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Original Article

Effect of Storage Time on Fishmeal Made from Four Commercial Nile Fishes collected from the White Nile, Sudan

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ABSTRACT

This study was carried out to evaluate the effect of storage time on nutritional values of fishmeal. Four commercial Nile fishes were used in producing the studied fishmeal: Gargur (Synodontis schall, Bloch and Schneider 1801), Dabis (Labeo niloticus, Forskål 1775), Garmout (Clarias gariepinus, Burchell 1822) and Himeila (Brycinus nurse, Rüppell 1832). Results showed that most nutritional values apparently decreased from the beginning readings taken in the first interval of the storage time. The decrease was clearly in the second interval; whereas, the third and fourth interval were similar to those readings of the second interval.

Crude protein content declined from 22.7% to 15.1%, with significant variation of 5.13 and a decline rate of 7.6 %. Fat content, however, showed decline, not only in the second interval, but during the whole study, from 3.7 % to 3.3 % in the second interval and then to 3.1% in the third interval. A decline rate of fat (0.6 %) was not significant. Ash content fluctuated in slightly increase during the three intervals. In the first interval, ash content was 16 %; in the second interval, it was 16.18 % and in third interval, it was 17.88 %. An increase rate of ash content in the second interval was 0.18% and that in the third interval was 1.88 %. Moisture content showed both decreasing and increasing rates during the study. In the first interval, it was 6.6 % and decreased to 3.6 % in the second interval period and then increased to 4.9% in the third interval.

Hence, this study concluded that preservation process of fishmeal without adding any preservatives may cause shortening in its nutritional values representing in crude protein.

Key words: *Nile fishes, fish production, fishmeal, preservation process*

INTRODUCTION

Fishmeal is a natural source of protein, fat, vitamin and minerals. It is used to reduce the cost of animal protein included in diet for improving the productivity of cultured fishes, poultry and cattle [1; 2]. Therefore, the use of fish byproducts for feeding animals is not a new idea; a primitive form of fishmeal is mentioned in the Travels of Marco Polo at the beginning of the fourteenth century: 'they accustom their cattle, cows, sheep, camels and horses to feed upon dried fish, which being regularly served to them, they eat without any sign of dislike [3].

Fishmeal is an excellent source of the essential polyunsaturated fatty acids (PUFA) in both the omega-3 and omega-6 families of fatty acids. Fishmeal's fats are highly digestible by all species of animals and are exactly between 6% and 10%, but can range from 4% to 20% [1; 4]. On the other hand, fat content of the fishmeal normally indicates the species used. Fluctuations in fat and moisture levels are seasonal and occur within species though protein is the main component in fish meal [3]. Therefore, fishmeal when subjected to heating, proteins tend to coagulate or denature [5]. For this, in Dyno air dryers the proteins are exposed to lower temperatures for shorter periods and denaturation of protein is low and functional properties of protein are better retained compared to Hetland and steam dryers [6].

Fish spoilage due to autolysis, lipolysis and microbial action will result in soft and degraded flesh, which will coagulate poorly during cooking. This will cause difficulties during processing, leading to lower protein content in the meal. Typical diets for fish may contain from 32 % to 45 % total protein; whereas, high-quality fishmeal normally contains between 60 % and 72 % crude protein [4]. Therefore, a growth rate in birds up to 42 days was recorded at 3.9% by using modern poultry diets composed of 3.8% fishmeal [1].

Preservation is a very important technique used for elongating nutritional values of fishmeal, because fishes are highly perishable raw materials, and due to spoilage that occurs if it is not processed in a timely manner. Fishmeal preservation performs by drying fishes' meat for being moisture content in low level enough to allow the meat to be stored and transported without any substantial mold or bacterial growth [4]. Hence, Handling of raw materials is a very important step in preserving freshness. Cooling and icing of raw materials will normally slow down the biological decomposition [7]. In addition, preservatives are added to prepare fishmeal for a long life such as antioxidants. The most commonly used antioxidant is ethoxyquin; the amount used varies, but is normally in the range 200-1000 mg/kg. Generally, fishmeal will keep for several years without detectable change in its nutritional value. Fatty fishmeal, however, will show a gradual decrease in fat content, as measured by extraction with ether, unless antioxidants are present; this is because the fats slowly oxidize during storage and become relatively insoluble in common organic solvents. Oxidized fat is less valuable nutritionally, because the animal cannot utilize it for its energy needs [3].

