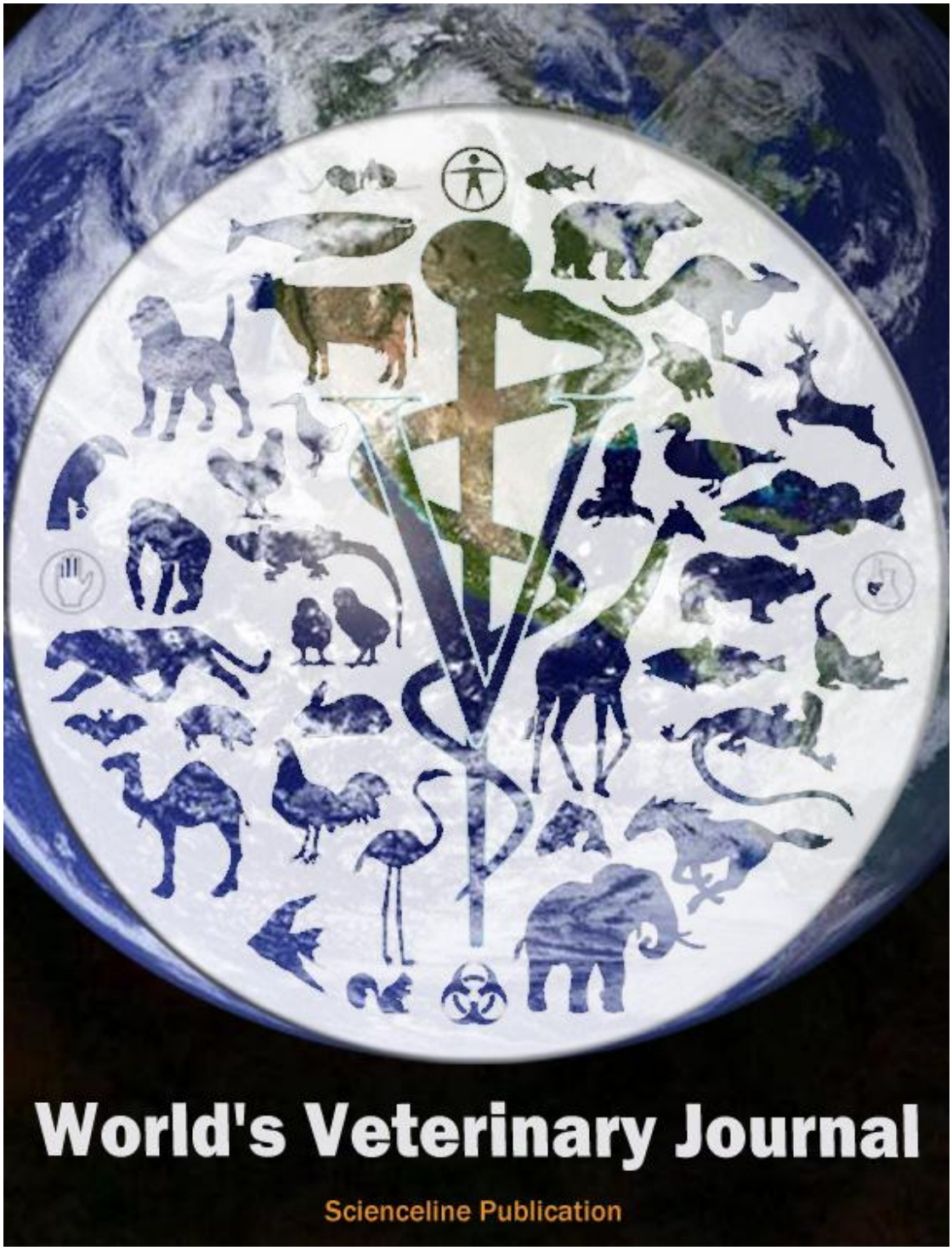

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Original Article

A Survey on Caprine Nematodiasis in Ladakh

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ABSTRACT

The present study was conducted for the time period of one year on goats of Ladakh (J&K) with the aim to find out the various nematode parasites infesting goats of this region and their prevalence with regard to season, sex, age, body condition, and agro-ecology. A total of 268 gastro intestinal tracts along with heart and lungs of the host animal of either sex and of different age groups belonging to different areas of the study area were collected randomly and were examined for nematode parasites. Out of these 116 (43.28%) were found infected with single or multiple parasite species. The study reveals the presence of four species of nematodes viz; Trichuris ovis, Haemonchus contortus, Dictyocaulus filaria and Chabertia ovina. It was also observed that among these T. ovis (48.03%) was most dominant followed by H. contortus (41.02%), D. filaria (37.05%) and C. ovina (22.35%) respectively. A significant difference was observed in prevalence of nematode parasites with respect to season, wherein higher prevalence (50.00%) was observed during the rainy season as compared to the dry season 35.93%. Similarly an association was observed between sex and age of the host with prevalence of nematode infections. It was also observed that females were more infected (46.15%) as compared to males (40.57%). Likewise young animals were more infected (45.83%) than the adult ones (41.21%). Similarly an association was observed between prevalence and agro-ecology of the study area where in higher values (45.45%) were recorded for comparatively lowland (Kargil) areas as compared to highland (Leh) areas (40.08%). The study also shown slight relationship between body condition and prevalence wherein the intensity of infection was higher (47.22%) in weak animals as compare to healthy ones (40.62%).Hence, it was concluded that season, sex, age, agro-ecology and body condition are some of the important risk factors associated with nematode parasitism in this area.

