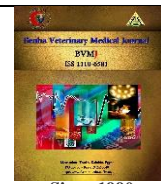




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Quality assessment of smoked herring fish in Egyptian markets

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ABSTRACT

In Egypt, smoked herring is frequently used as a traditional fish product. Therefore, the purpose of the current study was to evaluate the chemical and microbiological quality of smoked fish. A collection of 100 samples of smoked herring fish products packaged and unpackaged (50 of each) was gathered from various supermarkets at El-Menofia, and yeast significantly differed ($p < 0.05$) between packaged and unpackaged samples. The chemical investigation of the examined packaged samples showed that the average concentrations of total volatile basic nitrogen (mg/100g), thiobarbituric acid (mg/Kg), free fatty acids (mg %), and Histamine (mg/kg) were 9.4 ± 0.5 , 0.37 ± 0.12 , 2.5 ± 0.4 and 20 ± 2 , respectively while, they were 12.9 ± 1.2 , 0.79 ± 0.2 , 3.1 ± 0.18 and 43 ± 4 for unpackaged samples, respectively. Therefore, packaged smoked fish was more acceptable and considered low risk than unpackaged fish. So, the packaging is important in producing good quality smoked fish.

1. INTRODUCTION

Consumers require fish and fish products because they are a significant source of superior-quality protein. The great nutritional value of aquatic items, which are abundant in omega-3 and polyunsaturated fatty acids, is reflected in the rising demand for them. Fish and seafood products are essential for many nations throughout the world because of their nutritional worth as well as their ability to generate foreign exchange in international trade (Saad et al., 2020). Fish must be processed or preserved somehow to keep it from becoming unfit for human consumption since it is more susceptible to contamination (Shewan, 2000). Fish smoking is, therefore, the most frequently used and advised way of preservation when more advanced equipment for better approaches is not available. By applying mild heat, the smoking process is accomplished by reducing the water activity. The heat and chemicals in the smoke deprive bacteria of essential development nutrients while drying off the food surface, which would typically support the majority of commensal organisms (Brown, 2004).

The microbiological analysis is used to assess the potential presence of microorganisms that are significant for public health and to provide an idea of the fish's hygienic quality. This includes handling and processing hygiene violations and temperature misuse (Hassanien et al., 2017). Estimating Aerobic plate count (APC) is regarded as more useful for estimating spoilage and the remaining storage period of fish and fisheries products (Viji et al., 2015; Abebe et al., 2020) and is utilized as an indicator in standards, guidelines, and specifications. During storage, the fish product may reabsorb moisture from the environment, which promotes the growth of microorganisms and increases the presence of *Aspergillus* spp. and *Penicillium* (Ayolabi and Fagade 2010). Due to poor sanitation, insufficient cleaning, or preservation in exposed open trays without cover, the market

can be a source of contamination for fish products, leading to the growth of fungi, the production of toxins, and product spoilage (Fredrick Sam et al. 2016). Histamine is an indicator of fish quality (Mendes, 1999). Where high levels of histamine cause edema, and anaphylactic shock, which are life-threatening. In the European Union (EU), the histamine legal limit in fish is 100 mg/kg (EC, 2005). Therefore, the current study's objectives were to evaluate the chemical and microbiological quality of smoked fish and the impact of packaging on smoked fish quality.

2. MATERIAL AND METHODS

2.1. Sample collection:

A total of 100 smoked herring fish samples, comprising 50 packaged and 50 unpackaged samples, were collected from several stores. In the El-Menofia governorate of Egypt, every individual sample was placed in an individual sterile plastic bag and maintained at a low temperature within an ice box. Subsequently, the samples were promptly transported to the laboratory while adhering to stringent aseptic protocols, where they were subjected to analysis. Microbiological testing was employed to evaluate the quality, safety, and compatibility of the collected samples for human consumption.

2.2. Preparation of samples (APHA 2001):

A dilution of 10-1 was prepared through weighing 10 grams from each sample and blending them with 90 ml of sterile buffered peptone water at a concentration of 0.1%. This mixture was homogenized using a stomacher. Subsequently, the homogenate was let to remain undisturbed at room temperature for 15 minutes. A volume of one milliliter from the original suspension was transferred in a sterile manner into a test tube containing nine milliliters of

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sterile buffered peptone water with a concentration of 0.1%. The mixture was then thoroughly mixed using a sterile blender for 1.5 minutes, resulting in a dilution of 10^{-2} . Then, additional dilutions were prepared by performing tenth-fold serial dilutions.

