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Study of Some Qualitative Characteristics and Chemical Composition of Some Canned Fish Meat Imported to Iraq

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ABSTRACT
This research was conducted on some canned fish products imported into the country to assess the pH, water capacity, and chemical composition. The outcomes demonstrated that the pH value was 6.25, 6.20 and 5.75 for sardine, mackerel and tuna, respectively. The water consumption capacity (WCC) of the meat was 26.29, 37.78 and 29.57% for sardine, mackerel and tuna, respectively. Based on results, no significant differences ($P<0.05$) were detected between the species studied. The composition of chemical substances in fish meat's results showed that the moisture content was 63.73, 66.82 and 65.58% in sardine, mackerel and tuna, respectively, and no significant differences ($P>0.05$) were observed between the species studied. The composition of protein was 21.8, 20.55 and 22.15 for sardine, mackerel and tuna, respectively, and no significant differences ($P>0.05$) were observed between the species studied. The results demonstrated that the percentage of fat was 9.49, 2.31 and 8.11% for sardine, mackerel and tuna, respectively, and the results showed that there were significant differences ($P<0.01$) between the species studied.

INTRODUCTION

The knowledge of the chemical composition of fish is crucial to the development of technological processes for processing fish and to the comparison of the nutritional value of different foods as a form of food. Fish typically contains 70-84% water, 15-24% protein, 0.1-22 % fat, and 0.1-1% carbohydrates. The fat in fatty fish species is primarily composed of Eicosapentaenoic acid (EPA) and Docosahexaenoic acid (DHA) (both of which are referred to as omega 3s). These fatty acids are essential for the healthy development of children and the prevention of cardiovascular disease **(Bigueja *et al.*, 2022)**. The chemical composition of fish differs greatly among species, and is dependent on the season, sex, age, water temperature, as well as the type and volume of nutritional components **(FAO, 2001)**. The primary constituents of fish muscle are water, proteins, lipids and connective tissue, the protein content and water content of fish muscles are oppositely related, and the fat content of fish muscles is much more variable than its protein and water content **(Boziaris, 2014)**. The pH of seafood has a significant impact on the growth of microorganisms, with higher pH values indicating a greater degree of spoilage and a shorter shelf life **(Newton & Gill, 1981)**. Water holding capacity (WHC) is the capacity of fish to maintain its original volume or increase it, the capacity is dependent on the method of handling the fish and the condition of the meat (fresh, chilled or cooked) **(Ruilova-Duval, 2009)**. The oxidization of proteins in processed meat products results in a decrease in their water content (WHC) and capacity to form texture **(Xiong *et al*., 2000)**. Canning is considered a preservation method that involves storing food products in hermetically sealed containers that are sterilized, this method ensures long-term quality **(Sousa *et al*., 2018)**. The primary steps in the canning process are cooking, cooling, filling with oil or tomato sauce that is sealed in hermetic containers, and the process of sterilization by heat **(El-Lahamy & Mohamed, 2020)**. During the canning process, seafood is confined to hermetically sealed containers using different media types for packaging (oil, brine, pickle, etc.). Typically, the process involves sterilizing the fish's tissues at a temperature of 110-130°C for 25-120 minutes; this procedure changes the nature of the raw material, which results in a product with different properties **(Banga *et al*., 1993)**. As a consequence of the heat treatment, enzymes and bacteria are permanently deactivated **(Lukoshkina & Odoeva, 2003)**. Canned fish is imported and consumed in large quantities in Iraq because it's inexpensive, simple to prepare, and can be found in most markets at any time; it also has a long shelf life, and doesn't require expensive storage methods like freezing, refrigeration, or does not spoil easily **(Doe, 2017)**. However, the process of canning fish decreases the nutritional value of the fish due to the heat treatment associated with the process; this is particularly true for fish that are stored poorly before being canned and have insufficient preservatives **(Prego *et al*., 2022)**. The current investigation intended to assess the validity of canned fish that were imported to Iraq (sardine, mackerel and tuna that were canned in vegetable oil) by measuring their pH, water capacity and chemical composition.

MATERIALS AND METHODS

Three types of canned fish produced in Thailand, namely sardine, mackerel, and tuna, are imported to Iraq. Fifteen different samples were purchased for the study, with each type having five samples replicated. It was assumed that the production of all three varieties should be at a go and that their shelf lives should be up to two years after the date of production.

pH

The pH of the canned fish meat samples was determined following a method given by **Verma *et al*. (2008)**. Ten grams of fish meat, taken after mashing, were thoroughly mixed with 100ml of distilled water using a homogenizer, then the pH of the resulting mixture was measured with a pH meter.

