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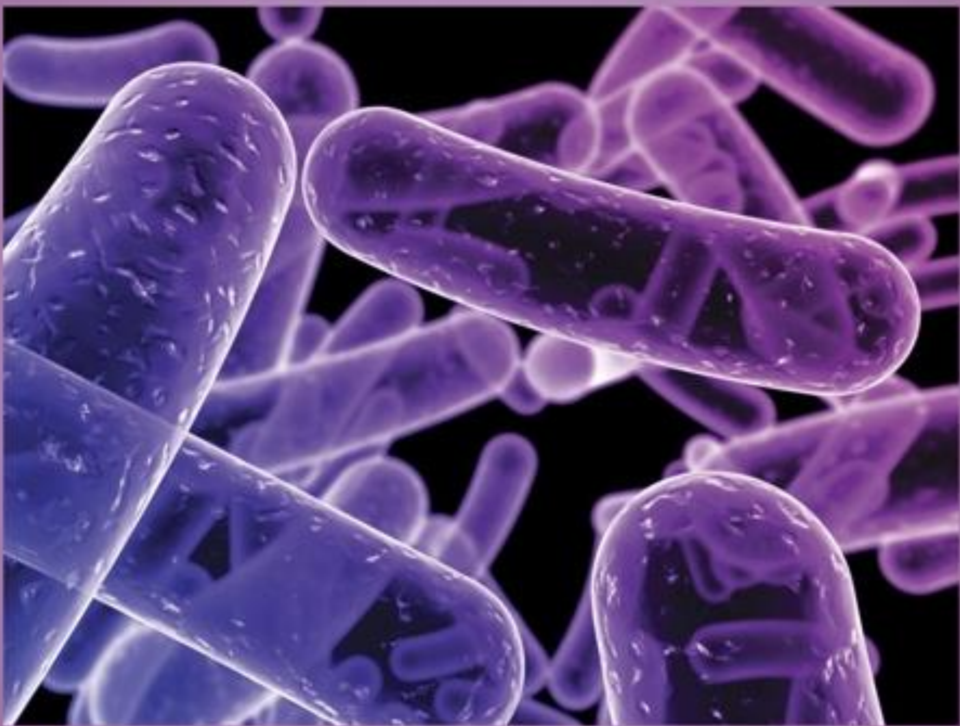

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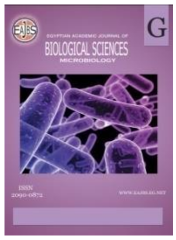

Effect of Frozen Storage on The Quality Properties of Common Carp Fish Fingers

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ABSTRACT

This study aims to compare the effect of using some different fillers (starch, rice groats, bean and soybean flours) on proximate analysis, physicochemical, microbiological and sensory characteristics of fingers samples that produced from common carp fish and stored at -18°C. The results showed that, the chemical composition of common carp fish fingers processed using starch, rice, groats, bean and soybean at zero time were as follows: moisture content (58.41, 60.08, 63.58, 65.87, 68.98%), crude protein (20.38, 15.29, 17.84, 19.45, 18.46%), lipids content (13.32, 11.55, 10.50, 10.64, 10.01%) and ash content (3.46, 3.64, 3.03, 3.61, 2.50%), respectively. On the other hand, moisture and ash showed significantly increase with prolonging freezing period, while protein, lipids and total bacterial counts were significantly decreased. Total volatile basic nitrogen content, pH values, thiobarbituric acid and trimethylamine were increased ($p<0.05$) significantly during frozen storage but not exceed the MPL. According to sensory evaluation fish fingers processed using soybean flour followed by starch, groats, bean and rice flour.

INTRODUCTION

Fish fingers is one of the nation's favorite foods, the most popular and preferred fish products among many different age groups, due to its delicious taste as a ready-to-cook product (Talab and Abou-Taleb, 2021). Several studies have been conducted to achieve the quality improvement and the shelf-life extension of fingers produced from common carp fish. Schubring (2000) studied the sensory evaluation and texture of fish fingers produced from 13 various fish species. Cakli *et al*., (2005) examined sardine, whiting and pike perch for the possibility of fish finger production. Also, the effects of frozen storage at -18°C on the qualities of mirror carp fish fingers produced from unwashed and washed mince were investigated (Tokur *et al*., 2006). Fish fingers made from common carp were examined by Elyasi *et al*. (2010) for changes in their chemical, microbiological, and sensory quality. On the other hand, Abdou et al. (2012) investigated the impact of various chitosan concentrations and chitosan nanoparticles as active coating on the microbiological parameters of fish fingers stored in frozen condition at -18 °C. The efficacy of ginger oil (0.5% and 1%) on sensorial and chemical quality and production of fish fingers mad from *Sarda sarda* were examined by Çoban (2013). Rezaei and Hedayatifard (2013) examined big head carp fish fingers using different formula.

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A three-component mixture design was used to investigate the effect of various components of breadcrumbs, textured soy protein and low-methoxyl pectin and their interactions on textural properties of an existing fish finger (Shaviklo, and Fahim 2014). Mostafa *et al*., (2017) produced fish finger from little tuna fish using starch, rice flour, bourghul and soybean flour at stored it at -18°C.

