Comparative Evaluation of Nutritive Value of Maggots

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Abstract - Conventional animal feeds ingredients are mostly imported into Nigeria, occasionally becoming scarce and very expensive. This has encouraged the search for possibly cheaper alternative nutrient sources with no concomitant reduction in nutrition value to the animals. The short life cycle of maggots- the larval stage of flies of the order Diptera (houseflies- Musca domestica) and their production in large biomass (quantity) from materials regarded as waste make them a viable option to explore. This study is an attempt to complement earlier studies on the nutritive value of maggots with a view to establishing average values for the nutrient composition of maggots for use in animal and fish feed using formulations. The maggots in this study were bred on fresh deep litter poultry wastes. The proximate analysis indicated 86.0 ±0.47% moisture content, 10.03 ± 0.44% ash content, 5.89 ± 0.05% crude fibre, 48.0 crude protein, 31.76 ± 0.02% crude fat, 3755 ± 190 kcal/kg energy. Gas Chromatographic analysis of the fatty acids profile revealed lauric acid (69.92%), palmitic acid (2.09%), oleic acid (15.25%) and stearic acid (12.75%). Colorimetric determination of amino acids gave lysine (5.03%) and methionine (2.58%).

Keywords- Maggots, livestock, aquaculture, proximate, colorimetry, amino acids.

INTRODUCTION

The high rate of increase in world population has made advances in agricultural technology imperative. Dairy, poultry, meat and fish are the main sources of animal proteins, lipids and vitamins which are essential ingredients for human nourishment. It is therefore critical that the animals and fishes be properly reared with complete diets formulated by the combination of essential nutrients in the right proportions (AIFP, 2004)[2].

In developing nations like Nigeria, the cost of commercial livestock farming and fish feeds have become very expensive[6] (Ayinla, 1988) accounting for over 60% of the recurrent overhead costs of livestock farming and about 70% of a fish farming venture[16] (Sogbesan et al. 2005). This is due mainly to the fact that fishmeal is imported while locally available alternatives like soya beans, groundnut oil and palm oil also serve as food for humans.

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Several attempts have been made to find inexpensive and relatively abundant nutrient-rich substrates to partially or, even completely, replace these expensive components. Maggots and other non-conventional animals like winged termites, earthworms and garden snails have been explored to check their nutrient contents, relative abundance, use and conversion into processed meals, incorporation into formulated diets and subsequent development of technique(s) for on-farm mass production (Ugwumba et. al. (2003), Ayinla (1988)[18, 6].

Calvert et.al[8] (1971) suggested the use of maggots as a replacement source of some key ingredients in feeds and this was further corroborated by Teotia and Miller[17] (1974). These led to experimentation on the use of maggot meal and/or live maggots as suitable substitutes for expensive feed meal as diets for livestock and aquaculture.

The current study aimed to obtain maggots from poultry droppings with the aid of fly attractants, determine its proximate composition and nutritive value and compare it with literature values with a view to establishing average values for the nutritional composition of maggot.

MATERIALS AND METHODS

Maggot breeding

0.8kg of 6-week old poultry droppings from the teaching and research farm unit of the University of Ibadan was put in a wooden substrate tank (78 x 39 x 16 cm). 1.5 litres of pipe borne water was used to moisten it to achieve quick putrefaction. 0.2kg animal offal (from Bodija market) and chopped rotten mangoes were introduced to act as fly attractants. The pH and temperature readings were monitored. Within 48 hours, white eggs were noticed, leading to maggot formation. The maggots were quantitatively harvested after 6 days and steamed to death. They were then spread on aluminium trays, sun-dried for two days before pulverization with an electric blender. The powdered sample was kept in a clean, air-tight plastic container prior to analyses.

Proximate Analysis

Standard methods as described in AOAC (1984)[1] were used Moisture, ash and crude fibre contents were determined by gravimetry. Crude protein content was obtained by the microkdejahl method while energy content was done using the Gallenkemp Ballistic Bomb Calorimeter. Extraction of fat was by the soxhlet method using diethyl ether and n-hexane. Each extract was quantitatively transferred into a pre-weighed, dry beaker or round-bottomed flask. The diethyl ether extracts were evaporated to dryness on a steam bath while the n-hexane extracts were distilled to remove the solvent. The container was covered with aluminium foil (pierced to allow for the escape of vapour) and periodically weighed until a constant weight was obtained.