Water holding capacity (WHC)

The water-holding capacity was determined gravimetrically with slight modification of the method of **Stasiak and Dolatowski (1998)**. Fifty grams of each treatment was mixed with 50mL of distilled water for 1min, followed by centrifugation at 4°C at 5,000 rpm for 10min. The percent water holding was calculated as:

$$\mathbf{WHC(\%)} = \frac{\text{Weight of water added} - \text{Weight of water after centrifugation}}{\text{Sample weight}} \times 100$$

Moisture estimation

Moisture was estimated by taking 5 grams of a sample of canned fish meat from each sample, with 5 replicates each for each type of fish. They were placed in a previously known weight container and dried using an electric dryer at a temperature of 105°C until the weight was consistent, then the following equation was used to calculate moisture content:

$$\text{Moisture content (\%)} = \frac{\text{Sample weight before drying} - \text{Sample weight after drying}}{\text{Sample weight before drying}} \times 100$$

Estimation of crude protein ratio

The protein composition of canned fish meat samples was determined using the Kjeldahl apparatus. This apparatus placed 0.2g of fish meat in each treatment of the digestion tub of the apparatus, along with 5ml of 95% concentrated sulfuric acid and two drops of perchloric acid (HCLO4). Digestion continued until the solution was no longer obscured. After the samples were digested, they were distilled along with 10ml of sodium hydroxide (0.1 molar). The released ammonia was then collected in a 50ml flask that contained 25ml of boric acid 2% and two drops of Bromocresol green and Methyl red. Later, the flour was passed through a filter, and the residue was collected and submitted to analysis by HCI at a concentration of 0.05 molar. The volume of acid that was necessary to turn the indicator's color from green to red was estimated. After that, the fish's crude protein composition was derived from the following formula:

$$\textbf{Crude protein (\%)} = \frac{\text{Amount of HCI consumed (ml)} \times \text{titer (0.05)} \times 0.014 \times 6.25}{\text{Sample weight (g)}} \times 100$$

Estimation of the percentage of fat

The percentage of fat in canned fish meat was estimated by taking 0.5g of dried ground meat, placing it in a filter paper and wrapping it, then adding 150ml of hexane to it and continuing the process for 16 hours. After that, the solvent was harvested from the device and the flasks were removed and placed in an electric oven for half an hour at a temperature of 80 degrees Celsius to facilitate the evaporation of the solvent's residues from the flasks and the fatty substances remained. After that, it was taken from the oven and allowed to cool down, then the weight of the fish was determined using a balance and the percentage of fat in the fish's meat was calculated using the following formula:

$$\textbf{Fat percentage (\%)} = \frac{\text{Weight of the flask before extraction} - \text{Weight of the flask after extraction}}{\text{Sample weight}} \times 100$$

Estimation of ash percentage

The percentage of ash in the sample was determined by burning a portion of canned fish meat with a specific weight in an oven that was intended for incineration at a temperature of 525 °C for 6 hours. White ash was then obtained according to the **AOAC (2005)** method. The percentage of ash in fish meat was determined by the following formula:

$$\textbf{Ash (\%)} = \frac{\text{Weight of the sample with the lid after burning} - \text{Weight of the empty lid}}{\text{Sample weight}} \times 100$$

Statistical analysis

The statistical program **SAS- Statistical Analysis System (2012)** was employed to analyze the data from the experimental samples in order to assess the effect of different treatments on the studied characteristics in a completely random fashion and to contrast the significant differences between the averages using the Duncan test **(Duncan, 1957)**.

RESULTS AND DISCUSSION

1. pH

The outcomes (Table 1) demonstrated that the pH of canned fish meat from the U.S. was 6.25, 6.20 and 5.75 for sardine, mackerel and tuna, respectively. The highest pH value was observed in sardine, followed by mackerel, and the lowest value was in tuna. The results showed that significant differences ($P<0.05$) were present in the pH of the fish on one hand, and the other hand, there were no significant differences between the fish species. The decrease in pH in tuna can be attributed to the chemical reaction of unsaturated fatty acids in the oil or natural fish fat, this produces acidic compounds like peroxides and organic acids, which causes the product to have a decreasing pH during storage or the process of sterilization is insufficient or subsequent contamination has occurred; this leads to the growth of acidophilic bacteria or fungi that produce organic acids as byproducts during the degradation of nitrogenous or carbohydrates in fish **(Gómez-Limia *et al*., 2021)**. Conversely, the increase in pH in sardine and mackerel may be caused by the breakdown of proteins into amines like ammonia and trimethylamine; this increases the pH of the product. The differences in pH values of canned fish are attributed to the different storage periods before being canned, the longer the period of storage, the greater the production of nitrogenous substances, such as ammonia, that are produced by microbes or enzymes that are autolyzed in the muscle **(Li *et al*., 2012)**. Therefore, the change in salt concentration of intracellular solution is responsible for the change in fish flesh pH following salt addition **(Goulas & Kontominas, 2005)**. The change in pH noted can be attributed to the partial release of amino acids and carbonyl compounds due to protein destruction **(Ab-aziz *et al*., 2020)**. The pH conditions of the products analyzed in can were 6.23, 6.11, 6.59, 6.46, 6.41, and 6.52 in canned mackerel, canned tuna, canned mackerel, canned anchovies, canned sardine, and canned tuna, respectively **(Morshdy *et al*., 2018)**.

