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PROXIMATE AND HEAVY METAL COMPOSITIONS OF COMMERCIALLY AVAILABLE FISH FEEDS IN GOMBE METROPOLIS

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ABSTRACT

This research work was carried out to investigate the proximate and some heavy metal contents of four different fish feed samples commercially available in Gombe metropolis. The proximate analysis was carried out according to various literatures to determine the amount of moisture, ash, crude protein, crude lipid, crude fibre and carbohydrate. The heavy metals were also investigated using Atomic absorption Spectrometry. The result of proximate investigation shows moisture content of 3.17 - 7.50%; Ash content of 9.39 - 11.62%.; Crude protein content of 37.85 - 48.90%; Crude lipid of 5.00 - 13.33%; Crude fiber content of 2.53 - 6.0% and Carbohydrate content of 21.31 - 30.78%. The heavy metals investigated include Cu; 0.35 - 0.61µg/kg, Cr; 0.27 - 0.44µg/kg, Co; 1.15-1.47µg/kg, Cd; 0.02-0.44µg/kg, Ni; 3.15-3.25µg/kg, Pb; 0.4-0.5µg/kg. The order of concentrations of the heavy metals are arranged as; Ni >Co >Cu >Pb >Cr >Cd. All the fish feed sample analyzed contain the required nutrient in the required proportion as declared by the manufactures and the regulatory guide lines.

Key words: Fish feed, proximate, nutrition, heavy metal.

INTRODUCTION

The nutrient balance of feed influence feed utilization and growth of fish. For optimum growth of fish species as well as in formulating a balanced died. It is very essential to know the nutritional requirements particularly for protein, lipid and carbohydrate. According to Lovell (1989), dietary protein and carbhydrate levels are known to affect growth and body composition of fish species. Some authors (Phillips, 1972; Prather and Lovell, 1973; Shyong *et al.,* 1998) observed that improper protein, energy other nutrient levels in feed increase production cost especially the recurrent expenditure and deteriorate water quality.

The chemical composition, mineral contents and protein quality of fish meal can vary greatly depending on the species of fish used, freshness of the raw materials, length of storage, amount of residual oil, processing methods, handling conditions, drying methods, temperature and either the meal is made from whole fish or the waste from some other processing operation (Anderson *et al.,* 1993). Thus, fish meals need to be evaluated continuously. It is

significance to include carbohydrate and minerals especially calcium and phosphorous in fish meal balance diets (NRC, 1994; Leeson and Summers, 2001). This research work was therefore aimed at assuring the quality of the fish feeds by investigating either they meet the specifications made by the manufacturers and regulatory agencies. This will ensure safety of the fish as well as the fish consumers. It is necessary to evaluate and monitor the manufactured feed by comparing the labeled information with those obtained in laboratory. Such comparisons are necessary not only to facilitate the farmers choosing the right feeds but also to enforce the manufacturers producing feeds of required quality.

MATERIALS AND METHODS

Sampling

Four commercially available fish feed samples were collected from fish feed shops in Gombe metropolis, Gombe state Nigeria, and were coded; A, B, C and D. The samples were sealed and transported to the Chemistry main laboratory of Gombe State university, Gombe. They were grinded using a mortar and pestle and kept in an airtight container for subsequent chemical analysis.

Proximate Analysis

Proximate analysis was carried out to determine the moisture, ash, crude fiber, crude lipid, crude protein and carbohydrate contents following various literatures as indicated below.

