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# The Effect of Direct and Indirect Boiling on Chemical Composition and Microbial load of Disposed Waste Fish of White Nile State, Sudan

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## ABSTRACT

The present study was conducted to evaluate the effect of direct and indirect boiling treatments on disposed fish collected from the White Nile River, South of Eldueim town, for the benefit of being used as local fishmeal. The fish samples were identified and analyzed microbiologically and chemically. Crude protein, fat, ash, and metabolizable energy values for treated and untreated samples were found higher than those of the imported broilers concentrates by 20%, 9.7%, 51%, and 36%, respectively. The levels of calcium for direct and indirect boiling treated and untreated samples were 5.6, 4.9, and 4.82%, while for phosphorus they were 3.49, 3.06, and 3.09%, respectively. Treated and untreated samples were higher in sodium content than that of the imported concentrate by 70%. They also one and a half times higher for the phosphorus content. The total concentrations of amino acids for direct and indirect boiling treated samples were 1.21 and 1.13% for methionine and 3.51 and 3.30% for lysine, respectively. *Escherichia coli*. was totally eradicated by treatments. The direct and indirect boiling gave large numbers of molds and *Salmonella spp.*, amounting to $1.00 \times 10^6$ and $2.00 \times 10^6$ and $0.50 \times 10^6$ and $0.50 \times 10^6$ cfu/g, respectively. The results indicated that disposed fish could replace imported concentrates as feedstuff after direct and indirect boiling for poultry feeding, in Sudan.

**Key words:** Disposed waste fish, White Nile State Direct and indirect boiling

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## INTRODUCTION

In 2005 the estimated world fish production was around 142 millions tons, annually (FAO, 2006). Approximately 75% of the production is used for direct human consumption. The remaining 25% is used for non-food products, particularly the fishmeal and oil production. According to FAO (2008) the world production of fish had been increased to 144 millions tons. Fishmeal is a product widely used as feed supplement for all types of animals, providing very high nutritive diet. Fishmeal and fish oil are derived from small pelagic fish species, but can also be derived from other sources (Peron *et al*., 2010). Zugarramurdi *et al*. (2002) reported that fishmeal contains high protein which results in good animal growth and feed conversion values. Protein content per unit fishmeal is up to 70-80% higher than in soybean meal, as well as the percentage of desired amino acids such as lysine is lower in soybean than in fishmeal. In fishmeal production, it is important to take in consideration not only the nutritional value but also the microbiological quality. Zugarramurdi *et al*. (2002) also reported that the quality improvement of the fishmeal is obtained by adjustment of drying and cooking temperatures. Mlay and Mkwisu (1982) reported that the artisanal fishmeal plants in Africa use simple technology to be suitable with characteristics of the area in which it is located.

Drying is done by solar radiation and cooking is prepared indoor. These methods will not be suitable when the amount of fish increases, because the labour costs will be high. The nutritive value of the fishmeal varies greatly depending upon the source of input, place of harvest and the addition of the preservatives. Maigualema and Gernet (2003) reported that fishmeal crude protein can vary from 57 to 77% depending on the species of fish used. Negesse *et al*. (2009) revealed that the local made fishmeal in Ethiopia contains 49% (crude protein), 23.5% (ash), and 18.4% (fat) in dry matter basis. The Ethiopian fishmeal composed of tilapia, cat fish, and barb. Hammad (2000) found that the protein content for five different types of fishmeals were 46.13, 44.04, 56.74, 40.58, and 53.78% of whole fishmeal, gutted whole fishmeal, semi-spoiled fishmeal, fish scrap meal and fish-

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entrails meal, respectively. Also, he reported that the minerals content of the five types were 80, 165, 6.6, 144, and 14 mg/kg for zinc, iron, cobalt, manganese and copper, respectively.

In Sudan, at the west bank of the White Nile near Eldueim town, there is a large land used for rice cultivation. At the dry season, there are different types of spoiled fishes found in large quantities. These fishes can be used as fishmeal for animal nutrition after simple cooking and drying processing.

The aim of the current study was to evaluate the chemical composition and microbial count of those spoiled fishes after conventional direct and indirect boiling. Also, to investigate if those processed fishes are suitable for being used as feedstuff for poultry in Sudan.

## MATERIALS AND METHODS

The samples of spoiled and disposed fishes were collected from the west bank of the White Nile River near Eldueim town at the central of Sudan, during 2009. The area where the samples were collected is used for rice cultivation when floods cover it. Different types of fishes were left in the dry season after the rice being harvested. Those fishes not used by human, naturally dried with some spoilage symptoms. About 100 kgs of spoiled fishes were collected and transported to the Faculty of Animal Production, University of Gezira to be treated, examined, and used as fishmeal for poultry rations. A quantity of five kilograms of the six identified fish species were crushed and chopped by electric beef meat chopper. The identified fishes include Bulti (*Tilapia spp*.), Khshmelbanat (*Mormyrius niloticus*.), Debsa (*Labeo niloticus*.), Gurgor (*Synodontis niloticus*.), Shelbaya (*Shilbe mystus*.), and Umkoro (*Protopterus aethiopicus*.).

