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PROXIMATE ANALYSIS OF NON-CONVENTIONAL ANIMAL SOURCES FOR THE PARTIAL OR COMPLETE REPLACEMENT OF COSTLY FISH MEAL

Mumtaz Ali Sahito[*1], Naeem Tariq Narejo[2], IbtessamTahir Ansari[1], Imran Suheryani[3] Javed Hussain Umrani[4], Zanib Abeer Ansari[1], Syed Rizwan Shah[4]

[1] Institute of Biochemistry, University of Sindh, Jamshoro, Sindh, Pakistan.
[2] Department of Fresh Water Biology, University of Sindh, Jamshoro, Pakistan.
[3]Department of Pharmaceutics, Faculty of Pharmacy, University of Sindh, Jamshoro, Pakistan
[4]Department of Food science and technology, Hamdard University Karachi, Pakistan
Corresponding Author: mumtaz.biochem@gmail.com

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Abstract:
Background: The worldly fish meal is utilized as a rich source of protein in animal feed formulation. The high price and curtly supply of fish meal encouraged us to find some indigenous informal sources of protein and energy for economical and desirable feed preparation. **Materials and Methods:** A profiled biochemical analysis of poultry by-products such as chicken offal excluding feathers and skin, head and neck, internal (chicken viscera), and two local trash fishes with high breeding and growth rate were analyzed to find nutritional value and low processing cost. **Results:** The desirable protein and energy content was determined in chicken head and neck whereas the lowest were found in chicken feet. In chicken internals and chicken composite meal, the protein and energy content was 46.4532%, 3484 Cal/kg and 44.6397%, 2705 Cal/kg respectively. The protein and energy level of karo dayo (*Oreochromis mosumbicus*) was 55.85 %, 3236 Cal/kg while kari mundhi (*Channa punctatus*) possess 52.97%, 2705 Cal/kg. The aflatoxin level was found below the threshold level and these ingredients are safe for feed preparation and utilization. **Conclusion:** The nutritional value of these chickens by-products and local trash fish confers as a good source of protein and energy. These could be used as a partial or complete replacement of existing conventional protein and energy sources in fish feed formulation while these ingredients are very low cost and easily available to fish growers.

Key Words: Fish meal, Chicken by-Products, Protein, Energy, Feed Formulation

INTRODUCTION

Instinctive grub in natural water bodies can affirm limited growth and development of a small fish population while intensive fish culture required prepared feed with optimum nutrient ingredients for survival and growth. Commercial fish feed prepared from conventional foodstuffs is expensive and curtly available around the year due to the increase in human population and commercialization of animal feed industries. Indigenous non-conventional foodstuffs with desirable nutrient quality can overcome these challenges and allow more stocking density. Thereby enhancing fish production in many folds (Iqbal et al., 2015). The success of intensive fish culture depends upon the availability of desirable nutrients (energy level, essential amino acids, vitamins, and minerals) required for optimal growth. The formulation, utilization, acceptability, and cost determine the manufacturer's and fish grower's interests. Worldly fish meal is used as a rich source of animal protein and commercial cereal bran as energy source in animal feed formulation. The high demand and low supply of this expensive stuff in the market due to intensive trash fish catching and increasing animal feed industries (Muzinic et al., 2006). The better protein diets are high-priced for aquaculture operations while huge demand and low supply of fish meal become an important problem (Houlihan et al., 2008; Jobling, 2012; Edwards et al., 2004; De Silva and Hasan, 2007). It is very important to replace fishmeal with animal by-products because previously in most studies, limited growth in fish was determined when a large proportion of the fish meal was replaced by plant proteins (Fournier et al., 2004; Espe et al., 2006; Palti et al., 2006), may be due to reduced essential amino acids in plants sources. Therefore it means a lot to replace fishmeal with more or less the same nutrient values. Animal by-products (slaughterhouse waste, kitchen waste hatchery waste, PBM poultry by-products, and local trash fish with no economic importance) can be a valuable replacement for fish meal. It is highly needed to find non-conventional and easily available alternate protein and energy sources to reduce the cost of feed at an affordable level and to replace the existing expensive commercial bran and animal protein sources. Previous studies also confer that Poultry by-product meal is one of the most important sources of animal protein used to feed domestic animals with deboned meat, blood, feather, and fish meal (Meeker and Hamilton, 2006). The nutrient content of poultry by-product meal can be quite variable and depends on the substrate that is being processed (Watson, 2006; Da Silva et al., 2010). It is generally a palatable and high-quality feed ingredient due to its content of essential amino acids, fatty acids, vitamins, and minerals, and in addition to its use in livestock, it is in high demand from pet food and aquaculture industries. Besides that many researchers attempted and used different protein sources and reported frog meal response in comparison with PBM (Poultry by-product meal), poultry offal meal, and silkworm pupae meal and found similar or little higher observations (Hasan et al., 1993; Fagbenro et al., 1993; Karthick et al., 2019). The proximate analysis of animal sources will serve to formulate a desirable feed for fish survival and growth. There are several protein sources that have the capability of replacing fishmeal in aquaculture feeds without affecting the growth performance of fish. (Abid and Salim, 2004). Care should be taken during processing so disease organisms are not being spread. Aquaculture Sustainability and provability depend on identifying alternative dietary protein sources have increased (Kissil et al., 2000; Naylor et al., 2000). Replacement of fishmeal with the animal- rendering by-product meals may be a more suitable alternative for some species of fish. In this study, a detailed profile of chicken by-products was carried out to select the better part of poultry by-product meal preparation with desirable nutrients and low processing cost. The study of two local fish with no economic value and high breeding rate and availability to fish growers was carried out to suggest that fish farmers prepare the fishmeal from local sources.

