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Effects of supplemental methionine and lysine on the nutritional value of housefly larvae meal (*Musca domestica*) fed to rats

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Abstract

The performance and blood composition of rats fed housefly larvae meal supplemented with, or without, methionine and lysine, or fed at high concentration were investigated. Rats fed supplemental methionine alone achieved highest body weight gain ($P < 0.05$). Dietary supplementation of both methionine and lysine or high dietary concentration of larvae meal depressed ($P < 0.05$) rat feed intake. The blood composition of rats was superior ($P < 0.05$) on methionine-supplemented larvae meal. Additional amino acids from larvae elicited higher ($P < 0.05$) serum proteins, cholesterol and triglyceride; however, other blood biochemical profiles were lower ($P < 0.05$) than in the unsupplemented group. In conclusion, housefly larvae meal seemed deficient in methionine and it benefited the rat tremendously to supplement with this amino acid: however, additional lysine and high dietary inclusion of larvae meal as sole protein source appeared nutritionally inconsequential. © 2001 Elsevier Science Ltd. All rights reserved.

Keywords: Housefly larvae meal; Amino acid supplementation; Nutritional evaluation

1. Introduction

Recycling of animal and poultry excreta as feed for livestock has limited uses especially for non-ruminants. However, these excreta provide an important habitat for the completion of the life cycle of the housefly (*Musca domestica*). The need to maximize the economic and environmentally benign disposal of poultry wastes has stimulated a renewed interest in harvesting premature housefly in their larva-pupae stage for possible use as protein feedstuffs. In addition, the limited supplies and the intense competition for available supplies of protein feedstuffs have provoked investigation for non-conventional protein sources in developing countries.

Many antecedent studies on the utilization of housefly larvae meal (HLM) are available (Calvert et al., 1969; Teotia and Miller, 1974; Ocio et al., 1980; Atteh and Adedoyin, 1993; Akpodiete, 1997) however, there are unresolved questions. First, there exist inconsistent data on its comparative utilization with fishmeal as the major animal protein source in poultry diets, with preponderant data indicating the inferiority of the larvae meal to fishmeal. However, amino acids compositions of fishmeal and HLM were reported to be somewhat similar (Teotia and Miller, 1974; Atteh and Adedoyin, 1993; Akpodiete, 1997). Second, studies on the supplemental effects of critical amino acids on the nutritive value of the HLM are scanty. For these reasons, further investigation is warranted because it may provide clues for optimal harnessing and utilization of HLM, especially in marginal agroecosystems.

To provide the missing information, two dietary formulations were implemented: first, the HLM supplied marginal dietary protein (100 g/kg) without or with critical amino acids supplementation and second, the HLM supplied adequate dietary protein (160 g/kg), but without amino acids supplementation. The experimental treatments were compared with a control diet containing fishmeal supplying marginally sufficient dietary proteins at 100 g/kg.

The rationale, for feeding the marginal dietary protein concentration (100 g/kg) was because it was expected to

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elicit maximum response when fed alone or in combination with critical amino acids unlike when fed in adequate quantity, while the extra dietary protein (160 g/kg) was fed without amino acids fortification to determine whether the quantitative increase per se would suffice for comparable growth and development.

Therefore, the objectives of this study were to determine the nutritional value of HLM and the effects of supplemental methionine and lysine in comparison with fishmeal using the rat as experimental animal. Data on the performance and some aspects of blood biochemistry of rats fed on HLM were obtained as response criteria during the investigation.

2. Methods

2.1. Rats and their management

Weanling albino rats of Wistar strain were obtained from the rat colony of the Faculty of Veterinary Medicine, University of Ibadan, Ibadan, Nigeria, and their average weight at the start of the experiment was 37.5 g $\pm$ 0.5. Six rats were randomly allocated to each dietary treatment. Each rat represented a replicate hence it was individually housed in a stainless steel cage provided with feeder, water bottles and facilities for seperate collection of urine and feces. The rats were fed ad libitum on the dietary treatments for 21 days.

2.2. Preparation of the test ingredients

Larvae of housefly were harvested from manure of laying chickens by the floatation method described by Akpodiete (1997). This essentially involved flooding of the manure with excess water, thus making the larvae float for their easy removal. The larvae were then washed in clean water three times until there was no remnant of manure, after which they were dewatered and later oven-dried at 50°C for 48 h. The larvae meal was dried and incorporated into the diet as the sole protein source. Fishmeal was obtained from commercial suppliers. The chemical composition as determined by the methods of AOAC (1980) is shown in Table 1.