Contamination of the materials during processing may seriously affect quality and then on preservation period; microorganisms like *Salmonella* that may ultimately cause disease in man, have to be kept out. Contaminated water, from a dock for example, should not be used for cooling or other purposes, if it can come in contact with the fish or the fishmeal. Moreover, temperature during processing is normally high enough to kill any *Salmonella* present. Therefore, the prime reason for drying is to reduce the moisture content of the non-aqueous material to such a level that insufficient water remains to support the growth of the micro-organisms, which feed on it. This level is also sufficiently low to stop chemical degradation [3; 8].

Enzymatic and bacteriologic activities in the fish can rapidly decrease the content and quality of the protein and oil. Because, the digestive enzymes may cause heavy autolysis leading to softening of the meat, rupture of the belly wall and formation of considerable amounts of blood water containing both protein and oil [7, 9]. In practice there may be some processing losses, which will slightly reduce the actual yield. For example, raw materials waiting cooking will lose some drips as they spoil; since the lost liquor contains protein in solution, yield will decrease when raw materials are delayed for a long period. The extent of this loss varies from species to species [3]. Furthermore, besides adding soluble showed that shifts in temperature during storage and, transport and cycled dehydration and humidification of fishmeal cause major changes in the moisture content and water activity, which may lead to severe problems including microbial deterioration and caking [6].

The objective of the paper was to evaluate the effect of storage time on nutritional values of the fish meal used for domestic animals and cultured fishes.

MATERIALS AND METHODS

Samples collection

Four commercial Nile fishes were assessed in this study. They were Dabs (*Labeo niloticus*), Himeila (*Brycinus nurse*), Garmout (*Clarias gariepinus*) and Gargur (*Synodontis schall*), bought from fish market in the Central Market, in the south of Khartoum. The total weights of the studied fishes were 4000g and their lengths ranged between 14cm and 18cm.

Fishmeal process and its chemical analysis

A process for producing fish powders (fishmeal) started in January 2008 for the whole year, after removing all the samples' viscera by knives and discarding fat by boiling study fishes into water as known cooking fish. Then, the cooked-fish were pressed by cylinder drum and a pistol to reduce the water quantity. All pressed meats were exposed to sunlight in order to be dried [4] and then the powder of each fish was packed and preserved for the whole year (2008). Each packed powder (fishmeal) was analyzed for assessing its nutritional value every three months (January, June and December) of the storage time. However, proximate chemical analysis followed in this study was according to [10].

Statistical analysis

The results from the experiment were analysed to determine the significant variation according to ANOVA and t-test by using PAST software, version 1.99 [12].

RESULTS

Weight loss

Drying process showed that there was apparent loss in body weights of dried fishes during the first three days of the process until being stable in the following two days (Table 1). The loss arranged between 37.5 % and 75 %, however, the analysis period was carried out in nearly similar temperature (24 – 28 °C) and humidity (43 - 45 %).

The highest loss in body weight after drying process was recorded in Himeila, where its body weight became 37%; whereas, the lowest loss in body weight after drying process was recorded in Gargur, where its body weight became 75 %. The other study fishes: Dabis and Garmout, their body weights declined after drying process to be exactly half (50 %) of initial their weights (Table 1).

