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STUDY OF OXIDATION INDICES OF SOME FISH MEAT IMPORTED TO IRAQ

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ABSTRACT

This study was conducted to determine the validity of three species of frozen fish imported to Iraq. A comparison was made between the status of whole fish and fillets of the same species, and then a comparison was made among the three species of fish: seabream *Sparus aurata*, seabass *Dicentrarchus labrax* and tuna *Tunnus alalunga*, depending on some oxidation tests of frozen fish samples, included determination of free fatty acids (FFA) mg/100 mg fat, total volatile nitrogen (TVN) mg N_2/ $100g^{-1}$ meat, peroxide value (PV) meq Kg^{-1} meat, and thiobarbituric acid (TBA) mg MDA Kg^{-1} meat. The results recorded significant differences ($P<0.05$)) between the case of whole tuna and the fillet of thiobarbituric acid. The results showed that significant differences ($P<0.01$) were recorded in the total volatile nitrogen value of whole seprim fish and fillets, while tuna fish recorded significant differences ($P<0.05$)) between the state of whole fish and the fillets. The results recorded significant differences ($P<0.01$)) in the peroxide value between the state of whole fish and fillets for cyprim fish. The results showed, based on the examinations and comparison with the local and international specifications, that the meat of the fish under study, seabream, seabass and tuna imported to Iraq is considered suitable for human consumption.

Keywords: Free fatty acids, Peroxide, Thiobarbituric acid, Volatile nitrogen, Seabream, Seabass, Tuna.

دراسة أدلة الأكسدة للحوم بعض الأسماك المستوردة للعراق

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الخلاصة

أجريت هذه الدراسة لتحديد صلاحية ثلاثة إنواع من الأسماك المجمدة المستوردة للعراق, تمت المقارنة بين حالة الأسماك (كاملة أو شرائح) للنوع نفسه ومن ثم المقارنة بين إنواع الأسماك الثلاثة وهي أسماك السيبريم *Sparus aurata*, أسماك السيباس *Dicentrarchus labrax* وأسماك التونة *Tunnus alalunga* من خلال إجراء بعض فحوص الاكسدة لعينات الأسماك المجمدة, إذ تم تقدير نسبة الاحماض الدهنية الحرة ملغم/100ملغم دهن,النتروجين المتطاير الكلي ملغم نتروجين/100 غم لحم,البيروكسيد ملي مكافئ/كغم لحم,حامض الثايوباربتيوريك ملغم مالونالديهايد/كغم لحم. سجلت النتائج فروق معنوية (P<0.05) بين حالة أسماك التونة الكاملة والشرائح لحامض الثايوباربتيوريك. وأظهرت النتائج تسجيل فروق معنوية (P<0.01) في قيمة النتروجين المتطاير الكلي لأسماك السيبريم الكاملة والشرائح,في حين سجلت أسماك التونة فروق معنوية (P<0.05) بين حالة الأسماك الكاملة والشرائح. سجلت

* **The article is taken from the master's thesis of the first researcher.**

النتائج فروق معنوية (P<0.01) في قيمة البيروكسيد بين حالة الأسماك الكاملة والشرائح لأسماك السيبريم. خلصت نتائج الدراسة الى إن لحوم الأسماك السيبريم والسيباس والتونة المستوردة للعراق تُعد صالحة للإستهلاك البشري بعد خضوعها للمقاييس والمقارنة بالمواصفات المعتمدة محلياً وعالمياً.

