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EFFECT OF DIETARY INCLUSION OF MUGA SILKWORM PUPA MEAL ON THE GROWTH PERFORMANCE OF LARGE WHITE YORKSHIRE GROWER PIGS

Manasee Choudhury[1], Keshab Barman[2], Santanu Banik[1] and Pranab Jyoti Das[1]

[1]Department of Animal Genetics and Breeding

[2]Department of Animal Nutrition

ICAR-National Research Centre on Pig, Rani, Guwahati, Assam

Abstract: Eighteen Large White Yorkshire grower pigs (weight ranged from 9.0 to 9.06 kg) were divided into three groups using randomized block design and they were supplemented with 0, 2% and 4% muga silkworm pupa powder by replacing the normal soybean diet and designated as T1, T2 and T3 respectively. The protein content of the experimental diets was found to be 17.85 ± 0.21, 18.17 ± 0.04 and 18.17 ± 0.11 respectively in T1, T2 and T3 groups. The feed intake was similar across all the treatment groups. The final body weight increased with the supplemented muga pupa diet in T2 and T3 in comparison to the control diet. A striking increasing trend was observed in the average daily growth (g/d) of the grower pigs with 146.11±32.49 in T3 and 127.44±6.61 in T2 group in comparison to the control T1 (125.11±31.14). The feed conversion ratio (FCR) was found to be economically impressive in T3 (2.87:1) and T2 (3.16:1) compared to T1 (3.45:1). This ultimately effected the feed cost/ kg gain, which was found to be encouragingly reduced by Rs 8 and Rs 16 at 2% and 4% in the muga pupa fed diet compared to the control diet. On the other hand, haematological parameters showed a rising trend in the RBC and haemoglobin count in the pupa fed meal compared to the control. This shows that the muga pupa diet has enhanced the digestibility of the grower pigs leading to their increased body weight and growth gain, thus lowering their FCR. The study unveiled that dried muga pupa powder can be supplemented @ 2% and 4% level by replacing soybean diet in grower pigs for better weight gain, growth performance, nutrient digestibility, feed conversion efficiency and lower feed cost production.

Keywords: Muga silkworm pupa, growth performance, Large White Yorkshire pig

INTRODUCTION

Silkworm pupa has been exploited as food from ancient times because of its rich source of protein. Pupae is the major by-product of silk industry, often discarded after the processes of reeling leading to a wastage of potential nutrients and adding up to further environmental concerns (Wang et al., 2010). Silkworm pupa meal has high nutritional value with crude protein content counting from 52 to 80% on a dry matter (DM) basis. However, the true protein in silkworms was found to correspond to only 73% of the crude protein content (Ioselevich et al., 2004). It is also a potent source of healthy lipids with omega-3 accounting for up to 35–40% of its total fatty acids (Makkar et al., 2014). The presence of chitin and insoluble protein may also explain the presence of fibre, and values of 6-12% DM of ADF have been reported (Ioselevich et al., 2004). Silk pupae (undefeated) is a rich source of fat, normally in the range of 20-40% on DM basis.

Defatted silkworm meal contains less than 10% of oil, which is high in polyunsaturated fatty acids, notably linolenic acid (18:3), ranging from 11 to 45% of the total fatty acids as reported (Ioselevich et al., 2004; Rao, 1994; Usub et al., 2008). Silkworm pupae meal is relatively poor in minerals (3-10% DM) as compared to other animal by-products (Finke, 2002). Owing to its high nutritive values silk pupae has been utilized as a potential source of feed meal in fish, broilers, poultry, ruminants and livestock.

Fermented silkworm pupae silage have been reported to increase survival rate, feed conversion ratio and specific growth rate in fishes (Rangacharyulu et al., 2003). Nandeesha et al., (2000) reported the use of un-defatted silkworm pupae meal in fish. A comparative study between silkworm pupae and plant leaf meals (alfalfa and mulberry) revealed that the feed conversion efficiency, nutrient digestibility and nutrient retention were better for diets based on silkworm meal than for diets based on plant leaf meals (Swamy and Devaraj, 1994). Improved performance was recorded in broilers fed with de-oiled silkworm pupae meal treated with 70% acetone for a time period of 12 hours (Yhoung-Aree et al., 1997). Several literatures have ascertained the use of silkworm pupae meal as a valuable cheaper alternate protein source compared to fish meal in poultry feeding. Due to high protein content and favourable amino acid profile, silkworm meal has been confirmed as a good source of feed in ruminants (Ioselevich et al., 2004). Narang and Lal (1985) reported that pupae meal could safely replace 33% of groundnut cake (GNC) in fattening diets for Jersey calves without affecting their performance, resulting in a cheaper economic diet.