Keywords: Goats, Nematode parasites, Prevalence, Ladakh

INTRODUCTION

Goats play an important role in the economy throughout the world and satisfy a number of needs of mankind in different ways, a large section of people is directly or indirectly dependent on them so is the case with the people of Ladakh where rearing of domestic animals including goats is one of the most important activity for ensuring livelihood for these resource poor people. However, unfortunately the production of these animals is being reduced by a number of factors and one among them has been recognized as parasitism. Economic losses are caused by helminth parasites in a variety of ways: they cause losses through lower fertility, reduced work capacity, involuntary culling, a reduction in food intake, lower weight gains, milk and meat production, treatment costs and mortality in heavily parasitized animals (Carmichael, 1972, and Akerejola et al., 1979). It is estimated that more than 300 species of helminths parasitize livestock in India (Singh and Srivastava, 1977) and new species are being frequently discovered and added to this already swollen list. Gastrointestinal nematodes have been recognized as a major factor limiting goat production throughout the World. After a century of research into their biology and control, nematode parasites continue to be an important constraint on goat production. Modern anthelmintics, together with an understanding of the epidemiology of parasitism, the immune response and nutritional requirements of goats, currently enable satisfactory management of the problem. However, the increasing incidence of resistance by the parasites to available anthelmintics is challenging task for producers to maintain high levels of productivity in the goats industry. Novel developments for the management of nematode parasites such as vaccines, biological anthelmintics, genetic markers and selective breeding of goats may, in the future, provide additional or alternative means of parasite control. However, such alternative control methods are likely to be more dependent on a sound understanding of the species, lifecycle and population dynamics of the parasites involved and the epidemiology of disease they cause than current methods that rely heavily on broad-spectrum anthelmintics.

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MATERIALS AND METHODS

Different parts of the study area were surveyed and a total of 268 gastrointestinal tracts together with heart and lungs of slaughtered goats were collected randomly for parasitological investigation following standard methods of Boomker *et al.* (1989). The GI tracts were separated anatomically, then each organ was opened separately and its contents and mucosa were washed in water to remove all parasites. The contents of the abomasum and small intestine were washed through a 90 mesh sieve and of the large intestine through a 250 mesh sieve for the collection of mature and immature parasites. Abomasum and small intestines were opened and examined by the naked eye for parasitic nodules put into a digestion solution (Pepsin 5 g, HCl 7ml, distilled water 1000 ml) and incubated at 37^0 C for 2 hours. The fluids were washed by the same way to get a collection of 100 nematodes from each organ. The total content of large intestine was examined in Petri dishes under a light microscope. The contents of the large intestine were also examined on a stereomicroscope for larval nematodes. The lungs and trachea were processed for parasite collection. The trachea and bronchi were opened, scrutinized for visible parasites and rinsed in running water over a sieve with 90mm mesh size. The entire lungs were washed and then cut into about 10mm cubes and placed in plastic jar with normal saline for further processing (for the collection of microscopic parasites). Every nematode recovered from the contents was cleaned with physiologic saline and fixed in hot 70% alcohol. The nematodes were then cleared in lactophenol and identified on the basis of various morphological and morphometric characters (Yamaguti, 1959).

RESULTS

The results of the present study show that nematode infection in goats of Ladakh is of common occurrence as is the case with the goats from other parts of the world but with comparatively low diversity as only four species have been recovered during the present study viz; *Trichuris ovis, Haemonchus contortus, Dictyocaulus filaria and Chabertia ovina* of which *T. ovis* was the most prevalent 48.03% followed by *H. contortus*, 41.02% *D. filarial* 37.05% *and C. ovina* 22.35% respectively Table 1.1. Of the 268 goats investigated, 116 (43.28%) were found to be infected with one or more parasite species. Most of the cases were reported with a multiple type infection it was also observed that the prevalence of *Dictyocaulus filaria* was increasing with a decrease in temperature. There was a significant difference in prevalence of parasites with respect to season, where in the prevalence was higher in rainy season (50.00%) than in the dry season (35.93%) Table 1.2. Similarly the prevalence was higher in females (46.15%) and adult animals (41.21%), as compared to males (40.57%) and young ones (45.83%) Table 1.3 and 1.4. Also the study show an association between the prevalence and agro-ecology of the study area wherein the infection rate was higher in comparatively lowland areas (Kargil), (57.35%) as compared to high-altitude (Leh), (42.64%) Table 1.5. Furthermore an association was observed in prevalence of parasite and body condition of the host as the weak animals were found more infected (47.22%) as compared to the healthy ones (40.62%) Table 1.6.