الكلمات المفتاحية: الأحماض الدهنية الحرة, البيروكسيد, حامض الثايوباربتيوريك,النتروجين المتطاير الكلي , الأسماك المستوردة

INTRODUCTION

Fish is a rich source of essential nutrients, especially proteins, fats, fat-soluble vitamins (A, D, E, K) and minerals **(Kadhim & Al-Khashali, 2020)**. The protein in fish is characterized by being simple, easy to digest, and metabolize **(Al-Hilali &Al-khashali, 2019)**. In addition, fish meat is rich in vitamins A , B and an essential source of salts such as iodine and chlorine **(Alabbody & Laft, 2022)**. For humans, fish has had high economic importance since ancient times, as in some countries and regions fish constitute a high percentage of the daily food for humans **(Al-khshali, 2019)**. In addition, fish is exploited in many fodder industries, fertilizers, dyes, oils, gums, and some medical preparations **(AL-Azzawy & Al-khashali, 2018)**. The global demand for seafood is constantly rising, not only because of population growth, but also because of the increased preference for fish as an example of healthy food, as it is a good food with high-quality protein and nutrients important for human health **(Mubarak *et at.*, 2020)**. it is generally believed that fish meat is highly perishable, so it must be preserved from spoilage and economic losses avoided, it is preferable to preserve fish by freezing in order to preserve the quality of the product, and its nutritional value, it is necessary to consume it quickly or store it by anti-perishable methods such as freezing, smoking, canning, salting, and other methods of preservation and processing **(Mahmoud & Al-Khashali, 2022)**. in general, freezing is preferred over other preservation methods because it preserves the quality of the product and the nutritional value as a final result **(Al-Sadoon & Al-Khashali, 2015)**. Therefore, this study aimed to conduct a detection of the suitability of some frozen fish imported to Iraq for human consumption after comparing them with standard specifications. Local and global using some tests for evidence of oxidation.

MATERIALS AND METHODS

This study was conducted for the period from 1/10/2022 to 28/12/2022, where 30 samples of three species of frozen fish imported to Iraq were used: seabream (*Sparus aurata*), seabass (*Dicentrarchus labrax*), and tuna *Thunnini alalunga*, of which 15 were in the form of whole fish while the other 15 were fish fillets. The samples were refrigerated for the experiment period after which chemical tests (oxidation tests) were performed. The procedure of was analyze thiobarbituric acid**,** free fatty acids test, estimate total volatile nitrogen, and the peroxide value estimated by **Witte *et at.*, (1970).**

Statistical Analysis

The Statistical Analysis System **(SAS, 2018)** was used in analyzing the data to evaluate the effect of different treatments on the studied traits. Significant differences between the means were compared according to Duncan's multiple range tests **(Duncan, 2012)**. where the experiment treatments were distributed according to the complete randomized design (CRD) based on the following mathematical model:

$Y_{ij} = \mu + T_i + e_{ij}$

Where:
Yij: observed value j of treatment i
μ: overall mean
Ti: species effect
eij: random error

RESULTS AND DISCUSSION

Thiobarbituric Acid (TBA)

Results of testing the effect of fish status and species on the TBA value of frozen fish did not record significant differences (P>0.05) for the status of fillets and whole fish for seabream and seabass, while significant differences were recorded (P<0.01) for tuna fish, with the superiority of fillets over whole fish with a TBA value of 0.917 mg MDA Kg^{-1} meat, compared to 0.875 mg MDA Kg^{-1} meat TBA in whole fish of the same species. There were significant differences (P<0.05) between fish species in the TBA value, as seabream fish fillets recorded 0.941 mg MDA Kg^{-1} meat, with a significant increase to fillets of seabass and tuna fish, which recorded 0.918 and 0.917 mg MDA Kg^{-1} meat, respectively. While whole seabass fish did not record significant differences between the status of whole fish and fillets, with the highest value of 0.941 mg MDA Kg^{-1} meat superior to seprem and tuna, while tuna fish recorded the lowest value of TBA at 0.875 mg MDA Kg^{-1} meat, and seaprim fish recorded 0.919 mg MDA Kg^{-1} meat. TBA levels depend on many factors, including product exposure to manufacturing processes, handling method, individual freezing time, catching time, as well as the production and expiration date of the products **(AL.Rubeii, 2006)**. The freezing process leads to slow fat oxidation, but repeated freezing and thawing of fish may lead to a rapid accumulation of thiobarbituric acid **(Chen *et al.*, 2000)**. These results are convergent with the results of **Taliadorou *et al.*, (2003)** in their study on frozen seabass and seabream, where a high TBA value was observed in frozen fish at a temperature of - 18. The value of TBA in the studied species (whole and fillets) falls within the permissible limits that do not exceed 2 mg MDA Kg^{-1} **(AL.Rubeii, 2006)**.