In pig farming, feed alone represents 70-75% of the total cost of production (Olomu and Oboh, 1995). In intensive pig husbandry practices, conventional fattening depends on the feeding of cereals like maize, wheat, oats, barley etc. along with required protein, mineral and vitamin supplements. Since, pig farming is prevalent mostly among the rural section, costly feeding program because of high cost of cereals and oil cakes becomes a major cause of concern for the rural farmers. Therefore, search for alternative feed resources especially unconventional feeds and other locally available feedstuff in order to produce economic feeding programme for pigs as well as for other livestock have engrossed the animal nutritionists (Kanengoni et al., 2015; Abd El-Hack et al., 2017a; Abd El-Hack et al., 2017b; Abd El-Hack et al., 2019; Stefanello et al., 2019). Though utilization of silk pupae has been carried out in certain livestock species, information on feeding of silkworm pupae in the diet of pigs is still very limited. Replacement of soybean meal with un-defatted silkworm (*Bombyx mori*) meal in growing and finishing pigs was reported to have no effect on growth performance and carcass characteristics (Coll et al., 1992). In another study silkworm meal fully replaced with fish meal (upto 100%) showed similar results on carcass, meat quality and blood parameters (Medhi, 2011; Medhi et al., 2009a; Medhi et al., 2009b) in growing and finishing pigs. Untill now pupa from *Bombyx mori* (mulberry) silkworm has been exploited as a feed supplement in animal nutrition. Therefore, the present study for the very first time reports on the use of non-mulberry silkworm pupae viz. *Antheraea assamensis* (muga) as a feed supplement on the growth performance and nutrient digestibility of grower pigs.

MATERIALS AND METHODS

Ethics statement:

The study was conducted at ICAR –National Research Centre on Pig Farm Rani, Guwahati, India. It was carried out after the approval from the Institute Animal Ethic Committee.

Preparation of dried pupa powder:

Pupae of muga silkworm have been collected from local muga silk farms in and around Guwahati, Assam. The pupae were allowed to sundry until it became crispy. After drying, the samples were grounded in an electronic blender to obtain fine particles of pupa powder. Subsequently, the powder has been stored in airtight conditions at 4°C until further use.

Animals and Experimental design:

Animals were housed in a well-ventilated shed. Eighteen Large White Yorkshire grower pigs (about 2-3 months old, weighing from 9.0-9.06 kg) of either sex were divided into three groups of six each using randomized block design. Three different diets were used for feeding of the animals namely - T1 (control diet): standard grower ration without silkworm pupae powder (SPP), T2: standard grower ration supplemented with 2% SPP, T3: standard grower ration supplemented with 4% SPP mixed with required salt and mineral mixtures similar to standard diet. The nutrient requirement of pigs was made as per Bureau of Indian Standard (BIS, 1986). The pigs were fed on the experimental grower rations twice daily in the morning and evening. The experiment was conducted for a period of 45 days. A metabolic trial for five days'

duration was conducted at the middle of the experiment. The lysine and phytase were balanced in all the rations as per requirement. The ingredient composition of the ration is given in Table 1. Proximate composition was done as per AOAC (1990). Muga silkworm pupae powder was mixed with the feed and fed directly to the animals. The body weight of the experimental animals was recorded fortnightly using digital balance.

Table 1. Ingredient composition (wt/wt) of experimental ration

INGREDIENTS	T1 (kg)	T2 (kg)	T3 (kg)
MAIZE	58.5	58.5	59
WHEAT BRAN	13	13	13
SILKWORM PUPA	0	2	4
SOYBEAN MEAL	19	17	14.5
G.N.CAKE	8	8	8
MINERAL MIXTURE	1	1	1
SALT	0.5	0.5	0.5
TOTAL	100	100	100
LYSINE	40 g	40 g	40 g
PHYTASE	20 g	20 g	20 g

Blood Collection:

Blood samples of experimental pigs were collected at zero days and after 45 days at the end of the experiment.

Haematological parameters:

Blood samples of experimental animals were analyzed by an automatic haematology analyzer (ABX Micros ESV60, Horiba Medical) to perform a complete blood cell count on each blood sample; red blood cell (RBC) counts, platelet counts, haemoglobin (Hb), white blood cell (WBC) counts and WBC differentials were recorded during the experiment.

RESULTS AND DISCUSSION

Proximate composition:

The proximate composition of the experimental diets is listed in Table 2. The crude protein content (% DM) of the experimental rations ranged from 17.85±0.08 to 18.17±0.06. The nitrogen free extract content (% DM) of the trialled diets was 71.60±0.46 in T1, 65.21±0.28 in T2 and 69.01±0.07 in T3 group. The protein content has been seen to be slightly higher in the muga silkworm pupa diet compared to the control soybean diet.