2. Water holding capacity

The results (Table 1) indicate that the water holding capacity for fish meat canned in various countries was found to be 26.29, 37.78, and 29.57% for sardine, mackerel, and tuna, respectively. Mackerel had the highest water holding capacity followed by tuna and the least was for sardine. The results proved the fact that the water holding capacity for meat species was not significantly different ($P<0.05$). Studies that ascertain the water-holding capacity of fish meat proved that most of the variations observed in water capacity in fish meat emanate from changes in the muscle fibers' ability to hold water **(Bremner, 2002)**. This could possibly be caused by changes that take place in muscles of fish when receiving the heat treatment, hence a reduction in the capacity of muscles takes place to store water, thereby causing the muscles to become less elastic **(Devadasan,**

2001). In the other study, the water retention capacity was 26.55% for the canned tuna and 52.8% for the canned mackerel; due to the thermal process employed during processing and its effect on the protein structure, bound water content was low **(ElShehawy & Farag, 2019)**.

Table 1. pH values and water retention capacity in canned fish meat

Canned Fish	pH	WHC %
Sardine	0.03±6.25 a	2.49±26.29 a
Mackerel	0.04±6.20 a	6.16±37.78 a
Tuna	0.03±5.75 b	3.71±29.57 a
Significance level	******0.0002	NS

Means with different letters within a column are significantly different from each other **($P<0.01$), NS: not significant.

3. Chemical composition

3.1 Moisture

The outcomes (Table 2) demonstrate that the percentage of moisture in canned fish meat from the U.S. was 63.73, 66.82 and 65.58% in sardine, mackerel and tuna, respectively. The highest percentage of moisture was in mackerel, followed by tuna, and the lowest percentage was in sardine. The results demonstrated no significant differences ($P>0.05$) in the moisture composition of the studied species. The low moisture content may be attributed to the fish's exposure to high temperatures for a long period of time; this causes the majority of the water in the fish to evaporate, or it may be due to the use of vegetable oils that take in the moisture from canned fish during storage **(Gunstone, 2011)**. The high moisture content may be attributed to the type of canned fish, which has a high moisture content on a percent basis, or it may be attributed to the fact that the fish used in canning is of high quality and contains a higher percentage of moisture than fish of lower quality or that was frozen for a long time before being canned, or it may be attributed to the fish not being sufficiently cooked before being canned, as it may retain a high percentage of moisture **(Samples, 2015)**. The treatment of canned tuna with different oils led to a significant decrease in water content and an increase in fat content. The decrease in water content was significantly different from the precooked and heat-treated tuna compared to fresh tuna. Precooking led to a 5% moisture content reduction while heat treatment in different oils resulted in an 11-13% water content reduction for canned tuna that was attributed to heat-induced changes in media. The initial moisture content of the yellowfin tuna was reduced from 72.6 to 59-61% in different oils **(Mohan *et al*., 2015)**. The decrease in water loss at higher temperatures (50-70°C) was attributed to the accumulation of sarcoplasmic proteins in the gaps between the sarcolemma and muscle fibers **(Ofstad *et al*., 1993)**. In another investigation, the moisture content of canned sardine was observed to be between 54.49 and 55.79%; canned mackerel was between 51.65 and 52.93%; canned tuna was between 61.41 and 76.86%; and canned tuna was between 60.66 and 77.05% **(Bilgin & Gençcelep, 2015)**.

3.2 Protein

The results presented in Table (2) show that the percentage of protein in canned fish meat imported was 21.80, 20.55 and 22.15% for sardine, mackerel and tuna, respectively. The highest protein percentage was in tuna, followed by sardine, and the lowest was in mackerel. The results showed that there were no significant differences (P<0.05) in the protein composition of the studied species. Protein degradation is primarily caused by three potential reasons: pre-cooking, liquid diffusion, and thermal destruction during the heat treatment process. It was established that commercial fish thermal treatments did not have a significant impact on the composition of amino acids in canned fish products. It was documented that a 10-20% reduction in amino acids is present in canned goods. The decrease in amino acids in preprocessed foods is attributed to their sensitivity to high temperatures **(Fellows, 1990)**. The increase in protein may be caused by the decrease in moisture content during the heat treatment and subsequent storage of the product **(Morsy, 2016)**. On the other hand, the decrease in protein percentages may be caused by the effect of the heat during the canning process that weakens the bonds between protein and fat, causing the protein to be hydrolyzed **(Castrilló *et al*., 1996)**. The discrepancies in protein composition in fish products are attributed to the diet the fish consume or their capacity to convert nutrients into essential ones in the native environment **(Adewoye & Omotosho, 1997)**. The protein composition of canned sardine was from 16.08 to 20.32%, canned mackerel from 14.39 to 14.55%, whole tuna fillets from 20.61 to 22.87%, and canned tuna fillets from 16.91 to 22.32% **(Bilgin & Gençcelep, 2015)**.