**Direct boiling treatment**

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Concerning the direct boiling treatment, 1000 grams of raw crushed fish samples were taken in a local made aluminum bowl, covered by 1000 ml of tap water and covered by a heavy weight bowl coverage. The bowl with its sample was then heated up to the water boiling point using charcoal fire and allowed to boil for fifteen minutes. The boiling water was discarded from the fish samples, which were weighed and placed in a specially designed wire-cage for sun drying. The cage was made of metal and covered by smooth screen-net to avoid flies and natural enemies. The cage was hanged in a pole of three meters height to be exposed to sun light for 48 hours. The fish samples were weighed and being put in a covered glass potter.

**Indirect boiling treatment**

About the indirect boiling treatment, a locally make aluminum bowl of doubled containers with an empty space between was used as a local water bath. The empty space was covered at the edge of the two bowls except a pore to pour the boiling water and to permit evaporation. About 1000 grams of the disposed and crushed fishes were placed inside the inner bowl and tap water was poured in the space between the two bowls to was a water bath. The double bowl was covered, put in charcoal fire till the water boiling point was reached, then left for fifteen minutes only steam was allowed to treat the fish samples. The fish samples were replaced into a special cage as above, exposed to direct sun lights for 48 hours, weighed and being put in a covered glass potter.

**Chemical analysis:**

Chemical analyses have been carried out at the Laboratory of Institute of Animal Sciences in the Central Laboratories, Berlin University of Humboldt and Nutrition and Food Research Center, Technical University of Munchen, (Germany). Before and after direct and indirect boiling treatments, samples were subjected to proximate analysis for the crude protein, crude fibre, moisture, ash, fat and amino acids using the the standard methods described by Naumann and Bassler (1997). The measurement was done by Ion-chromatography Fa/Typ: BIOCHROM 30. Amino acids analyzed were Methionine, Lysine, Asparagine, Threonine, Serine, Glutamine, Glysine, Alanine, Valine, Isoleucine, Leucine, Phenylalanine, Histidine, Arginine, and Proline.

For minerals analysis the samples were dried by oven, milled with 1 mm mash size. To make the sample soluble it was treated with 65% HNO3 and 30% $H_2O_2$ and cooked in the microwave (Type MarsXpress). The measurement was done with the Inductively Coupled Plasma- Optical Emission Spectrometry (ICP-OES) ICAP 6300 Duo MFC Fa. Thermo. This method allows a simultaneously measurement of the different elements. All values have been adjusted to dry matter basis. Metabolizable energy values in the tables were calculated by the modified equation of Ellis (1981) and transferred to kcal/kg:

ME = 1.549 + 0.0102 CP + 0.0275 oil + 0.0148 NFE – 0.0034 fibre.

ME: Metabolizable energy (MJ/kg).

CP: Crude Protein (g/kg).

NFE: Nitrogen free extracts (g/kg).

**Microbial analysis:**

The types of media used for microbial analysis were MacConkey Agar, Baired-Parker agar, potato dextrose agar, salmonella shigella agar, and nutrient agar for *E. coli.*, *Staphylococcus spp.*,yeast, *Salmonella spp. and Shigella spp.*, and non-fastidious bacteria, respectively.

## RESULTS AND DISCUSSION

Although, there were no noticeable differences between treated and untreated samples for crude protein, fat, ash, and metabolizable energy (Table 1), the values were higher than those recorded for the imported broiler concentrates by 20%, 9.7%, 51%, and 36%, respectively. This indicates that the crude protein, fat, ash, and metabolizable energy values were not influenced by direct and indirect boiling treatments. However, the fiber content was reduced by the indirect boiling but unchanged with direct boiling, it was 0.89, 1.04 and 1.03, for indirect boiling, direct boiling and the untreated samples, respectively. These results are in agreement with those found by Negesse *et al*. (2009) who reported that fishmeal can serve as a good source of crude protein and metabolizable energy in livestock diets.

