EFFECT OF FREEZING PRESERVATION PERIOD ON SOME SENSORY CHARACTERISTICS OF THREE IRAQI LOCAL FISH SPECIES

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ABSTRACT

The current study was conducted to determine the ideal period for freezing of three fish species of in the Iraqi local markets which are common carp *Cyprinus carpio* ,catfish *Silurus triostegus* and mullet *Planiliza abu* through sensory evaluation and the effect of freezing time on the flavor, juiciness and general acceptability of fish .A total of 20 samples, were taken for each species of fresh local fish and were frozen at 18°C for different freezing periods : 1 day (T2), 15 days (T3), 30 days (T4) and 45 days (T5) , in addition to the fresh treatment T1 that has not been subjected to freezing. Results of common carp showed that the best freezing time was recorded for treatments T2, T3 and T4 which attained 6.8, 6.6 and 6.2, respectively, for the flavor. The treatment T2, T3 and T4 were recorded 6.4, 6.8 and 6.6 respectively, for tenderness .The treatments T2, T3 and T4 were amounted 7.4, 6.6 and 6.6 respectively, for the Juiciness. Results of the general acceptance of treatments T2, T3 and T4 were 7.6, 7.2, 6.6 respectively. Results of the catfish and the mullet for flavor showed that the best freezing period was for the two treatments T2 and T3, which were 7.4, 6.4 in the catfish and 6.6 and 5.4 in the mullet respectively. T2 and T3 continued to be significantly superior to the freshness of the catfish and the mullet over T4 and T5 and it was 7.0, 6.4 for the catfish and 5.8, 5.6 for the mullet, respectively. T2 and T3 were superior for the juiciness of catfish by 7.0 and 6.6 and for mullet, 5.8 and 5.6 respectively. As for the trait of general acceptance, it was superior in the two treatments T2 and T3 for catfish and mullet and they were 7.4, 6.8 for catfish 6.8 and 6.4 for mullet respectively.

Key words: freezing, common carp, catfish , mullet, sensory evaluation.
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مجلة العلوم الزراعية العراقية -2022 :53(4):767-773 محمود و الخشالي

تأثير مدة الحفظ بالتجميد في بعض الصفات الحسية لثلاثة أنواع من الأسماك المحلية العراقية

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المستخلص

أجريت الدراسة لتحديد المدة المثالية لتجميد ثلاثة أنواع من الأسماك الموجودة في الأسواق المحلية العراقية وهي أسماك الكارب الشائع *Cyprinus carpio* وأسماك الجري *Silurus triostegus* وأسماك الخشني *Planiliza abu* من خلال تقييمها حسياً وتأثير مدة التجميد في النكهة والطراوة والعصيرية والتقبل العام للأسماك .اخذت 20 عينة لكل نوع من الاسماك المحلية الطازجة وتم تجميدها في مجمدة منزلية بدرجة حرارة −18م° لمدد تجميد مختلفة : 1 يوم (T2) ,15 يوم (T3) , 30 يوم (T4) و 45 يوم (T5) على التوالي إذ مثلت كل مدة تجميد معاملة بذاتها فضلا عن المعاملة (T1) الطازجة التي لم تتعرض للتجميد. أظهرت نتائج أسماك الكارب الشائع أن أفضل مدة تجميد سجلت للمعاملات T2 و T3 و T4 إذ بلغت 6.8 و 6.6 و 6.2 على التوالي لصفة النكهة . سجلت صفة الطراوة للمعاملات T2 و T3 وT4 : 6.4 و 6.8 و 6.6 على التوالي. سجلت صفة العصيرية للمعاملات T2 و T3 و T4 التالي 7.4 و 6.6 و 6.6 على التوالي. بلغت نتائج التقبل العام للمعاملات T2 و T3 و T4 : 7.6 و 7.2 و 6.6 على التوالي . بينت نتائج أسماك الجري وأسماك الخشني لصفة النكهة أن افضل مدة تجميد كانت للمعاملتين T2 و T3 وبلغتا 7.4 و 6.4 في الجري و 6.6 و 5.4 في الخشني على التوالي . استمر تفوق المعاملة T2و T3 معنوياً لصفة الطراوة لأسماك الجري وأسماك الخشني على T4 و T5 وكانت 7.0 و 6.4 للجري و 5.8 و 5.6 للخشني على التوالي . وتفوقت المعاملتان T2 و T3 لصفة العصيرية لأسماك الجري 7.0 و 6.6 وأسماك الخشني 5.8 , 5.6 على التوالي .أما صفة التقبل العام تفوقت في المعاملتين T2 و T3 لأسماك الجري والخشني وبلغتا 7.4 و 6.8 للجري و6.8 و 6.4 للخشني على التوالي.