Table (1): Effect of frozen fish species and state on TBA (thiobarbituric acid) values**.**

Fish Species	mean±standard error		Significance level
	Whole fish	Fillets	
Seabream	0.919 ±0.02 Ab	0.941±0.02 a a	NS
Seabass	0.941 ±0.01 a a	0.918 ±0.0002 ab	NS
Tuna	0.875±0.007 b b	0.917±0.0002 ab	□□
Significance level	*	□	---
Means followed by different uppercase letters within a column (among species) or followed by different lowercase letters within a row (state of fish) are significantly different according to Duncan's multiple range tests * (P≤ 0.05), **(P≤ 0.01), or NS (No significance)			

Free Fatty Acids (FFA)

The data in Table (2) indicate the effect of the state and species of frozen fish on the value of free fatty acids (FFA), results recorded significant differences (P<0.05) between the state of tuna fish, as the whole fish recorded 2.076 mg/100 mg fat with a significant difference from the fillets which recorded 1.816 mg/100 mg fat, no significant differences were observed for the state of whole fish and fillets in seabass and seabream. There were also significant differences (P < 0.01) for the species of fish in the state of whole fish, as whole tuna fish was higher than the other two fish species with a value of 2.076 mg/100 mg fat compared to 1.710 mg/100 mg fat and 1.206 mg/100 mg fat in seabass and seabream, respectively. Also, there were significant differences (P < 0.01) between the fish fillets, where seabass recorded the highest value of 1.836 mg/100 mg of fat, while seabream recorded the lowest that of 1.710 mg/100 mg of fat, and 1.816 mg/100 mg of fat for tuna fillet. Free fatty acids levels vary by species and within same species, whether farmed or wild, the age of the fish caught, the type and abundance of food **(Ibrahim & Al - Khashali, 2019)**, increasing in fatty acids in fish meat may be due to the removal of the amine group in the amino acid **(Castro *et at.*, 2006)**. The amount of fatty acids produced is not the only one affecting the quality of food, it is also associated with fat oxidation **(Roopma *et al.*, 2012)**. Therefore, the production of free fatty acids is a measure of the progress in the oxidation process of lipolysis, where the production of fatty acids can be used as a measure to determine the degree of degradation of fats, and then food products **(Yousef & Al-Khashali, 2023)**. Results of the current study agreed with the results of **(Khidhir *et al.*, 2013)** in a study on imported frozen fish fillet samples, as no significant differences were shown in the percentages of fatty acids between the studied species, where all the values were within the recommended limits. The value of FFA in the studied fish was within the acceptable limits for free fatty acids, which ranged from 1 to 2 mg/100 mg fat **(Al-Taie, 1986)**.

Table (2): Effect of frozen fish species and state on free fatty acid values.

Fish Species	Mean±standard error		Significance level
	Whole fish	Fillets	
Seabream	1.206±0.04 c a	1.710±0.04 b a	NS
Seabass	1.710 ±0.06 b a	1.836 ±0.09 a a	NS
Tuna	2.076±0.06 a a	1.816±0.05 a b	□
Significance level	**	**	---

Means followed by different uppercase letters within a column (among species) or followed by different lowercase letters within a row (state of fish) are significantly different according to Duncan's multiple range tests * (P≤ 0.05), **(P≤ 0.01), or NS (No significance)