Assessment of nutritional values

Assessment of nutritional values of the fishmeal showed that there were significant variations in results of crude protein (5.13) and ash content (5.03). Himeila had the highest percentage of crude protein (18.5 ± 4.80 %); whereas, the rest of the studied fishes had the same content of crude protein (17 %), with very slight variations ranged between 0.1% and 0.7 %. Ash content ranged between 14.1 ± 0.17 % and 17.2 ± 1.06 %, where Dabis had the highest content and Himeila had the lowest (Table 2).

On the other hand, results of fat content and dry matter content were not significant. Fat content ranged between 3.27 ± 0.31, recorded in Gargur and 3.47 ± 0.40, recorded in Garmout; whereas, dry matter ranged between 94.4 ± 2.15, recorded in Gargur and 95.8 ± 0.76, recorded in Himeila (Table 2).

Storage time and nutritive values

Results of the storage time showed that all nutritional values apparently decreased during the second interval particularly, from the first readings recorded in the first interval of the storage time (Table 3).

Contents of crude protein declined clearly from 24 %, recorded in Himeila, in the first interval period and 15 %, recorded in Gargur, in the second interval and then its readings were stable in the third interval period for all fishmeal, with a decline rate of 7.6 % and significant variation of 5.13.

Fat content, however, showed decline, not only in the second interval, but during whole the study, from 3.9 % (Gargur) in the first interval to 3.1 % (Dabis) in the second interval and 3.0 % (Dabis and Himeila) in the third interval, with a decline rate of 0.6 %.

Ash content fluctuated in slightly increase during the three intervals of the study, with two increase rates of 0.18 % in the second interval and 1.88 % in the third interval. Apparent increase readings of ash content recorded in both Dabis and Garmout respectively in the second interval (18 % and 17.7 %) and in the third interval (18.7 % and 18.5 %).

Moisture content showed both decreasing and increasing rates during the study. In the first interval, it was 6.6 %; in the second interval period, it was 3.6 % and in the third interval period, it was 4.9 %. High content of moisture in the first interval was 7.8 % recorded in Gargur; whereas, the lowest moisture content was 5.0 % recorded in Himeila. In the second interval, the highest moisture content was 4.1 % recorded in Garmout; whereas, the lowest content moisture was 3.3 % recorded in Dabis. In the third interval, the highest moisture content was 6.0 % recorded in Dabis; whereas, the lowest moisture content was 4.0 % recorded in both Garmout and Himeila.

DISCUSSION

As well-known that fishmeal is a natural source of animal protein for producing diets for both human and domestic animals and cultured fish. Therefore, protein content in any fishmeal is the main component and by which, quality of fishmeal depends on. Based on this, it should be taken in care preventing loss of protein content in fishmeal that subjected to preservation purposes.

Results showed that fishmeal of four commercial Nile fishes were affected by storing them for the whole year. This is clear in their nutritive values as: content of crude protein, content of fat, content of ash and content of moisture. Protein content declined 7.6% during whole year of preserving, from the initial reading in the first interval (22.7 %) as shown in Table (3). This loss may be due to some reasons: 1) fishmeal produced may be subjected to high degrees of temperature during preparing fishmeal by drying process, where treated fishes were subjected to sunrays and boiling. Moreover, boiling process that practiced to each fish was not used a thermometer for controlling the temperature degrees. This may be affected on chemical bonds of protein and leading them tended to coagulate or denature through a storage time and eventually resulted in decrease in protein content. This is in line with results of [1; 5; 3; 2]; 2) fishes of the study may already have been subjected to initial autolysis (Enzymatic) and bacterial activity due to conditions of transporting and handling in fish market till had been bought. This is may lead to lower the initial protein content in the meal before preserving fishmeal, in which its nutritive value effects and due to fluctuation in moisture level (Table 3) that recorded during the three intervals of the study, which was a good medium for bacterial action that resulting in reduce protein content. This is in harmony with results of [7; 7; 4]; 3) shifts in temperature during the three intervals of the study included winter, summer and autumn seasons, definitely affected on moisture content and already on dehydration and humidification of preserved fishmeal, which may lead to severe problems resulting in lowing protein content. This agrees with results of [6; 3].