الكلمات المفتاحية: التجميد، الكارب الشائع، الجري، الخشني، التقييم الحسي .
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INTRODUCTION

Fish is a rich source of important nutrients such as proteins, fats, vitamins and minerals (12). Fish is more protein source than any other animal source (13). Al-Azzawy and Al-Khshali (2) noted that in many parts of the world, fish is tops the diets of many peoples, as a good source of feeding . In addition, fish muscle is easier to digest than other animal proteins due to its lower level of connective tissue (17). Because of its great nutritional importance and its vulnerability to microbial corruption, several methods and means are available for preserving and circulating fish meat to maintain its quality, the most important of which is the freezing process. Freezing is one of the most common methods used in preserving fresh fish and other marine products (3). Frozen fish are not immune to physical, chemical and enzymatic changes, which eventually lead to making their meat in an undesirable state. Pourshamsian et al.(15) reported that texture, flavor and color are part of the quality indicators of fish meat that may deteriorate during the frozen storage process, and that the freezing period and temperature fluctuations are some of the factors that affect the reduction or loss of quality. It is necessary to know the effect of freezing and thawing on the muscles of frozen fish in order to choose preservation conditions and maintain the quality of fish to be acceptable to the consumer. The freezing process preserves the freshness of the product as it is kept at the beginning and extends its shelf life for different periods, and this depends on several factors such as the initial state of the fish, frozen species, and the time between harvesting and freezing (6) .Yerlikaya and Gokoglu (19) explained that protein denaturation may occur during cryopreservation by simply changing the nature of the protein in muscle tissue, thus affecting the water holding capacity, color, flavor and tenderness of frozen fish meat, as well as its general acceptability, because protein of the muscles is the main contributor to the distinctive characteristics of the structure of tight fish muscle tissue in edible muscle. As a result, proteins are more susceptible to spoilage and essential amino acids are more likely to be lost (5). Since determining the duration of freezing affected the final quality of frozen fish. The current study aimed to determine the ideal period for freezing three species of commercial fish in Iraq, Common carp *Cyprinus carpio*, Catfish *Silurus triostegus* and Mullet *Planiliza abu* by conducting a sensory evaluation process for their meat.

MATERIALS AND METHODS

This study was conducted in the Graduate Studies Laboratory at the College of Agricultural Engineering Sciences / University of Baghdad for a period of 45 days from 1/11/2020 to 15/12/2020. A total of samples of Common carp , Catfish weighing 1.5 kg and Mullet weighing 100g were purchased from the local market. Fish were washed, gutted, cleaned well and the samples were placed in freezer at 18°C for four periods: 1 day (T2), 15 days (T3), 30 days (T4) and 45 days (T5) with a fresh meat sample that has not been frozen (T1). After the end of each storage period, three replicates of fish of each species were taken, and a sensory evaluation process is conducted for the meat of the studied fish in full in each freezing period . Fresh fish were prepared after washing and cleaning with water. Common carp and Catfish were cut into equal size pieces and Mullet prepared for cooking by frying method without any additives in an electric air fryer at a temperature of 120 °C for 20 minutes. This method was used to cook the frozen samples for each freezing period. Sensory evaluation of the samples was conducted for each period by means of tests for flavour, tenderness, juiciness and general acceptability.

Flavor : It is a complex sensation that includes smell, taste, texture, temperature and pH. The natural flavor and aroma combine together to create that sensation that the consumer finds while eating, and it is one of the most important characteristics of the palatability of meat .These sensations depend on the smell through the nose and the tongue's sense of sweet, salty, sour and bitter taste, but the flavor of meat is also affected by the animal species , method of cooking and the method of preservation (11).