MATERIALS AND METHODS

Collection of Samples: The slaughterhouse wastes from poultry processing were obtained separately from slaughterhouses for proximate analysis. Two indigenous trash fish with high breeding rates, Kari Mundhi (Channa punctatus) and Karo Dayo (Oreochromis mosumbicus) were collected from the drain and natural water bodies from district Thatta adjunct to the Indus River.

Processing of animal sources: Processing of animal sources was done according to a previous study (El-Boushy and Van-der-Poel, 2013) with slight modifications as shown in Fig.1

Proximate composition analysis of non-conventional animal sources: Total protein constituent was determined by the Kjeldhal method using Foss Tecaor automatic protein analyzer (2300 Kjeltec analyzer unit) after digestion by multiplying an indirect nitrogen-to-protein conversion factor of 6.25. Total fat, ash and moisture content were determined by standard analytical methods (Horwitz and Latimer, 2006).

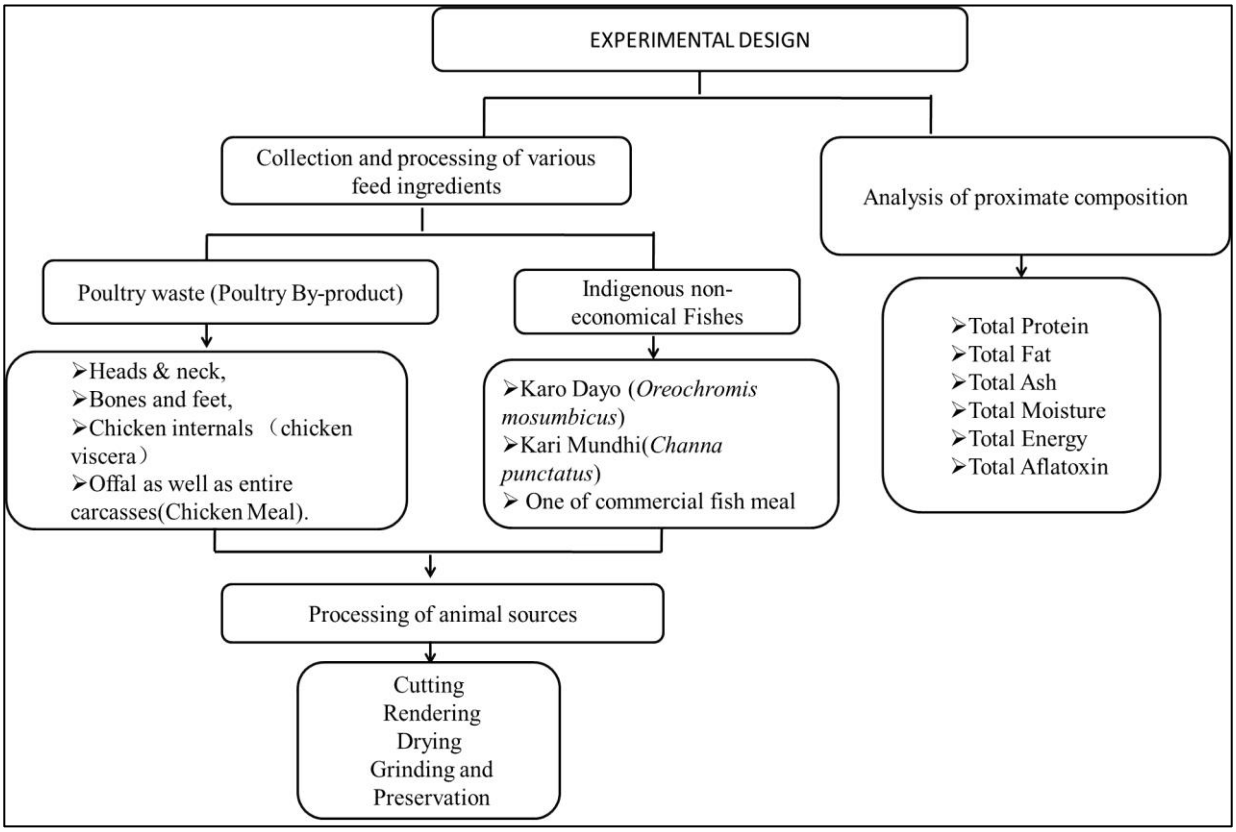

Figure. 1. Schematically represented diagram for processing and proximate analysis of non-conventional animal sources.

Assessment of total metabolic energy: Total metabolic energy (kcal/kg) from non-conventional animal sources (poultry waste and indigenous trash fish) was assessed by Parr bomb calorimeters **(**6400 Automatic Isoperibol Calorimeter, Moline, Illinois, USA).

Determination of Aflatoxin content: Determination of Aflatoxin content (ppb) in non-conventional animal sources was carried out through VICAM Series-4EX Fluorometer (Milford, MA, USA)

Statistical Analysis: All experiments were performed at least in triplicate. Data were analyzed by one-way analysis of variance (single factor) ANOVA for significance ($P < 0.05$). The means were separated by the least significant difference (LSD) at 5% probability level using SAS 8.1 software. (SAS Institute Inc., NC. USA).

RESULTS

The mean values of proximate composition for the non-conventional poultry waste and indigenous trash fish are summarized in Table 1 and 2

Table 1 Proximate composition of non-conventional poultry waste

Samples	**Protein (%)**	**Fat (%)**	**Ash (%)**	**Moisture (%)**
