Effect of Silkworm Pupae Meal as Protein Supplement on Performance of Broiler Chickens

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A total of 250 day-old Ross broiler chicks were used to investigate the replacement value of silkworm meal for fish meal on growth performance of broiler chickens. The birds were randomly allotted to five treatment groups of 50 birds with each treatment having five replicates of 10 birds each. Five isonitrogenous and isocaloric diets (A-E) were formulated such that silkworm meal was used to replace different levels of fish meal thus: Diet A (control), B, C, D and E had 0; 40 kg/ton; 80 kg/ton; 120 kg/ton and 160 kg/ton silk worm meal, respectively. The birds were given feed and water *ad-libitum*. The performance in terms of mean feed intake, mean body weight gain, feed conversion **efficiency of the chicks indicated had significant ($P < 0.05$) differences among the treatment means. The results of this study demonstrated that cheaper silkworm meal can be an excellent substitute for fish meal in formulating diets for broiler chicks leading to improved health status.**

Key words: Silk worm meal, fish meal, performance, broiler.

Broiler industry provides not only a good source of protein but also employment. Poultry meat contributes about 37% to the total animal protein consumption and so broiler industry is gaining importance due to increasing demand of animal protein. Compared to the other nutrient sources, animal protein is the most costly ingredient for formulation of poultry diet, account 15% of feed cost (Dutta *et al*., 2011). It has been reported that fish meal is the only conventional animal protein source for poultry and that fish meal is scarce, expensive and most importantly in recent times is questionable (Lgaiya and Eko, 2009). The quality of fish meal is very much variable and availability is uncertain. In addition fish meal is often adulterated with other ingredients, eg. Fish bones, sand, sawdust. Producers sometimes use insecticides for the preservation of fish meal, which may cause toxicity in poultry (Khatun *et al*., 2003).

Little work has been done to replace the traditional animal protein supplements in animal feed with by-products of agro-industrial origin. In silk industry silk warm pupae are experimentally used as an animal feeds for chickens, pigs, rabbits and cattle and also for freshwater fish (Dutta *et al*., 2011). Silkworm meal is of high biological value rich in protein (63.8%:56.8%), lipid (19.6%:31.5%), crude fiber (0%:5.8%) and ash (7.4%:3.3%) (SN1, 2005; Loselevich *et al*., 2004). Apart from these food nutrients, it has an amino acid profile which in most cases compares favorably with those of fish meal (Solomon and Yusufu, 2005).

From the above information, it is evidence that successful use of cheaper silkworm pupae as a substitute of costly fish meal might reduce the production cost of balanced poultry diet with a consequent increase in profitability of poultry production. With those considerations, the present study was designed to determine this unconventional but important protein and energy source for poultry can be utilized in replacement of fish meal for optimum performance of broiler chicks.

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MATERIALS AND METHODS

The present study deals with evaluating silkworm pupae meal in a feeding trail using broiler chickens. The upper silk layer was discarded by heating with baking powder solution for 30 minutes and properly washed by using fresh water, sun dried and ground to powder and used as silk worm pupae meal. A completely randomized design was used for this experiment. A total of 250 day old broiler chicks were used for the experiment. The chicks were randomly allotted to five treatment groups with each treatment having five replicates. Each treatment was allotted 50 chicks with each replicate having 10 chicks. The birds were weighed collectively per replicate on the first day before being assigned to their individual treatment and the weights per chick calculated and recorded to form the initial body weight.

Five isonitrogenous and isocaloric (21% CP and 3100kcal/kg) diets (A-E) were formulated such that silkworm meal was used to replace different levels of fish meal thus: Diet A (control), B, C, D and E had 0; 40 kg/ton; 80 kg/ton; 120 kg/ton and 160 kg/ton silk worm meal, respectively (Table 2). There were (Table 2) five levels of silk worm meal for the starter (S) 0 to 21 days of age (S-A, 0 - control; S-B, 40; S-C, 80; S-D, 120; and S-E 160),and five levels for the grower (G) 21 to 42 days of age (G-A, 0 - control; G-B, 40; G-C, 80; G-D, 120; and G-E, 160) . All diets met the National Research Council (1994) recommendations for broiler.

The birds were reared on deep litter made of wood shavings. Light to supply the required heat was provided using 200 watt electric bulb (24 hours) with controlled adjustment to regulate the heat. Water and feed were provided *ad-libitum*. All required routine medications were administered accordingly.

Production parameters were measured from mean feed intake and mean body weight gain. The diets, fish meal and silk worm meal were analyzed for proximate composition according to AOAC (1990) (Table 1).

All data were subjected to one way analysis using analysis of variance (ANOVA) and means were separated by Duncan's multiple range test. Means were considered different at $p<0.05$.