Table1.1. Prevalence on the basis of parasite species

Host	No. Examined	No. Positive	*T. ovis*	*H. contortus*	*D. filaria*	*C. ovina*
Goats	268	(43.28%)	48.03%	41.02%	37.05%	22.35%

Table1.2. Prevalence on the basis of Season

Host	No. Examined	Wet Season	% age	Dry Season	%age
Goats	268	70/140	50.00%	46/128	35.93%

Table1.3. Prevalence on the basis of Sex of the host

Host	Total No. Examined	Males	%age	Females	%age
Goats	268	56/138	40.57	60/130	46.15

Table1.4. Prevalence on the basis of Age of the host

Host	Total No Examined	Young	%age	Adult	%age
Goats	268	55/120	45.83	61/148	41.21

Table1.5. Prevalence on the basis of Agro-ecology

Host	Total No Examined	Total No. Positive	Kargil (Lowland)	%age	Leh (high-altitude)	%age
Goats	268	116	65/143	45.45	51/125	40.08

Table1.6. Prevalence on the basis of body conditions of the host

Host	Total No Examined	Total No. Positive	Healthy	%age	Weak	%age
Goats	268	116	65/160	40.62	51/108	47.22

DISCUSSION

This study showed that the overall prevalence of nematode parasites in goats of Ladakh to be (43.03%). It also disclosed that regardless the season, age, sex, and locality; the animals are infected with a variety of nematode parasites of which *Trichuris ovis* was the most abundant. However the presence of comparatively less species diversity could be due to the environmental conditions of the study area as it is the world's cold desert and the temperature falls below -30

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degree calicoes during winter another possible reason for the same could be that some of the parasites might had been not encountered by the author during the period of study. The higher prevalence in wet season than dry is in consent with many reports around the world (Fritche et al., 1993; Moyo et al., 1996; Tembely et al., 1997; Githigia et al., 2005). This could be due to the existence of a direct relationship between prevalence with the rainfall, humidity and temperature. The presence of sufficient rainfall and moisture during the wet season favoured the survival of infective larvae in the pasture and higher probability of uptake of the infective larvae leading to higher prevalence rate (Sissay, 2007).

The study further revealed that sex of the animals showed an association with the prevalence of the parasites, it was observed that females were more infected than their counter partners. This could be due to the physiological peculiarities of the female animals, which usually constitute stress factors thus, reducing their immunity to infections, and for being lactating mothers, females happen to be weak/malnourished, as a result of which they are more susceptible to the infections besides some other reasons (Blood and Radostists, 2000).

Similarly, a higher prevalence recorded in younger animals as compared to the adult ones is in agreement with most literatures (Dunn, 1978; Shah-Fischer and Say, 1989; Nwosu et al., 1996, Kiyyu, 2003; Nganga et al., 2004) from different corners of world. The reason for which may be the fact that younger animals are more susceptible to infections than adults. Adult animals may acquire immunity to the parasites through frequent challenge and expel the ingested parasite before they establish infection, (Dunn, 1978; Shah-Fischer and Say, 1989).

The study also indicated higher prevalence in Kargil which is comparatively lowland as compared to Leh (high altitudes) which is in consent with reports from many parts of world (Teklye, 1991, Fikru et al., 2006).These low lands are characterized by a comparatively hot humid environmental situation which is favorable for the survival of the infective larval stage of most of the parasites.

The possible reason for higher prevalence of infection in weak animals could be that these animals possess weak immune system which cannot fight against the parasites to the same extent as that of the healthy immune system, or the reason could be sampling error as the number of healthy animals examined was comparatively more than the weak animals (Kuchai, 2008).

CONCLUSION

Based on the findings of present study it is clear that goats of Ladakh are infected with a variety of nematode parasites so may be the case with other animals of this region, therefore it seems to be an urgent task to take further steps towards the same field in order to gather more and more knowledge for a better management of helminth parasites which will lead to the better production.

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Original Article

Effect of Firewood and Sawdust Smoke on Chemical and Physical Properties of Clarias Fish Meat

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ABSTRACT

This study was conducted to determine chemical composition and sensory evaluation of dried and fresh smoked of *Clarias sp* fish meat prepared using firewood and sawdust at traditional kilns. *Clarias sp.* fish (20 kg) was collected from Elmorada fish Market Omdroman (Sudan), these fish were in the range of 26 – 36 cm in length and 140 – 350 g in weight, the studied samples were divided into two main groups; fresh and dried. Each group was divided into two subgroups and treated with firewood and sawdust separately. The final products of the studied fish were analyzed for proximate analysis (crude protein, fat, moisture, dry matter, ash and nitrogen free extract) in addition to sensory evaluation. The study revealed that there were no significant differences in moisture, protein, fat, ash and nitrogen free extract content among studied samples. In the case of sensory evaluation of the smoked product, the fish smoked with firewood gave better overall acceptability than those smoked with dust wood. It could be concluded that the sawdust can be used practically as alternative to firewood to reduce the cost of smoking and waste of carpenter.

Keywords: Firewood, dust smoke, chemical physical attributes, *Clarias sp*.

INTRODUCTION

Shortage and deficiency of food supplies that the requirements of an increasing world population are major problems which are likely to lead to malnutrition and poor health. The current world fish production amount to 116 million tons, almost 50 percent of total world landings are estimated to be from small-scale capture fisheries, and most of the production is used for direct human consumption (FAO, 1997). However, aquaculture production is estimated at 16 million tons of fish which constitutes 23% of food fish supplies (FAO, 1997). In the Arab world, the fishery resources are estimated at eight million and seven hundred metric tons, but until now only five million tons were located, and economically four million and four hundred thousand tons are available for exploitation **(**Arab organization for Agricultural Development Report (1996). The fisheries resources of the Sudan form only less than 3.5% of total world estimates while they cover an overall area estimated at 100.000 km^2 of land water and 700 km^2 of Red sea coast (FAO, 1997).