Chicken Feet	42.9 ± 0.8^{a}	4.35 ± 0.2^{a}	14.2 ± 0.12^{d}	20.86 ± 0.6^{d}
Chicken Internals, (Chicken Viscera)	46.5 ± 0.41^{c}	14.91 ± 0.18^{c}	3.1 ± 0.01^{a}	17.04 ± 0.81^{b}
Chicken Head & neck	48.4 ± 0.06^{d}	18.48 ± 0.14^{d}	13.5 ± 0.08^{c}	9.14 ± 0.26^{a}
Chicken Meal	44.6 ± 0.28^{b}	8.79 ± 0.07^{b}	10.9 ± 0.1^{b}	19.47 ± 0.04^{c}

Superscript letters mean ($p<0.05$). Means with different letters in the same column are significantly different at the 5% level.

Table 2 Proximate composition of non-conventional indigenous trash fishes

Samples	Protein (%)	Fat (%)	Ash (%)	Moisture (%)
Karo Dayo (*Oreochromis mosumbicus*)	55.85±0.54[b]	12.49±0.31[c]	21.75±0.19[b]	11.17± 0.06[a]
Kari Mundhi (*Channa punctatus*)	52.97 ±0.36[a]	9.92±0.04[a]	19.94 ±0.62[a]	14±0.51[c]
Commercial Fish Meal HQ	59 ±0.05[c]	11.22±0.2[b]	23±0.31[c]	13.75±0.09[b]

Superscript letters mean ($p<0.05$). Means with different letters in the same column are significantly different at the 5% level.

Determination of protein content: The content of poultry waste protein was profiled to distinguish the most appropriate part of the chicken as a better protein source for partial or complete replacement of fish meal with chicken by-product meal. The highest protein content obtained from chicken head and neck followed by chicken internals (chicken viscera) was 48.4% and 46.5% respectively while the lowest protein content observed in chicken feet was 42.9%. In comparison to high-quality commercial fish meal (protein content, 59%), the protein content of chicken waste falls in the medium-quality fish meal but because of its very low economic value, it can be a good source of protein in the replacement of fish meal to reduce the pressure on trash fish. In addition, two indigenous trash fishes Karo Dayo (Oreochromis mosumbicus) and Kari Mundhi (Channa punctatus) with protein content 55.85% and 52.97% respectively are economically cheap with high breeding efficiency. Thus, the inclusion of chicken waste, combined with these non-conventional indigenous trash fish, may contribute to the formulation of diets involving partial or total replacement of fishmeal.