Tenderness : It is the most important factors that affect the viability and quality of meat , and it naturally depends on the strength of the

cut and the ease of chewing, which in turn depends on the amount of connective tissues and the amount of fat, as soft meat is more soft and palatable (18).

Juiciness : It is the amount of apparent juice that comes from the meat during chewing. The abundance of juice depends on the amount of water retained in the cooked meat product, as the abundance of juice increases the flavor and helps in softening the meat, making it easy to chew. The retention of water inside the meat and its content of lipids are determines its juiciness (11). Forms containing the required information's shown in (Tab.1) were distributed four arbitrators. The assessors were provided with detailed information about the nature of sensory assessment . Each judge put a score for each sample after evaluating the samples prepared from frozen fish meat after each freezing period. This degree represented the affinity found in the flavor of the sample with the natural flavor, and the scores used for evaluation in this way ranged between 1-8 (10).

Table 1. Model of sensory assessment form of fish

Treatment	Flavor	Tenderness	Juiciness	Degree of general acceptance
T1: Fresh Fish T1				
T2: 1 day freezing				
T3: 15 days freezing				
T4: 30 days freezing				
T5: 45 days freezing				

Flavor	Tenderness	Juiciness	Degree of general acceptance
Very strong=7	Very good=7	Very good=7	Very acceptable =7
strong =6	Good=6	Good=6	Passable =6
Medium =5	Medium =5	Medium =5	Acceptable =5
few =4	Freshness a few=4	Law juice=4	Somewhat acceptable=4
Available somewhat =3	Low hardness=3	Dry a little=3	Somewhat rejected=3
Somewhat non-existent =2	Medium hardness =2	Dry Medium=2	Middle rejected =2
There is no=1	Hardness is high =1	Dry =1	Rejected =1

Statistical analysis

The use of the Complete Randomized Design (CRD) to analyze the effect of experimental treatments on the studied traits and the ready-made statistical program SAS (16) was used to analysis the results. The significant differences among the studied traits were tested using Duncan Multiple Range Test at the level of significance (0.05) and (0.01).

RESULTS AND DISCUSSION

Results of the sensory evaluation of common carp (Tab.2) indicated that the fish of the T1 tenderness was significantly superior in flavor compared to the rest of the freezing periods at a highly significant level ($p\leq0.01$) at a rate of 7.6, and no significant differences ($p>0.01$) were recorded among the treatments T2, T3 and T4 and those which reached 6.8, 6.6 and 6.2 respectively. Whereas, T1, T2, T3 and T4 differed significantly($p\leq0.01$) compared to T5, which amounted to 2.8. The tenderness showed a significant superiority($p\leq0.01$) of 7.6 for T1 compared to rest of the treatments, while there were no significant differences ($p>0.01$) among treatments T2, T3 and T4 by 6.4, 6.8 and 6.6, respectively. As for juiciness, T1 by 7.8 significantly outperformed T3 and T4 by 6.6 and 6.6 and did not differ significantly ($p>0.01$) compared to T2 by 7.4. As for the general acceptance test, it did not found significant differences ($p>0.01$) for treatments T1, T2 and T3 by 7.6, 7.6 and 7.2 respectively, to a level of highly significance ($p\leq0.01$), but it differed significantly ($p\leq0.01$) compared to T4 and T5 by 6.6 and 3.8 respectively.

Table 2. Sensory evaluation of common carp during the freezing process

Treatments	Flavor	Tenderness	Juiciness	Degree of general acceptance
T1	7.6±0.25A	7.6±0.25A	7.8±0.20A	7.6±0.25A
T2	6.8±0.20B	6.4±0.25B	7.4±0.25AB	7.6±0.25A
T3	6.6±0.25B	6.8±0.20B	6.6±0.25B	7.2±0.20AB
T4	6.2±0.20B	6.6±0.25B	6.6±0.25B	6.6±0.25B
T5	2.8±0.37C	4.2±0.37C	4.2±0.37C	3.8±0.37C