2.3. Diet formulation

The major sources of experimental variation were the source of dietary protein and amino acid supplementation and the dietary plan was adapted from Fetuga et al. (1974) and Fanimo et al. (2000). Essentially, the dietary treatments are described as follows: Diet 1 was the control treatment containing fishmeal; Diet 2 contained HLM; Diet 3 contained HLM and 2.5 g/kg of supplemental methionine; Diet 4 contained HLM, 2.5 g/kg methionine and 1.5 g/kg lysine and Diet 5 contained HLM that supplied 160 g/kg of dietary protein. The protein sources used in Diets 1–4 supplied 100 g/kg dietary protein, which was considered marginally sufficient for growth and development of the rats, whereas Diet 5 supplied 160 g/kg, which was considered sufficient for weanling rats. Methionine and lysine were supplemented at the expense of maize starch because they are the first and second most limiting amino acids in most protein sources. The composition of the experimental diets is shown in Table 1.

2.4. Data collection and analysis

Each rat was considered as a replicate and results were pooled for each treatment. Data on feed intake and weight gain were obtained weekly, while blood biochemistry data were terminally obtained on the 21 day according to procedures reported by Onifade and Tewe

Table 1
Composition of experimental diets (g/kg)[a]

Ingredients	100 CP g/kg Fishmeal	100 CP g/kg Larvae meal	100 CP g/kg Larvae meal +2.5 Met	100 CP g/kg Larvae meal +2.5 Met, +1.5 Lys	160 CP g/kg Larvae meal
Maize starch	492.5	450.6	448.1	446.6	332.4
Glucose	50.0	50.0	50.0	50.0	50.0
Sucrose	100.0	100.0	100.0	100.0	100.0
Non-nutritive cellulose	52.5	52.5	52.5	52.5	52.5
Vegetable oil	100.0	100.0	100.0	100.0	100.0
Premix	20.0	20.0	20.0	20.0	20.0
Oyster shell	10.0	10.0	10.0	10.0	10.0
Bone meal	20.0	20.0	20.0	20.0	20.0
Protein source	155.0	196.9	196.9	196.9	315.1
Methionine	–	–	2.5	2.5	–
Lysine	–	–	–	1.5	–

[a] Proximate composition (g/kg) of HLM: crude protein (CP) 507.8; crude fat (C_{fat}) 291.3; Ash 59.3; crude fiber (CF) 23.6; NFE 18.0; Fishmeal: CP 645.5; C_{fat} 70.5; Ash 100.0; CF 8.0; NFE 176.0.

(1993) and Onifade et al. (1999). A one-way ANOVA was used for the analysis of the data collected and differences in the treatments were considered significant at $P < 0.05$ (Daniel, 1995).

3. Results and discussion

Generally, the performance data (Table 2) obtained from rats fed on the control fishmeal diet were superior ($P < 0.05$) to all the HLM-based diets and clearly fishmeal was the best. For the HLM-based diets, the highest body weight gain ($P < 0.05$) was recorded in rats fed on supplemental methionine alone followed by rats fed a combination of methionine and lysine. The former diet elicited approximately 4-fold increase in the rate of weight gain, while the latter diet supported about 3.5-fold increase in growth. The interpretations of this observation are that methionine was critically limiting in the HLM while the supplementation of lysine appeared not useful. When larvae meal alone was the source of dietary protein (Diet 5), it elicited only a 2-fold increase in growth rate, which was significantly lower ($P < 0.05$) than either of the supplemented low-protein larvae meal-based diets. The inference was that the protein quality in the larvae meal was inferior and the augmented dietary supply could not compensate for the shortfall in quality. A similar opinion on the protein quality and quantity on the performance of broiler chickens had been expressed by Boorman and Ellis (1996).

Table 2 shows that the total feed consumption differed ($P < 0.05$) among the treatments with rats fed on the control diet having the highest ($P < 0.05$). Compared to the unsupplemented HLM, the supplemental methionine alone did not cause any difference ($P > 0.05$) in feed consumption; however, the supplementation of methionine and lysine decreased ($P < 0.05$) feed intake by 7%, and the diet containing extra protein was the least ($P < 0.05$) consumed of the larvae meal-based diets. The crucial information in the feed consumption pattern of rats fed on HLM is that improvement in protein quality (supplementation of methionine, Diet 2) did not increase feed intake, although body weight gain was tremendously enhanced. The lowest consumption of Diet 5 by the rats probably indicated feed aversion arising from unknown inherent dietary factors or palatability of the HLM itself. On the other hand, a comparison of the very low and high feed consumption of rats fed on HLM and fishmeal based diets, respectively, suggests that palatability may be a major drawback affecting the consumption and nutritive value of the former to the rats. Using the data on protein intake, gain: feed and protein intake: gain (Table 2), a significant ($P < 0.05$) enhancement of the efficiency of utilization of the HLM protein upon methionine addition was indicated, while the data obtained when the two amino acids were added conjointly indicated an inconsequential effect of additional lysine.