Peroxide Value (Pv) Test

The results showed that the value of peroxide PV differed between fish species and the state of frozen fish (Table 3). Significant differences ($P < 0.01$) were recorded for the state of seabream fish, as the whole seabream fish was higher than fillet with 3.86meq Kg^{-1} meat and 2.58 meq Kg^{-1} meat, respectively. Significant differences were not recorded among the fish state of seabass and tuna. as for whole fish, tuna outperformed seabass and seabream, recording 4.28 meq Kg-1 meat, compared to 3.67 meq Kg^{-1} meat in seabream and 3.86 meq Kg^{-1} meat in seabream. Significant differences ($P < 0.01$) were also recorded in fish fillets between tuna and seabream, with a value of peroxide in tuna fillets was 3.78 meq Kg^{-1} meat. Seabream fillets recorded the least value 2.58 meq Kg^{-1} meat while seabass fillets resulted in 3.55 meq Kg^{-1} meat. Through the results, it is clear that the peroxide value was high in the three species of frozen fish, although it was within the permissible limits. The different results of research related to the peroxide value may be due to the different species studied, the conditions of rearing and feeding, handling, and the extent to which fish are exposed to poor storage conditions, which in turn are reflected in the peroxide values **(Rostamzad *et al.*, 2011)**. This may be due to the exposure of fish muscles to air, which makes fats more susceptible to oxidation **(Anthony *et at.*, 2000)** or due to the formation of hydroperoxide, whose accumulation in muscle tissues leads to an increase in the peroxide value, where hydroperoxides are the primary products of oxidation and are an indicator of oxygen uptake in the initial stages of oxidation **(Ali *et al.*, 2013)**. Results of the study are consistent with **(Saeed & Howell, 2002)** on Nile tilapia fish *Oreochromis niloticus* frozen when exposed to a freezing point of - 18. The value of peroxide less than 10 milliequivalents per kg of meat is within the permissible limits, as fish meat becomes rancid by more than 20 milliequivalents per kilogram of meat

Table (3): Effect of frozen fish species and state on PV (peroxide value).

Fish Species	Mean±standard error		Significance level
	Whole fish	Flilets	
Seabream	3.86 ±0.10 ab	2.58 ±0.18 b b	**
Seabass	3.67 ±0.04 b a	3.55 ±0.16 a a	NS
Tuna	4.28±0.19 a a	3.78±0.07 a a	NS
Significance level	*	□□	---
Means followed by different uppercase letters within a column (among species) or followed by different lowercase letters within a row (state of fish) are significantly different according to Duncan's multiple range tests * (P≤ 0.05), **(P≤ 0.01), or NS (No significance)			

Total Volatile Nitrogen (Tvn) Concentration

With regard to the effect of the state and species of frozen fish on the value of total volatile nitrogen (Table 4), the results showed significant differences ($P<0.05$) between seabream fillets, which recorded 4.20 mg N_2/ $100g^{-1}$ meat, compared to whole fish of the same species 3.33 mg N_2/ $100g^{-1}$ meat. significant differences ($P < 0.01$) were recorded for seabass, as fillets were superior to 4.50 mg N_2/ $100g^{-1}$ meat for whole fish of the same species, which recorded 2.43 mg N_2/ $100g^{-1}$ meat, while no significant differences were recorded for whole tuna fish and fillets. For the three species of fish, there were significant differences (P<00.1) for whole fish. tuna recorded the highest value of 4.33 mg N_2/ $100g^{-1}$ meat, with a significant difference from seabass and seabream with TVN values of 2.43 and 3.33 mg N_2/ $100g^{-1}$ meat, respectively. The values of total volatile nitrogen varies among fish from one species to another according to age, sex, and season **(Jasim & AI-Obaidi, 2022)**. in general, the results showed that the values of TVN in the fish species under study were within the permissible limits, on the other hand, the increase in TVN values may be attributed to an increase in ammonia emission from hypoxanthine in fish, or caused by protein denaturation that increases the formation of nitrogen groups and other nitrogenous compounds **(Khalaf, 2021)** . Results of the study are consistent with the results of **(Al-Azazy, 2002)** in his study on frozen Bunni *Mesopotamichthys sharpeyi* and grass carp *Ctenopharyngodan idella*, as the values of TVN were 4.32 and 3.54 mg N_2/ $100g^{-1}$ meat, respectively. The results were similar to the results of **(Seifzadeh *et al*,. 2012)** who reported that the volatile nitrogen values of *Clupeonella cultriventris* fish stored by freezing amounted to 21.7 mg N_2/ $100g^{-1}$ meat. The values of total volatile nitrogen in fish are acceptable with less than 20 mg N_2/ $100g^{-1}$ meat, as the fish loses its freshness if its TVN exceeds 20 mg N_2/ $100g^{-1}$ meat**.**

Table (4): Effect of frozen fish species and state on TVN (total volatile nitrogen).

