a steam cook operator at 90 - 95°C for 45 - 60 minutes. The steamed dough were freshened in iced water and chilled at 4±1°C for 2 hr. (Fig. 1). These formulations were prepared as described by Bakar, *et al.,* (2001) and Kamari and Shabanpour (2013).

The refrigerated dough was cut into slices with thickness from 1 to 3 mm and were deep fried in vegetable oil at 170°C for 4 minutes in electric fryer to carry out the sensory evaluation for fried formulations and choose the best formulations then dried in oven at 70°C for 5 hr. until their moisture content reached to 38 - 40%. Dried fish chips were put in sealed plastic bags and stored at -18ºC for three months. Fish chips samples were subjected to organoleptic evaluation as "fried", as well as physicochemical and microbiological analysis, monthly.

Analytical methods

Physicochemical analysis

Moisture, crude protein, fat and ash contents were carried out according to the methods recommended by the AOAC (2000). The salt content of fish chips was determined by Mohr method as described by Kenkel (1994). Total volatile basic nitrogen (TVB-N) contents were determined according to the method described by Pearson (1976). While, the thiobarbituric acid (TBA) value was measured according to the method described by Tarladgis, *et al*., (1960). The pH value was carried out according to the procedure of AOAC (2000).

Sensory analysis

The sensory evaluation of fried fish chips was carried out according to Amerine, *et al.,* (1965); it was done in terms of color, tenderness, taste, flavor and overall acceptability. Fish chips was evaluated by 10 panelists from (National Institute of Oceanography and Fisheries, El-Kanater El-Khiria, Fish Research Station). A 9 point hedonic scale was employed in this sensory evaluate.

Statistical analysis

All measurements were performed in triplicate and values expressed as the mean ± SD. Statistical analyses were performed using SPSS 18.00 for Windows. Analysis of variance (ANOVA) was used and statistical significance was set at $p < 0.05$ to detect the significant effect between means during storage periods according to Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

Chemical composition and quality properties of processed fish chips

Moisture, protein, lipids and ash of common carp, kawakawa and little tuna fish chips at zero time were (68.76, 70.95, 63.13), (4.43, 1.92, 4.52), (1.08, 0.45, 1.30) and (2.54, 2.61, 3.18%); on wet weight respectively. Izci, *et al*., (2011) found that, moisture, fat, protein and ash analysis were performed for crude fish chips dough produced from sand smelt fish were 69.9, 1.97, 11.75 and 2.83%, respectively. While these parameters for pre-fried fish chips samples produced from sand smelt were 66.24, 5.24, 11.69 and 3.22%, respectively. Cortez Netto, *et al.*, (2014) produced fish snacks containing different inclusion levels (20, 30, and 40%) of minced fish obtained from Nile tilapia processing waste and found that, protein content, ash, water activity, and hardness increased with increasing inclusion of minced fish. The study demonstrated that, it is possible to include 20-40% of MF of Nile tilapia in snacks without affecting their physicochemical quality. Mahmoud, *et al*., (2016) found that, moisture content of raw fish chips in formulas B (50% fish, 25% potato and 20% starch); C (40% fish, 35% potato and 20% starch) and D (35% fish, 35% potato and 25% starch) and 5% other additives for all were 67.52, 67.38 and 63.25% respectively. The crude protein contents in raw fish chips ranged from 7.22 to 8.23% for formula D and C respectively. In the same trend, fish chips product was low fat and salt, it had crude fat ranged from 1.62% to 1.89% in formula C and B, while ash content was ranged from 2.14 for formula C to 2.28% in formula B. While, the pH, TVBN, TMA and TBA values of common carp, kawakawa and little tuna fish chips at zero time were (6.16, 6.44, 6.07), (11.38, 39.04, 43.94 mg/100g), (2.86, 10.86, 11.96 mg/100g) and (0.008, 0.009, 0.005 mg MDA/kg); respectively. Mahmoud, *et al*., (2016) concluded that, TVB-N value of raw fish chips ranged from 11.07 to 11.72 (mg N/100g); TMA-N value ranged from 0.84 to 1.13 (mg N/100g); tyrosine value ranged from 5.34 to 9.47 (mg /100g) and the TBA value as O. D was ranged from 0.02 to 0.06.

