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Effect of Dietary Inclusion of Silkworm in Poultry Rations

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Abstract

The present investigation was conducted to evaluate the potential use of silkworm pupae as poultry meal replacing costly fish meal. In the study two to five day old chicks were randomly allocated to five dietary groups of ten birds each. Out of five groups the first group was the control one with 100% Fish Meal (FM) 0% Silkworm Pupae Meal SWPM, and remaining 2,3,4,and 5 group respectively had 75 % Fish Meal (FM) 25% Silkworm Pupae Meal (SWPM) 50 % Fish Meal (FM) 50% Silkworm Pupae Meal (SWPM) 25 % Fish Meal (FM) 75% Silkworm Pupae Meal (SWPM) 0 % Fish Meal (FM) 100% Silkworm Pupae Meal (SWPM). Growth performance in terms of food consumption and weight gain of the control and experimental group was worked out and energy budget was prepared. The results of the study revealed that cost per kg of feed decreased with increasing level of inclusive SWPM and growth performance was observed maximum in Group 3 having 50% FM and SWPM. It is suggestive from the present study that costly Fish meal can be replaced with cheaper silkworm as alternate protein supplement in formulating diet of poultry ration.

Keywords: Poultry, SWPM, FM, Growth Performance, Energy Budget

Introduction

Silkworm is an economically important insect, reared primarily for production of silk (cocoon). The silkworm is the caterpillar of moth butterfly known as Bombyx mori whose cocoon is used to make silk. However, it is not known that silkworm pupae obtained after the extraction of silk are remarkable by-product of silk industry. These pupae obtained from, reeling centers are very rich in amino acids, oil, carbohydrate and minerals but are often thrown away as worthless product. Consequently a large quantity of wastes accumulates in silk reeling process and without proper disposal. These waste that can be threatening to the environment, could be utilized as a high potential raw material for various industries including animal nutrition. In India, the poultry industry is one of the fastest-growing agro-businesses, but the use of expensive maize and fish meal as a feed ingredient is not profitable to poultry farmers mainly local ones. Moreover vegetable (plant) protein sources are nutritionally unbalanced and poor in certain EAA that decreases their biological value. Therefore Poultry nutritionists prefer to the use of animal protein sources to create a balanced diets (Akhter et al., 2008).

Among the animal protein sources fish meal is particularly suitable to meet the nutrient requirements of animals (Karimi, 2006). It contains high level of protein and substantial quantities of fat and minerals. Fish meal is very scarce and expensive to be used as feed ingredient in the diets for poultry. Poultry is in competition with human and other livestock so fish meal being the conventional animal protein source for poultry, which makes it very expensive and its inclusion in the diets results in less profitable poultry production (Agbede and Aletor, 2003; Karimi, 2006)., The feed industry needs new sources of highly digestible protein with a desirable amino acid composition to substitute valuable but limited protein sources of animal origin, such as fishmeal. Therefore silkworm caterpillar meal can be used as high potential protein ingredient in poultry ration replacing expensive fish meal.

Review of Literature

Among many alternative protein sources, Insects that can convert waste biomass into high value food and feed resource are of recent interest.. A study has shown that it is technically possible to produce insects on a large scale reared on substrates of bio-waste and organic side streams and to use them as an alternative sustainable protein rich

ingredient in poultry ration, generating particularly high benefit. Insects have high nutritive value in proteins as well as in fats, vitamins, and minerals. Ravindran and Blair (1993) Ramos Elorduy et al. (2002), Osongo et.al (2018) and many other workers conducted experiments with insects and have explored the potential of insects larvae to be utilized as feed for poultry and livestock. Conversely, limited work has been done on the use of silkworm meal in feed.

Besides availability and high cost, the quality of fish meal is quite uncertain due to the use of different varieties, part of fish and different processing technologies in its production. Among many alternative protein sources, waste silkworm pupae (SWP) is considered as an important dietary protein source for poultry after proper processing at a reasonable cost. Utilizing SWP as a livestock or poultry feed would partly meet the protein feed deficiency. SWP generates vast resources of nutrients for livestock and poultry.

Solomon and Yusuf (2005) explored the utilization of silkworm meal as feed ingredient due to its high nutritional value of protein as a substitute to reduce feed cost. Waste silkworm pupae (SWP) is considered as a vital dietary protein source for poultry after proper processing at a rational cost.

Silkworm pupae meal contain high quality protein (49.4-60% CP), lipids (14.5-30.3 % crude fat), and amino acid profile is as close to fish meal. SWP is one of the unconventional source of good proteins (65-75% CP) and lipid and is obtainable four times in a year. Utilizing SWP as a poultry feed would economically meet the protein feed deficiency. Methionine is an essential amino acid for animals particularly poultry.