Many reports have focused on using natural antioxidants during processing fish fish fingers e.g. (Abdeldaiem *et al*., 2017) studied the impact of cinnamon, rosemary, cardamom and fennel essential oils on sensory, chemical and microbiological properties of carp (*Cyprinus carpio*) fish fingers through refrigerated storage at 4 °C. Also, the antioxidant and antimicrobial potential of kiwifruit, sage and clove peel extracts as well as their mixture were examined as natural preservative substances for fish fingers (Abdel-Wahab *et al*., 2020). Recently, Talab and Abou-Taleb, (2021) studied the efficacy of some hydrocolloids on the quality characteristics of fish fingers mad from common carp.

Thus, this study aims to compare the effect of using different carbohydrate sources e.g. starch, rice flour, groats, bean and soybean flour on the sensorial properties, proximate analysis, physicochemical, and microbiological characteristics of fish fingers mad from common carp during frozen storage at -18 °C.

MATERIALS AND METHODS

Common carp (*Cyprinus carpio*) fish samples were obtained from the local fish market, in Cairo city, Egypt. The fish samples were put in an ice box and transferred to the fish processing technology laboratory, fish research station, El-Kanater El-Khiria, National Institute of Oceanography and Fisheries. Sunflower oil, starch, rice, groats, bean, sodium chloride, onion powder, garlic powder and spices mixture (black pepper, cumin, cardamom, ginger, cloves, cubeb, coriander and red pepper) were purchased from the local market. Soybean flour was obtained from Food Technology Research Institute, Agriculture Research Center at Giza Governorate, Egypt

Preparation of Fish Fingers:

Fish samples were manually washed, deboned and cut into small pieces. These pieces were washed again to remove any blood traces and then drained for a few minutes. The fish meat was ground using a laboratory universal kitchen machine (Varimix-Spomoasy, Poland). Fish fingers were prepared by mixing: 70% minced fish meat, with 8% vegetable oil, 15% starch (T1) as the control sample, 15% rice flour (T2), 15% groats (T3), 15% bean (T4) and 15% soybean flour (T5). The rest of the ingredients are represented in 2% sodium chloride, 2.5% onion, 0.5% garlic and 2% spices mixture to produce fish finger samples (Chandrasekhar and Mohite, 1978) with some modification. The spices mixture consisted of 42% black pepper, 23% cumin, 18% all spices, 5% ginger, 5% cardamom, 2% cubeb, 2% clove, 2% coriander and 1% red pepper. The control and treated samples were packed in polyethylene bags and kept frozen (at - 18° C). During freezing storage, the samples were examined at 0, 1, 2 and 3 months for physiochemical, microbiological and sensory evaluation.

Physicochemical Analysis

Moisture, crude protein, fat and ash contents of the fish finger were determined as described by A.O.A.C. (2012). The pH value was determined as described by Egbert *et al.,* (1992). Total volatile basic nitrogen (TVB-N was determined according to the method described by Pearson (1976). Trimethylamine-nitrogen (TMA-N) was determined as described in AOAC (2012). Thiobarbituric acid (TBA) is determined spectrophotometrically according to the procedure described by Tarladgis *et al.* (1960). The total bacterial count (TBC) and total spore-forming bacterial count were determined by using a nutrient agar medium as described by (Oxoid, 2006). Sensory evaluation of fried fish finger samples was evaluated by 10 panelists (from the National

Institute of Oceanography and Fisheries- El-Kanater El-Khiria branch). A 9-point hedonic scale was employed in this sensory analysis by Teeny and Miyaauchi (1972).

Data were expressed as the mean values of three replicates and standard deviations were statistically analyzed by performing analysis of variance technique (ANOVA) using the statistical analysis system according to SAS, (2008). Differences among means were compared using Duncan's multiple range test (1955) at a significant level of 95% (P≤0.05).

RESULTS AND DISCUSSION

Proximate Analysis of Fish Fingers:

Proximate analysis of common carp fish fingers processed using starch, rice, groats, bean and soybean at zero time were as follows: moisture content (58.41, 60.08, 63.58, 65.87, 68.98%), crude protein (20.38, 15.29, 17.84, 19.45, 18.46%), lipids content (13.32, 11.55, 10.50, 10.64, 10.01%) and ash content (3.46, 3.64, 3.03, 3.61, 2.50%), respectively.