Moisture Content

The moisture content was determined according to the method reported by Ayuba and Lorkohol, (2013) in which 2g of the fish feed sample were weighed (W_1) into a pre-weighed crucible (W_0) and placed into a hot oven at 105^{o}c for about 24 hours. It was removed, cooled and reweighed. The heating and weighing were repeated until a constant weight was obtained. The final constant weight (W_2) was recorded and % moisture content was calculated as;

$$\% \text{ moisture} = \frac{W1-W2}{W2} x100$$

Where; W_1 =Weight of sample; W_2= weight of dried sample

Crude Fibre Content

The Percentage of crude fibre was determined by the method reported by Al-Mahmud, (2012) in which 3g of the sample was weighed (W_0) into a beaker. Water (100cm^3) and 20cm^3 of 20% H_2SO_4 were added and boiled gently for 30min. The content was filtered through Whatman No.1 filter paper. The residue was scrapped back into the beaker with a spatula. Water (100cm^3) and 20cm^3 of 10% NaOH were added and allowed to boil gently for 30min. The content was filtered and the residue was washed thoroughly with hot distilled water, it was then rinsed once with 10% HCl and twice with ethanol and finally three times with petroleum ether. It was allowed to dry and scrapped into a crucible and dried for 6 hours at 105^{o}C in an oven. The dried sample was weighed (W_1) and ashes at 600^{o}C for 90min in a muffle furnace. It was finally cooled in a desiccator and weighed again

(W_2). The percentage crude fibre was calculated as;

$$\text{Crude fibre (\%)} = \frac{W1-W2}{W0} x100$$

Where, W_0 = Weight of sample (g); W_1 = Weight of dried sample (g); W_2 = Weight of ash sample (g)

Crude Lipids

The crude lipid content in the sample was extracted using Soxhlet extraction procedure, described by Al-Mahmud, (2012). In this method, 3g of the ground sample was weighed (W_0) into a porous thimble and covered with a clean white cotton wool. Petroleum ether (200cm^3) was poured into a 250cm^3 extraction flask, which was previously dried in the oven at 105ºC and weighed (W_2). The porous thimble was assembled. Extraction was done for 3 hours. The thimble was removed carefully and the extraction flask placed in a water bath so as to evaporate the petroleum ether and then and dried in the oven at a temperature of 105^{0}C to completely free the solvent and moisture. It was then cooled in a desiccator and reweighed (W_1). The percentage crude lipid was calculated using the relationship;

$$\text{Crude lipid (\%)} = \frac{W2-W1}{W0} x100$$

Where, W_0 = Weight of sample (g); W_1 = Weight of empty extraction flask (g); W_2=Weight of extraction flask + lipid (g)

Ash Content

The method followed was described by Alam *et al.,* (2012) in which 2g of the fish feed sample was weighed (W_1) into a pre-weight empty crucible (W_0), and placed into a muffle furnace at 500^{0}c and allowed for 6 hours. It was then removed and cooled in a desiccator and weighed (w_2). The weighed of the sample was determined by difference between the ash sample and pre-weighed crucible. The percentage ash calculated as;

$$\text{\% ash} = \frac{W1-W2}{W2} x100$$

Where, W_1 = Weight of sample (g); W_2 = Weight of ash sample (g)

Crude Protein Content

The crude protein content of the sample was determined using the kjeldahl method as reported by Shumaila and Mahpara (2009). The principle of this method is based on the transformation of protein and that of the other nitrogen containing organic compounds, other than nitriles and nitrates into ammonium sulphate by acid digestion:

$$Sample\ nitrogen + H_2SO_4 \rightarrow (NH_4)_2SO_{4\,(aq)} \quad \ldots\ldots (1)$$

$$(NH_4)_2SO_{4\,(aq)} \rightarrow 2NH_{3(aq)} + 2H_2O + Na_2SO_{4(aq)} \quad \ldots\ldots (2)$$

$$NH_{3(aq)} + H_3BO_{3(aq)} \rightarrow NH^+_{4(aq)} + H_2BO^-_{3(aq)} \quad \ldots\ldots (3)$$

$$H^+_{(aq)} + H_2BO^-_{3(aq)} \rightarrow H_3BO_{3(aq)} \quad \ldots\ldots (4)$$

The crude protein was calculated as; Crude protein (%) = %N × 6.60

The nitrogen content of the sample is given by the formula below;

$$N\ (\%) = T_V \times Na \times 0.014 \times V_1 / G \times V_2 \times 100$$

Where; T_V = Titre value of acid (cm^3); Na = Concentration or normality of acid; V_1 = Volume of distilled water used for distilling the digest ($50cm^3$); V_2 = volume of aliquot used for distillation ($10cm^3$); G = Original weight of sample used (g).