Results of (Tab.3) for flavor in catfish showed that treatment T1 was highly significantly ($p\leq0.01$) at a rate of 7.6 compared to among T3, T4 and T5 which reached 6.4, 4.4 and 2.2 respectively, and there was no differ significantly ($p>0.01$) compared to T2 which was 7.4. But there were a highly significant ($p\leq0.01$) compared to among T3, T4 and T5. T1 was highly significantly ($p\leq0.01$) in the tenderness at a rate of 7.4 compared to among T3, T4 and T5 by 6.4, 5 and 3.2 respectively, and did not differ significantly compared to T2 at a rate of 7, which was highly significant ($p\leq0.01$) compared to T4 and T5 and did not differ significantly compared to T3 at a highly significant level ($p\leq0.01$). As for juiciness, T1 was highly significantly ($p\leq0.01$) compared to among T3, T4 and T5 by 7.6, by 6.6, 4.6 and 3 respectively, and did not differ significantly ($p>0.01$) compared to T2, which amounted to 7, which did not differ significantly ($p>0.01$) compared to T3 . In the general acceptance treatment T1 was highly significantly ($p\leq0.01$) at a rate of 7.6 compared to among T3, T4 and T5 a percentage of 6.8, 4.4 and 2.4 respectively. But it did not differ significantly ($p>0.01$) compared to T2 by 7, which in turn differed significantly($p\leq0.01$) compared to T4 and T5 and did not differ significantly ($p>0.01$) compared to T3.

Table 3. Sensory evaluation catfish during the freezing process

Treatments	Flavor	Tenderness	Juiciness	Degree of general acceptance
T1	7.6±0.25A	7.4±0.25A	7.6±0.25A	7.6±0.25A
T2	7.4±0.25A	7.0±0.31AB	7.0±0.31AB	7.4±0.25AB
T3	6.4±0.25B	6.4±0.25B	6.6±0.25B	6.8±0.20B
T4	4.4±0.40C	5.0±0.31C	4.6±0.25C	4.4±0.25C
T5	2.2±0.20D	3.2±0.20D	3.0±0.44D	2.4±0.25D

Results of (Tab.4) for the flavor of the mullet fish indicated that T1 was highly significantly ($p\leq0.01$) at a rate 7 compared to among T3, T4 and T5 a percentage of 5.4, 3.6 and 2.4 respectively. It did not differ significantly ($p>0.01$) compared to T2 by 6.6 . T1, T2 and T3 were highly significantly ($p\leq0.01$) in tenderness than T4 and T5 by 4.2, 2.8 respectively. Results of juiciness showed that T1 was highly significantly ($p\leq0.01$) by 6.4 compared to among T3, T4 and T5 a percentage of 5.6 , 4.4 and 2.2 respectively, but they did not differ significantly ($p>0.01$) compared to T2 by 5.8, and T2 did not differ significantly ($p>0.01$) compared to T3. As for the trait of general acceptance T1 was highly significantly ($p\leq0.01$) by 7.4 compared to among T3, T4 and T5 by 6.4, 4 and 2.2 respectively. but it did not differ significantly ($p>0.01$) T2 by 6.8, while T2 differed highly significantly ($p\leq0.01$) compared to T4 and T5 and did not differ significant ($p<0.01$) T3.

Table 4. Sensory evaluation of mullet fish during the freezing process

Transaction	Flavor	Tenderness	Juiciness	Degree of general acceptance
T1	7.0±0.31A	6.4±0.25A	6.4±0.25A	7.4±0.25A
T2	6.6±0.25A	5.8±0.20A	5.8±0.20AB	6.8±0.20AB
T3	5.4±0.25B	5.6±0.25A	5.6±0.25B	6.4±0.25B
T4	3.6±0.50C	4.2±0.37B	4.4±0.25C	4.0±0.54C
T5	2.4±0.25D	2.8±0.20C	2.2±0.20D	2.2±0.20D