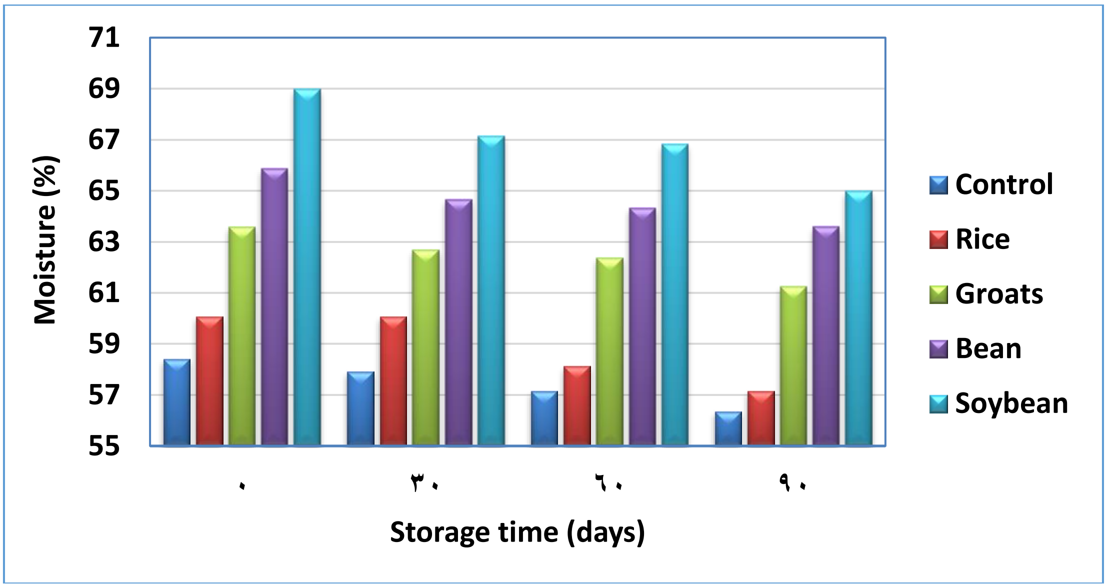

Fig. 1. Changes in moisture content of common carp fish fingers stored at -18°C.

Fig. (1) shows the various changes in moisture content values of fish fingers produced from common carp through froze condition storage at -18°C. It could be noticed that, there were a considerable difference in moisture content according to flour type. On the other hand, moisture content of frozen fish fingers with starch, rice, groats, bean and soybean were significantly decreased from 58.41, 60.08, 63.58, 65.87, 68.98% at zero time to 56.35, 57.15, 61.25, 63.59, 64.98% after three months, respectively. Similar results were found by Gandotra *et al*., (2012) and Mostafa *et al*., (2017) whom reported that, the decrement of moisture content values in fish fingers through storage under frozen condition may be due to the loss of water by evaporation or due to protein denaturation.

Crude protein content of common carp fish fingers stored at -18 °C are shown in Fig. (2). The results indicated that, there was a significantly decrease (p<0.05) recorded in protein content values of carp fish fingers during storage at -18°C. On the other hand crude protein content of carp fish fingers with starch, rice, groats, bean and soybean at zero time recorded 20.38, 15.29, 17.84, 19.45, 18.46% and it decreased to 16.80, 14.36, 18.23, 17.56, and 15.33%, respectively.

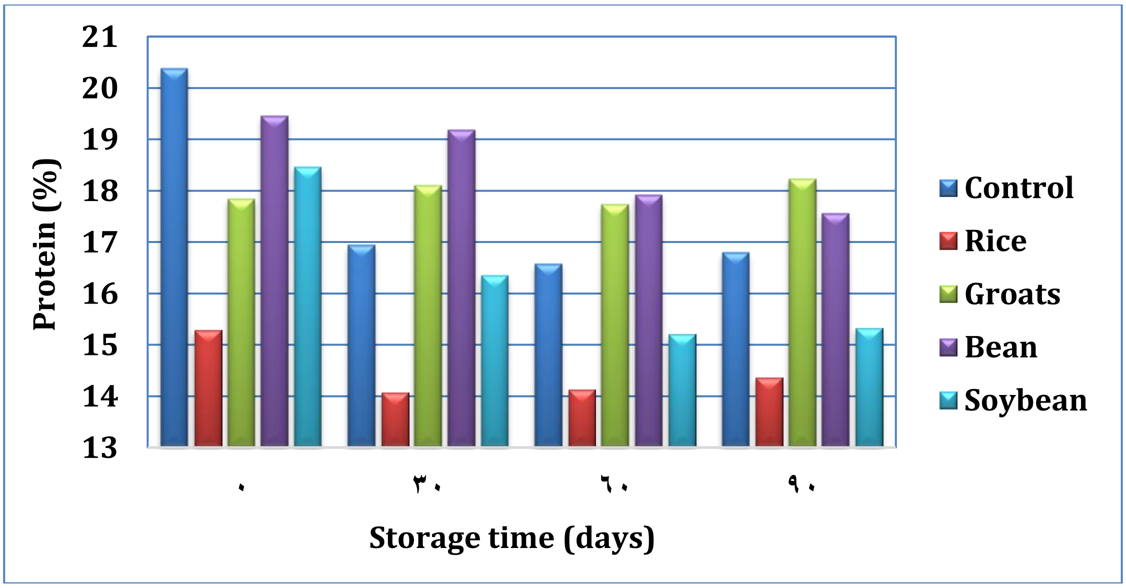

Fig. 2. Changes in protein content of common carp fish fingers stored at -18°C.

Similar findings were reported by Mostafa *et al*., (2017) and Talab &Abou-Taleb (2021) who reported that the decrease in crude protein content of frozen fish fingers may be due to protein hydrolysis by enzymatic proteolysis forming small nitrogenous compounds.

Lipid contents of frozen fish fingers mad from common carp were significantly ($p<0.05$) decreased in all treatment during the freezing period (Fig. 3). The highest values of lipid contents were recorded in starch and rice flour treatments. Lipid contents of carp fish fingers ranged from 13.32-12.77 (T1, starch), 11.55-11.05 (T2, rice), 10.50-10.37 (T3, groats), 10.64-10.40 (T4, bean), and 10.01-10.31% (T5, soybean), respectively.

The obtained results are in accordance with some previous studies reported by Gandotra, *et al*., (2012), Mostafa *et al*., (2017) and Talab &Abou-Taleb (2021), they attributed the decrease of lipid content during the freezing process of fish fingers to lipid hydrolysis and formation of some volatile compounds.