Evaluation of nutritional composition of silkworm pupa by Srinivas et.al.(2012) has shown that rich methionine component in pupa makes it as an ideal feed for poultry. Addition of methionine in poultry dietshave resulted in less total body fat (Rostagno et al 1995), improved growth performance and reduced odor-related compounds in excreta.

Aim of the Study

The objective of this study was to investigate the effects of replacing expensive Fish meal with silkworm meal in basal diets on growth performance, of poultry.

Material and Method

During the present study, the spent silkworm pupae were obtained from Silk Reeling Centre Sihora The spent pupas were dried, crushed manually and the chitinous matter was removed. The pupa matter was then ground and used for the preparation of experimental diets mixed with other ingredients. Pellets in the form of crumbles were used for newly hatched chicks.

Experimental Design, Diets and Management of Experimental Birds

A total of 50, two to five day-old broiler chicks (Cobb) were randomly divided into five replicate groups with 10 birds per replicate. Each replicate group was housed in 10 × 10 feet cages, in the same poultry shed. The 5 replicates were randomly assigned to five experimental diets according to a completely randomized design (CRD). The five diets were formulated with the step-wise i.e. 0% (D1), 25% (D2), 50% (D3), 75% (D4) and 100% (D5) replacement of commercial fishmeal with silkworm meal. The feed were so prepared that only the fish meal (FM) was replaced by Silkworm pupae, at varying percentage in different groups.

Throughout the experiment, feed and water were provided adlibitum and the chicks were vaccinated accordingly. Gas brooder was used to maintain the body temperature of growing chicks. During the starter phase, all birds were fed with control diet for two to three days and thereafter experimental diets were introduced. The trial continued till 60 days of age and data on feed intake of each replicate was recorded on daily basis. The individual body weight of the birds was recorded at the beginning of the study and thereafter weekly. Feed conversion ratio was calculated on weekly basis, for each experimental unit. Birds were reared under standard managemental conditions till the experiments got completed.

The experimental feeds were pelleted through private company. The ingredients of the five experimental diets used are as under. (Table1).

Table1- Feed Groups

Group 1 100% Fish Meal (FM) 0% Silkworm Pupae Meal (SWPM)

Group 2 75 % Fish Meal (FM) 25% Silkworm Pupae Meal (SWPM)

Group 3 50 % Fish Meal (FM) 50% Silkworm Pupae Meal (SWPM)

Group 4 25 % Fish Meal (FM) 75% Silkworm Pupae Meal (SWPM)

Group 5 0 % Fish Meal (FM) 100% Silkworm Pupae Meal (SWPM)

Observations Recorded

Live body weight, Weight gain, Production, food consumption were recorded first daily at starter phase and thereafter weekly. The average values used for further calculations. Energy budget for A-Assimilation, R-Metabolism, A/C- Assimilation Efficiency, K1-Growth Gross Efficiency, K2-Net Growth Efficiency was prepared. Cost benefit ratio was worked out for different feed groups.

Results:

Table 2- Growth Performance of Chick with FM+ SWPM

Feed Group	Initial (Live)Weight W1 (g)	Final (Live) Weight W2 (g)	Wt Gain /day (g)	Production W2-W1	Food consumption (g/day/bird)	Total Food Consumption (g)
Gr1	46.3	2858.2	46.86	2811.9	26.84	1610.82,
Gr2	45.8	2843.4	46.63	2797.6	26.59	1595.62
Gr3	46.0	2869.5	47.05	2823.5	26.71	1602.80

Gr4	45.4	2835.2	46.49	2789.8	26.36.	1581.82
Gr5	45.3	2825.2	46.33	2779.9	26.09	1565.42

Data on growth performance of chick is summarized in Table 1. Food consumption values in Gr 3 were found to be in equivalence to Gr1. Weight Gain, Live body weight (Final), and Production was higher in G3 than G1, G2, G4 and G5 diet groups. Lowest values for weight gain, production and food consumption was observed in G5

Table 3-Energy Budget of experimental chick fed on formulated diet (SWPM+ Commercial feeds with FM)

FG	W1 (g)	W2 (g)	P=W2-W1 (g)	C	F	A=C-F	M=P-A	A/C	P/C	P/A
Gr1	46.3	2858.2	2811.9	1610.82,	16.85	1593.97	1217.93	98.95	174.56	176.41
Gr2	45.8	2843.4	2797.6	1595.62	16.45	1579.17	1218.43	98.96	175.33	177.15
Gr3	46.0	2869.5	2823.5	1602.80	16.65	1586.15	1237.35	98.96	176.16	178.01
Gr4	45.4	2835.2	2789.8	1581.82	16.36	1565.46	1224.34	98.96	176.36	178.20
Gr5	45.3	2825.2	2779.9	1565.42	16.25	1549.17	1230.73	98.96	177.58	179.44

FG Feed Group, W1- Initial Weight , W2 Final Weight, P- Production, C- Total Food Consumption, F- Average Faecal output, A-Assimilation, R-Metabolism, A/C- Assimilation Efficiency, K1-Growth Gross Efficiency, K2-Net Growth Efficiency.