Carbohydrate Content

The carbohydrate content was calculated by subtracting the sum of moisture content, ash content, crude fibre, crude lipid and crude protein from 100 (Alam *et al.,* 2012).

Heavy Metal Analysis

The samples were digested according to procedure describe by Bukar and Saeed (2015) in which the residual ash from ash determination were dissolved using concentrated HNO_3 acid and then filtered using Whatman filter papers. The filtrates were poured into $50cm^3$ standard flask and made up to the mark with distilled water. The sample solutions were then kept in sample bottles for further AAS analysis

RESULTS

Table 1 shows the mean result of proximate compositions of the fish feed samples analyzed.

Table 1: Mean proximate composition of analyzed feed samples (%)

Parameter	Samples			
	A	B	C	D
Moisture Content	7.17±0.79	3.1 7±0.88	7.50±0.71	4.80±0.45
Ash content	11.62±0.81	11.62±0.81	9.42±0.05	9.39± 0.00
Crude Protein	48.90±0.05	46.17±0.02	37.85±0.02	42.50± 0.02
Crude lipid	5.0 ± 0.00	7.66 ± 0.00	13.33±0.00	10.0 ± 0.00
Crude fibre	6.0 ± 0.57	2.77 ± 0.28	3.0 ± 0.00	2.53 ± 0.00
Total carbohydrate	21.31±0.0	28.61±0.00	28.90±0.01	30.78 ±0.00

*Results are mean ± standard deviation for triplicate determinations

Table 2 shows the mean concentration of some heavy metal investigated in the feeds.

Table 2: Mean heavy metals concentration in feeds analyzed (µg/kg)

Heavy metal	Samples			
	A	B	C	D
Cu	0.61	0.41	0.35	0.60
Cr	0.27	0.44	0.30	0.38
Co	1.47	1.25	1.15	1.22
Cd	0.03	0.33	0.02	0.04
Ni	3.25	3.13	3.24	3.15
Pb	0.5	0.5	0.5	0.4

*Result are mean of triplicate determinations

DISCUSSION

The mean moisture content of Samples analyzed ranged between 3.17 to 7.50%. Samples A and B has moisture contents which fall within the ranges declared by the companies in which company A pegged a maximum moisture content of 8% and company B has 12%. The results obtained for samples C and D were less than the literature values reported by Alam *et al.,* (2012) in Mega and Nourish feed feeds with values of 10.06% and 10.38% respectively. These variations in result may be due to different environmental conditions. Excess moisture can lead to nutrient dilution while less moisture leads to nutrient concentration.

The ash contents of Samples were found to be between 9.39-11.62%. All the analyzed samples have 1-2% lower ash contents than the values declared by the companies (10% maximum), but they are all within an acceptable limit. These results agreed with the literature values reported by Ayuba and Iorkohol (2013) and Alam *et al.,* (2012) who reported ash contents of fish feeds to be 5.33-9.45% and 8.51-24.40% respectively. The lower ash content in the feeds indicate high nutritional value which is characterized by high protein content.

The analyzed crude fibre content of Sample A, Sample B, Sample C, and Sample D were; 6.00%, 2.77%, 3.00%, and 2.53% respectively. The crude fibre in Sample A and C were slightly higher than the 5% and 2.7% declared by the companies, while Samples B and D with crude fibre contents of 2.77% and 2.53% fall within the ranges of 2.70% and 2.0% declared by the companies. Crude fibre provides physical bulk to the feeds. A certain amount of fibre permits better binding and moderates the passage of feed through the alimentary canal. However, it is undesirable to have a fibre content exceeding 8 – 12% in diets for fish, as the increase in fibre content would result in the decrease of the quality of a usable nutrient in the diet. (Ponce and Gernet, 2002). When fibre content is excessive, it results to lower digestibility of nutrients. The analyzed crude fibre contents of all the feeds under study were within the safe dietary limit for fish. So, fibre may not have any negative effect on fish (Ponce and Gernet, 2002).