Table 1. Decline in weights of treated meat of the studied fishes during drying process

Type of meal	1st Day Wt.(kg)	2nd Day Wt.(kg)	3rd Day Wt.(kg)	4th Day Wt.(kg)	5th Day Wt.(kg)	Loss in Wt. %
Dabis	4	3	2	2	2	50%
Himeila	4	2	1.5	1.5	1.5	37.5%
Gargur	4	3	3	3	3	75%
Garmout	4	3	2	2	2	50%

Table 2. Chemical composition of the studied fishes after drying process.

Fish	Crude Protein %	F of Crude Protein	Fat %	F of Fat	Ash %	F of Ash	Dry Matter %	F of Dry Matter
Dabis	17.6±3.99		3.30±0.43		17.2 ±1.06		94.8 ±1.78	
Himeila	18.5±4.80	**5.13	3.30 ±0.43	†2.30	14.1 ±0.17	*5.03	95.8±0.76	†0.39
Gargur	17.1±3.81		3.27 ±0.31		15.1 ±0.36		94.4 ±2.15	
Garmout	17.7±4.59		3.47 ±0.40		16.7 ±1.91		95.0 ±1.73	

F= F value at (3.0) DF, †= No significant, *= high significant, **= highly significant.
Values are mean of 4000gm of treated fishes.

Table 3. Percentages of crude protein, fat, ash and dry matter of fishmeal of the studied fishes during interval periods of the storage time

Fish	Crude Protein %			Fat %			Ash %			Dry Matter %			Moisture %		
	Jan.	June	Dec.	Jan.	June	Dec	Jan.	June	Dec	Jan.	June	Dec	Jan.	June	Dec
Dabis	22.2	15.6	15.0	3.8	3.1	3.0	18.0	18.0	18.7	93.5	96.8	94.0	6.5	3.3	6.0
Himeila	24.0	15.9	15.5	3.6	3.2	3.0	14.0	14.0	14.3	95.0	96.5	96.0	5.0	3.5	4.0
Gargur	21.5	15.0	15.0	3.9	3.4	3.1	15.0	15.0	15.5	92.2	96.5	94.5	7.8	3.6	5.5
Garmout	23.0	15.1	15.0	3.5	3.3	3.2	17.0	17.7	18.5	93.0	96.0	96.0	7.0	4.1	4.0
Total %	**22.7**	**15.4**	**15.1**	**3.7**	**3.3**	**3.1**	**16.0**	**16.18**	**17.88**	**93.4**	**96.5**	**95.1**	**6.6**	**3.6**	**4.9**

Fat content showed gradual decrease during the whole study. This may be due to nature of fats that slowly oxidize during storage. Therefore, a decline rate of fat was very slight (0.6 %) and may be due to fish species used, where they are generally not classified as fatty fishes. This result is in-line with result of [3].

Ash content showed clear differences among fishmeal of the study. This may be due to nature of fish body, which related to portion of bones that composed the body. Moreover, the results showed also apparent fluctuations in ash content representing in descending and ascending rates that counted as 0.18 % in the second interval and 1.88 % in the third interval respectively. This may explain a dust that may be mixed with meat when handling to take the nutritional value reading or to mix with dust around the place of preserving fishmeal box containing the preserved fishmeal (Tables 2, 3).

On the other hand, result of nutritive value showed that crude protein of Himeila declined more than the rest fishes of the study. This recommends using small sizes of Dabis in producing fishmeal for elongate its nutritional values. Selecting mall sizes of Dabis for producing fishmeal may due to large numbers of fine spines that compose its body, which may harm a man when eating it and explain why it had the highest content of ash (18.0 %) among the rest of fish used (Table 3).

Based on the results of nutritive value presented in Tables (2 and 3), this study confirms that preservation process of fishmeal without adding any preservatives may cause shortening in its nutritional values representing in crude protein.

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