However, *Staphylococcus aureus* and *E.coli*, were not detected at zero time of fish chips. In addition, total bacterial count and total coliform of common carp, kawakawa and little tuna fish chips at zero time were (1.90, 2.16 and 2.09) and (1.98, 1.94 and 1.27), $\log_{10}$ cfu/g; respectively. Mahmoud, *et al*., (2016) reported that, the total bacterial count (TBC) in raw fish chips were 83, 70 and 85×10^3 cfu/g for B, C and D formulas, respectively.

The mean values of appearance, flavor, taste, tenderness, juiciness and overall acceptability of different types of fish chips indicated that kawakawa fish chips was the best type followed by common carp and little tuna fish chips (Table 1). Mahmoud, *et al*, (2016) found that, sensory quality of fish chips formulas were better than that of dried fish chips after frying in terms of color, tenderness, taste, flavor and overall acceptability of fish chips. In addition, the color, taste and flavor in all fried fish chips samples were good, full and moderately, respectively when the scores of these attributes over than 6 at least and lower than 8.5 at least. On the other hand, the texture of fried raw samples was slightly brittleness in (B) and (C) formulas since scores less 6 but it was moderately brittleness over than 6 such as found in (D) formula.

Table 1: Chemical composition and quality properties of processed fish chips.

Constitutes	Common carp	Kawakawa	Little tuna
Chemical composition			
Moisture (%)	68.76±0.23	70.95±0.42	63.13±0.16
Protein (%)	4.439±0.14	1.920±0.21	4.520±0.21
Lipids (%)	1.08±0.12	0.45±0.22	1.30±0.09
Ash (%)	2.54±0.07	2.61±0.07	3.18±0.11
Physicochemical quality criteria			
pH value	6.16±0.09	6.44±0.09	6.07±0.04
TVBN (mg/100g)	11.38±0.14	39.04±0.11	43.94±0.18
TMA (mg/100g)	2.86±0.03	10.86±0.03	11.96±0.08
TBA (mg MDA/Kg)	0.008±0.002	0.009±0.003	0.005±0.003
Microbiological quality criteria			
TBC (log^{10} cfu/g)	$1.90x10^4$	$2.16x10^4$	$2.09x10^4$
Total coliform (log^{10} cfu/g)	$1.98x10^4$	$1.94x10^4$	$1.27x10^4$
Staphylococcus aureus	nd	nd	nd
E.coli	nd	nd	nd
Sensory evaluation			
Appearance	8.5±0.65	9±0.63	7.5±1.41
Flavor	8±1.11	8.5±0.96	8±1.32
Taste	7.5±1.23	8±0.78	7.5±0.85
Tenderness	9±0.47	7.5±0.52	6.5±1.29
Juiciness	8±0.42	7±1.29	6.5±1.46
Overall acceptability	8±1.18	8.5±1.03	7±0.93

Data are presented as means ± standard deviation (SD).

Effect of frozen storage on Chemical composition and quality properties of processed fish chips:

During frozen storage moisture contents of common carp, kawakawa and little tuna fish chips decreased from 68.76, 70.95 and 63.13% at zero time to 66.56, 68.80 and 61.34% at the end of storage period; respectively (Fig. 2).

Protein and lipid contents of common carp, kawakawa and little tuna fish chips were increased during the first month of frozen storage then decreased until the end of frozen storage. Ash contents of common carp, kawakawa and little tuna fish chips increased during frozen storage from 2.54, 2.61 and 3.18% at zero time to 2.93, 2.95 and 3.44% at the end of storage period; respectively (Fig. 2). On the other hand, Mahmoud, *et al.,* (2016) found that, frozen storage of dried fish chips at -18°C±2 for 3 months had significant effect ($p<0.05$) on moisture and ash contents in all formulas, however, the differences not clearly in formula D. The moisture content of formulas B and C decreased after the 1st and 2nd month of frozen storage, then subsequently increased after 3 months of storage. Thus, there are no significant differences between the start and the end of frozen storage for both formulas. Whereas moisture content increased significantly ($p<0.05$) after 3 months of storage in formula D and reached to 39.59% at the end of storage.