Medani, (1972) showed that fish represent the source of animal protein for many Nilotic tribes in southern Sudan and the characteristics of fish consumption pattern. Abu Gideiri, (1973) stated that in the Sudan the importance of fish in the diet, seems to follow a markedly pattern regional pattern. Handling and post-harvest treatment of fish in Sudan shows a wide spectrum as the choice, consumption and ways of utilization. People consume fresh fish or presented in one away or other (salted, dried or smoked). Most recently fishes themselves have been used for other purposes as feeds for other animals, e.g. fish meals for poultry, or fishes themselves, or even remains of fish as fertilizers in agriculture (Abu Giddier et al., 1999).

One of the most important smoked fish in Sudan those formed an economical values are *Clarias spp.* fish, which served as dried fish (local name: Kejeik) which traditionally produced by Nilotic tribes, of the south from the Nile Sudd swamps. Fish may be re-dried after smoking, depending on the moisture content (Abu Giddier *et al.,* 1999). Sun drying and smoking are the final, yet an important step in traditional method of fish processing in many African countries, with the exception of Fessiekh, Mindeshi and Terkin in the Sudan (Essuman, 1992). Smoking demands great quantities of firewood and wood is becoming scarce and expensive eroding the profit of processors who often have to purchase it, the situation is known to be critical in fishing villages and urban centers where fish processing takes place on a daily basis. Most type of wood hard or soft can be used for smoking fish. Red mangrove wood which is available in

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tropical countries burns well even immediately after cutting but hardwood being the best burns slowly and produces more smoke than soft wood. The use of firewood though a traditional energy resource in fish smoking is an increasing environmental concern (Akande *et al*., 1998). Research and development work on development of fuels for use in smoking has been minimal thus far and should now be seriously looked into as part of future trends in area of fish processing, some alternatives presently in use either separately or in combination with firewood include such materials as palm nut, coconut husk, sugar cane trash and etc.

The main objectives of this study:

1- to develop an alternative use and efficiency of local fuels, (wood and its sawdust; Teak wood *Cordia africana*), in smoking of fish using traditional kilns.

2- and to determine the effect of firewood and sawdust smoke on the chemical and physical attributes of *Clarias* Sp. meat.

MATERIALS AND METHODS

Locality

This study was conducted at Sudan University of Science and Technology (sustech.edu), College of Science and Technology of Animal production, department of fisheries and Wildlife Science.

Experimental Trials

Fresh *Clarias sp* fish (20 kg) was purchased from Elmawarda Fish Market (Sudan). These fish were in the range of 26 – 36 cm in length and 240 – 350 g in weight. Fish were thoroughly washed with tap water and weighed, and then gutted using clean knives and washed again with tap water to remove all traces of viscera and blood. The fish were then immersed into a salt solution (NaCl 10%), and divided into two batches; one batch was dried in the sun and open air for one day and other batch was kept fresh. The products were prepared and introduced into steel kiln smoker which was consisted of two parts as follows: 1. the smoking chamber with dimension 86 x 87 x 93 cm^3. 2.The chimney of two parts, the marginal part of 75 cm, height of 80 cm and diameter of 25 cm whose fuel was composed of Teak wood *(Cordia Africana*) at rate of 4 kg and kept at an average temperature of 45◦C throughout the period of exposure for continuous two hours.

Smoking process

The studied fish were divided into two fresh and dried groups while each of them was further divided into subgroups that smoked with sawdust and firewood separately using traditional kiln. The time taken to smoke of dried fish samples with firewood was 5 hours, while it took 12 hours in the case of sawdust, also the time taken to smoke fresh fish with firewood was 6 hours while it took 14 hours when using sawdust. The smoked products were taken to laboratory for analysis.

Chemical analysis

The gross chemicals of samples were determined according to standard methods of Association of Official Analytical Chemists (AOAC, 1984**)** for moisture, fat, protein, ash and nitrogen- free extract.

Sensory evaluation

The sensory evaluation was undertaken to determine the taste, odour, texture and general acceptability of the smoked products. The panelists of ten members who already have experience with scoring smoked fish in addition to staff members and some students of college of Science and Animal production Sudan University of Science and Technology. An overall acceptability score was given to smoked product using scale of 8-excellent, 7-very good, 6-good, 5-fairy good, 4-fair, 3-poor, 2-very poor and 1-extremely poor.

Statistical analysis

Data of biochemical constituents of studied fish were analyzed by one - way ANOVA procedures and SPSS version 10.

Results and Discussion

The results of this study shed a light on fish meat (*Clarias sp.*) somking, in view of its high preference by and its availability in dry and wet seasons for consumers. The studied fish product parameters were analyzed, investigated chemically, organoleptically and recorded in Tables 1,2,3,4 and 5.

The result of investigation on *Clarias sp.* meat indicated that the chemical composition resulting from smoking by firewood and sawdust on studied fish no significant difference ($P > 0.05$) was found to be in moisture, protein, fat, and ash values. These findings were in the line of Ali *et al.*, (1996) who studied the chemical composition of some of Nile fish species in addition to its body characteristics, yield indices and chemical composition. Also these results were in agreement with the finding of Akande *et al*. (1998) who found that no significant difference in the gross chemical composition of *Clarias garpeninus* smoked using firewood and sawdust in an improved Chorkor oven. The ash contents were shown in this study a lowest mean value in the fresh and dried smoked products; this might be resulted from the analysis which carried out on the edible portion of fish not incisive of the bones. Also the results revealed that a combined smoking with drying (open – air), obtained a highest level of gross chemical composition particularly in the case of protein and fat content, while the ash content recorded the lowest level as previously reported (Akande *et al.*,1998).