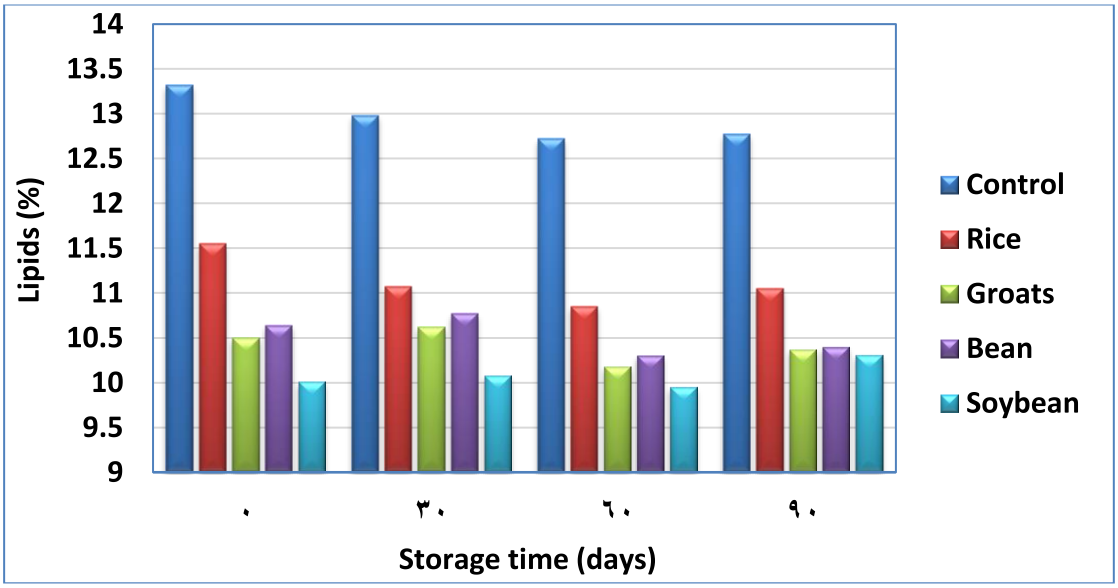

Fig. 3. Changes in lipid content of common carp fish fingers stored at -18°C.

In contrast, ash content of frozen common carp fish fingers showed a significantly ($p<0.05$) rise in all treatments (Fig. 4). The second trail (T2, rice) recorded the highest values (3.46%) of ash content followed by bean (3.61%), then starch (3.46%), groats (3.03%) and soybean (2.59%). The obtained data are similar with those reported by Mostafa *et al*., (2017) and Talab &Abou-Taleb (2021).

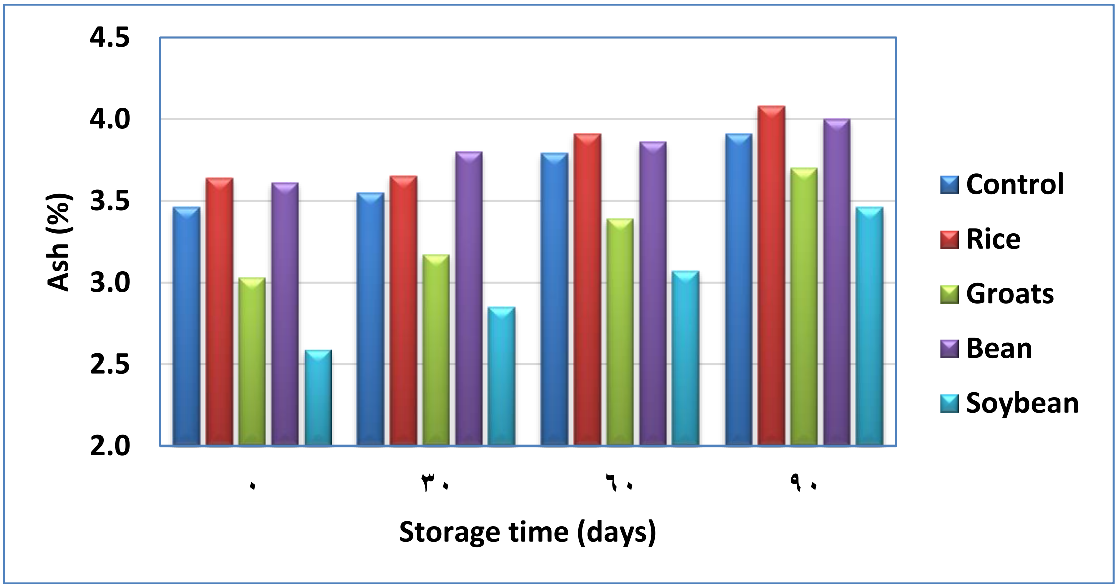

Fig. 4. Changes in ash content of common carp fish fingers stored at -18°C.

Physicochemical and Microbiological Properties of Common Carp Fish Fingers:

Fig. (5) shows the changes in pH value of frozen common carp fish fingers. The pH value of starch, rice, groats, bean and soybean fish fingers trails at zero time recorded 6.17, 6.21, 6.23, 6.19, 6.23 while it reached after three months of frozen storage to 8.25, 8.39, 8.42, 8.45 and 8.29, respectively.