The pH, TVBN, TMA and TBA values of common carp, kawakawa and little tuna fish chips increased during frozen storage tile reached to (7.89, 7.95, 7.98), (16.66, 48.14, 48.35 mg/100g), (4.52, 13.59, 13.62 mg/100g) and (0.426, 2.109, 2.103 mg MDA/kg); respectively at the end of frozen storage (Fig. 3). Mahmoud, *et al,* (2016) concluded that, the pH value of all dried formulas showed slight significant increment ($p<0.05$) and reached to 6.13, 6.10 & 6.02, respectively at the end of frozen storage at -18ºC for 3 months, however, the different significant ($p<0.05$) was only between samples at zero time and after the 3rd month of storage.

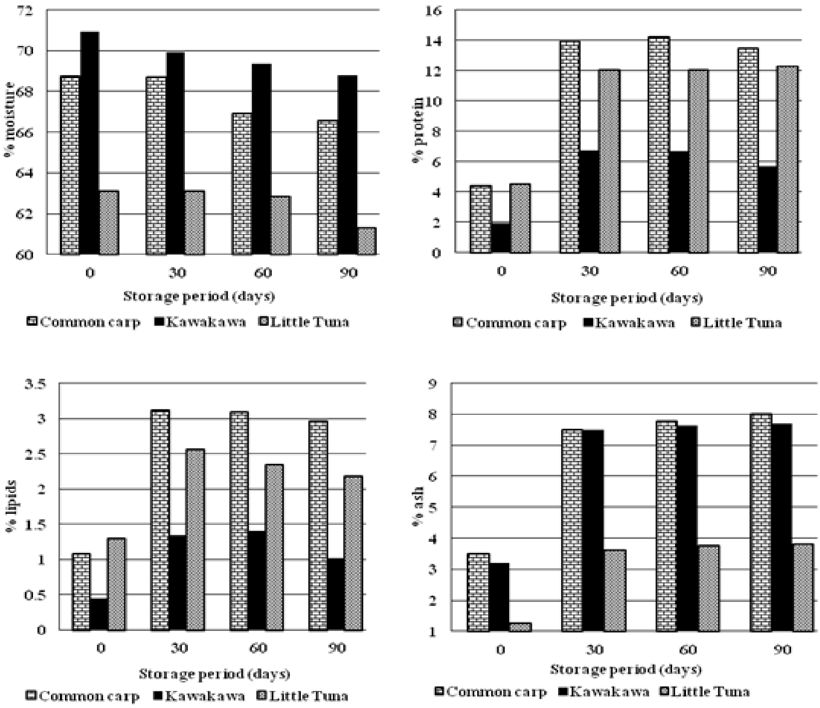

Fig. 2: Effect of frozen storage at -18°C for 3 months on chemical composition (%, w/w) of processed fish chips.

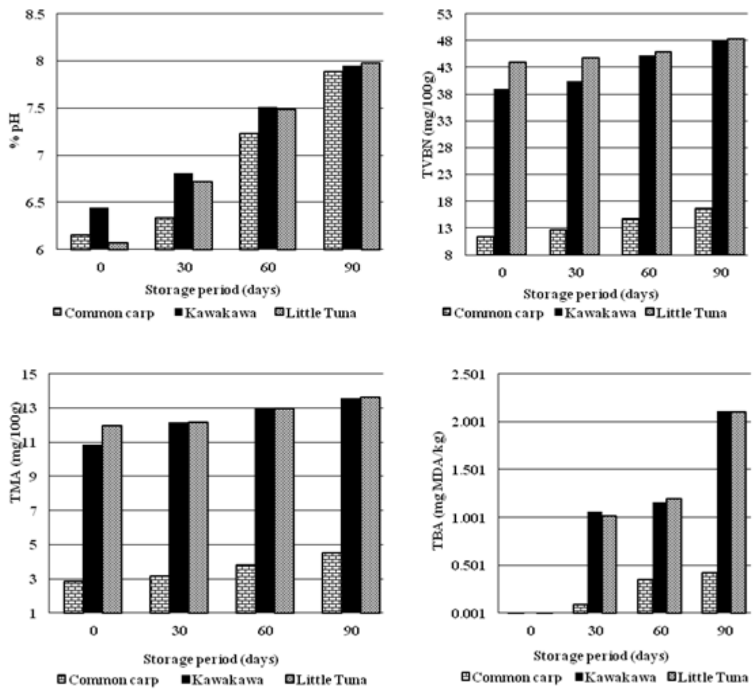

Fig. 3: Effect of frozen storage at -18°C for 3 months on physicochemical properties (%, w/w) of processed fish chips.