Table 2
Performance characteristics and blood chemistry of rats fed on HLM supplemented with or without amino acids[A]

Performance indices	100 CP g/kg Fishmeal	100 CP g/kg Larvae meal	100 CP g/kg Larvae meal +2.5 Met	100 CP g/kg Larvae meal +2.5 Met +1.5 Lys	160 CP g/kg Larvae meal	SEM
Body weight gain						
($g\ rat^{-1}\ 21\ days^{-1}$)	44.1^a	5.3^d	19.4^b	17.7^b	10.5^c	2.05
Feed intake						
($g\ rat^{-1}\ 21\ days^{-1}$)	254.1^a	123.3^b	$121.8^{b,c}$	115.0^c	103.3^d	4.70
Protein intake						
($g\ rat^{-1}\ 21\ days^{-1}$)	25.4^a	12.3^c	12.2^c	11.5^c	16.5^b	1.65
Gain: feed (g/kg)	173.6^a	42.6^d	159.2^b	153.8^b	101.5^c	24.8
Protein intake: gain (g/kg)	576.2^a	2348.5^d	$627.6^{a,b}$	650.0^a	101.5^c	48.7
Blood chemistry						
Haematocrit (%)	40.5^b	42^b	46^a	40^b	42^b	1.2
Haemoglobin (%)	11.0	12	12.8	11.1	11.7	1.4
Erythrocytes $10^6\ \mu l^{-1}$	8.5^b	8.5^b	10.0^a	7.9^b	9.2^a	1.3
Total protein ($g\ dl^{-1}$)	7.5^a	2.6^c	4.8^b	5.9^b	5.1^b	0.3
Albumin ($g\ dl^{-1}$)*s*	4.2^a	1.1^c	2.6^b	2.5^b	2.5^a	0.2
Urea ($mg\ dl^{-1}$)	8.2^c	15^a	$12^{a,b}$	$13^{a,b}$	11^b	1.5
Creatinine ($mg\ dl^{-1}$)	0.4^b	0.7^a	$0.5^{a,b}$	0.6^a	$0.5^{a,b}$	0.1
Cholesterol ($mg\ dl^{-1}$)	43.7^d	60^c	80^b	110^a	95^a	7.5
Triglyceride ($mg\ dl^{-1}$)	22^d	32^c	23^d	68^a	49^b	8.3
AST ($IU\ l^{-1}$)	42.9^b	61^a	28^c	55^a	$42^{a,b}$	11.2
ALT ($IU\ l^{-1}$)	35.1^b	37^b	20^c	47^a	20^c	3.9

[A] a–d: Means in the same row not followed by the same superscript are significantly different ($P < 0.05$).

Some aspects of the blood chemistry (Table 2) showed that rats fed methionine-supplemented HLM diets had superior ($P < 0.05$) packed cell volume and red cell counts, while feeding amino acid-supplemented and adequate protein diets elicited higher ($P < 0.05$) total protein, albumin, cholesterol and triglyceride than the unsupplemented larvae meal diet. The superior nutrition and welfare of rats fed the supplemented diets (Eggum, 1989; Etukudo et al., 1999; Onifade and Tewe, 1993; Onifade et al., 1999; Fanimo et al., 2000) were corroborated by these biochemical data. Contrarily, the inferior protein nutrition of rats fed unsupplemented larvae meal-based diet was indicated by the highest ($P < 0.05$) concentrations of urea, creatinine, aspartate (AST) and alanine aminotransferases (ALT), according to Eggum (1989) and Onifade et al. (1999). The aggravated concentrations of serum cholesterol and triglyceride in rats fed Diet 4 tended to corroborate the poor utilization of additional lysine. Compared to the fishmeal control diet, all the HLM diets provoked higher ($P < 0.05$) circulating cholesterol and total lipids in blood and this appeared to be a resultant of the high lipid content (Table 1) of the HLM.

There was lack of clear-cut patterns in the relative weights of the organs (data not shown) of the rats that could be attributed strictly to dietary factors; therefore, it is submitted that feeding HLM had no serious deleterious effects on organ development of rats.

In summary, larvae meal of housefly was inferior to fishmeal, seemed deficient in methionine and benefited the rat tremendously when supplemented with this amino acid; however, additional lysine appeared inconsequential. High dietary inclusion of larvae meal as the main protein source and supplementation of any amino acid beside methionine should be carried out cautiously.

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