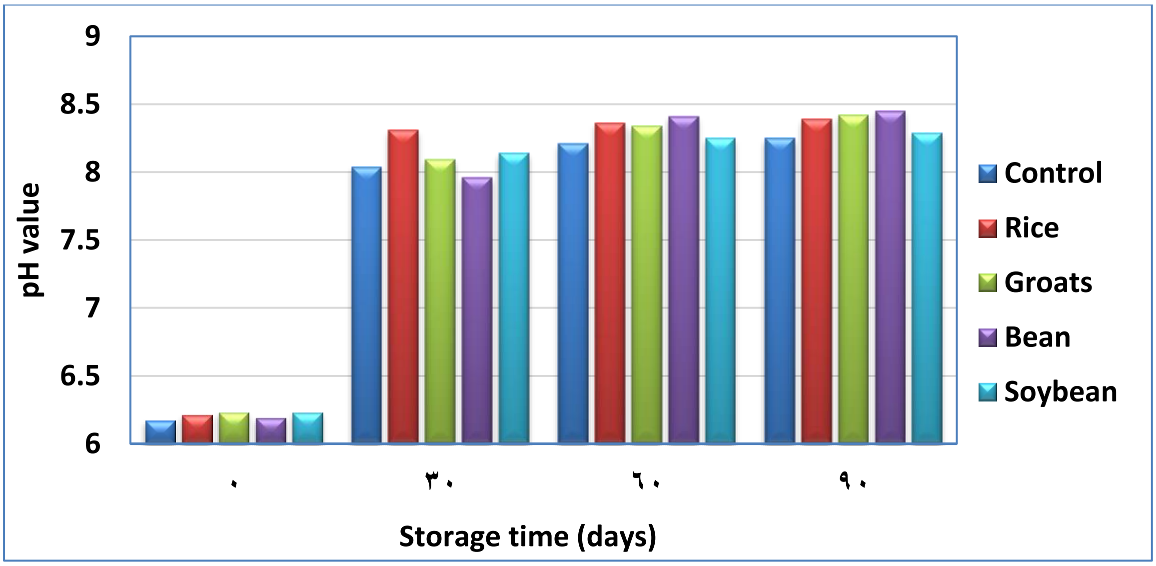

Fig. 5. Changes in pH value of common carp fish fingers stored at -18°C.

The obtained results showed that, pH values of frozen common carp fish fingers showed a significant increased ($p<0.05$) due to the glycogen breakdown causing lactic acid formation. These results agree with Bilgin *et al*., (2011) and Mostafa *et al*., (2017).

Total volatile basic nitrogen (TVBN) of frozen common carp fish fingers processed with starch, rice, groats, bean and soybean fish fingers trails at zero time recorded 12.21, 12.38, 13.14, 13.21, 14.27 (mg/100g ww), while it was significantly ($p<0.05$) increased to 17.70, 17.71, 17.32, 18.99, 18.95 (mg/100g ww), at the end of frozen storage, respectively (Fig. 6). TVBN values of frozen fish fingers mad from common carp recorded a significant ($p<0.05$) increased during frozen storage but not exceed the maximum permissible limits reported by Egyptian Standard Specifications. Our results agree with (Bengigirey *et al*. 1999, Bahar *et al*., 2004, Pandey and Kulkarni 2007, Ninan *et al*. 2010, Mahmoudzadeh *et al*.,2010, Vanitha *et al*., 2013, Mostafa *et al*., 2017 and Talab &Abou-Taleb, 2021).

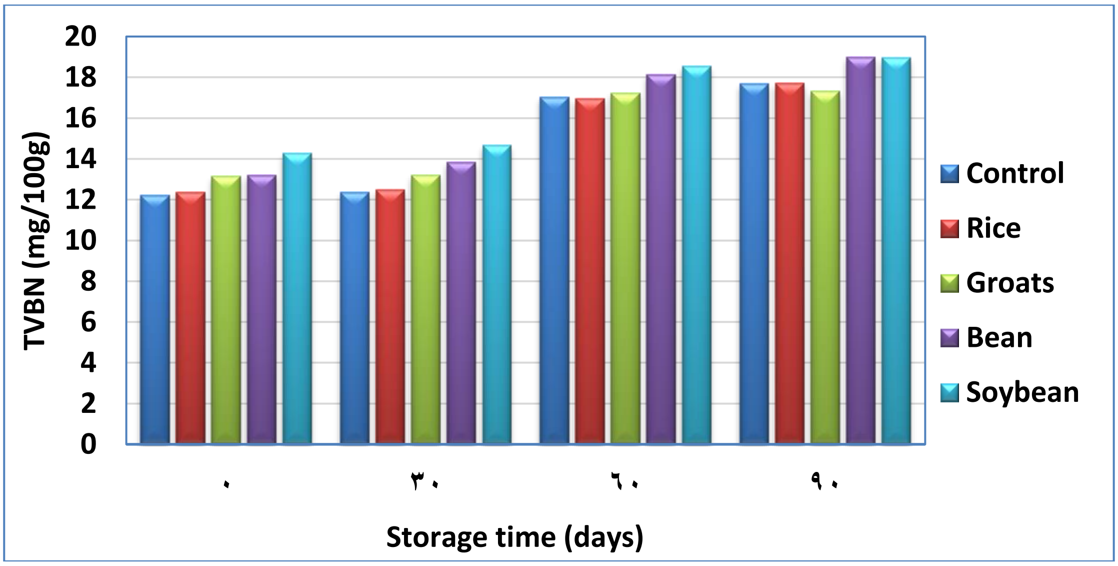

Fig. 6. Changes in TVBN (mg/100g ww) of common carp fish fingers stored at -18°C.