TBC of common carp fish chips was increased from 1.90 $\log_{10}$ cfu/g at zero time to 2.01 $\log_{10}$ cfu/g at the end of storage period. While, TBC of kawakawa and little tuna fish chips were decreased from 2.16 and 2.09 log_{10} cfu/g at zero time to 2.06 and 1.85 log_{10} cfu/g at the end of frozen storage; respectively. On the same way, total coliform of common carp, kawakawa and little tuna fish chips were decreased from 1.98, 1.94, 1.27 to 1.91, 1.89, 1.08 log_{10} cfu/g at the end of frozen storage; respectively (Fig. 4). In addition, all obtained results in this investigation did not exceed the maximum permissible levels as determined by the Egyptian Standard Specification for both freshwater and marine fish. Izci, *et al.* (2011) found that, the total mesophilic aerobic microorganisms of fish chips dough was 5.98 $1og_{10}$ cfu/g, and showed significant decline trend during frozen storage at -18°C for 6 months. Mahmoud, *et al*, (2016) reported that, the total bacterial count (TBC) values of total bacterial count and aerobic spore forming bacteria had significant decline trend after the 1st month of frozen storage. While, it was steady from the 2nd month till the end of frozen storage after 3 months.

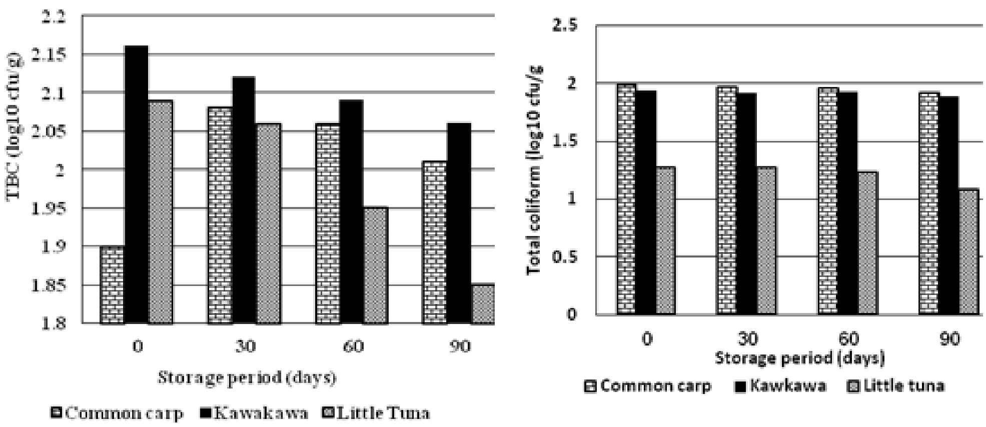

Fig. 4: Effect of frozen storage at -18°C for 3 months on microbial load of processed fish chips.

The changes of appearance, flavor, taste, tenderness, juiciness and overall acceptability of fish chips processed from common carp, kawakawa and little tuna during storage at-18°C for 3 months were illustrated in (Fig. 5). The obtained results explained the same trend of sensory parameters during frozen storage and fish chips processed from kawakawa was the best type followed by common carp and little tuna fish (Fig. 5).

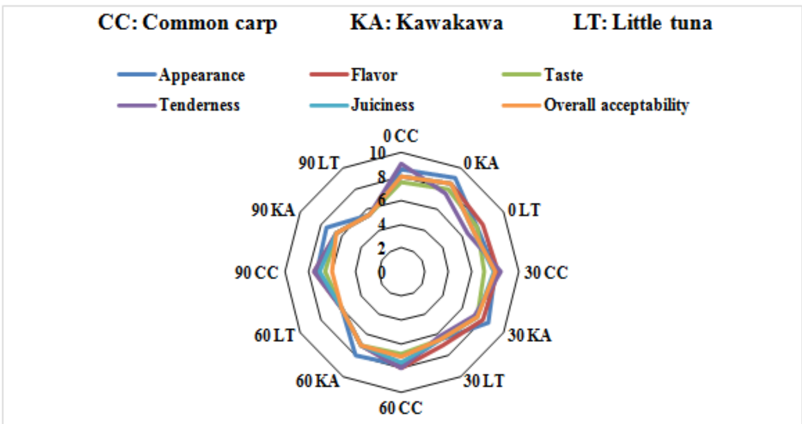

Fig. 5: Effect of frozen storage at -18°C for 3 months on sensory evaluation of processed fish chips.