Assessment of fat constituent as a dietary energy source: Assessment of fat constituent is the determinant as a key factor for nutritional evaluation of non-conventional animal sources. The fat values of chicken head and neck (18.48% ±0.14), chicken internals (chicken viscera) (14.91% ±0.18) and Karo Dayo (*Oreochromis mosumbicus*) (12.49%±0.31) were higher respectively than a high-quality commercial fish meal with 11.22% ±0.2 fat value. Whereas the slightly lower fat constituent of Kari Mundhi (*Channa punctatus*) (9.92%±0.04) also falls in the range of good quality fish meal.

Estimation of ash content: The ash content of any food sample suggests the mineral elements available within the food sample which is an essential component for normal metabolism and life processing. The ash composition presented in table 2 reveals the highest percentage value in Karo Dayo (*Oreochromis mosumbicus*) (21.75% ±0.19) followed by Kari Mundhi (*Channa punctatus*) (19.94% ±0.62). Whereas, chicken feet, chicken head and neck, and chicken composite (chicken meal) comprise 14.2% ± 0.12, 13.5% ±0.08, and 10.9% ±0.1 respectively. The lowest ash percentage (3.1% ±0.01) was found in chicken internals.

Analysis of moisture content: Moisture content is directly correlated to the freshness and stability of any food sample. Distribution of moisture content in chicken feet, chicken composite (chicken meal), chicken viscera, and chicken head and neck was 20.86% ± 0.6, 19.47% ±0.04, 17.04% ±0.81, and 9.14% ±0.26 respectively. While it was 11.17% ± 0.06 in Karo Dayo (Oreochromis mosumbicus) and 19.94% ±0.62 in Kari Mundhi (Channa punctatus). Even though the moisture content of poultry waste was observed a little higher except for chicken head and neck (9.14% ±0.26) but for the indigenous trash fishes it was found within the limits of commercial fish meal

Evaluation of total metabolic energy: A comparative representation of evaluated total metabolic energy of poultry waste and indigenous trash fish with commercial fish feed is given in Fig. 2. An outstanding amount of total metabolic energy was obtained by chicken head and neck (4075 kcal/kg) in comparison of total metabolic energy analyzed by high- quality commercial fish feed (3565 kcal/kg). Relatively a little difference was seen in chicken Internals (3484 kcal/kg) and one of the indigenous trash fish Karo Dayo (*Oreochromis mosumbicus*) (3236 kcal/kg) whereas, the lowest metabolized able energy was found in chicken feet (2148 kcal/kg).