Trimethylamine (TMA) of frozen common carp fish fingers processed with starch, rice, groats, bean and soybean fish fingers trails at zero time recorded 2.89, 3.52, 3.94, 3.26, 4.19 (mg/100g ww), while it was significantly ($p<0.05$) increased to 6.65, 8.06, 7.98, 6.64, 5.99 (mg/100g ww), at the finish of frozen storage, respectively (Fig. 7). TMA values of frozen fish fingers mad from common carp recorded a significant ($p<0.05$) increment during frozen storage.

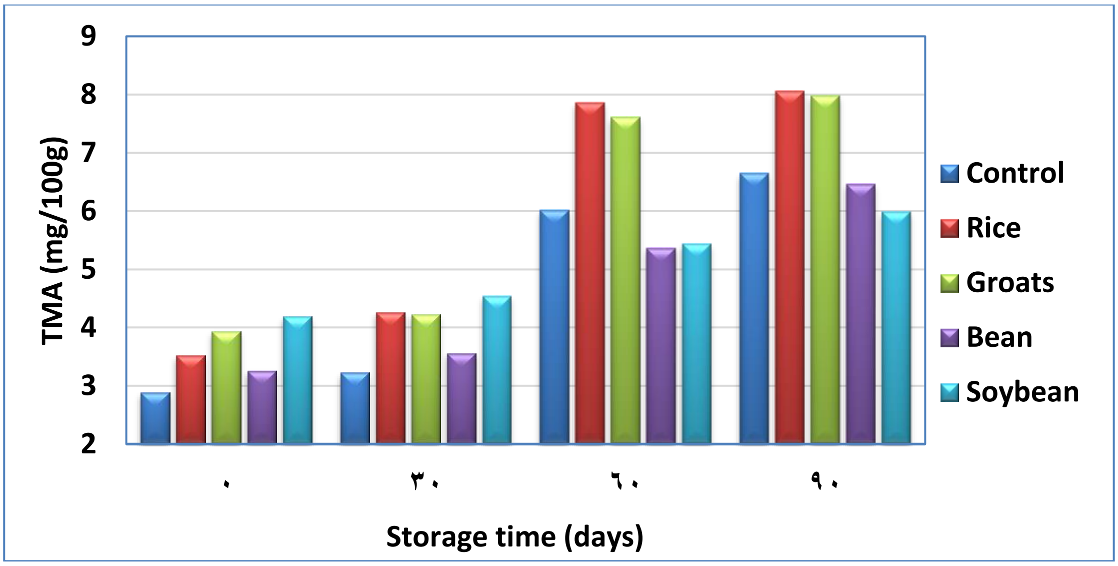

Fig. 7. Changes in TMA (mg/100g ww) of common carp fish fingers stored at -18°C.

These results were in good accordance with those revealed by (Talab, 2014), who mentioned that the values of TMA-N in carp fish cutlets showed a significant ($p < 0.05$) increment through the storage under frozen conditions. While Ježek and Buchtová (2011) reported that the TMA-N concentration was 9.32 mg/100g in fresh fish.

The value of thiobarbituric acid (TBA) is generally based on the reaction of TBA substance with malonaldehyde to produce a red pigment, that is produced when two molecules of TBA are condensed with one molecule of malonaldehyde and perhaps two molecules of water are eliminated. The value of thiobarbituric Acid (TBA) shouldn't be used as a standard indicator of rancidity because it might vary depending on species, age, diet and cooked or raw meat (Fernandes et al., 1997). According to Schormuller (1969), the value of TBA which used to evaluate the level of oxidation must be less than 3 mg MA/kg in material that considered very good, must not be greater than 5 mg MA/kg in good material, and must not exceed 7-8 mg MA/kg in order to be considered acceptable.

Thiobarbituric acid value (TBA) of frozen common carp fish fingers processed with starch, rice, groats, bean and soybean fish fingers trails at zero time recorded 0.016, 0.030, 0.040, 0.060 (mg MDA/kg ww), while it was significantly ($p<0.05$) increased to 1.520, 1.530, 1.450, 1.470, 1.480 (mg MDA/kg ww), at the end of frozen storage, respectively (Fig. 8). TBA values of frozen common carp fish fingers recorded a significant ($p<0.05$) increment through storage under frozen conditions.

