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EFFECT OF SALT CONCENTRATION LEVEL AND SEASON ON CHEMICAL COMPOSITION OF WET-SALTED FERMENTED FISH SPECIES

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ABSTRACT: *The study was conducted to investigate the effect of salt concentration level and season on chemical composition of wet-salted fermented product (local name; fassiekh) processed from new two fish species (Labeo spp, local name; Debs, Schilbe spp local name Shilbaya) compared with popular fassiekh fish species (Hydrocynus spp, local name: Kass), in reducing the over fishing and use of Alestes and Hydrocynus spp.in fassiekh production in the Sudan. A assorted of 12 Kgs of each of three fassiekh fish species group, consisted of Hydrocynus spp; (25 -30 cm in total length), Labeo spp (20 -25 cm in total length) and Schilbe sp. (17 -22 cm in total length) were collected from Jebel Aulia Dam landing. Fish species were transferred to Khartoum fishing company for processing of fassiekh product. The samples were divided into 3 batches with three replicates. Each batch was treated with different common salt concentration level (20%, 25%, 33% and 0% as a control). The findings of the study clearly revealed, the chemical composition of fresh salted-fermented product showed no significant differences between Labeo and Hydrocynus spp. while Schilbe sp. recorded significantly higher fat content. The salt concentration level on studied fish species resulted in an increase in crude protein and ash content than fresh fish. The highest salt level (33%) resulted in significantly lower moisture content, and produced well wet-salted fermented product with reasonably long storage shelf life. The effect of different season's production time on wet-salted fermented product showed no significant differences in final product of wet-slated fermented fish species chemically. But there were differences in the duration of processing time, depending on ambient temperature. The study concluded that, the best fish species for production of fassiekh product was the Labeo sp. in winter time with 25% slat concentration level treatment. The second and third were Hydrocyun sp. and Shelibe sp. respectively at the same slat concentration level of treatment and season time.*

Key words: *salt concentration levels, season, chemical, composition, wet- salted Fermented, fish species*

ORIGINAL ARTICLE

INTRODUCTION

Water constitutes about 71.0% of the earth's surface and has always been an important actual and potential source of food. There is an increasing demand for aquatic resources and fish products as dietary protein source around the World (Feldhusen, 2000). Fish as a foodstuff is very rich in protein and amino acids that very well meets human dietary requirements (Heen and Kreuzer, 1962; Borgtrom, 1962). Fish do also help in enhancing other animal protein when converted to fish meal and then used as feed for poultry and fish produce protein in commercially more attractive forms.

Fish consumption patterns in many African countries show relatively higher levels in the coastal countries than in the hinterland. The average annual fish consumption in the west African coastal region for example is approximately 20 kg per capita. In the hinterland countries for example Chad, Mali and the Sudan, per capita fish consumption is low, ranging from 2 to 9 kg per annum, where ; the main source of animal protein is red meat. Sudan is one of the developing countries it has limited economic and technological aspects in this sector.

The Natural Fisheries of Sudan are divided into two main sectors: The inland and marine fisheries (Fisheries Department Report, 1995). The primary fishing ground being the group of the reservoirs of the north and the vast swamps area (the Nile Sudd) of the south the reservoirs occupy about 3000 km2 and swamps about 17.000 km2.

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The potential holding capacity of these resources has been estimated of 104.700 tonnes of fresh fish annually. At present, only 29% of this potential is exploited, about 98% is used as fresh and 2% used as processed, and nearly 8,000 tones is processed in to salted and dried fish (Fessiekh and Kejeick). Most of the Fessiekh of the Sudan, representing about 70 percent of total output, is exported to Egypt but Kejeick is consumed locally except in the Southern Region.

Most processors of these products use simple artisanal technologies for processing, fermentation, packaging and storage. These methods usually date back in history and were introduced in the country by settler communities during the Turko-Egyptian occupation. These methods are easily transferred either by tradition within a family or through non-formal training, as a result of the mode of technology transfer in all the country there is a lack of use of a definite salt concentration level, hygienic conditions and standardization in production processes. Product quality differs from another to batch or from one locality to another in all the country.

The major goal for the food processing industry is to provide safe, wholesome and acceptable food to the consumer. Control of microorganisms is essential to meeting this goal. This control is partly exerted through processing and preservation techniques that eliminate microorganisms or prevent their growth. It is also required that the basic hygienic level during processing is high and that efficient cleaning and disinfecting procedures that eliminate spoilage and pathogenic bacteria are used. Many food pathogenic and spoilage bacteria are able to attach to food contact surfaces (Fonnesbech Vogel et al., 2001).