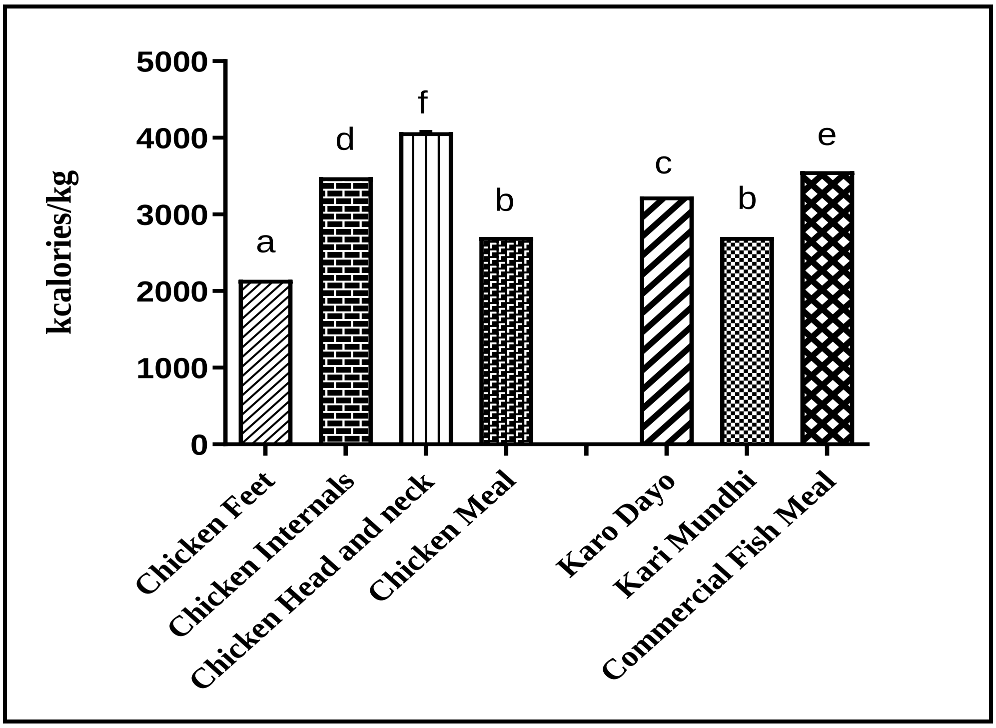

Fig. 2. Total metabolic energy (kcal/kg) of non-conventional feed ingredients (Superscript Means with different letters are significantly different at the 5% level. p<0.05).

Estimation of total aflatoxin level: The level of total aflatoxin (ppb) in non-conventional animal sources, assessed by VICAM (Florimeter) analyzer is represented in Fig. 3. The total aflatoxin level of chicken head and neck, chicken viscera, chicken meal, and chicken feet were found to be 9 ppb, 8 ppb, 7 ppb, and 4 ppb respectively. As per the food and drug administration (FDA), a threshold level of aflatoxin for human and animal health is 20 ppb. Although the aflatoxin level of Karo Dayo (Oreochromis mosumbicus) (13 ppb) and Kari Mundhi (Channa punctatus) (11 ppb) is a little higher than poultry waste but is also in the safe margin for animal feeds.

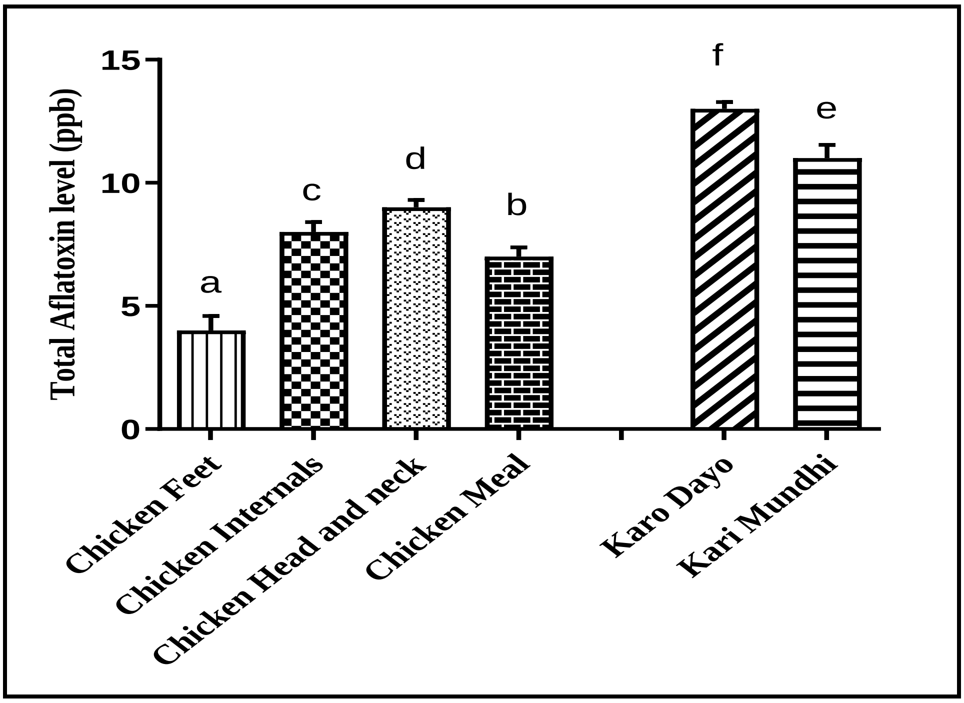

Fig. 3. Levels of aflatoxin (ppb) in non- conventional feed ingredients (Superscript Means with different letters are significantly different at the 5% level. $p<0.05$).

DISCUSSIONS

In order to provide fish as a source of protein for the population, fish breeding is essential to increase the production of fish (Djissou *et al.,* 2016). Achieve a high yield in terms of fish growth accompanied by optimum features of the fish meat is the main target of aquaculture processing. Fish feeds are the highest contributors to fish production costs and therefore greatly impact the economic returns from fish farming (Wong *et al.,* 2016). Fish meals are being used as large feed ingredients for decades, but with limited resources and high cost nowadays, it is necessary to find an alternative protein source, to replace fishmeal either partially or completely.