Table 2. Proximate composition of experimental rations

Ration	OM %	CP %	CF%	EE %	Ash %	NFE %
T1	97.20±0.16	17.85±0.07	5.75±0.09	2.00±0.08	2.80±0.04	71.60±0.46
T2	91.45±0.18	18.17±0.11	6.25±0.13	1.82±0.22	8.55±0.05	65.21±0.28
T3	94.80±0.22	18.17±0.06	5.90±0.12	1.71±0.14	5.20±0.02	69.01±0.07

(T1: 0% silkworm pupa meal in the diet; T2: 2% silkworm pupa meal in the diet; T3: 4% silkworm pupa meal in the diet)

Table 3: Effect of supplementation of silkworm pupae on growth and nutrient utilization of the experimental animals

Parameters	**T1**	**T2**	**T3**	***P* value**
Feed intake, g/d	402.00	402.00	402.00	NS
Initial Body wt, kg	9.00±0.68	9.01±0.58	9.06±2.07	0.997
Final Body wt, Kg	14.63±1.74	14.75±0.74	15.86±3.05	0.732
Growth, g/d	125.11±31.14	127.44±6.61	146.11±32.49	0.581
FCR	3.45±0.99	3.16±0.00	2.87±0.55	0.578
Feed cost/kg gain (Rs.)	96.73±27.84	88.56±4.60	80.40±15.30	0.578

The food intake of the animals was 402 g per animal per day in each groups. The final body weight of the animals was found to increase with the supplemented muga pupa diet (Table 3) in T2 and T3 groups in comparison to the control diet. Though the increase was not found to be statistically significant but it has shown an increasing trend in the pupa fed diet ($p>0.05$). Similar trend in increase was observed in the average daily growth (g/d) of the grower pigs. Table 3 shows that a striking increase in growth of the animals of T3 group (146.11±32.49) was found in comparison to the control T1 group (125.11±31.14). The feed conversion ratio (FCR) was found to be impressively lower in T3 (2.87:1) and T2 (3.16:1) compared to T1 (3.45:1). This shows that the muga pupa diet has enhanced the digestibility of the grower pigs leading to their increased body weight and growth gain, thus lowering their FCR. This ultimately effected the feed cost/ kg gain, which was found to be encouragingly less in the muga pupa fed diet compared to the control soybean diet viz. 80.40±15.30 in T3, 88.56±4.60 in T2 and 96.73±27.84 in T1. Silkworm pupa is reported to be an excellent cheaper substitute of costly protein concentrate for growth and egg production in chicks leading to increased profitability (Khatun et al., 2005). Partial substitution of soybean meal/oil with silkworm meal in the diet of chickens, ensured satisfactory growth performance and carcase traits, and increased meat quality (Miah et al., 2020).

Haematological parameters:

It was observed that among the haematological parameters, the RBC count and haemoglobin content in blood profile increased in the pupa fed pigs in comparison to the control group. However, no significant change was observed in the WBC count, platelet count and WBC differentials. A good RBC count and haemoglobin content is necessary for healthy wellbeing of animals. A decrease in RBC and haemoglobin count may cause anaemic deficiency in pigs, which in turn will affect their production performance and sometimes even lead to death. In contrast, substitution of fish meal with increasing percentage of *Bombyx mori* silkworm pupa meal in rainbow trout *Oncorhynchus*, significantly decreased their RBC and haemoglobin count. Whereas, the MCH, MCV, and white blood cell values increased with increasing of silkworm pupae percent in the diet (Shakoori et al., 2015). From the present study it can be inferred that muga silkworm pupae might be used as supplement in anaemic pigs. The results of RBC count and haemoglogin content is shown in Table 4.

Table 4: Table showing RBC count and haemoglogin content of control and pupae fed pigs

Haematological Parameters	Experimental Rations			Normal Range
	T1 (0% pupa)	T2 (2% pupa)	T3 (4% pupa)	
RBC Count (M/mm3)	5.36 ± 0.68	7.19 ± 1.22	7.25 ± 0.43	5.0 - 8.0
Haemoglobin content (g/dl)	10.93 ± 1.77	11.7 ± 2.17	13.13 ± 1.62	10 - 16

Thus the study revealed that the muga silkworm pupae diet is economically viable compared to the conventional soybean diet and can be used for weight gain, better growth, digestibility enhancement, feed conversion efficiency and minimise the feed cost for economic pig farming.

CONCLUSION

The present study is the first report on utilization of muga silkworm pupa as a feed meal in livestock especially in pigs. The study confirms that supplementation of 2% and 4% of muga silkworm pupae in the diet of Large White Yorkshire grower pigs improved the overall production performance along reduction in the cost of production. Therefore, supplementation of muga pupa diet is revealed to be both nutritionally and economically viable in grower pigs. However, further research is needed with higher percentage of silkworm pupae diet to achieve significant results.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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