Hydrocynus and *Aletes* species are the main two species use of in the Fassiekh production in the Sudan. These species were over fished specially areas near to highly populated towns and already almost fully exploited. The Fishery Administration report - Khartoum State (2005) pointed to the attrition of the salted fish by illegal fishing that threatens the extinction of this kind of fish so that, other kind of fish needs to be discovered as replacement.

The main objective of this study was to investigate the effect of season, fish species and salt concentration level on chemical attributes of salted -fermented (Fassiekh) fish species (*Labeo spp*, local name; Debs, *Schilbe spp* local name Shilbaya) compared with popular fassiekh fish species (*Hydrocynus spp*, local name, Kass), to help in reducing the over fishing and use of *Alestes and Hydrocynus spp*. in fassiekh production.

MATERIALS AND METHODS

Locality

The sampling site was chosen at Jebel Aulia Dam (45 Km south of Khartoum-Sudan), on the White Nile, which it's the major source of fessiekh production. The potential of Jebel Aulia reservoir is around 14000 tons a year (Yousif, 1988).

Fish samples

A total of 39 Kg of assorted fresh fish samples consisting of *Hydrocynus spp.* (25 -30 cm in total length), *Labeo spp.* (20 -25 cm in total length) and *Schilbe sp.* (17 -22 cm in total length) were obtained from Jebel Aulia dam landing area. These samples were transferred to Khartoum fishing company (well equipped company) for processing.

Fessiekh preparation

Fresh fish samples were carefully and individually gutted and cleaned to rid them of any adhesive material using untreated river water. Treated samples were divided in to 9 batches. These batches were put in Baskets and treated with different common salt (solar salt which was obtained from Port Sudan on the Red Sea- east of Sudan) percentage levels (20%, 25%, 33%; and 0% as of control). The salt of different percentage levels for each group was spread over the whole mass of fish body with special emphasis on the gill area and the cavity of the gutted specimens. The treated samples were stacked in layers, separated by layers of salt.

The fish were left to undergo fermentation for 3 days. Within the first few hours of fermentation, juice was withdrawn from fish by osmotic action of the salt and evacuated. The fermented products were transferred to other experimental tanks and left for 15 days in summer and 25 days in winter. The final product was lighter in its colour and has tougher consistency. Random samples of final fessiekh product for both seasons were taken, secured and wrapped tightly in separated plastic bags, then send to the meat laboratory, University of Khartoum, Faculty of Animal production for proximate analysis. The sensory evaluation was conducted and done at Khartoum fishing company.

Chemical analysis

The gross chemical composition of samples were determined according to standard methods of AOAC (1990).

Statistical analysis

The results of effect of season, salt percentage level on major chemical components of studied fish species were also determined by simple linear regression analysis using statistical package for social science (SPSS, version 9 as described by Gomez and Gomez 1984).

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RESULTS

The present study was carried out to investigate the effect of different salt percentage levels (0%, 20%, 25% and 33%) on chemical composition and physical attributes of Fassiekh fish species (*Hydrocynus spp., Labeo spp,and Schilbe spp.*) at different seasons time (summer and Winter). The data Tables 1, 2, 3, 4, 5 and 6 shows mean values of the proximate analysis of Fassiekh species during the study period.

These findings revealed that, there was a distinctive variation in chemical composition between fresh fish species (control) and salted wet-fermented studied fish species (fasseikh product).

Table 1 - Effect of salt percentage level and season on dry matter content of fassiekh fish species during the study period

Treatment		Dry matter	
Salt	**Fish spp**	**Summer**	**Winter**
Control 0%	*Labeo*	21.3	20.3
	Schilbe	24.6	39.3
	Hydrocyon	25.6	29.3
20% Salt	*Labeo*	47.0	40.6
	Schilbe	50.9	54.8
	Hydrocyon	47.8	43.7
25% Salt	*Labeo*	49.4	44.3
	Schilbe	55.6	58.0
	Hydrocyon	49.9	43.9
33% Salt	*Labeo*	53.4	48.8
	Schilbe	57.0	59.0
	Hydrocyon	51.5	47.5
Main effect			
Salt	Control	26.72±8.8^{d}	
	20% Salt	47.45±5.2^{c}	
	25% Salt	50.18±5.5^{b}	
	33% Salt	52.83±4.4^{a}	
	Significance	0.00	
Fish spp	*Labeo*	40.63±12.2^{c}	
	Schilbe	49.91±11.6^{a}	
	Hydrocyon	42.35±10.6^{b}	
	Significance	0.00	
Season	Summer	44.49±12.5	
	Winter	44.11±11.7	
	Sign. level	NS	

Key: a,b,c,d means within the same column followed by the different superscripts are significantly (P < 0.01) different.