In this study, two experimental indigenous trash fish along with poultry waste showed significant nutritional attributes as well as a good alternative protein and energy source. In poultry waste, chicken head and neck contribute the highest protein value (48%) and fat content due to the presence of phospholipids, cerebrosides, and myosins followed by chicken viscera (46.5% protein), chicken meal (44.6% protein), and the chicken feet (42.9% protein) respectively (Table 1). However, the lowest fat percentage of chicken feet is may be due to more collagen content. Lipid as an energy source also plays an important role in fish diet.

In addition, the protein value (52.97% and 55.85%) of indigenous trash fish with no economic value falls within high- quality fish meal with a slight difference (Table 2). One of the studies conducted by (El-Sayed, 2007) reveals the significantly higher growth performance of *Cirrhinus mrigala* fingerlings on a 40 percent protein diet. The research findings on the nutritional requirements of fish and the advances in fish feed composition reveal that there is the provision of partial or complete replacement of fishmeal with these novel protein and energy sources. Some of the other comprehensive reviews (FAO reports) for protein requirement for Nile tilapia have been reported to vary from 28-30 percent for on-growing fish, 30-35 percent for juveniles, 35-40 percent for fry and fingerlings, and as high as 45-50 percent for larval growth and survival (El-Sayed, 2007; Farias *et al.,* 2004; Cruz *et al.,* 2008).

The skeleton and the bones are important sources of ash and minerals (e.g. calcium and phosphate) so the ash level comprised by the biological materials are thus more or less an indication of the amount of mineral present and are known to be essential for cellular metabolism and fish growth (Chanda, 2015). Ash level equal to 21.75% in Karo Dayo (Oreochromis mosumbicus) and 19.94% in Kari Mundhi (*Channa punctatus*) (Table 2) is also a good indication of complete or partial replacement of these non- conventional trash fishes as a value able source of minerals in comparison to existing conventional sources to reduce the high demand pressure in the market. However, the ash component of chicken feet, chicken head and neck, and chicken meal fall into a slightly lower percent value but their protein and fat constituent demonstrate the potential of these sources to have a dietary purpose with promising nutritional attributes.

Since the quantity of dry material is associated with the amount of humidity, the moisture content of fish feed has a direct economic impact on processors and consumers. As compared to two indigenous trash fish Karo Dayo (Oreochromis mosumbicus) and Kari Mundhi (Channa punctatus), the higher moisture content was found in poultry waste excluding head and neck. Most of the biochemical analyses in this study including ash and moisture percentage are a bit lower than the reported data of previous studies (Dozier and Dale, 2005; Kamalak et al., 2005; Nadeem, 2005), but the difference in results may be due to rendering process as most of the reported results are observed from the raw sample while we have gone through the rendering process before analysis. The highest metabolic energy (figure. 2) was obtained in the chicken head and neck is may be due to the presence of fat and carbohydrates while the lowest energy content was found present in chicken feet. Besides the nutritional characteristics and metabolic energy, aflatoxin analysis is another crucial step. The food and drug administration (FDA) has established action levels for aflatoxin present in food or feed to provide an adequate margin of safety to protect human and animal health. According to FDA, 20 ppb of aflatoxin is within the margin of safety. Aflatoxin levels of non-conventional indigenous fish or poultry waste (figure.3) are also encouraging the replacement of these harmless highly nutritious feed ingredients with high-cost conventional sources or commercial fish feed.

CONCLUSION

Biochemical analysis of animal-origin chicken by-products and local fish of no economic value reveals that these are a good source of protein and energy and could be used as a partial or complete replacement of existing conventional sources. The aflatoxin analysis of chicken by-products suggests that these ingredients are acceptable and safe for feed preparation and utilization by animals and fish. The composite of chicken head and neck and chicken internals can be used in the preparation of low-cost fish feed by replacing a high-cost commercial fish meal. Two local fish have high growth and breeding rate along with resistance to various environmental factors including water quality. The entire outcome regarding these two trash fish, confer that these can be used as a complete replacement for expensive commercial fishmeal. Importantly non-conventional feed sources are readily available at low - cost to fish growers.

Competing Interest: The authors have declared that no competing interest exists

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