Table 1. Chemical composition of six mixed, raw and treated fish species and broiler imported concentrate (dry matter basis)

| Composition | Treatments | | | |
|---|---|---|---|---|
| | Untreated | Direct boiling | Indirect boiling | Imported concentrate |
| Crude protein (%) | 51.78 | 51.76 | 51.58 | 43.0 |
| Crude fat (%) | 10.66 | 11.18 | 10.64 | 9.7 |
| Fibre (%) | 1.03 | 1.04 | 0.89 | 19.2 |
| Ash (%) | 32.33 | 31.22 | 32.54 | 20.7 |
| Nitrogen free extract (%) | 0.24 | 1.2 | 0.57 | 1.0 |
| Metabolizable energy (kcal/kg) | 2333.3 | 2400.9 | 2339.9 | 1716.0 |

Table 2 shows that the sodium contents of the direct boiling treated samples were lower than that of the untreated samples by 22%, whereas the calcium percent for direct and indirect samples were higher than those found for the untreated samples by 1.7%. However, still the treated and untreated samples were higher in their sodium contents than that of the imported concentrates. On the other hand, the phosphorus content of the treated samples was more than one and a half times that of the imported concentrates (Table 2). Hammad (2000) also reported in his work that the five different types of fishmeals tested were highly rich in their mineral contents.

Table 2. Minerals composition of six mixed raw and treated fish species and broiler imported concentrate (dry matter basis).

| Component | Treatments | | | |
|---|---|---|---|---|
| | Untreated | Direct boiling | Indirect boiling | Imported concentrate |
| Sodium (%) | 6.49 | 5.12 | 6.27 | 2.8-3.0 |
| Potassium (%) | 0.94 | 0.74 | 0.93 | - |
| Calcium (%) | 4.82 | 5.6 | 4.9 | 12.0 |
| Phosphorus(%) | 3.09 | 3.49 | 3.06 | 1.2 |

The amino acid contents of the direct and indirect boiled samples are shown in (Table 3). Although there are no significant differences between both treatments as far as the amino acid contents are concern, the levels of both glutamine and phenylalanine were higher for the direct boiling (6.03 and 2.05, respectively), compared with the indirect treatment (5.77 and 1.87, respectively). This means that the direct and indirect boiling treatments did not affect the composition of most of the amino acids. These findings were consistent with the results of Regenstein *et al*. (2003) who reported that fish meals have high digestibility degrees and balanced amino acid compositions, which make them superior in their increased nutritional values. However, according to NRC (1994), excessive and/or prolonged heating during drying of fishmeal will lower digestibility and cause some loss of the essential amino acids.

Table 3. Amino acid composition (%) of six mixed treated fish species (dry matter basis)

| Amino acid | Treatments | |
|---|---|---|
| | Direct boiling | Indirect boiling |
| Methionine | 1.21 | 1.13 |
| Asparagine | 4.49 | 4.19 |
| Threonine | 2.24 | 1.86 |
| Serine | 1.91 | 1.75 |
| Glutamine | 6.03 | 5.77 |
| Glysine | 3.46 | 3.55 |
| Alanine | 3.13 | 3.10 |
| Valine | 2.14 | 2.00 |

| | | |
|---|---|---|
| Isoleucine | 1.96 | 1.79 |
| Leucine | 3.42 | 3.17 |
| Phenylalanine | 2.05 | 1.87 |
| Histidine | 1.03 | 0.96 |
| Lysine | 3.51 | 3.30 |
| Arginine | 2.70 | 2.56 |
| Proline | 2.62 | 2.56 |

Howe *et al*. (2002) reported that fishmeal is a good source of polyunsaturated fatty acids (PUFAs), which are very important nutrients for human health. They are essential to reduce the incidence of cardio-vascular diseases (Ruxton *et al*., 2007). Thus, fishmeal has health benefits in addition to its nutritional value. According to Pike (1999) and Anonymous (2002), fishmeals can reduce the use of antibiotic and other drugs.

Table 4 shows that both direct and indirect boiling treatments were able to eliminate *E. coli*. from the fishmeals completely. However, the treatment seems to allow more *Staphylococcus spp.* to grow. Gram and Huss (2000) reported that Gram-negative fermentative bacteria spoil unpreserved fish, whereas psychrotolerant Gram-negative bacteria can grow on chilled fish. However, the bacterial level on tropical fish was similar to the level on temperate fish species (Gram *et al*., 1990). There were some pathogenic microorganisms in the treated samples, so antifungal and antibiotics should be added. In conclusion, the direct and indirect boiling treated samples could replace completely or partially, the use of imported concentrates. About 15 tons of different types of disposed fish could be produced annually from the area of this study (Salih, 2009). These treatments may also increase the digestibility of keratin and/or collagenous proteins of the fish bones and scales. That is because keratin and collagenous proteins are not easily digested.

