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Effect of different salt concentrations level on chemical composition of wet-salted fermented product (fessiekh)

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Abstract
This work was performed to investigate the influence of different salt concentrations level (20%, 25%, 30% and 0% as a control) on chemical composition of wet-salted fermented product (local name; fessiekh) processed from new fish species *Schilbe* spp local name (Shilbaya) compared with popular fessiekh fish species (*Hydrocynus* spp, local name: Kass), in reducing the over fishing and use of *Hydrocynus* spp. in fessiekh production in the Sudan. Moisture content, crude protein, crude fat, crude fiber, ash content and some minerals content were analyzed to determine chemical quality before and after salting. Chemical composition of the *Hydrocynus* spp and *Schilbe* spp after salting, indicated some losses of the nutritive value when compared with fresh state. Also the findings of the study clearly revealed, the chemical composition of fessiekh product showed no significant differences between *Hydrocynus* spp. and *Schilbe* sp. Effect of salt concentrations (20%, 25% and 30%) on the nutritive value of Fessiekh product showed significant variation, although salt concentration level 20% gave better results than the two other concentrations. Taste panelists found product from fish fermentation treated with salt concentration 20% more acceptable.

Keywords: Fessiekh, salt concentration, *Schilbe* spp and chemical compositions

1. Introduction

Fish processing remains the predominant and most important method of fish preservation in Africa (Gumisiriza *et al*., 2009 and Foline, *et al*., 2011) [18, 16]. The principal methods are salting, fermentation, drying and smoking. These processes may either be used alone or combined in order to achieve the desired product (Turan *et al*., 2007) [27]. Traditional fermentation in developing countries is one of the oldest processing methods which are used for preserving fish, where it is not only extend the shelf life but also enhanced a unique taste, flavor and nutritional quality of end products. (Anihouvi *et al*., 2006 and Dincer *et al*., 2010) [4, 8]. In the Sudan, special types of traditional fermented fish products have long been made, locally termed as “Fessiekh” making. Fessiekh is a wet salted product that is soft in texture with a strong pungent smell and a shiny silvery appearance. It can be stored for more than three months (Ahmed, *et al*., 2010) [2]. Fessiekh is not a truly indigenous Sudanese food product but is a major fermented product from fish in the Sudan. The product has immense popularity in Egypt and is also familiar to some regions of the Middle East, (Makie, *et al*., 1971) [23]. Fessiekh which is consumed as a source of protein also furnished fat which is a welcomed addition to the diet in areas where there is shortage in calories. The bulk of the Fessiekh product is made from the fish locally called “Kass” (Tiger fish; *Hydrocynus* spp) belong to the family Characidae. The major reason given by the processors for the choice of Kass to make fessiekh is that these fish type is relatively lean. Other reasons given for the choice of this speciese for fessiekh include a belief that their product is tastier than that from other fish types. Moreover, this species, keep their original shape, color and flesh, whereas other fish become soft, lose firmness and liquefy fast, (Dirar, 1993) [7]. The variation in the product quality has drawn the attention to the need for further investigation of the nutritive value and correlation with the preparation of the product in the final form in order to satisfy the requirement of the consumer both locally and abroad. The main objective of this study was to investigate the effect of salt concentration level on chemical analysis of salted -fermented (Fassiekh) and to examine possibility of other species of fish (*Schilbe* spp) for Fessiekh making to help in reducing the over fishing and use of *Hydrocynus* spp. in fassiekh production.

Materials and Methods
This study was conducted at the Fisheries Research Center, Ministry of Science and Technology, University of Khartoum and Veterinary Research Center, Soba.

Sample Collection
Samples of fresh fish were brought from El Mwrada market, namely kass (*Hydrocynus* spp) and Shilbaya (*Schilbe* spp). The samples were transported immediately (early in the morning) to the laboratory at Elshagra Fisheries Research Center. The chemical analysis were immediately carried out for fresh sample. The salt used in the processing of the experimental methods was obtained from Khartoum market.

Treatment
Fresh fishes were weighed, washed, eviscerated, washed again and transferred to baskets to dry up. Then weighed again to obtain the actual weight, which will be treated with salt and divided into three equal groups. Then the first group was subjected to addition of a total weight of salt amounting to 20% of the fish weight, the second to 25% while the third to 30%. The idea was to study the effect of salt concentration. The procedure used is called dry salting. In this method salt was applied by hand and then brushing of the fish surface, the inner lining of eviscerated abdominal cavity and the gills chambers. This process was conducted by arranging the fish in layers and separated by coarse salt layers inside the plastic container.