2.3. microbiological quality:

The aerobic plate count at 35 °C was determined using the pour plate surface plate method as described by ISO 4833-1 (2013) standard.

The enumeration of *Staphylococcus aureus* was performed according to the methodology described by the Food and Drug Administration (FDA) (2001). Baird Parker agar medium was used as the growth medium, and the samples were incubated at a temperature of 37 °C for a duration of 48 hours.

The enumeration of total coliforms was conducted according to the ISO 4832 (2006) standard using violet-red bile agar as the growth medium. The samples were incubated at a temperature of 37 °C for a period of 24 hours.

The determination of mold and yeast count is conducted in accordance with the guidelines provided by ISO 21527-1 (2008).

2.4. The chemical quality:

The chemical quality of the smoked herring was assessed using the AOAC (2009) method to determine the concentrations of total volatile basic nitrogen (TVB-N), thiobarbituric acid (TBA) equivalents in milligrams of malondialdehyde per kg (mg MA/kg), free fatty acids in milligrams per percent (mg%), and histamine in milligrams per kilogram (mg/kg).

2.5. Statistical analysis:

The statistical evaluation of the outcomes was conducted using the student t-test with a confidence level of 95% ($P < 0.05$).

3. RESULTS

As seen in fig. (1) the value of Aerobic plate counts in the fish samples ranged from 4.1 to 4.9 with an average value of 4.5 ± 0.16 log cfu/g for packaged herring fish while, APC in unpackaged herring fish ranged from 5.2 to 6.2 with an average value of 5.7 ± 0.07 log cfu/g with p value < 0.05 between packaged as well as unpackaged herring fish. The acceptability of package herring fish was 100% (50 samples) while, 100% (50 samples) were unacceptable (table 1).

The value of staphylococcal count represented as mean \pm SD in packaged herring estimated 1.8 ± 0.05 log cfu/g while, in unpackaged it was 2.5 ± 0.06 log cfu/g (table 2). Acceptability of samples was 16 (32%) and 10 (20%) acceptable for packaged and unpackaged smoked herring fish. The percent of unacceptable samples for unpackaged smoked herring fish was 80% while, it was 68% for packaged samples (table 3).

Also, the count of coliform in packaged and unpackaged smoked herring fish ranged from 1.6 to 2.1 with mean value of 1.9 ± 0.09 (log cfu/g) and 2.2 to 3.1 with mean value of 2.8 ± 0.02 (log cfu/g), respectively as seen in table (4). Furthermore, packaged smoked herring fish was more acceptable than unpackaged samples as presented in table (5). Also, the count of mold and yeast that presented in table (6) showed that the count varied from 1.97 to 2.013 with mean value of 2.05 ± 0.01 (log cfu/g) and 2.5 to 3.15 with mean value of 2.9 ± 0.03 (log cfu/g) in packaged and unpackaged smoked herring fish.

In table (7) the chemical investigation revealed that packaged samples showed that TVB-N (mg/100g), TBA (mg/Kg), FFA (mg %) and Histamine (mg/kg) valued

were 9.4 ± 0.5 , 0.37 ± 0.12 , 2.5 ± 0.4 and 20 ± 2 , respectively while, they were 12.9 ± 1.2 , 0.79 ± 0.2 , 3.1 ± 0.18 and 43 ± 4 for unpackaged samples, respectively.

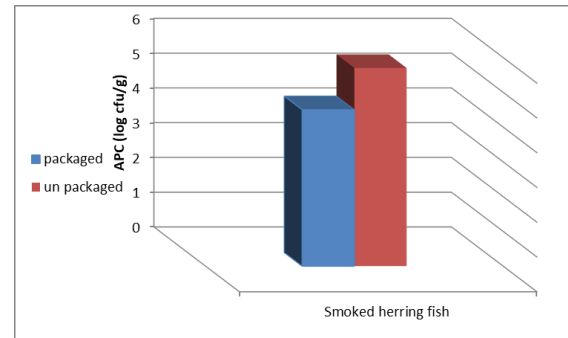


Figure 1 Aerobic plate counts log cfu/g (APC) in the examined packaged and unpackaged smoked herring fish samples.

Table 1 Acceptability of the examined packaged and unpackaged smoked herring fish based on their APC (n=50).