Fish Species	**Mean±standard error**		**Significance level**
	Whole fish	**Fillets**	
Seabream	3.33 ±0.14 B b	4.20 ±0.20 A a	*
Seabass	2.43 ±0.21 B b	4.50 ±0.15 A a	**
Tuna	4.33±0.18 A a	4.46±0.23 A a	NS
Significance level	**	NS	---
Means followed by different uppercase letters within a column (among species) or followed by different lowercase letters within a row (state of fish) are significantly different according to Duncan's multiple range tests * (P≤ 0.05), **(P≤ 0.01), or NS (No significance)			

CONCLUSION

1- Freezing maintained the chemical and organoleptic qualities of frozen imported fish**.**
2- Frozen imported fish did not exceed the permissible limits for thiobarbiturate acid (TBA), Total Volatile Nitrogen (TVN), peroxide (PV), and free fatty acids (FFA) **.**
3- Decrease in total bacterial count, coliform bacteria and salmonella in frozen fish**.**
4-The study showed that fish fillets contain larger numbers of bacteria than whole fish**.**

REFERENCES

1. Alabbody, H. H., & Laft, I. J. (2022). comparison beteeen the consumption of red meat and white meat for a sample of citizens of the city of Baghdad/an exploratory study: comparison beteeen the consumption of red meat and white meat for a sample of citizens of the city of Baghdad/ an exploratory study. *Iraqi Journal of Market Research and Consumer Protection*, 14(1), 45-51.
2. Al-Azazy, A. S. (2002*). A study of the effect of freezing and ice storage on the chemical composition and qualitative characteristics of Bunni fish and grass carp*. MSC., College of Agriculture, University of Baghdad. Iraq.
3. Al-Azzawy, M. A. N. & M. S. Al-Khshali. (2018). Relationship of growth hormone gene with some of productive traits of common carp *Cyprinus carpio*. L. *The Iraqi Journal of Agricultural Science*. 49(6): 1011.
4. Al-Hilali, H. A. A., & Al-Khshali, M. S. (2019). Effect of Different Salinity Concentrations on the Chemical analysis and Time Appearance of Feces for *Cyprinus carpio*. *Aquatic Science and Technology,* 7(2): 28-38.
5. Ali, S. M.; Pirestani, S., & Barzegar, M. (2013). Effect of Froze Storage on Quality Changes of Five Fish Species from South Caspian Sea. *Current Nutrition and Food Science,* 9(4): 315-320.
6. Al-khshali, M.S. (2019). Effect of different ratio of addition of Nacl to the diet on some growth traits in grass carp *Ctemopharyngodon idella*. *Plant Archives*. 19(1):908-911.
7. Al-Rubeii, A. M. S. (2006). Effects of sodium lactate, potassium sorbate and cetylpyridinum chloride on physicochemical properties and Microbial Count of Cold Ground Beef Meat. *Alex. J. Fd. Sci. and Technol.* 3 **(**2**)**,1-11.
8. Al-Sadoon, N. M. M., & Al-Khashali M. S. (2015). Studying of some chemical and qualitative characters of some frozen fish meat imported to Iraq. *The Iraqi Journal of Veterinary Medicine*, 39(2):6-11.
9. Al-Taie, M. A. J. (1986). *Meat and fish technology*. Dar Al-Hikma Press, University of Basra.
10. Anthony, J. A., Roby, D. D., & Turco, K. R. (2000). Lipid content and energy density of forage fishes from the northern Gulf of Alaska. *Journal of Experimental Marine Biology and Ecology*, 248(1): 53-78.
11. Castro, P., Padrón, J. C. P., Cansino, M. J. C, Velázquez, E. S. & De Larriva, R. M. (2006). Total volatile base nitrogen and its use to assess freshness in European sea bass stored in ice. *Food control*, 17(4): 245-248.
12. Chen, C. Q., Ren, L., Wu, Y. M. & Xue J. H. (2000). Effect of chitosan on normal intestinal microflora of mouse. *Practical preventive medicine*. 7: 413-414.
13. Duncan, D.B. (2012). Multiple Rang and Multiple F-test. *Biometrics*. 11: 142.
14. Ibrahim, A. B., & AL-Khshali, M. S. (2019). Study Of The Chemical Composition Of Common Carp Fish Reared In Different Culture Systems. *Plant Archives*, 19(2), 1816-1818.
15. Jasim, Q. A., & AI-Obaidi, T. S. (2022). Substitution of animal protein by different ation of dried rumen meal in common carp *cyprinus carpio* diets, *Iraqi Journal of Market Research and Consumer Protection*, 14(1), 65-74.
16. Kadhim, H.H. & Al-Khashali M.S. (2020). Effect of stocking density on the survival rate and growth traits of common carp cultured in rice fields in Iraq, *Plant Archives*, 20(2): 5773-5776.