In the case of dried fish smoked with firewood, the moisture content (14.9%) , dry matter (85.2%), crude protein (21.3 %), fat (5.7%) , ash (3.9%) , NFE (65.2 %) were obtained in comparison to smoked with sawdust with

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moisture content (10.5%), dry matter (89.4%), crude protein (21.3%), fat (5.1%), ash (3.8%), N.F.E (65.2%) that showed a considerable variations. These findings in agreement with Ikeme, (1991) who studied characterization of traditional smoked dried fish in Nigeria. Chemical composition can vary widely, not only from fish of the same species, but also within an individual fish, according to age, six, and environmental condition (FAO, 1997).

Sensory assessment as judged by taste panelists was presented in Table 5. Fresh Fish smoked using firewood (5.6) were found to be better in terms of overall acceptability when compared with sawdust smoked products (4.5). Dried fish smoked using firewood were also found to be better in terms of overall acceptability (5.0) fairly good when compared with fish smoked with sawdust (4.5). Also these results were in agreement with Clifford *et al.* (1980), who observed that the texture, toughness and dryness of smoked fish were greatly influenced by the panelist's preference.

Table1. Chemical composition of fresh and dried studied fish (*Clarias sp*).

Treatment	Moisture	Dry matter	Crude protein	Crude fat	Ash	Nitrogen free extract
Fresh fish (smoking with sawdust)	89.55±0.64	10.5±0.64	21.3±0.35	5.1±0.1	4.0±.14	51.5±2.1
Fresh fish (smoking with fire wood)	91.35±0.49	8.65±0.49	21.3±0.39	5.2±0.1	3.70±0.14	59.7±0.63
Dried fish (smoking with sawdust)	14.85±1.9	85.2±1.6	22.9±0.91	5.7±0.2	3.9±0.07	65.2±0.42
Dried Fish (smoking with fire wood)	10.45±0.64	89.4±0.64	26.2±0.49	7.8±0.1	3.8±0.07	65.2±0.42

Values as mean of 10 fish species for each treatment. SD = Standard deviation.

The appearance of smoked fish is usually judged based on the black golden luster, which the heavy smoke of the sawdust may have conferred on the product as opposed to the firewood. The panelists judged the sawdust smoked fish slightly firmer in texture than the firewood smoked fish. This may also explained from the fact that the low fire characteristic of burning sawdust as opposed to the initial high heat produced from firewood may have prevented case hardening of the fish and thereby making the texture more acceptable to taste panelists. Skrede and Strobeken (1986) observed that the color of smoked products depends on textural properties, chemical composition, and the liquid binding ability of the muscle. The result of this study particularly in the case of smoking fish with sawdust was fair good comparing with that results obtained by firewood. When the findings were analyzed statistically there was no significant difference.

Table 2. Effect of firewood and sawdust smoke on dry matter and Crude protein of studied fish

Treatment / Smoking		Dry matter		Crude protein	
		Firewood	**sawdust**	**Firewood**	**Sawdust**
	Fresh	8.7±0.49	10.5±0.2	21.3±0.31	21.3±0.35
	Dried	89.4±0.64	85.5±0.49	22.9±0.95	26.2±0.49
Main effects:					
Samples	**Fresh**	6.00±0.202		24.00±0.359	
	Dried	9.55±0.202		22.05±0.359	
	Sig. level	NS		NS	
Smoked	**Firewood**	7.22±0.202		25.05±0.359	
	Sawdust	8.32±0.202		22.00±0.359	
	Sig. level	NS		NS	
Interaction Sig. level		NS			

NS = Not significant. SD Standard deviation

Sawdust can be obtained at practically with no cost. Initially, a combination of sawdust and wood may be used in fish smoking as used to the sawdust only. Sawdust can be made into briquettes, which will reduce waste and constant replenishment. The duration of smoking using firewood (5 hrs) is less than sawdust (12 hrs) period, this could be a

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disadvantage because it means that the labour cost may be increase. However, this problems was never might to fish smokers in the villages are used to smoking overnight. It could be concluded that the sawdust can be used practically as alternative of firewood to reduce the cost of smoking and waste of carpenter.

Table 3. Effect of firewood and sawdust smoke on fat and ash content of studied fish

Treatment / Smoking		Fat		Ash	
		Firewood	**sawdust**	**Firewood**	**Sawdust**
	Fresh	5.2±0.1	5.1±0.1	3.70±0.14	4.0±0.14
	Dried	7.8±0.1	5.7±0.2	3.8±0.07	3.9±0.07
Main effects:					
Samples	**Fresh**	5.20±0.061		3.80±0.056	
	Dried	5.40±0.061		3.85±0.056	
	Sig. level	NS		NS	
Smoked	**Firewood**	5.10±0.061		3.72±0.056	
	Sawdust	5.50±0.061		3.92±0.056	
	Sig. level	NS		NS	
Interaction Sig. level		NS			

NS = Not significant. SD Standard deviation

Table 4. Effect of firewood and sawdust on nitrogen free extract and moisture content of studied fish

Treatment / Smoking		Fat		Ash	
		Firewood	**sawdust**	**Firewood**	**Sawdust**
	Fresh	59.7±0.63	51.5±2.1	91.35±0.49	89.55±0.64
	Dried	65.2±0.42	65.2±0.42	10.45±0.64	14.85±1.9
Main effects:					
Samples	**Fresh**	63.00±0.575		90.50±1.08	
	Dried	55.55±0.575		12.65±1.08	
	Sig. level	NS		NS	
Smoked	**Firewood**	62.42±0.575		50.9±.1.08	
	Sawdust	56.12±0.575		52.2±1.08	
	Sig. level	NS		NS	
Interaction Sig. level		NS			