Trans-esterification of the fat was done using the methanolic acid method of Inderti et.al (2005)[12] with slight modifications as approved by the Instrumental committee of the American Oil Chemists Society (Christie, 1989)[9]. 11 of the fatty acids methyl esters (FAME) so formed were identified using Gas Chromatography.

Sodium and potassium were analysed using flame photometry while zinc, copper, calcium and magnesium were determined using Atomic Absorption Spectrophotometry. Phosphorus was determined as the phosphate using molybdovanandate method while the two limiting amino acids (Lysine and methionine) were determined by spectrophotometry (AOAC, 1984).

RESULTS AND DISCUSSION

Maggot breeding yields ranged from 22% to 50%, with substrates without fly attractants giving lower values. This agrees largely with the submission of Nzamujo (2001)[14] that maggot yield is largely affected by the quantity of fly attractants as well as weather conditions. The results of analyses carried out are presented in Tables 1:

Table 1: Proximate composition of maggot meal (this study):

PARAMETER	Mean ± S.D (3 repeat analyses)
MOISTURE CONTENT (%)	86.0 ± 0.47
CRUDE PROTEIN (%)	48 ± 0.52
ASH CONTENT (%)	10.03 ± 0.44
CRUDE FIBRE (%)	5.89 ± 0.05
ENERGY CONTENT (kcal/kg)	3755 ± 190

The moisture content obtained is in close agreement with Sogbesan et. al. (2005)[16] confirming the high water content of maggots. Ash content (10.03%) also falls within reported range of 11% by Cadag et.al[7] (1981), 8.41% by Sogbesan et. al (2005)[16] and 9.72% by Ugwumba et.al1[9] (2001). This result is also within the range obtained for cake meal (7.9%) and fishmeal (19.10%).The crude fibre content (5.86%) tallies with that obtained by Awoniyi etal[5] (2003) (6.3%) and is higher than that of fishmeal (1.0%) and groundnut cake meal (4.0%). It is, however, lower than the (7.5%) Aniebo et. al. (2008) [4] obtained for maggot meal generated from a mixture of cattle blood and wheat bran.

Table 2 shows the result of analyses of the fat content of maggot meal in two solvents.

Table 2: Fat content of Maggot meal (this study)

Parameter	Mean ± S.D (3 repeat analyses)

Fat content (%) – n-hexane	16.35 ± 0.65
Crude fat (%) – diethyl ether	31.76 ± 0.02

Fat content was determined using two solvents- diethyl ether and n-hexane. Results from the n-hexane extract (16.35%) are similar to that obtained by Faturoti et.al (1998) (16.70%) 11, Ugwumba et.al[19] (2001) (18.50%) and Akinwande[3] et. al (2002) (15.63%). The ether extract gave a value of 31.76% which vindicates the fact that different solvents extract different fractions of the total lipids content of a sample. This justifies the established custom of the preferential use of diethyl ether for lipids, including the triglycerides and other polar lipids (Encyclopaedia of Anal. Sc., 1995) [10]. The fact that small amounts of substances other than fats are present in the ether extract (Maynard (2003)[13] led to its being referred to as crude fat or ether extract. This value however is in the range (25.3% – 54.8%) of the fat contents of soya bean (25.3%), sesame seed (46.4%), African oil bean seed (47.4%) and sunflower (54.8%).

Fatty acids profile by gas chromatography revealed a preponderance of saturated fatty acids like lauric(69.22%), palmitic (2.09%) and stearic (12.75%). Unsaturated oleic (15.22%) was also found in the samples. There is also an absence of essential fatty acids like linoleic acid which are largely unsaturated. A comparison of the common fatty acids content of maggot meal with that of conventional plant fats is shown in Table 3:

Table 3: Fat contents of maggot meal and some conventional sources

Source	Oleic acid (%)	Palmitic acid (%)	Stearic acid (%)	Total %
Maggot meal	15.22	2.09	12.75	30.06
Soya bean	25.4	10.6	4.4	40.4
Sesame seed	40.4	9.1	4.8	54.3

The values indicate that the total fatty acid content of maggot meal is of the same order of magnitude as in other conventional sources.