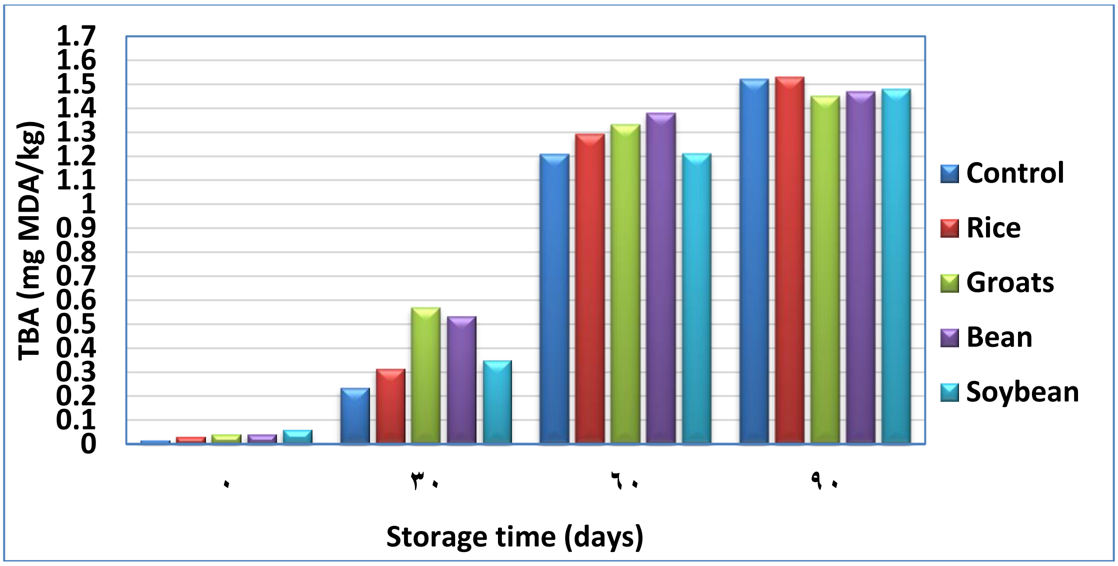

Fig. 8. Changes in TBA (mg MDA/kg ww) of common carp fish fingers stored at -18°C.

All fish finger samples were kept in acceptable limit values in this study. The recorded data were in accordance with those reported by (Vanitha *et al.*, 2013), they recorded that the TBA increased from 0.47 to 0.8 and 0.29 to 0.67 mg mal/kg in fish cutlet and fish burger produced from catla (*Catla catla*), respectively at the end of 90 days storage at -20 ºC. A significant increment in the TBA values through storage under frozen conditions has been recorded by Tokur *et al.* (2004) in fish burgers produced from tilapia and by Yanar and Fenercioglu (1999) in fish balls produced from carp. The same findings were recorded by Ninan *et al.* (2010) in fish cutlets which kept for 21 weeks at -20 °C. The TBA value of raw and cooked common carp cutlets showed significantly increment trend with frozen storage period advanced (Talab, 2014).

Total Bacterial Count (TBC) of frozen common carp fish fingers processed with starch, rice, groats, bean and soybean fish fingers trails at zero time recorded 1.93, 1.95, 1.91, 1.89, 1.91 (log cfu/g), while it was significantly ($p<0.05$) decrease to 1.90, 1.91, 1.89, 1.87, 1.88 (log cfu/g), at the end of frozen storage, respectively (Fig. 9). TBC values of frozen fish fingers produced from common carp recorded a significantly ($p<0.05$) decrease during frozen storage.

As a result of storage under Freezing condition, the loss of the ability of bacterial multiplication and in sub-lethal decreased, and it seems that this effect depends on the freezing temperature and composition of the bacterial community present (Al-Bulushi *et al.*, 2013).

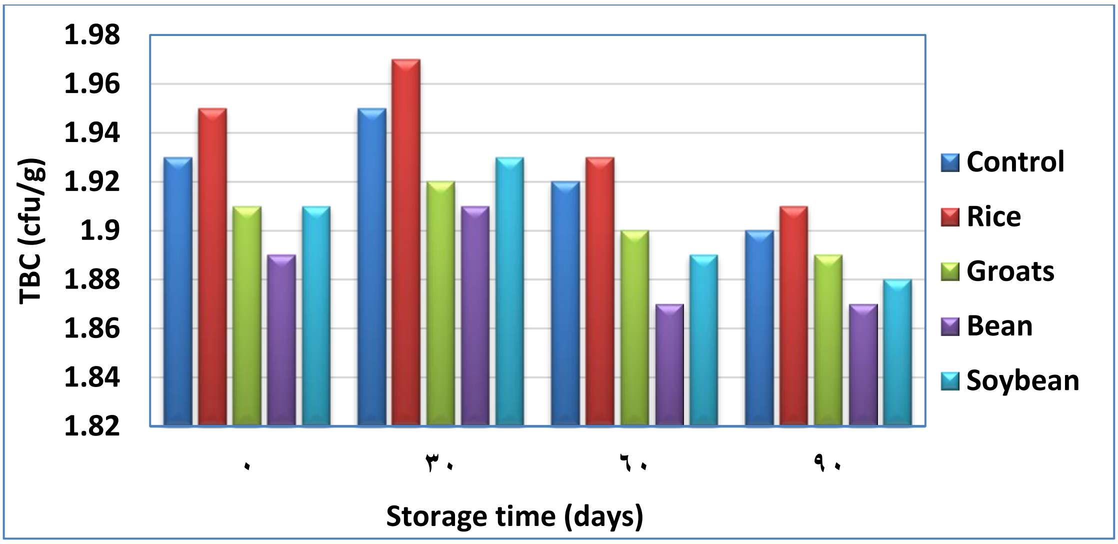

Fig. 9. Changes in TBC (cfu/g) of common carp fish fingers stored at -18°C.

Fig. (9) shows the microbiological changes of common carp fish finger samples during frozen storage temperature at -18 ºC. It was noticed that the initial TBC of the control sample (1.93 log cfu/g) and rice was the highest count compared with all treated samples and the lowest count was 1.89 log cfu/g for bean treatment. There was an increment after 1-month frozen storage in control sample and all treated samples. At the end of 3 months frozen storage TBC in all samples (control and treated) decreased and the lowest count was 1.87 log cfu/g for bean treatment while the highest count was 1.91 log cfu/g for the rice treatment sample.