NS = Not significant. SD Standard deviation

Table 5. The mean values of overall acceptability of organoleptic indices of smoked product

Parameters / Treatment		Color M±SD	Odor M±SD	Taste M±SD	Texture M±SD	Appearance M±SD	Overall acceptability M±SD
Fresh (n=10)	**Smoking with sawdust**	4.1±2.02	4.7±1.15	4.8±1.9	4.6±1.8	4.0±1.3	4.5±1.6
	Smoking with firewood	4.6±1.42	5.9±1.52	5.30±1.4	6.6±1.8	5.7±1.3	5.6±1.5
Dried (n=10)	**Smoking with sawdust**	5.0±.81	5.0±1.8	4.6±1.6	4.6±1.6	3.2±1.6	4.5±1.5
	Smoking with firewood	5.4±1.42	5.5±1.50	4.6±1.6	5.4±1.4	4.3±2.1	5.0±1.6

Note: each result is mean ± standard deviation of ten panelist response on a scale of 8 = excellent, 7= very good, 6= good, 5= fairly good, 4= fair, 3=poor, 2= very poor and 1= extremely poor.

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Original Article

Quality and Microbial Analysis of Local Salted-Fermented Paste Product (Terkin)

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ABSTRACT

The study was conducted to determine the nutritive values (crude protein, crude fiber, ether extract, moisture, dry matter, ash and nitrogen free extract) of commercial Terkin paste product which was collected from Jebel Al-aulia area (Khartoum State, 45Km south of Khartoum) and Wadi Halfa Town (lied in Sudanese-Egyptian border, North of Sudan) and to investigate the total bacterial count and pH level in order to ensure the hygienic situation of two products, using a Sudanese Standards and Metrology Organization (SSMO), SDS 3767/2007 standards. The results of this study revealed highly significant differences ($p > 0.01$) in crude protein 24.0% and 30.7%, ether extract 6.3% and 11.8%, moisture 56.4% and 39.2%, dry matter 43.6% and 60.8% and ash 13.2% and 19.1% for Jebel Al-aulia and Wadi Halfa Terkin product, respectively. The study recorded also no significant differences in crude fibre 1.5% and 1.2% and nitrogen free extracts 3.1% and 3.4% for Jebel Al-aulia and Wadi Halfa Terkin product respectively. It could be concluded that the findings of microbial analysis of studied products, the Jebel Al-aulia Terkin showed a lower level of total bacterial count (3.5×10^5 CFU/g) than Wadi Halfa Terkin product (6.2×10^5 CFU/g and pH level of studied products had recorded a higher level (7.2) in Terkin of Jebel Al-aulia than Wadi Halfa Terkin product (6.7).

Keywords: Quality, microbial, fermented product, fish, Terkin, paste

INTRODUCTION

Fish and fishery products are highly nutritious and contain high percentages of animal protein with several other nutrients such as vitamins A, B, E, and K and they are good sources of some minerals like calcium, phosphorus and iron (Lunven, 1982). Fish is important source of protein in the daily diet. However, fish also has the disadvantage that it spoils quickly. If fish is not boiled, salted, dried, smoked or preserved in some other way, it will quickly spoil. In South-East Asia, fermentation is the most important way of preserving fish. Fermented fish paste and sauces have a more important product in the daily diet than salted or dried fish (Brigitte *et al*., 2004). In Sudan, fish is distributed over an area of 100,000 km^2 of fresh-water and 760 km^2 of marine, the total sustainable production amount to 114,100 tones/year and human consumption is estimated at only 1.4 kg/year (Meske, 1985), nearly 70% of the total fish landing is cured either by salting, fermentation or sun-drying. Very little of the local fish supply is smoked, except in southern Sudan where smoked, dried and fermented fish products are very popular among the local communities (FAO, 1992a).

Terkin (fermented fish paste) is the one of traditional product in the Sudan particularly in the northern part of the country. Terkin's area famous for its production and consumption is centered on Dongola, the ancient town of Nubia region, Northern Sudan. The region has a long experience in fish fermentation (Besyuni, 1979). Traditional methods of fish fermentation (Fesseikh, Terkin) are two main techniques have clearly emerged as methods commonly practiced in many African countries. These are fermentation with salting and drying, fermentation and drying without salting and fermentation with salting but without drying (FAO, 1992a).

The microbiological examination of fish products is to evaluate the possible presence of bacteria or organisms of public health significance and to give an impression of the hygienic quality including temperature abuse and hygiene during handling and processing (WHO, 1999). According to El-Tom, (1989) and Abu Giddeire (2001) the count of microorganism increased rapidly during first fermentation days and began to decrease later, and that traditional product had a large number of micro-organisms than the laboratory products.

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Research problems are tackled to unavailability of scientific procedures and no standard level of microbial load from Sudanese Standards and Meteorology Organization (SSMO) for Terkin product. The main objective of this study to determine the nutritive value, microbial load and pH level of collected Terkin product paste (wet-salted fermented fish) from two more famous localities of its production in Sudan.

MATERIALS AND METHODS

The studied Terkin paste (wet-salted fermented fish product) samples were purchased from commercial sources of two manufacturing compasses; Elhuda Fishing Establishment located in Jebel Al-aulia dam – Khartoum State, 45Km south of Khartoum, and Mohammed El-halfawi Manufactory located in Wadi Halfa Town – North Sudan.