Table 4 shows the mineral composition of maggot meal:

Table 4: Mineral composition of maggot meal (this study)

Mineral	Ca	Mg	Na	K	Mn	Zn	Cu	P
%	0.344	0.067	0.864	0.672	0.004	0.007	0.003	0.970

A comparison of the results with literature values indicate that Ca (0.344%) is lower than that obtained by Cadag et al (1981)[7] (0.74%) and Nzamujo (2001) (1.54%) [14]. The phosphorus content (0.970%) compares favourably with the value obtained by Nzamujo(2001)(1.2%)[14]. A comparison of the values of these two minerals with those of fish meal and meat meal is presented in Table 5:

Table 5: Comparison of Calcium and phosphorus content with other feed sources

Feed Source	Ca (%)	P (%)
Maggot meal	0.344	0.97
Fish meal	5.44	3.0
Meat meal	8.30	3.90

The results imply that supplementary sources of Ca and P may be required when maggot meal is used in feed formulation. This also holds true for the other minerals except for Zn and Cu.

The results obtained for the analysed amino acids – lysine and methionine are 5.03% and 2.58% respectively. They are comparable with the 4.23% and 1.82% obtained by Omoyinmi et.al [15]. A comparison with the literature values of other nutrition sources are given in Table 6:

Table 6: Lysine and methionine in different feed ingredients

Nutrition Source	Lysine (%)	Methionine (%)
Maggot meal	5.03	2.58
Earthworm	2.38	1.98
Garden Snail	9.95	1.85
Meat meal	2.60	0.75
Fish meal	7.85	2.84

The results indicate the possibility of maggot meal being used as an alternative nutrition source as it compares favourably with the other nutrition sources. It should be noted, however, that amino acids from a single source cannot provide all essential amino acids to support body growth and maintenance hence formulators normally combine more than one source. Table 7 gives the average composition of nutrients obtained for maggot meal relative to other authors:

Table 7: Comparison of proximate analysis results with reported values

NUTRIENT	REPORTED VALUES	THIS STUDY
Moisture	83.3% (Sogbesan et.al (2005);	86.0%
Crude Protein	47.1% (Aniebo et.al 2008); 41.3% (Ugwumba et.al. 2001); 45.0% (Attey & Ologbenla 1993); 45.0% (Fashakin et.al 2003); 63% (Calvert et.al 1971). (Average = 48.28%)	48%
Fat Content	8.5% (Ugwumba et. al. 2001); 15.63% (Akinwande et.al 2002); 25.3% (Aniebo et. al. 2008) (Average = 16.48%)	16.32% (n-hexane), 31.76% (diethyl-ether) 25.3% (Soy bean); 46.4% (Sesame);
Ash	8.4% (Sogbesan et.al 2005); 9.72% (Ugwumba et.al 2001); 6.25% (Aniebo et. al. 2008) (Average = 8.12%)	5.89% (this study) 19.1% (fishmeal);
Crude Fibre	6.3% (Awoniyi et.al 2003); 7.0% (Aniebo et al.) 2008; (Average = 6.65%)	5.89% (this study) 1.0% (fishmeal); 4.0% (groundnut meal)

The results indicate that maggot meal from poultry droppings contains nutrients in comparable proportions with those from other substrates and is not unduly influenced by the substrate medium. The available nutrients are also comparable to those in other feed sources. It can, thus, be used as a major contributor to feed meals by formulators.

CONCLUSION

This study has shown that maggots can be quantitatively bred from waste materials like poultry wastes by careful selection of a suitable substrate, fly attractants and controlled weather conditions among other factors. The nutritive values inherent in this source compares favourably with other

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established sources hence can be a useful substitute for them in diet formulations.

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