Table 4 -Cost Benefit Ratio of Different Feed Group Set I (exp III)

		Group I		Group II		Group III		Group IV		Group V	
Items	Rs/g	Kg	Cost	Kg	Cost	Kg	Cost	Kg	Cost	kg	Cost
Maize	16	18	288	18	288	18	288	18	288	18	288
Soya bean meal	36	8	288	8	288	8	288	8	288	8	288
Fish Meal	50	3	150	2.25	112.5	1.5	75	0.75	37.5	00	-
Silkworm Pupae Meal	20	-	-	0.75	15	1.5	30	2.25	45	3	60
Rice	16	2.5	40	2.5	40	2.5	40	2.5	40	2.5	40
Balancer	56	3.5	196	3.5	196	3.5	196	3.5	196	3.5	196
Total feed Cost			962		939.5		917		894		872
Cost /kg			27.48		26.84		26.2		25.54		24.91

Total feed cost Rs. 4584.5/- (175.5 KG)

Although there is not much difference in performance in terms of feed intake, body weight gain , feed conversion efficiency viz assimilation and net growth and gross growth efficiency and nutritional digestibility of chick in various dietary treatments. The similarity in weight gain and other performance characteristics indicated that the diets were equally efficient with no superiority of fish meal over SWPM. It was also noted that best results were obtained with 50% inclusion of silkworm pupae in diet formulation. It was observed that production increased from 2811.9 to 2869, Assimilation Efficiency as98.95 to98.96, K1-Growth Gross Efficiency 174.56 to176.16 and K2-Net Growth Efficiency 176.41 to 178.01 respectively of Gr1 (with 100% FM) to Gr 3 (with 50% FM and 50% SWPM). Total feed cost and per kg cost of feed both gradually declined with increasing levels of Silkworm. Total cost of feed being Rs 962 (Gr1), Rs 947 (Gr2), Rs 932(Gr3), Rs 917 (Gr4), Rs 902 (Gr5) and cost per kg as 27.48 (Gr1), 27.05 (Gr 2), 26.6 (Gr3), 26.2(Gr4) and 25.77(Gr5). It is clear from the findings that silkworm meal is less expensive than conventional meal easily accessible and making it well suited in economic terms as a substitute. This study demonstrated that SWPM and SWCM can be an excellent substitute for fish meal in diet formulations resulting in augmented economic gain in poultry production. Silkworm pupae meal was found to constitute a high quality replacement for fish meal in poultry with no reduction in final weight.

Discussion

Highly priced conventional sources of animal protein especially fish meal, have forced researchers to focus on exploring alternate economical protein sources as feed supplements. In recent years, different species of insects and flies have become known as a new, low-cost alternative protein sources in animal feed (Sun et al., 2013; Sanchez-Muros et al., 2014; Veldkamp and Bosch, 2015). Therefore, the present study was conducted to evaluate the effect of replacement of fishmeal with silkworm meal in poultry chicks

It was observed that Feed intake and weight gain was affected with the inclusion of silkworm meal in the feed, and the highest feed intake and body weight was recorded for diet containing 50% fish meal replaced with silkworm meal. It may be endorsed to silkworm meal because Our Results of the experiments conducted in our study are in line with findingsof Khatun et.al.(2003), (2005) and Loselevich et al. (2004) who have also reported that SCM has pleasant taste and is palatable and acceptable by both broilers and laying birds. The findings of the present study are also in agreement with the observations of Rahman et al. (1996) who attributed the improved growth performance of SCM fed broilers to balanced amino acids profile of SCM. In another study, Ijaiya and Eko (2009) have reported a higher weight gain with 75% replacement of fish meal with silkworm meal and the intake and production performance reduced with 100% replacement of fish meal with silkworm meal (Ijaiya and Eko, 2009; Dutta and Dutta, 2012). In the present study also birds showed low performance with 100% replacement of fish meal with silkworm meal. The findings suggest tha this could be due to the adverse effect of high fat content and the inability of young chicks to utilize the crude fibre in the chitinous exoskeleton of the

silkworm caterpillar as also noticed by other workers. (Fagoonee, 1983; Makkar et al., 2014; Valerie et al., 2015).