Table 2 - Effect of salt concentration level and season on moisture content of fasseikh fish species during the study period

Treatment		Moisture	
Salt	**Fish spp**	**Summer**	**Winter**
Control 0%	*Labeo*	78.7	79.7
	Schilbe	72.9	60.7
	Hydrocyon	74.4	80.4
20% Salt	*Labeo*	53.1	59.4
	Schilbe	49.1	45.2
	Hydrocyon	52.3	56.3
25% Salt	*Labeo*	50.6	55.7
	Schilbe	44.4	42.0
	Hydrocyon	50.2	53.5
33% Salt	*Labeo*	46.6	51.2
	Schilbe	43.0	41.0
	Hydrocyon	48.5	52.5
Main effect			
Salt	Control	74.46±7.2^{a}	
	20% Salt	52.55±5.2^{b}	
	25% Salt	49.38±4.9^{c}	
	33% Salt	47.10±4.3^{d}	
	Significance	0.00	
Fish spp.	*Labeo*	59.37±12.2^{a}	
	Schilbe	49.77±10.9^{b}	
	Hydrocyon	58.48±11.5^{a}	
	Significance	0.00	
Season	Summer	55.31±12.2	
	Winter	56.44±12.4	
	Sign. level	NS	

Key: a,b,c,d means within the same column followed by the different superscripts are significantly (P < 0.01) different

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Table 3 - Effect of salt concentration level and season on crude protein content of fasseikh fish species during the study period

Treatment		Crude protein	
Salt	**Fish spp**	**summer**	**winter**
Control 0%	*Labeo*	19.7	15.1
	Schilbe	18.0	19.2
	Hydrocyon	22.2	15.2
20% Salt	*Labeo*	25.8	26.3
	Schilbe	19.1	26.8
	Hydrocyon	26.0	17.4
25% Salt	*Labeo*	25.9	16.9
	Schilbe	23.4	18.9
	Hydrocyon	26.6	21.5
33% Salt	*Labeo*	27.1	24.3
	Schilbe	19.2	19.4
	Hydrocyon	25.9	29.2
Main effect			
Salt	Control		
	20% Salt	23.55±4.9[a]	
	25% Salt	22.19±5.9[a]	
	33% Salt	24.17±5.0[a]	
	Significance	0.00	
Fish spp	*Labeo*	22.62±4.9[a]	
	Schilbe	20.49±3.8[b]	
	Hydrocyon	23.00±6.8[a]	
	Significance	0.025	
Season	Summer	23.22±3.7	
	Winter	20.85±6.4	
	Significance	0.00	

Key: a,b,c,d means within the same column followed by the different superscripts are significantly (P < 0.05) different

Table 4 - Effect of salt concentration level and season on fat content of fassiekh fish species during the study period

Treatment		Fat	
Salt	**Fish spp**	**summer**	**winter**
Control 0%	*Labeo*	0.8	1.2
	Schilbe	7.6	20.5
	Hydrocyon	4.1	4.9
20% Salt	*Labeo*	0.8	1.3
	Schilbe	8.6	13.3
	Hydrocyon	1.3	5.3
25% Salt	*Labeo*	1.7	2.2
	Schilbe	10.3	13.3
	Hydrocyon	0.4	1.5
33% Salt	*Labeo*	1.8	1.6
	Schilbe	10.4	15.0
	Hydrocyon	0.5	1.0
Main effect			
Salt	Control	6.48±6.8[a]	
	20% Salt	3.43±4.1[b]	
	25% Salt	4.98±5.1[ab]	
	33% Salt	5.06±6.0[ab]	
	Significance	0.00	
Fish spp	*Labeo*	1.43±0.9[b]	
	Schilbe	11.13±5.2[a]	
	Hydrocyon	2.35±3.2[b]	
	Significance	0.00	
Season	Summer	4.02±4.0	
	Winter	5.92±6.8	
	Significance	0.00	

Key: a,b,c,d means within the same column followed by the different superscripts are significantly (P < 0.01) different

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Table 5 - Effect of salt concentration level and season on ash content of fassiekh fish species during the study period