During frozen storage the dried fish chips showed significant decline ($p<0.05$) in color, texture and general acceptability scores. Izci, *et al.*, (2011) noticed that sensory evaluation carried out for pre-fried fish chips according to general acceptability during storage period of zero time, 1st , 2nd , 3rd , 4th , 5th and 6th month, showed significant difference ($p<0.05$) between fresh sample 8.33 and 1st month (8.27) comparatively the end of period at 6th month (7.67), but not showed differences in 2nd , 3rd , 4th , 5th month. In general there was a statistically significant ($p<0.05$) decrease from the initial level of general acceptability at the end of the 6 months storage period.

CONCLUSION

The study concluded that the frozen fish chips produced from common carp, kawakawa and little tuna fish gain high organoleptic acceptance as a cheap product and according to sensory scores, fish chips processed from kawakawa was the best type followed by common carp and little tuna fish. Effect of frozen storage at -18°C for three months on the fish chips quality properties varied between fish species and depended on the functional properties of fish muscles.

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ARABIC SUMMARY

خصائص رقائق السمك المجمدة المصنعة من بعض الأنواع السمكية غير المستغلة اقتصاديا

محمد أبوطالب، عبدالرحمن سعيد تعلب، محمد عبدالهادى إبراهيم، مها إسماعيل جنينة، فيفى راغب أنيس، مصطفى مصطفى محمود، شيماء محمد أبوطالب

تحدث لدى المصريين تغيرات سريعة في العادات الغذائية في وقتنا الحاضر وتعتبر الأغذية الخفيفة من الأكلات الممتعة ولكن مساهمتها الغذائية كانت ضئيلة. لذلك يهدف البحث إلى دراسة إنتاج شرائح السمك من بعض أنواع الأسماك غير المستغلة اقتصاديًا على سبيل المثال المبروك العادى ، الكواكاوا والتونة الصغيرة وتقييم خصائص الجودة الفيزيائية والميكروبيولوجية والحسية لهذه المنتجات خلال تخزينها بالتجميد لمدة ثلاثة أشهر علي -١٨ درجة مئوية.

أشارت النتائج المتحصل عليها إلى أن قيم كلا من الـ pH و TVBN و TMA و TBA قد زادت خلال فترة التخزين على -١٨ درجة مئوية في جميع العينات .لم تكتشف كلا من المكورات العنقودية الذهبية ، و *E.coli*، أثناء التخزين ، وانخفض كل من العدد الكلى للبكتيريا والعدد الكلى للبكتيريا القولونية حتى نهاية فترة تخزين عينات رقائق السمك .بالإضافة إلى ذلك ، لم تتجاوز جميع النتائج التي تم الحصول عليها في هذه الدراسة الحد الأقصى للمستويات المسموح بها على النحو المحدد في المواصفات القياسية المصرية لكل من أسماك المياه العذبة والأسماك البحرية .لم تظهر نتائج التقييم الحسي أى فروق معنوية ملحوظة ($p> 0.05$) في جميع أنواع عينات شرائح السمك حتى نهاية فترة التخزين. وخلصت هذه الدراسة إلى أن رقائق السمك المجمدة المنتجة من المبروك العادى ، الكواكاوا وسمك التونة الصغير تحظى بقبول حسى عالي كمنتج رخيص يمكن أن يساعد في حل مشاكل سوء التغذية ونقص البروتين خاصة في المراهقين والأطفال في سن ما قبل المدرسة ، ووفقًا لنتائج التقييم الحسى، فإن رقائق السمك المجهزة من أسماك الكاواكاوا هي أفضل الأنواع تليها المجهزة من أسماك المبروك العادى ثم أسماك التونة الصغيرة.