Chemical Analysis
Preparation of the Sample
The samples of fresh and treated fish were minced through a meat mincer, and then mixed several times to be homogenized before analysis. The methods of A.O.A.C. (1996) [3] were used to determine the moisture, crude protein (C.P), ash content, crude fiber and the crude fat of the sample.

pH Measurement
The pH was read using digital pH-meter (model Jenway 3015). Two grams of sample was minced with 9 ml distilled water and was transferred to a buffer tub of pH meter for reading. The pH was taken as a mean of 3 readings.

Determinations of Minerals
All minerals (Phosphorus, Iron, Copper, Calcium, Sodium and Potassium) studied of fresh and salted fish were determined according to the methods of A.O.A.C. (1996) [3].

Sensory Evaluation
For examination purposes, end products were submitted on 20 persons test panel. From Fisheries Research Center staff, fishermen and some students of Department of Fisheries, College of Natural Resources, University of Bahri and judged in comparison with salted fish. Comparison was carried out in terms of organoleptic characteristics, such as color, flavor, taste, texture and general appearance. The panel was requested to rate each organoleptic feature of the end products according to a 10 point scale (9 = excellent; 8-9 very good; 6.5-7.9 good; 5-6.4 fair; <5 bad), using the score method as reported by (Afolbi *et al*., 1984) [1].

Statistical Analysis
The data obtained were analyzed as a completely randomized design and the means were tested for significance using Duncan Multiple test described by **SPSS** soft word (Version 13).

Results and Discussion
Chemical analysis of fresh fish (control) used in fessiekh preparation, namely *Hydrocynus spp* (Kass) and *Schilbe spp* (Shilbaya) are presented in table (1). It could be seen that there are minor differences of chemical composition between the two species. The result are in close agreement with those reported by Mahmoud, (1977) [24] who found that the chemical analysis of common Nile fishes were in the range of 63.29-78.19, 14.99-22.01%,0.36-2.50% and 0.45-1.94% for moisture, protein, fat and ash respectively. In comparison with other fresh water species, Elagba *et al*., (2010) [11] reported that the chemical composition(dry weight) of the Nile fishes: *Lates niloticus*, *Bagrus bayad*, *Oreochromis niloticus*, *Synodontis schall* and *Tetraodon lineatus*, Lipid content was range from1.8 to 17.3%, moisture was 73 to 80% and protein content was 59.8% to 79.1%. Egbal *et al*. (2016) [10], reported that the proximate composition (dry weight) of six commercially important fish species in Sudan,(*Lates niloticus, Bagrus bayad, Oreochromis niloticus, Synodontis schall, Labeo niloticus* and *Hydrocynus froskalii*), protein content was in the range (71.46% -89.13 %) in the fish samples, crude fat was (6.34 % - 9.66 %) while moisture and ash were (75.33% -79.33 %) and (3.83 % -7.07 %) respectively. This can be attributed that, the nutritional components of the fresh water fishes tend to differ between species, sexes, sizes, seasons and geographical localities (Huss, 1995; Zenebe *et al.*, 1998) [19, 29]. Minerals content of two fresh species, is very low specially phosphorus (table 2). The low contents of minerals that observed in this study may be due to the fresh water fish and the natural variation of these constituents; it is impossible to give comparable figures (FAO, 1995) [15].

After salting the moisture contents decreased significantly ($p<0.05$) with respect to different salt concentrations, ash, protein, fat, fiber and pH followed the same trend (table 3). The moisture content ranged between 59.07±0.36-68.64±0.56%. The reduction in moisture contents can be attributed to protein denaturation and consequent loss of water-holding capacity of the protein in the fish samples. Dry salting produced considerable loss of constituent water due to heavy uptake of salt (Martínez-A. and Gómez-G., 2006) [25]. The findings of present study are similar to the findings of (Bahri *et. al*., 2006) [6] on salted Grey Mullet and Hussien, (2002) [20] who reported a moisture content range of 74.94-60.20%, for dry salted *Hydrocynus forskalii*. There was no significant difference in protein contents among studied fish species treated with different salt percentages level (table 3). The protein content of salted samples ranged from 16.06±0.76 to17.85±0,64. It is evident that the protein content of processed fish has decreased after the course of salting. Loss of protein during processing is extremely variable. Salting of fish is usually accompanied by protein losses, as water is drawn out a meal brine is formed, some protein is dissolved into the brine (Clucas and Ward 1996) [6]. Generally the quantity of protein lost depends on the exact nature and duration of the salting process and the conditions of fish when salted (Eltom, 1989) [13]. These changes seem to be related with salt concentration. This is explained by the large uptake of salt (NaCl) by the muscle, resulting in competition with muscle protein for water molecules, and denaturation and aggregation of these proteins by a process of "salting out"