Smoked herring fish	APC /g*	Accepted		Unaccepted	
		No.	%	No.	%
Packaged	10^5	50	100	-	-
Un packaged	$>10^5$	-	-	50	100

Egyptian Standards (2005): ES: 288/2005 for smoked herring fish

Table 2 Staphylococcal count (log cfu/g) in the examined packaged and unpackaged smoked herring fish samples (n=50).

Smoked herring fish	Min. (log cfu/g)	Max. (log cfu/g)	Mean \pm S [*] (log cfu/g)
Packaged	1.29	2.3	1.8 ± 0.05^a
Un packaged	1.9	3.1	2.5 ± 0.06^b

*Mean values with different superscripts in the same columns are significantly different at ($P < 0.05$).

Table 3 Acceptability of the examined packaged and unpackaged smoked herring fish based on their Staphylococcal count (log cfu/g) (n=50).

Smoked herring fish	staphylococcal counts	Accepted		Unaccepted	
		No.	%	No.	%
Packaged	$>10^2$	16	32	34	68
Un packaged	$>10^2$	10	20	40	80

Egyptian Standards (2005): ES: 288/2005 for smoked herring fish

Table 4 Coliform count (log cfu/g) in the examined packaged and unpackaged smoked herring fish samples (n=50).

Smoked herring fish	Min. (log cfu/g)	Max. (log cfu/g)	Mean \pm SE [*] (log cfu/g)
Packaged	1.6	2.1	1.9 ± 0.09 a
Un packaged	2.2	3.1	2.8 ± 0.02 b

*Mean values with different superscripts in the same columns are significantly different at ($P < 0.05$).

Table 5 Acceptability of the examined samples of packaged and unpackaged smoked herring fish based on their coliform count (log cfu/g) (n=50).

Smoked herring fish	Coliform count	Accepted		Unaccepted	
		No.	%	No.	%
Packaged	$>10^2$	30	60	20	40
Un packaged	$>10^2$	10	20	40	80

*Egyptian Standards (2005): ES: 288/2005 for smoked herring fish

Table 6 Mean mold and yeast count isolated from packaged and unpackaged smoked herring fish samples.

Smoked herring fish	Min. (log cfu/g)	Max. (log cfu/g)	Mean \pm SD (log cfu/g)
Packaged	1.97	2.13	2.05 ± 0.11^a
Un packaged	2.5	3.15	2.9 ± 0.53^b

Table 7 Chemical indices in examination of packaged and unpackaged smoked herring fish samples (n=50).

Smoked herring fish	TVB-N (mg/100g)	TBA (mg/Kg)	FFA (mg %)	Histamine (mg/kg)
Packaged	9.4 ± 0.5	0.37 ± 0.12	2.5 ± 0.4	20 ± 2
Un packaged	12.9 ± 1.2	0.79 ± 0.2	3.1 ± 0.18	43 ± 4

4. DISCUSSION

Fish is one of the most widely preferred foods all over the world, as it is considered an important source of PUFA,

animal protein, and essential amino acids, along with micronutrients like minerals (calcium, iron, zinc, and selenium) and vitamins (A, B, and D). Increased consumption of fish can reduce problems related to malnutrition (anemia in women and obesity), and nutritional deficiencies like iron, zinc, iodine, and vitamin A can be treated (FAO, 2020). Fish, however, is a reservoir for a variety of microorganisms, and unhygienic handling and storage of the product can cause unpleasant odors and contamination with unfavorable microorganisms (Hassanien et al. 2017).