17. Khalaf, R.A.M. (2021). *Effect of freezing on some qualitative and sensory traits of three local fish species.* MSC, College of Agricultural Engineering Sciences, University of Baghdad.50pp.
18. Khidhir, Z. K; Murad, H.O.M; & Arif، E.D (2013). Qualitative assessment of imported frozen fish fillets in Sulaimani markets. *Iraqi Journal of Veterinary Sciences*; 27(1), 49-55.
19. Mahmoud, R. A., & Al-Khshali, M. S. (2022). Effect of freezing preservation period on some sensory characteristics of three Iraqi local fish species. *Iraqi Journal of Agricultural Sciences*. 53(4), 767-773.
20. Mubarak, A. S., Pursetyo, K. T., & Monica, A. (2020). Quality and quantity of ephipia moina macrocopa resulting from mating using tilapia fish feces suspension feed. *The Iraqi Journal of Agricultural Science*, 51, 157-167.
21. Roopma, G. Sharma, S. Koul, M. and Gupta, S. (2012). Effect of chilling and freezing on fish muscle. *Journal pharmalogy Biology Science*, 2: 5-9.
22. Rostamzad, H., Shabanpour &B., Shabani, A and Shahiri, H. (2011). Enhancement of the storage quality of frozen Persian sturgeon fillets by using of ascorbic acid, *Internal Food Res* J,18,109-116.
23. Saeed, S. & Howell, N. K. (2002). Effect of lipid oxidation and frozen storage on muscle proteins of Atlantic mackerel (*Scomber scombrus*). *Journal of the Science of Food and Agriculture*. 82(5): 579-586.
24. SAS. (2018). *Statistical Analysis System, User's Guide. Statistical.* Version 9.6th ed. SAS. Inst. Inc. Cary. N.C. USA.
25. Seifzadeh, M. Motallebi, A.A & Mazloumi, M.T. (2012). Evaluation of fat quality in packaged common kilka fish soaked in whey protein compared with sodium. alginate.Scholarly *The Journal of Agricultural Science.* 2(2): 26-31.
26. Taliadourou, D., Papadopoulos, V., Domvridou, E., Savvaidis, I. N., & Kontominas, M. G. (2003). Microbiological, chemical and sensory changes of whole and filleted Mediterranean aquacultured sea bass (*Dicentrarchus labrax*) stored in ice. *Journal of the Science of Food and Agriculture,* 83(13): 1373-1379.
27. Witte, V. C., Krause, G., & Bailey, M. E. (1970). New extraction method for deter mining 2-thiobarbituric acid values of pork and beef during storage *Journal of Food Science.,* 35:582-585.
28. Yousef, T. A., & Al-Khshali, M. S. (2023). Relationship Of Growth Hormone Receptor Gene with Some Of Productive Traits Of Common Carp *Cyprinus carpio. Iraqi Journal of Agricultural Sciences*. 54(3), 777-783.