(Ünlüsayın *et al.,* 2001; Sannaveerappa *et al*., 2004; Martínez-A. and Gómez-G., 2006) [28, 26, 25]. There was a significant difference in fat contents among studied fish species treated with different salt concentrations level, the fat content of fessickh samples range was 1.05±0.59-1.47±0.40% (tables 3). These variations were pronounced between different salt percentage levels of *Schilbe* spp and *Hydrocynus* spp. Lower values of fat content which appeared in the studied fish species of Fasseikh might be due to the leaching out of some substances during processing correlated with penetration of salt in muscle. The ash content of salted samples were increased significantly (p<0.05) with the level of salt concentrations. It is known that the oozing of fish juice during salting,thus the relatively high ash content observed in salted samples could be attributed to salt penetration into fish flesh during the curing process. The ash content of the salted-fermented fish in this study was in agreement with Kofi (1992) [21] who reported that the ash content could be ranged between (1.3 - 22.5%). The pH values of samples were 6.77±0.63 - 6.49±0.44 (Table 3). Similar results were reported in salted fish by some other researches (Gökoğlu *et al.* 1994, Kucukoner and Akyuz, 1992 and Bahri *et. al*., 2006) [17, 22, 5]. Although the later author found values reduced depending on storage time for the species of tout, anchovy and mirror carp. All of mineral studied were decreased during salting these may be due to losing of water. The salt penetration is lower water activity in the deepest parts of the flesh (Doe *et al*., 1983) [9], these reduce the water activity and the occurrence of impurities interferes with salt penetration, which lead to low quality product (FAO, 1981) [14]. The higher value of sodium after salting could be referred to added amounts of sodium chloride from salts. Thus lead to increase, as the result of moisture removed and concentration of nutrient materials. It is evident that the mineral content of salting decreased after the course of salting. A general observation shows that fermentation does not adversely affect the minerals content of Sudanese fermented fish product "fessiekh". However, the content of minerals in the fermented fish was within the range recorded in other fresh Nile fish (Elagba& LeelwaAl, 2016**)** [12]. The present study, therefore, revealed that fermented fish products are generally good sources of minerals required for human health.

The sensory evaluation conducted in this investigation may be considered as a more relevant method for the determination of fish quality, since the tasters possessed experience earned through a long period of time. In the present experiment, statistically there was significant difference (p<0.05) in the sensory evaluation based on the panel's score (Table 5). It could be noticed that salted. It could be noticed that *Hydrocynus* spp treated with salt concentration 20% have received higher scores, followed by *Hydrocynus* treated with 25% salt concentration. *Schilbe* species treated with 20% and 25% have received same scores of *Hydrocynus* species treated with 25% salt. *Hydrocynus* species and *Schilbe* species treated with 30% salt, received the lowest scores. This wide range indicated the diversity in the final quality and can be largely attributed to the effect of varying conditions upon the fermenting agents and activities. It is seen that the main factors affecting fessiekh quality are due to amount of salt used for processing of fessiekh.

Conclusions

From the results the chemical composition of two species after salting there were slight variations in all parameters taken. These results reflect suitability of *Schilbe* species as a potential alternative to *Hydrocynus* species which represent the first class of fessiekh industries. Three salt concentrations (20, 25, and 30%) showed marked variation in chemical composition of salted fish samples, but the concentration of 20% gave the best result in comparison with other two concentrations.

Table 1: Chemical composition of fresh fish (mg/100ml %)

Parameters / Fish Species	Moisture	Ash	Crude protein	Crude fat	Crude fiber	pH
Hydrocynus spp	69.45±0.23^a	1.4±0.10 ^{a}	19.5±0.22^a	1.6±0.66^a	1.0±0.12^a	6.8±0.46^a
Schilbe spp	67.23±0.77^b	1.3±0.12^a	19.25±0.22^a	1.9±0.65^b	1.0±012^a	6.7±0.46^a

Values are shown as mean ± standard deviation of triplicate measurements. Different superscript letters in the same column indicate significant differences between groups (p<0.05).