Jebel Al-aulia Terkin Preparation

Studied Terkin product was collected from Elhuda Fishing Establishment, located in Jebel Al-aulia Dam area; it's specialized in production of fermented fish products (Fessiekh and Terkin). Terkin was prepared and processed from small-young fish namely; Kass (Tiger fish; *Hydrocynus* spp.) and Kawara (*Alestes* spp.). The procedures of production of Terkin, whole unwashed fish (ungutted) was placed in plastic sac and sprayed with little salt, closed tightly and left for 1 – 2 days until fermentation signs appeared. Little boiled-water added and left till it ripened. The product was stirred continuously through this period until completely pasted product was achieved and cooled in steel-vessel. After cooling, 10% salt should be added. The mixture transferred to burlap, placed in clean, sandy and slope place for drainage. After drainage completed, the product transferred to a large closed-plastic-barrel and left to ferment till the desired flavour was occurred (usually 3 – 4 days in summer and increased in winter). Finally, Terkin was packed in packs "250g/pack" and sold in this manner. Shelf-life of Jebel Al-aulia Terkin product was 6 months.

Wadi Halfa Town Terkin Preparation

The other studied Terkin was collected from Wadi Halfa plants. Fish species for Terkin preparation in this plants was the same fish species as in Jebel Al-aulia Dam, but larger in its size. The large fish of *Kass and Kawara* were collected from fishermen, eviscerated, packed and treated with little salt. The fish were placed in boiled water and stirred continuously until the fish were completely pasted, and left for cooling. After that, the mixture packed in large plastic Jerri cans (about 30 kg/jerrican). Finally, sealed tightly with its covers and transferred to market for selling. Shelf-life of this product was 6 months.

Sampling Method

Generally, the large representative samples were collected according to Sudanese Standards and Metrology Organization (SSMO), SDS 3767/2007. Sampling was carried-out with aseptic precautions using sterile containers with spoon (Stool-Containers) from the two studied products. The samples were placed in a large container and transferred to the laboratories of Khartoum University (Laboratory of Animal Nutrition) and University of Sudan of Science and Technology Department of Fisheries and Wildlife Science for analysis.

Microbiological investigations

The media used to determine total viable count (TVC) was obtained in a dehydrated form as manufacturer described, the media was composed of casein enzyme hydrolysate 5.0g, yeast extract 2.5g, dextrose 1.0g and agar 15.0g. It was prepared according to manufacturer's instructions, by using 23.5g of media dissolved in 1 liter of distilled water (DW). The resulting mixture was mixed well and allowed to boil in water-bath until it was completely dissolved. Media was sterilized in an autoclave at 121˚C for 15 minutes. Finally, the media was let to cool at 45˚C and immediately poured in petri dishes for plating. Normal saline solution was prepared and used. Microbiological investigation was determined as described by Barrow and Feltham (1993). Total bacterial count (TBC), in determination of (TBC), the sterile, single-use syringes were used to transfer 1ml of a selected dilution into duplicate sterile plates. 15-20ml Plate Count Agar (PCA) were added to each plate. The plates were incubated at 37˚C for 24 hours according to International Standard, ISO No: 4832/2006. Colonies were counted and determined according to Barrow and Feltham, (1993).

pH determination

The pH value was determined at room temperature. Two grams of wet-salted fermented fish product (Terkin) were weighed in a sensitive-digital balance and blended with 20 ml distilled water and stirred well with a glass stirrer and centrifuged 2000/rpm. The pH level of supernatant was measured using glass-electrode of a newly calibrated Digital pH meter (JENWAY-3015 pH meter).

Chemical composition

Moisture content, dry matter (DM %), crude protein (CP %), ether extract (EE %), nitrogen-free extract (NFE %), crude fibre content (CF %) and ash% were determined for wet-salted fermented fish sample (Terkin) followed the AOAC (1990) method.

Statistical Analysis

The data was analysed using statistical package (IBM SPSS version 19.0), and one way ANOVA test was employed.

RESULTS AND DISCUSION

The Sudanese fermented fish product (Terkin, paste) falls in the category of Sudanese traditional fish products. The producers along the stretch of Nile seem to carry-on the job with no scientific background, but are dependent on heritage and tradition; no control is exerted over the fermentation. In this way, chances for competition in regional or world markets will not definitely succeed. This study aimed to determine and evaluate the nutritive value, microbial load

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and pH values of wet-salted fermented fish product (Terkin) in the targeted regions in Sudan, Jebel Al-aulia dam and Wadi Halfa town (Lake Nubia).

Table 1 showed that the protein content of Terkin made in Jebel Al-aulia dam was 24%, while in the Wadi Halfa was 30.7% ($p \leq 0.01$). This might be probably due to use of different salt concentrations, because Jebel Al-aulia Terkin contains 10% salt, whereas Terkin of Wadi Halfa contains a few salt, just the salt added by processors for preservation in abdomen region and surfaces of fish considered negligible. These results agreed with Agab and Shafie, (1989) and El-tom, (1989) who reported that, the protein content of wet-salted fermented fish product, prepared from Kawara (*Alestes sp*.) is ranged between 27.7 and32.9% .