Fish rotting, which is characterized by the softening of the muscular tissue and the generation of slime and disagreeable odors, has been found to be greatly influenced by microbial action (Eyo, 2001). The examined samples showed a significant difference between packaged and unpackaged smoked herring fish. Packaging provides protection for fish as it decreases the access of air to fish, which provides a micro-aerophilic condition that suppresses aerobic bacterial growth. APC measures the number of bacteria growing aerobically (in the presence of oxygen) and at moderate temperatures (mesophilically) rather than the total number of bacteria present (ICMSF, 1996). The same results were seen by Hassanien et al. (2017), as the APC of smoked herring was 4.17 ± 0.12 log cfu/g and Adeyeye et al. (2015) found that the APC was 4.0×10^4 in smoked spotted tilapia. While Khater and Farag (2013) found that the APC in herring samples was 5.35 ± 0.23 . Also, Adegunwa et al. (2013) mentioned that APC in smoked herring ranged from 1.26×10^6 to 3.00×10^7 cfu/g. Lower results were recorded by Kumar et al. (2022), who found that APC in smoked fish was 3.78 (log cfu/g). The bacterial load was found to be higher in the samples of smoked fish, which may have been caused by secondary contamination during handling and storage of the fish in ice made from contaminated water, as well as by inadequate processing conditions for hygiene and sanitation (Hatha et al. 1998). However, when the smoking procedure is not effectively carried out, microbial development and activity still continue, resulting in the degradation of the fish. Smoking serves to block the activities of microorganisms. Total aerobic count (TAC) is therefore regarded as a food quality indicator. Total aerobic count is a predictor of the shelf-life of items as well as the potential for growth of the microorganisms that are present, even if there is no direct association between this and the presence of pathogenic bacteria (Arvanitoyannis et al., 2005). Also, the staphylococcal count in packaged samples was significantly different ($P < 0.05$) from unpackaged samples. Adeyeye et al. (2015) assumed results that were nearly identical. On the other hand, Kumar et al. (2022), recorded that the staphylococcal count in smoked fish was 1.39 log cfu/g, recording lower results.

The majority of fish food poisoning cases resulted from eating raw or undercooked fish, which might have picked up bacteria during heat processing or from land sources (Novothy et al. 2004). The data in Table 4 demonstrated that the mean coliform count corresponded to the values published by Soliman et al. (2002) and Vigano et al. (2007). The use of insufficient hygienic measures, incorrect handling, improper storage, the use of unclean water during marketing, and other unhygienic storage conditions have all been connected to the presence of coliform in food (Sousa et al., 2008). Inadequate sanitation during fish handling, processing, salting, storage, shipping, distribution, and marketing may be to blame for the prevalence of mold in fish. As a likely result of some fungal strains producing aflatoxins, contamination with a variety of mold genera

caused unfavorable alterations in fish that made it unfit for marketing and increased the likelihood of customers becoming infected with the corresponding disease. Ibrahim et al. (2017) reported better results, citing mold counts of 5.28 and 4.32 log cfu/g for packaged and unpackaged smoked herring, respectively. Furthermore, Hassanien et al. (2017) found that the count of mold and yeast isolated from smoked fish was 3.96 ± 0.14 log cfu/g. Furthermore, according to Ibrahim-Hala's (2000) research, the average total mold count per gram of smoked fish was 3.5 ± 1.3 log cfu per gram. The average total mold count per gram of smoked salmon was 4.18 log cfu per gram, according to El-Sayed (1995). Mold growth is thus one of the most frequent reasons for spoilage in smoked fish. Tadros-Safaa (1999) reported similar findings where the mean value of the total mold count was 2.87 2.4 log cfu/g.

The chemical quality indicators showed that fish packaging made things better, as the amounts of TVB-N, TBA, FFA, and histamine in packaged fish samples were lower than those in unpackaged samples.

The bacterial and enzyme action that causes fish to spoil produces a variety of volatile chemicals, including ammonia and volatile acids (TVB-N), which are mostly generated as byproducts of protein breakdown. One of the volatile amines that can be used as a spoiling indicator is trimethylamine (TMA), which is also combined with ammonia. Additionally, the degree of fish rotting is determined using the thiobarbituric acid value (TBA). The TBA test quantifies monoaldehyde, a byproduct of lipid oxidation (da Silva, 2002).

The oil's free fatty acid value (FFA value) reveals the extent to which lipase action has broken down the glycerides. Heat and light hasten the breakdown. The finding is frequently used as a general indicator of the condition and edibility of oil or foods containing oil because rancidity is typically followed by the development of free fatty acids. Adeyeye et al. (2015) had better results, as TVB-N (mcg/100g), TBA (mg/kg), and FFA (mg%) values for smoked spotted tilapia were 19.85, 1.86, and 2.33, respectively. Similar outcomes were found by Ayeloja et al. (2020), though. Additionally, packed samples had lower histamine levels than unpackaged samples.

The main toxigenic BA found in foods is histamine, which can cause a variety of negative health effects in people, including food poisoning, food allergies, and changes in blood pressure, brain activity, and stomach acidity (Maintz and Novak, 2007; Liang et al., 2019).

5. CONCLUSION

Finally, the study revealed that packed smoked fish exhibited more acceptability and was regarded as having a lower level of danger compared to its unpackaged counterpart. The significance of packaging in the production of high-quality smoked herring is widely acknowledged.

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