Table 2: Minerals content of fresh *Hydrocynus* spp *and Schilbe* spp (g/100 g)

Parameters / Fish Species	Na	P	Fe	Ca	K
Hydrocynus spp	174.5±0.12^a	1.8±0.22^a	60±0.12^a	8.8±0.23^a	6.8±0.68^a
Schilbe spp	170.2±0.33^b	1.9±0.22^a	65±0.22^b	8.9±0.33^b	6.7±0.68^a

Values are shown as mean ± standard deviation of triplicate measurements. Different superscript letters in the same column indicate significant differences between groups (p<0.05).

Table 3: Changes in chemical composition of *Hydrocynus* spp *and Schilbe* spp after salting (g/100 g)

species	salt	Moisture	Crude ash	Crude protein	Crude fat	Crude fiber	PH
Schilbe spp	20%	63.56±0.34^d	11.50±.74^b	17.75±0.89^a	1.47±0.40^{ab}	1.03±0.34^a	6.89±0.32^c
	25%	59.77±0.70^e	12.16±0.84^a	17.85±0.64^a	1.27±0.57^b	0.79±0.32^b	7.14±0.22^b
	30%	59.07±0.36^e	12.22±0.44^a	17.71±0.77^a	1.17±0.74^c	0.75±0.40^c	7.49±0.41^a
Hydrocynus spp	20%	68.64±0.56^a	12.13±0.49^c	17.41±0.77^a	1.27±0.67^a	1.07±0.70^a	6.77±0.63^c
	25%	67.54±0.71^b	12.97±0.72^b	16.11±0.63^a	1.16±0.68^a	0.88±0.61^a	7.05±0.28^b
	30%	66.55±0.40^c	13.52±0.82^b	16.06±0.76^a	1.05±0.59^b	0.81±0.74^a	7.21±0.44^a

Values are shown as mean ± standard deviation of triplicate measurements. Different superscript letters in the same column indicate significant differences between groups (p<0.05).

Table 4: Changes in minerals of *Hydrocynus* spp *and Schilbe* spp after salting (g/100 g)

species	salt	Na	P	Fe	Ca	K
Schilbe spp	20%	373.58±0.23[c]	1.33±0.40[a]	55.86±0.22[a]	7.97±0.40[a]	6.20±0.14[a]
	25%	378.96±0.30[b]	1.19±0.55[b]	52.29±0.54[a]	7.61±0.44[b]	6.01±0.31[b]
	30%	732.42±0.36[a]	1.05±0.67[c]	52.38±0.39[a]	7.59±0.34[b]	5.91±0.22[c]
Hydrocynus spp	20%	339.43±0.77[c]	1.44±0.73[a]	60.14±0.36[a]	8.49±0.66[a]	5.55±0.28[a]
	25%	536.19±0.51[b]	1.26±0.21[b]	57.38±0.38[a]	8.23±0.44[ab]	5.36±0.31[b]
	30%	713.19±0.40[a]	1.14±0.53[c]	56.81±0.30[a]	8.10±0.24[c]	5.23±0.34[b]

Values are shown as mean ± standard deviation of triplicate measurements. Different superscript letters in the same column indicate significant differences between groups (p<0.05).

Table 5: organoleptic properties (*Hydrocynus spp* and *Schilbe spp*)after salting with different concentration

Parameters / Sampling	Odor	Taste	Color	Texture	General appearance
Hydrocynus spp 20%	8.80 ±1.30[a]	9.00±1.21[a]	7.90 ±1.01a	8.05 ±1.00[a]	7.30±1.30[a]
Hydrocynus spp 25%	8.50 ±2.62[b]	7.90±2.41[b]	7.50 ±1.48[b]	7.75 ±1.04[b]	6.92±1.06[b]
Hydrocynus spp 30%	6.50 ±1.36[c]	5.80±2.39[c]	6.60 ±1.56[c]	6.40 ±1.03[c]	5.49±1.36[c]
Schilbe spp 20%	7.90 ±1.34[b]	7.65±2.06[b]	7.55 ±1.66[b]	7.85 ±2.06[b]	6.78±2.12[b]
Schilbe spp 25%	7.90 ±1.98[b]	7.70±1.66[b]	7.65±2.36[b]	7.65±2.30[b]	6.77±1.66[b]
Schilbe spp 30%	6.70 ±1.86[c]	6.15±1.96[c]	6.30 ±1.86[c]	6.10 ±1.12[c]	5.43±1.36[c]

Values are shown as mean ± standard deviation of triplicate measurements. Different superscript letters in the same coulmn indicate significant differences between groups (p<0.05)

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