Treatment		Ash	
Salt	**Fish spp**	**Summer**	**Winter**
Control 0%	*Labeo*	1.3	2.3
	Schilbe	0.8	0.9
	Hydrocyon	1.2	1.1
20% Salt	*Labeo*	17.9	16.9
	Schilbe	16.7	14.8
	Hydrocyon	15.7	16.8
25% Salt	*Labeo*	19.4	19.9
	Schilbe	18.0	15.4
	Hydrocyon	20.1	16.3
33% Salt	*Labeo*	20.5	19.1
	Schilbe	18.0	17.5
	Hydrocyon	20.9	16.3
Main effect			
Salt	Control	1.31±0.7[c]	
	20% Salt	16.47±1.6[b]	
	25% Salt	18.38±1.8[a]	
	33% Salt	18.69±2.9[a]	
	Significance	0.00	
Fish spp	*Labeo*	14.69±7.6[a]	
	Schilbe	12.74±7.3[c]	
	Hydrocyon	13.71±7.7[b]	
	Significance	NS	
Season	Summer	14.19±7.8	
	Winter	13.23±7.2	
	Significance	NS	

Key: a,b,c,d means within the same column followed by the different superscripts are significantly (P < 0.01) different

Table 6 - Effect of salt concentration level and season on crud fiber content of fassiekh fish species during the study period

Treatment		Crude fiber	
Salt	**Fish spp**	**Summer**	**Winter**
Control 0%	*Labeo*	0.8	10.8
	Schilbe	4.9	17.3
	Hydrocyon	2.3	10.3
20% Salt	*Labeo*	2.7	13.7
	Schilbe	6.6	8.9
	Hydrocyon	5.4	16.9
25% Salt	*Labeo*	5.1	16.7
	Schilbe	3.6	7.0
	Hydrocyon	3.9	15.6
33% Salt	*Labeo*	3.0	18.2
	Schilbe	6.0	7.1
	Hydrocyon	1.3	11.7
Main effect			
Salt	Control	7.71±6.0	
	20% Salt	9.05±5.4	
	25% Salt	8.65±6.9	
	33% Salt	7.88±6.1	
	Significance	NS	
Fish spp	*Labeo*	8.88±6.7	
	Schilbe	7.68±4.4	
	Hydrocyon	8.42±6.9	
	Significance	NS	
Season	Summer	3.79±2.5	
	Winter	12.85±5.1	
	Significance	**	

Key: a,b,c,d means within the same column followed by the different superscripts are significantly (P < 0.01) different

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DISCUSSION

The study of nutritional value of wet-salted fermented product (fassiekh) in relation to different fassiekh product fish species at various salt concentration level plays an important role in fish industry, marketing, preservation and processing. With this concept three fresh water fish species, the more dominant Fasseikh fish species in the Sudan (*Labeo sp., schilbe sp. and Hydrocynus* sp.) were selected for this study to evaluate their chemical characteristics after being treated by different salt concentration levels at different seasons time of (winter and summer). The proximate composition parameters of these fassiekh product fish species are provided in Tables 1, 2, 3, 4 and 5.

Fresh samples (control) of the studied species (*Labeo sp., schilbe sp. and hydrocynus sp.*) in Table 1 have moisture content 78.7±0.4, 72.9±4.2, 74.4±2.7 respectively. These mean values are within the normal range and are in line with many authors (Iskander, 1982, Omer, 1984, Dirar, 1993, Eltom, 1989).

Moisture content has no nutritional value but is essential in describing food composition, preservation and to some extent shelf life (Pike and Brown 1967). Also the moisture content is a factor to be considered in the assessment of salted fish. The level of moisture content of studied species treated with different salt percentage levels (20, 25, 33%) showed distinct variation among the studied species (*Labeo spp*, 53.1±1.4, 50.6±1.3, 46.6±1.1 respectively for summer while in winter 59.4±0.5, 55.7±0.9, 51.2±1.1, respectively), (*Schilbe spp*,49.1±2.5, 44.4±1.6, 43.0±1.6 respectively for summer and 45.2±4.1, 42.0±0.9, 41.0±0.6 respectively for winter), (*Hydrocyuns spp*, 52.3±1.7, 50.2±0.3 and 48.5±1.1 respectively for summer and 56.3±3.2,53.5 ±0.4, 52.4 ±0.4 respectively for winter, all these findings within the range reported by many authors (Agab and Bashir, 1989, El tom 1989, Mahmoud, 1977, Kofi, 1992a).

The lower mean value of moisture content was recorded 41.0 ±0.6 with 33% salt concentration level for *Schilbe* species in winter. The highest was recorded 59.4±0.5 with 20% salt concentration level for *Labeo* species at winter season. This variation could be attributed to increase of salt level .i.e. the increase of salt concentration level (33%) resulted in significantly lower moisture content and longer shelf life.