Table 4. Types and number of micro-organism (cfu/g)

| Type of micro-organism | Treatment |
|---|---|

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| | Direct boiling | Indirect boiling |
|---|---|---|
| *E. coli.* | 0.00 | 0.00 |
| *Staphylococcus spp.* | $11.50 \times 10^6$ | $3.00 \times 10^6$ |
| *Salmonella shigella.* | $0.50 \times 10^6$ | $0.50 \times 10^6$ |
| Yeasts and molds | $1.00 \times 10^6$ | $2.00 \times 10^6$ |
| SE | 0.57 | 0.56 |

Further investigations are needed to done to evaluate the effect of those treated fish samples on poultry performance or any other farm animals.

## REFERENCES

**Anonymous (2002).** Fish meal facts and figures. Fishmeal information network (Fin). 2 College yard, Lower dongall street, St. Albans. A13 APA U.K. Association Official Analytical.

**Ellis, N. (1981).** Calculation of metabolizable energy values. The Nutrient Composition of Sudanese Animal Feeds. Bulletin 1: Northern and Central Sudan. Central Animal Nutrition Research Laboratory – Kuku, Khartoum.

**FAO – Food and Agriculture Organization (2006).** The state of world fisheries and aquaculture. Rome.

**FAO – Food and Agriculture Organization (2008).** Food outlook, global market analysis. Rome.

**Gram, L., Oundo, O. and Bond (1990).** Storage life of *Lebeo niloticus* in relation to temperature and initial bacterial load. Tropical Science. 29 (24): 221-236.

*EDITORIAL*

**Gram, L. And Huss, H. H. (2000).** Fresh and processed fish and shellfish. In. The microbiological safety and quality of food, edn 1. Edited by Lund B. M. Baired-Parker A. C. Gould, G. W. London: Chapman and Hall. 472-506.

**Hammad, A. M. K. (2000).** The effect of five different locally produced fishmeal on broilers performance. M.Sc. Thesis, Faculty of Sciences, University of Khartoum.

**Howe, P. R. C., Downing, J. A., Grenyer, B. F. S., Grigonis-Deane, E. M. and Bryden, W. L. (2002).** Tuna fishmeal as a source of DHA for n-3 PUFA enrichment of pork, chicken, and eggs. Lipids. 37: 1067-1076.

**Maigualema, M. A. and Gernet, A. G. (2003).** The effect of feeding elevated levels of tilapia (*Oreochromus niloticus*.) by-product meal on broiler performance and carcass characteristics. Int. J. Poult. Sci., 2: 195-199.

**Mlay, M. And Mkwizu, B. (1982).** The production of fishmeal at village level, FAO Fisheries Report, 268: 267-274.

**Naumann, C. and R. Bassler (1996).** Die Chemische Untersuchung Von Futtermitteln. VDLUFA-Methodenbuch. VDLUFA-Verlag, Darmstadt.

**Naumann, C. and R. Bassler, (1997).** Die Chemische Untersuchung Von Futtermitteln. VDLUFA-Methodenbuch. VDLUFA-Verlag , Darmstadt.

**Negesse, T., Makkar, H. P. S. and Becker, K. (2009).** Nutritive value of some non-conventional feed resources of Ethiopia determined by chemical analysis and an *in vitro* gas method. Animal Feed Science and Technology,154: 204-217.

**NRC, (1994).** Nutrient Requirements of Poultry. National Academy Press, Washington, DC.

**Peron, G., Mittaine, J. F. and Gallic, B. L. (2010).** Where do fishmeal and fish oil products come from? An analysis of the conversion ratios in the global fishmeal industry. Marine policy, 34: 815-820.

**Pike, L. H. (1999).** Health benefits from feeding fish oil and fishmeal: The role of long chain omega-3 polyunsaturated fatty acids in animal feeding. International Fishmeal and Oil Manufactures Association, 2 College yard, Lower Dagnall Street, St. Albans, Herts: AL3 4PA, U. K. Bulletin NO. 38.

**Regenstein, J., Goldhor, S. and Graves, D. (2003).** Increasing the value of Alaska Pollock by-product. In P. J. Bechtel (Ed), *Advances in seafood byproduct:2002 conference proceeding* (pp. 459-483). Fairbanks: University of Alaska, Alaska Sea Grant College Program.

**Ruxton, C. H. S., Reed, S. C., Simpson, M. J. A. and Millington, K. J. (2007).** The health benefits of omega -3 polyunsaturated fatty acids: a reveiw of the evidence. Journal of Human Nutrition and Diebetics. 20: 275-285.

**Salih, G. E. (2009).** The economical and social effect of the disposed fishes by the White Nile River Ravines at Edweim area (central Sudan) on the rural when used as fishmeal in poultry feeds. A paper presented in the 5th International Conference. March, Taba, Egypt. 10-13.

*EDITORIAL*

**Zugarramurdi, A., Parin, M. A., Carizzo, G. A., Gadaleta, L. and Lupin, H. A. (2002).** Investment and production costs for fishmeal plants in developing and developed countries. Int. J. Production Economics, 76: 53-59.