3.3 Fat

The results depicted in Table (2) reveal that the percentage of fat in canned fish meat from abroad was 9.49, 2.31 and 8.11% for sardine, mackerel and tuna, respectively. The highest percentage of fat was in sardine, followed by tuna, and the lowest percentage was in mackerel. The results showed that there were significant differences (P<0.01) in the fat composition of the species studied, with sardine having a higher percentage of fat than tuna and mackerel. The amount of fat in fish is species-specific, gender-specific, age-specific, type-specific and quantity-specific. Additionally, the season of fishing and the temperature of the water have an effect on the fat content in fish **(Petricorena, 2015)**. The high percentage of fat in both sardine and tuna, as well as the low percentage in mackerel, is likely due to the chemical composition of these species, as both types of fish have a higher percentage of fat in their meat than mackerel **(Ahmed *et al*., 2022)**. The high fat content of sardine and tuna in canned form is likely due to the fact that fish tissue is capable of absorbing part of the oil; this increases the fat content of the product or causes the tissue to become dry, which increases the concentration of the fat in the oil **(Brannan *et al*., 2014)**. Despite all canned fish samples being permitted to drain off the oil mixture before chemical composition analysis, the process was not effective in removing all of the added vegetable oil from the finished product **(Bahurmiz *et al*., 2018)**. The low-fat content of mackerel may be due to the lipids being oxidized by the high temperatures which used to affect the chemical composition of the lipids **(Negara *et al*., 2021)**. Another worker found that the fat content of mackerel canned in tomato sauce was 16.60%, sardine canned in soybean oil was 16.56%, tuna canned in vegetable oil was 11.88%, and sardine canned in vegetable oil was 11.48% **(Odiko & Obirenfoju, 2017)**.

3.4 Ash

The results (Table 2) show that the percentage of ash in canned fish meat from abroad was 2.26, 1.40, and 1.10 in sardine, mackerel, and tuna, respectively. Sardine had the highest ash content, mackerel ash content comes second in the rank while tuna had the least ash content. The results indicated that significant differences (P<0.05) existed between ash percentages in sardine and mackerel as well as between sardine and tuna. Ash content in sardine was higher than that in mackerel and tuna, respectively. There was an insignificant difference between mackerel and tuna. High ash content could result from the dependence of canned fish on a particular kind of mineral source, such as calcium and phosphorus with small bones or scales, or is due to preservatives or supplements that lead to increased ash contents **(Dey, 2023)**. A lower mineral content results from the species because specific parts of the fish are usually removed before canning; thus, the leaching process is applied. Lower mineral content may also be caused by the mineral interaction between the oils used in canning and the canned fish, and thus lower mineral content is realized. Or higher ash content can be brought about by added salinity into the process of canning. The chemical composition of fish varies with species due to a wide range of factors, among them, the area in which the fish are caught, age, size, sex, season of capture, and locomotory activity **(Ali *et al*., 2005)**. In a study, sardine canned ash content gave a range of 2.87-3.16%; mackerel canned, 1.25-1.64%; tuna canned, 1.25-1.71%; and again canned tuna, 0.97-1.70% **(Bilgin & Gençcelep 2015)**.

Table 2. Chemical analysis of imported canned fish meat

Canned Fish	Moisture (%)	Protein (%)	Fat (%)	Ash (%)
Sardine	1.40±63.73 a	1.47±21.80 a	0.07±9.49 a	0.29±2.26 a
Mackerel	0.83±66.82 a	0.67±20.55 a	0.11±2.31 c	0.12±1.40 b
Tuna	1.97±65.58 a	1.17±22.15 a	0.01±8.11 b	0.04±1.10 b
Significance level	NS	NS	**<.0001	*0.0115

Means with different letters within the same column are significantly different from each other *(*P*<0.05), **(*P*<0.05), NS: not significant.

CONCLUSION

Ultimately, we can deduce from this research through the pH, water capacity and chemical composition of the canned fish that came from Iraq, namely sardines, mackerel and tuna, that the fish are safe and consumable in terms of quality and values evaluated are within the permissible limits for consumption.

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