Chitin, a polysaccharide found in the exoskeleton of insects, may have a positive effect on the functioning of the immune system. By feeding insects to chickens, the use of antibiotics in the poultry industry – which may lead to human infection with drug-resistant bacterial strains (Box 4) – may be diminished. Research is needed to ascertain whether feeding chickens with insects (containing chitin) will make the use of antibiotics superfluous by strengthening the immune system.(Source: van Hall et al., 2011,FAO 2013 Insects as animal feed.) Although the anti-viral and anti-tumour activities of chitin/derivatives have been known for some time, the immunological effects of chitin have only recently been recognized (Lee, Simpson and Wilson, 2008). Recent studies have demonstrated that chitin has complex and size-dependent effects on innate and adaptive immune responses (see Lee, Simpson and Wilson, 2008).Moreover, chitin has shown potential for boosting immune system functioning, making it a promising alternative to antibiotics currently used in livestock (H. Wichers, personal communication, 2012). The use of chitin for medical and industrial purposes needs to be explored further.

Another study performed by Fadiyimu et al., 2003 .shows that the protein requirement at the finisher phase depends more on the amino acid profile than the total nitrogen content. The results of present study and literature suggests that improved performance of chicks with the replacement of fishmeal with silkworm meal (up to 50%) could be related to higher content of essential amino acids, minerals and energy in silk worm meal (Khatun et al., 2003). Moreover Fogoonee (1983) holds his different view suggesting that silk worm meal contain growth prompting factors such as ecdysteroid activity (a hormone involved in protein synthesis and tissue formation), though this has not been confirmed since. In the present study the highest feed intake and live body weight was observed with 50% replacement of FM meal with silkworm meal. The reasons for best growth outcome with the 50% replacement level may be due to adequate supply of essential amino acid profile (particularly tryptophan), nutrient digestibility and an increased rate of protein accumulation (Khan et al., 2015).

In the present study, cost per kg of feed gradually decline with increasing dietary level of SCPM inclusion levels, indicating higher economic benefit.. Decrease in the cost of production per unit of feed intake and gain in weight with increasing level of SWPM inclusion in the diet in present study agreed with the report of Atteh and Ologbenla (1993), Khatun et al. (2003) and (2005). Although no direct comparisons could be made for economics due to lack of literature data, Fagoonee (1983), Konwar et al. (2008) and Dutta and Dutta (2012) reported that replacing 50% of the fish meal with silkworm meal in broiler ration supported optimum growth performance and improved the profit margin due to its much lower cost. Onsongo et.al.has reported that expensive conventional feed protein ingredient such as soyabean and fish meal can economically replaced by insect protein using Black soldier fly meal in broiler chickens diet formulations. Makkar et.al. reported that insecs other than silk worm are lacking in lysine and methionine, and addition of silkworm meal in the poultry ration can improve performance as well as serve as profitable alternate to fishmeal and soyabean in the diet formulations. Dutta et.al.(2012) have also suggested that the cheap waste product of silk industry can be effectively used as replacement of costly ,usually contaminated fish meal as protein source. the results of the present study are also in concurrence with findings of other workers mentioned as above. The results of the present study showed that fish meal may be economically replaced with silkworm meal in the poultry ration without having adverse effect on growth performance of the chicks. Moreover, the best results in terms of feed intake and live body weight may be achieved with 50% replacement of fish meal with silkworm meal in the commercial poultry ration as reported and suggested in the present study.

As reported by S. Khan (2018) the digestibility of nutrients is unaffected, or at least improved, by the use of insect meal in poultry diet when compared with FM and this is especially true when insect meal has a comparable AAs (Amino Acids) profile and replaces the whole FM in the diet determining some economical positive effects.

The present investigation evaluated the effect of replacing costly Fish Meal in poultry rations by alternate protein source as silkworm. In accordance with the results of the present investigation it is observed that spent silkworm pupae can be utilized as protein source in poultry feed, without affecting the growth performance of chicks. It was also noted that best results were obtained with 50% inclusion of silkworm pupae in diet formulation. The cost of feed can also be minimized with this cheaper feed source. The inclusion of insect meals in poultry diets may lower the cost of feeds, thus contributing to the more profitability of smallholder poultry production. The costs of conventional feed materials such as SBM and FM are very high in demand and moreover, future availability may be limited.

Thus this insect protein of pupae has the potential to replace the costly protein meal used in poultry feed. It can also be concluded that the silkworm is rich in some unidentified growth factors which help in better growth of chicks without mortality except in early trial that may be due to some environmental factor and not due to silkworm feed.

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