The analyzed crude lipid contents of different fish feeds varied considerably among the feed manufacturers. The analyzed crude lipid for sample A was found to be less than the manufacturers' maximum value of 12% but it falls within the range but for Sample C, it was slightly higher than the manufactures value of (13%) and Sample D has 3% higher crude lipid value than that declared by the manufacturer.

Lipids are primarily included in formulated diet to maximize their protein sparing effect (Hassan, *et al.,* 2007) by being a source of energy. The analyzed crude lipid content of different commercially fish feeds ranged from 5.00%-13.33% which marched with the company's declared crude lipid content. Shyong *et al.,* (1998) stated that; dietary lipid levels of 5-6% are often used in tilapia diet.

The crude protein contents were found to be between 37.88 to 48.77% in samples analyzed. From the chemical analysis, it was observed that most of the analyzed data of crude protein were more or less similar to the company declared values (35-45%). The crude protein content of most of the feeds of different commercial fish industries analyzed were within the

acceptable range recommended in commercial fish (NRC, 1983). High protein content indicates high nutritional value of the feed.

The concentration of Cd in the four samples were found to be, 0.03µg/kg, 0.03µg/kg, 0.02µg/kg, 0.04µg/kg for samples A, B, C, and D respectively. Which are almost closer to the findings of Islam *et al.,* (2007) with values of 0.0579µg/kg and 0.0232µg/kg, and also lower than that declared value by WHO/FAO (2001). Okacha and Adedeji (2011) reported that the highest cadmium levels were detected in the kidneys and liver of fish. Fish exposed to cadmium above permissible levels are known to have problems ranging from mortality, reduced growth, inhibited reproduction, and other adverse effect.

The copper contents of the samples were found to be between 0.31 to 0.61µg/kg. These values were all higher than the finding of Benjamin and Kaana (2012) of 0.0002 in coppens feed and 0.0005 in multi feed, and also lower than the 30µg/kg declared value by WHO/FAO (2001). Studies have shown that Cu is highly toxic in aquatic environments and has effect on fish, invertebrate, and amphibians. Kamaruzzaman *et al*., (2010) observed that copper will bio-concentrate in many different organs in fish and mollusks. While mammals are not as sensitive to copper toxicity as aquatic organism.

Nickel concentrations in the samples were observed to be 3.25, 3.13, 3.24, 3.15µg/kg for sample A, B, C and D respectively. Ololade and Ogini, (2010) reported that Nickel toxicity include skin rash (called nickel dermatitis), nausea, dizziness, diarrhea, headache, vomiting and chest pains. The result is lower than the 30 declared by WHO/FAO (2001).

The concentrations of lead (Pb) were found to be 0.4 to 0.5µg/kg in all the samples investigated. Lead is known to cause the disease called plumbism and is also known to damage the brain, liver, kidney and reproductive system (Ekpo *et al.,* 2008).

The concentration of Cr was found to be 0.27 to 0.44µg/kg in the samples analyzed. Toxicity of Chromium causes diseases such as asthma, chronic bronchitis and chronic irritation. (Rahman *et al.,*2014).

CONCLUSION

In conclusion, the result of this study shows that all the fish feeds analyzed contained a lot of nutrients especially protein and lipid within the limits specified by the manufacturers. This ensures the feed retains its quality from the production to the selling points. Heavy metals investigated were also found in varying proportions within the safe limits pegged by the World health organization. Therefore, the feeds are recommended to be used by the fish farmers as its safe and nutritious. But adequate measures should be taken by the manufactures to avoid contamination of fish feeds by heavy metals.

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