The decrease of TBC during frozen storage was similar with the data obtained by Gandotra *et al*. (2012) who recorded that freezing of fish muscles slows down the growth of bacteria as well as decreases the biochemical decomposition of fish muscle. Vanitha *et al*. (2013) found that total bacterial count of fish burgers produced from catla (*Catla catla*) decreased from 3.16 x 10^4 cfu/g of the sample to 1.92 x 10^3 cfu/g of the sample during frozen storage. Al-Bulushi *et al*. (2013) reported that there were no changes in the bacterial load of the commercial fish sausage (CFS). Also, Rota and Gonzalez (2006) revealed that storage under frozen condition at -18 °C was not an effective factor in the bacterial count. However, Abd-El-Rahman (2002) recorded that there was an increment of total bacterial during storage for 6 months at -20 °C, and Al-Harbi and Uddin (2005) mentioned that aerobic plate count was reduced 2 log cycles after 1 month on hybrid tilapia at -20 °C.

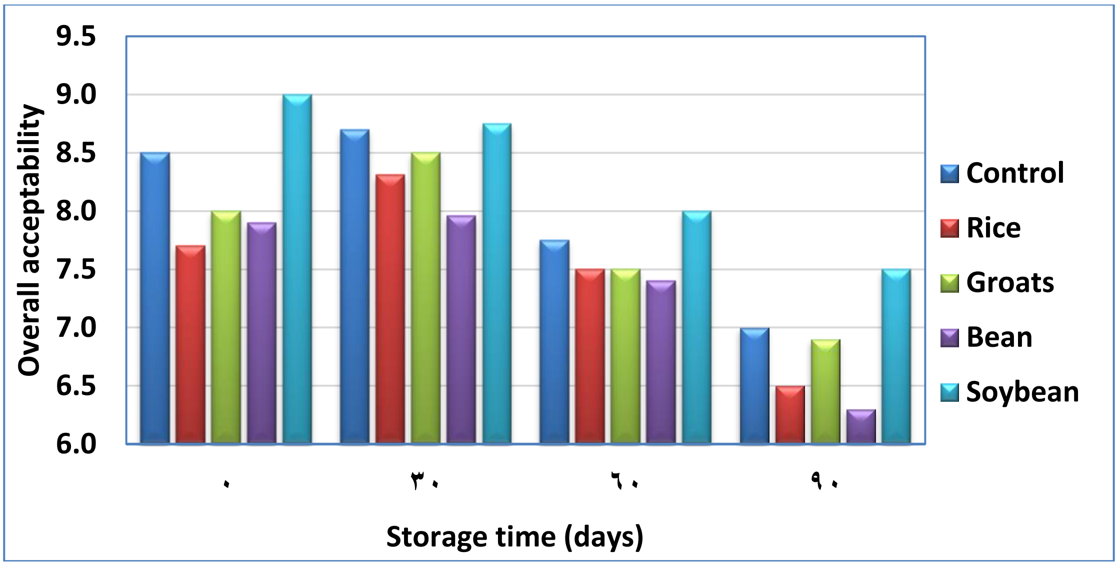

Fig. 10. Changes in overall acceptability of common carp fish fingers stored at -18°C.

Fig. (10) shows the overall acceptability of common carp fish fingers stored at -18 °C. The results indicated that, fish finger processed with soybean flour was the best trail followed by starch, groats, bean and rice flour, respectively.

Conclusion

The obtained results revealed that, frozen common carp fish fingers are processed using some different filler materials (starch, rice groats, bean and soybean flours) can stored at -18 °C. According to sensory evaluation fish fingers are processed using soybean flour was the best trail followed by starch, groats, bean and rice flour.

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ARABIC SUMMARY

تأثير التخزين بالتجميد على خصائص جودة أصابع أسماك المبروك العادى

عبد الرحمن سعيد تعلب،محمد عبد الهادى إبراهيم،مها إسماعيل جنينة،فيفى راغب أنيس
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تهدف هذه الدراسة إلى مقارنة تأثير استخدام بعض المواد المالئة المختلفة (النشا ، دقيق كلا من الأرز ، البرغل، الفول، الصويا) على التركيب الكيميائي والخصائص الفيزيائية والكيميائية والميكروبيولوجية والحسية لأصابع أسماك المبروك العادى والمخزنة على درجة حرارة -18°م. أظهرت النتائج أن التركيب الكيميائي لأصابع أسماك المبروك العادى المصنعة باستخدام النشا والأرز والبرغل والفول و الصويا في وقت الصفر كانت كما يلي: محتوى الرطوبة (58.41 ، 60.08 ، 63.58 ، 65.87 ، 68.98٪) ، البروتين الخام (20.38 ، 15.29 ، 17.84 ، 19.45 ، 18.46٪) ، محتوى الدهون (13.32 ، 11.55 ، 10.50 ، 10.64 ، 10.01٪) ومحتوى الرماد (3.46 ، 3.64 ، 3.03 ، 3.61 ، 2.50٪) على التوالي. ومن ناحية أخرى حدثت زيادة معنوية في الرطوبة والرماد بزيادة فترة التجميد ، بينما انخفضت نسبة البروتينات والدهون والعدد الكلى للبكتريا. كما حدثت زيادة معنوية فى قيم الأس الهيدروجيني والنيتروجين الكلى المتطاير وثلاثى ميثيل أمين ورقم الثيوباربتيوريك بشكل ملحوظ أثناء التخزين المجمد ولكن لم تتجاوز الحدود القصوى المسموح بها. وطبقا لنتائج التقييم الحسي فإن أصابع السمك المصنعة باستخدام دقيق فول الصويا كانت هى الأفضل يليها النشا والبرغل والفول ودقيق الأرز.