There was no significant difference ($p > 0.05$) shown in the crude fibre between the two production sites. Ether extract for Jebel Al-aulia and Wadi Halfa Terkin was found to be 6.3% and 11.8%, respectively. There was a highly significant difference ($p \leq 0.01$) in fat content between Terkin of the two production sites; however, Wadi Halfa Terkin contained a higher percentage of fat than that of Jebel Al-aulia. These differences suggested being due to differences in nutritional environment, size of fish and physiological status of fish, these factors The results of this experiment were in agreement with Agab and Shafie (1989); who reported that, the fat content of Fesseikh prepared from Kawara ranged from 10.6 to 22.5%. Also, the findings agreed with Mohamoud, (1977). NFE% for Jebel Al-aulia Terkin and Wadi Halfa Terkin was 3.1% and 3.4%, respectively. As it was clearly noticeable in Table 1, there was no significant difference ($p > 0.05$) in NFE content between Terkin made in Jebel Al-aulia dam and Wadi Halfa. Moisture content of Jebel Al-aulia and Wadi Halfa, was 56.4% and 39.2%, respectively. There was a highly significant difference ($p \leq 0.01$) in moisture content between two production sites. However, moisture of Jebel Al-aulia Terkin was higher than moisture of Wadi Halfa Terkin. So, this difference suggested to be due to the difference in fish size, because, fish size of Jebel Al-aulia Terkin was smaller than fish size of Wadi Halfa Terkin, since the small fish size has higher moisture than larger ones in the same species. The results are in the lines of Agab and Shafie (1989).The results were in agreement with Agab and Shafie (1989), who figured-out that, the matter of Fesseikh prepared from Kawara ranged from 54.5 to 89.3%. Also, these results were in agreement with El-tom (1989), who reported that, Fesseikh prepared from Kawara contained 55.9–68.7% DM. Furthermore; the findings were in agreement with Mohamoud (1977), who reported that, dry matter of Fesseikh prepared from Kass contained 65.4%.

Table 1. Nutritive values of Terkin paste product collected from two production sites in the Sudan

Production site	Crude Protein %	Crude fiber %	Fat %	Nitrogen free energy%	Moisture %	Dry Matter %	Ash %
Jebel Aulia	24.0±0.21**	1.5±0.23	6.3±0.24**	3.1±0.49	56.4±0.51**	43.6±0.51**	13.2±0.31**
Wadi Halfa	30.7±0.64**	1.2±0.12	11.8±0.26**	3.4±0.62	39.2±1.01**	60.8±1.01**	19.1±0.49**

Values are means ± standard error; **: Highly Significant Differences at $p \leq 0.01$.; S.E: Standard Error. Sign: Significance

Table 2. Total viable count (TVC, CFU/g) and pH level of Terkin paste obtained from two production sites in the Sudan

Parameter	Production site	Mean ± SE
TVC	Jebel Al-aulia	$3.5\times10^5 \pm 7.7\times10^{3NS}$
	Wadi Halfa	$6.2\times10^5 \pm 2\times10^{4NS}$
pH	Jebel Al-aulia	7.2 ± 0.01**
	Wadi Halfa	6.7 ± 0.04**

CFU/g: Colony Forming Unit per gram. TVC: Total Viable Count. NS: no significant differences ($p > 0.05$). **: Highly Significant Differences at $p \leq 0.01$.

As Table 1 illustrated, the ash and dry matter content was found to be as the similar of many authors. The TVC for Jebel Al-aulia Terkin as shown in Table 2 was found to be3.5×10^5CFU/g,, whereas the TVC for Wadi Halfa Terkin was recorded 6.2×10^5 CFU/g. The findings showed that, there was no significant difference in TVC between Terkin of the two production sites. However, in spite of there was no significant difference but markedly that, Wadi Halfa Terkin recorded a higher number of total bacterial count than that of Jebel Al-aulia, so this increase in TVC probably to be due to the difference in salt concentration, because Jebel Al-aulia Terkin contains more salt than Wadi Halfa Terkin, and as we know, whenever salt concentration takes place total bacterial count expected to be low, because, increase of salt lead to increase of pH, and as we know, the preferable medium for bacteria is neutral and semi acidic (El Tom, 1989). Dirar (1993) reported that, there was no doubt, however, that bacterial enzymes contribute to flavour development in fermented sauces and pastes. The relative importance of the fish and microbial enzymes in Terkin fermentation probably depends on the procedure followed in the preparation. When the method involves an initial fermentation of the unsalted fish, for instance, the bacterial role would be expected to be pronounced as reflected in swelling of fish and the development of strong odour. These results were in agreement with Knochel and Huss (1984), who studied the microbiology of barrel salted herrings, revealed that both aerobic and anaerobic viable counts (in media containing 15 percent sodium chloride) were low, i.e. not more than 3 x 10^5CFU/g of fish. Also, Dirar, (1993) mentioned that, there

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were no official reports on food poisoning was recorded in Terkin product, but this does not negate the possibility, since that many food poisoning cases in the Sudan do not reach official channels. However, the limits for TBC (CFU/g) in fermented fish products were not found in Sudanese Standards and Metrology Organization (SSMO).

The pH values shown in Table.1 were 7.2 and 6.7 for Terkin of Jebel Al-aulia and Wadi Halfa, respectively. This was showed a highly significant difference ($p \leq 0.01$) in pH between Terkin of the two production sites. However, Jebel Al-aulia Terkin recorded a higher pH value than that of Wadi Halfa. So, this increase in pH might to be due to the increase of salt, because when the salt increased lead to increments in pH. The results of this study are showed a similarity and an agreement with findings of Agab and Shafie, (1989) and El Tom, (1989).

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