RESULTS AND DISCUSSION

Table 1 shows the result of the proximate composition of the fish meal and silkworm meal used in the study. Silkworm meal had slightly higher crude protein value of 50.30% than 48.25% reported by Solomon and Yusufu (2005) but this was quite lower than those reported by SNI (2005) (63.8%) and Loselevich *et al.* (2004) (56.8%). This disparity can be attributed to such factors as source, stage of harvesting, method of processing and storage as opined by Oduguwa *et al*. (2005) and Ojewola *et al*. (2005). The ether extract of silk worm meal (16.43%) was higher compared to that of fish meal (10.26%) which is reflected in the apparently high NFE. This value agreed with the report of (Ljaiya and Eko, 2009). Also silk worm meal had higher crude fiber (10.90%) content than the experimental fish meal (7.63%). This could be due to the high proportion of fiber in some parts of the silkworm caterpillar mainly exoskeleton which is made of chitin as is also evident in the high ash content (12.03%). High fiber content of most non-conventional feed ingredients had been reported by previous workers (Khatun *et al.*, 2003; Khatun *et al.*, 2005; Oduguwa *et al.*, 2005; Olaniyi and Babasanmi 2013). The results of the mean body weight gain, mean feed intake, FCR are presented in Table 3.

The silk worm pupae used in this study was highly nutritive and without anti-nutritional factors. Thus, cheaper silkworm powder meal may be a supplement and has potential to replace the costly protein meal used in poultry industry. There was no mortality recorded in any group, which is also supported by Sengupta *et al*., (1995) and Das and Saikia (1972) who reported that mortality did not increased with silk worm meal feeding. Post mortal investigation did not show any pathological symptoms. This indicated that silk worm meal is not toxic to birds. This is also supported by the fact that there was no toxicological effect on broiler chicks and there may be some unidentified growth factors in silk worm meal which have contributed to the better growth of broilers (Horie and Watanabe,1980).

Compared to control, in all periods the values of mean weight gain, mean feed intake and feed conversion ratio have gradually increased due to increased level of dietary silk worm meal. This linear enhancement was continuous up to group D, but in group E a negative effect was observed ($p<0.05$) and the highest being in treatment C. Increased broiler growth performance on increasing levels of dietary silk worm meal is supposed by many previous findings Khatun *et al* 2003, Khatun *et al*, 2005; Ljaiya and Eko, Dutta *et al*, 2011a; Olaniyi and Babasanmi, 2013.

Birds fed diet C (80 kg/ton silk worm meal) had the highest feed intake while lowest intake was recorded in diet A (0 kg/ton silk worm meal). This low intake at group E (160 kg/ton silk worm meal) inclusion level can be attributed to high fibre content of silk worm meal as reflected in Table 1. Intake was depressed because of the inability of young chicks to effectively utilize the crude fiber inherent in the exoskeleton (made of chitin) of the silkworm caterpillar. This finding agrees with the report of Fagoonee (1983) who opined that complete substitution of silk worm meal for fish meal in broiler chicks depressed consumption due to high oil and fiber contents of silkworm caterpillar.

The highest daily weight gain also was recorded in diet C while the lowest gain was recorded in control group. The mean daily gain was however not affected by any level of inclusion of silk worm meal in the diets although the data gave an impression that dietary 160 kg/ton silk worm meal (group E) had little effect on weight gain. The similarity in weight gain indicated that the diets were equally efficient with no superiority of fish meal over silk worm meal. This result agrees with findings of Ichhponani and Malik (1971), Khatun *et al*. (2003) and Loselevich *et al*. (2004). The authors reported that silkworm pupae meal constitute a high quality replacement for fish meal in poultry with no reduction in final weight.

There was increase in feed conversion ratio with increase dietary silk worm meal. The efficiency of utilization of the protein in feed increase with increase in silk worm meal inclusion levels indicating better utilization of the protein in the silk worm meal. The reason for this performance can be linked to the better amino acid, profile of silk worm meal shown from its determined analysis which agrees with the findings of Fadiyimu *et al*. (2003) who reported that the quality of protein of

Table 1. Proximate Composition of Experimental Fish Meal and Silkworm Meal

components	CP (%)	EE (%)	CF (%)	ASH (%)	NFE (%)	DM (%)	Ca	P
Fish meal	60.04	10.26	7.63	19.80	2.27	93.74	4.53	1.33
Silk worm meal	50.30	16.43	10.90	12.03	10.34	94.90	2.77	1.05

CP: Crude Protein; EE: Ether extract; CF: Crude fibre; NFE: Nitrogen free extract; DM: Dry Matter; Ca: Calcium; P: Phosphorus