As for the crude protein content, the chemical analysis revealed that the protein content of each species *Labeo spp* (25.8±0.6, 25.9±0.6 and 27.4±1.3 for summer, and 26.3 ±3.3, 16.9±3.3 and 24.3 +3.8 respectively for winter), *Schilbe spp* (19.1±0.3, 23.4±1.9 and 19.2±3.7 for summer, and 26.8±3.6, 18.9±0.6 and 19.4±3.9 respectively for winter), *Hydrocyuns spp*. (26.0±1.5, 26.6±1.2 and 25.9±3.6 for summer, and 17.4±6.3, 21.5±12.4 and 29.2±4.8 respectively for winter). These little variations in findings were not significantly different when compared to the range values recorded for many Nile fish species as wet product (Babiker, 1981, Mac, 1992, Awouda, 1984). Also when these results were compared with the findings of same fish species studied by Agab and Bashir 1989, El tom, 1989 and Mahmoud, 1977 data were found within the range for Fassiekh product.

The effect of salt concentration level resulted an increase of crude protein significantly. The lower value was recorded 16.9±3.3 for *Labeo spp* at 25% and the highest one was 29.2±4.8 for *Hydrocyuns spp* at 33% salt concentration level. The discrepancy in protein level might be due to different salt concentration level (20%, 25% and 33%) and climatic condition.

There was a significant difference in fat contents among studied fish species treated with different salt percentages level and fresh fish species (Tables 3-5).This could be attributed to the fish species type, nutritional status and season. These variations were more 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 possibly be due to loss of fat with exuded fluids due to the osmotic effect. The effect of different season on fat content is clearly explicated in (Table 6) which normally varies considerably even for the same fish at different seasons. Fat content was significantly higher in fish species caught in winter (1.6, 13.0, 3.1%) than in summer ones (1.3, 9.2, 1.5%) as in *Labeo, Schilbe and Hydrocynus spp.* respectively. These results are in accordance with the findings of Johnston (1994) who found that, the fat content varies widely from species to species and from season to season. Remijo (1992) and Dirar (1993) reported a higher value of fat content (3.5% and 6.7% respectively) for salted-fermented fish*;* these findings are agreement with the present study, which showed considerable variations among the studied species. The fat content could exceed the 6.7% for salted-fermented fish as in this study. In this study fat content was significantly higher in *Schilbe* spp (11.1%) than *Hydrocynus spp* (2.3%) and *Labeo spp* (1.4%).

Ash content as a nutrient element is important in metabolic process, but has little value as food item (Karar, 1997).The effect of salt concentration levels (0%, 20%, 25%, 33%) on wet salted-fermented fish had significantly higher ash content17.4%, 19.6%, 19.8% in *Labeo spp*.; 0.82%, 15.7%, 16.7%, 17.7% ; *Schilbe spp.*, 16.3%, 18.8%, 18.6% *Hydrocynus spp* than fresh fish species 2.0%, 1.1% and 2.0% respectively. The ash content of the salted-fermented fish in this study was in agreement with Kofi (1992) who reported that the ash content could be ranged between (1.3 - 22.5%).

The effect of season on chemical composition of fassiekh product as in Table 5 indicated that there was no significant difference in ash content among the studied fish species in summer and winter (14.7%, 12.7%, and 13.7%) repetitively.

In conclusion the present study clearly revealed that proximate chemical compositions of the salted-fermented fish showed that, there were no significant differences among studied species *Labeo* and *Hydrocynus*, while *Schilbe* showed significantly higher in fat content, at different salt concentration percentages.

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The effect of salt concentration levels on the studied species resulted in an increase of crude protein and ash content than fresh fish. The highest salt level (33%) resulted in significantly lower moisture content, and produced well-salted-fermented fish with reasonably long storage life. which normally vary considerably even in the same fish species at different seasons.

The effect of different seasons on salted-fermented fish showed that, there were no significant differences in final product of wet-fermented fish species chemically. But there were differences in the duration of processing time, depending on ambient temperature.

From this study we could conclude that, the best fish species for production was the *Labeo spp*. in winter at 25% slat concentration level treatment. The second and third was *Hydrocyun spp*. and *Shelibe spp*. respectively at the same slat concentration and seseason.*The Labeo sp. and Shelbie spp.* could be substitute the present fassiekh fish species such as *Alestes and Hydrocyun spp*.

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