Freezing meat in general, and fish in particular, is an effective method that has been widely used to maintain the goodness and quality of these meats. However, freezing, frozen storage and post-freezing thawing can cause biochemical and physical changes that may affect the sensory appearance of meat, fish and other seafood (7). Abraha et al.(1) showed that freezing and thawing had a profound effect on the muscle

physicochemical properties of frozen fish and sensory evaluation of fish such as flavor, tenderness, juiciness and general acceptability when stored for a long period. Changes in meat in general depend on several factors, including genetic factors, muscle species, diet, stress to which fish are exposed, duration of storage after slaughter, freezing temperature, method of thawing meat before cooking, as well as the period of rigor mortis (8). The impact of these factors may be attributed to the quality and reform indicators of fish meat, which is subjected to many synthesis and morphological changes during the freezing and thawing process . The biochemical processes that occur in the muscles of fresh fish before freezing determine their quality after freezing and thawing. The state of pre-rigidity is related to the endogenous changes and activation of muscle-digesting enzymes, which will determine their activity by softening the muscles, the distribution and quantity of fluids outside and inside the cell, characteristics of muscle structure and pH which determine the freshness, juiciness and color, which are related to the nutritional value of the fish, are related to the development of changes after slaughter of the meat and in turn will determine the final quality of fish and frozen fish products . Nakazawa and Okazaki (14) explained that the development of biochemical processes after slaughter leads to the forming of larger and larger ice crystals that change the structure of the muscles of frozen fish and increase the amount of exudative fluid loss after thawing. It was noted that T1 in present study was superior in flavor, juiciness and freshness to the rest of treatment because it was not subjected to the rest of freezing ,and it preserved its flavor, juiciness and tenderness, followed by T2, which did not showed a clear effect on the sensory characteristics of the biochemical processes, because the fish of this treatment was subjected to a short freezing period of 24 hours, and the protein become denaturated and exudative liquid (thawing drip) may not have occurred clearly in it. It was followed by T3, which was subjected to freezing for 15 days, as it affected the biochemical processes to a clear degree in catfish ,mullet and to a lesser extent in common carp. With regard to the results of lack of flavor, tenderness and juiciness for the freezing periods in T4 and T5 for the three species, it was noted that most of the judges preferred the soft texture that characterizes small fish such as mullet with the early onset of protein denaturation. Perhaps changing the flavor is more important than the texture, because this can happen early as the fish gradually loses its juice and freshness after freezing and continuous storage for a period exceeding 30 days, this is due to the weak ability of the muscles to retain water and increase of thawing drip after dissolving and analyzes the protein, which led to disappearance of flavor and lack of juiciness in cooked meat gradually fried after a period of 30 days for common carp and after a period of 15 days for catfish and mullet , where a clear difference was observed in flavor and juiciness. As for the tenderness, a slight change occurred, as evidenced by the results of assessing the freshness of the common carp, while the difference was clear in the fried fillets of the catfish and mullet. All of these major changes in quality that occur in fish and other fish products during the freeze-thaw cycle are related to changes in the amount and distribution of moisture within muscle tissues, and the release of intracellular components into the extracellular space of the muscle, and changes in metabolic muscle composition, deterioration of structural properties due to physical damage or self-digestion, protein denaturation, lipid oxidation (1). The reason for this phenomenon is also as a result of analyze or denaturation of protein, which is the process in which the protein loses its quaternary and binary structure in the natural state when exposed to external stress or exposure to acid compounds, salts, organic solvents, radiation, heat and changes that occur in muscle proteins or protein-related pigments., or changes in some pigmented proteins such as, myoglobin and oxyglobin and changes in the muscle tissue of fish such as hardness, spongy, roughness, dryness, rubbery texture, lack of freshness, loss of water-retaining properties or loss of juice as they are recognized as the result of protein denaturation during storage frozen foods, especially myofibrils, which represent one of the most important changes that occur in

frozen foods because they lower muscle goodness due to reduced juiciness, flavor degradation, and color change (20). Huff-Lonergan and Lonergan (9) reported similar results, as they showed that the ability of muscles to retain water and the associated sensory juices of fish are directly related to the structure of proteins in the muscle. Flavor degradation (such as undesirable flavour, rancidity, bitterness or total loss of taste) is believed to be due to the formation of low molecular weight compounds from protein hydrolysis or lipid oxidation as a result of prolonged storage periods, oxidation of fats in frozen products leads to the breakdown of fats and the formation of a wide range of oxidation products and this was reported by Amaral et al.(4) in the effect of fat oxidation on the color, texture, nutritional value, taste and aroma of frozen meat. This means that the fish should be stored, if necessary, for a short period of time to retain flavour, providing both protein and fat at an optimal level. The general acceptance index is a final summation of the aforementioned sensory evidence for the freezing periods of the studied fish species.

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