Table 2. Composition of experimental diets of broiler chickens during 0 to 42 days of age

Ingredients	S-A	S-B	S-C	S-D	S-E	G-A	G-B	G-C	G-D	G-E
Corn grain	583.3	587.2	590.7	594.2	597.7	630	627.4	624.4	622	619
Soybean meal	366.6	322	275.9	229.7	183.6	320	279.5	239	198	157.3
Silkworm meal	0	40	80	120	160	0	40	80	120	160
Dicalcium phosphate	15.9	12.8	12.4	12	11.5	12.7	12.4	12.1	11.8	11.6
Limestone	13.2	14.7	14.7	14.7	14.8	15	15	15.1	15.1	15.1
Vitamin–mineral mix[1]	5	5	5	5	5	5	5	5	5	5
Vegetable oil	11.8	14.8	17.8	20.8	23.9	12.4	16.5	20.4	24.3	28.3
Salt	3.5	3.5	3.5	3.5	3.5	3.4	3	3	3	3
DL-Methionine	1.2	1.2	1.2	1.2	1.2	1.5	1.3	1.1	0	0

[1]Supplied per kilogram of diet: vitamin A, 10000 IU; vitamin D_3, 9790 IU; vitamin E, 121 IU; B_{12}, 20 ¼g; riboflavin, 4.4 mg; calcium pantothenate, 40 mg; niacin, 22 mg; choline, 840 mg; biotin, 30 ¼g; thiamine, 4 mg; zinc sulphate, 60 mg; manganese oxide, 60 mg

Table 3. Effect of silkworm meal on mean feed intake, mean body weigh gain and feed conversion ratio of broiler chicken from 0-42 day of age

Treatment *	Mean feed intake (g/day)					Mean body weight gain (g/day)					FCR				
	0-10	10-21	21-28	28-35	35-42	0-10	10-21	21-28	28-35	35-42	0-10	10-21	21-28	28-35	35-42
A	220	260^{c}	380^{c}	690^{b}	840^{c}	130^{c}	110^{c}	170^{d}	290^{c}	350^{d}	1/69a	2/36^{a}	2/23^{a}	2/37^{a}	2/4^{a}
B	230	350^{ab}	510^{b}	1030^{ab}	670^{d}	140^{bc}	160^{b}	240^{c}	370^{c}	410^{cd}	1/64^{a}	2/18^{ab}	2/12^{a}	2/78^{a}	1/63^{b}
C	210	400^{a}	690^{a}	1100^{a}	1440^{a}	180^{a}	220^{a}	430^{a}	700^{a}	660^{a}	1/18^{b}	1/81^{b}	1/76^{b}	1/57^{b}	2/18^{ab}
D	230	360^{ab}	660^{a}	910^{ab}	1130^{b}	170^{a}	180^{ab}	400^{a}	560^{b}	560^{b}	1/35^{ab}	2/01^{ab}	1/65^{b}	1/62^{b}	2/01^{ab}
E	190	310^{cb}	560^{b}	940^{ab}	1180^{b}	140^{b}	150^{bc}	330^{b}	520^{b}	470^{c}	1/35^{ab}	2/06^{ab}	1/69^{b}	1/80^{b}	2/51^{a}
P value	0/31	0/0029	0/0001	0/0001	0/0001	0/0001	0/0021	0/0001	0/0001	0/0001	0/04	0/004	0/004	0/004	0/01

Mean within column with different uppercase superscript letters are significantly different ($p<0.05$).
* Diet A (control), B, C, D and E had 0; 40 kg/ton; 80 kg/ton; 120 kg/ton and 160 kg/ton silk worm meal, respectively

feed ingredient is determined by the level of amino acids it furnishes and not the actual quantity of protein in it.

On the other hand, we survey the effect of silk worm meal on intestinal microflora (the data was not presented). Silk worm meal supplementation did not significantly affect on microflora but decreased total gram negative bacteria counts. Pathogenic microbial floras in the small intestine compete with the host for nutrients and also reduce the digestion of fat. This leads to depressed growth performance and to increased incidence of disease. However, silk worm meal treatments to diets helped to decreased gram negative bacteria count in intestine and helped to improve growth performance. Unfortunately we couldn’t find any established to demonstrated that the supplementation of silkworm meal to broiler diet changed or improved the gut microflora. To confirm this matter, there needs to be more research in the future.

CONCLUSION

The result of the present study showed that the supplementation of silk worm meal in the diet improved growth performance without imposing any side effects. Therefore, we suggest that this supplementation into chicken basal diet could be used as a practical approach for health status; all of which would have a significant economic impact on the poultry industry.

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