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Replacement of Fish Meal by Silkworm Pupae in Broiler Diets

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Abstract: A total of 144 day old straight run Arber Acres broiler chicks were fed *ad libitum* up to 42 days of age on 4 isonitrogenous and isoenergetic diets formulated by replacing dietary fishmeal (FM) by silkworm pupae (SWP) up to 42 days of age. Four diets; D_0 (6% FM + 0% SWP), D_1 (4% FM + 2% SWP), D_2 (2% FM + 4% SWP) and D_3 (0% FM + 6% SWP) were fed to observe the effect of dietary SWP on performance. The growth rate, feed conversion, livability, meat yield and profitability increased almost linearly on increasing level of SWP.

Key words: Fish meal, silkworm pupae and broiler

Introduction

Broiler industry provides a large part of increasing demand for animal protein, cash income and creating employment opportunities. Poultry meat contributes approximately 37% of the total animal protein supplied in the country (Ahmed and Islam, 1985). There is a great possibility of growth and expansion of this sector both at domestic and commercial level. But, broiler producers are facing much difficulty with availability and higher prices of feed ingredients. Feed cost account 65-70% of total poultry rearing cost (Bhuiyan, 1998) and protein cost account 15% of feed cost (Banerjee, 1993; Singh, 1990) The animal protein source is obviously the most costly ingredient for the formulation of poultry diets than any other source of nutrients.

In Bangladesh, very limited number of feed ingredients are available to choose for the formulation of balanced diet. Grain and by-products are quite insufficient, as there is a competition among poultry, human and other livestock for some of these ingredients. The availability of conventional feed items is insufficient to meet the requirement of poultry. The unconventional feed ingredients, which are also reasonably cheaper and available may be very prospective ones to solve the growing feed crisis.

In Bangladesh, fishmeal (FM) is the only conventional animal protein source for poultry and poultry is in competition with human and other livestock for dry fish consumption. As a result, the cost of FM is very high and its inclusion in diet hardly permits profitable poultry farming. The quality of FM is very much variable and availability is uncertain (Islam, 1993; Ali, 1993 and Nazneen, 1995). In addition, FM is often adulterated with other ingredients, eg. fish bones, sand, sawdust (Ali, 1995). Producers sometime use insecticides for the preservation of FM, which may cause toxicity in poultry. Silkworm pupae, a waste product of silk industry, could be used as a top class unconventional protein and energy feed for poultry after proper processing at a reasonable cost. Compared to fishmeal, silkworm pupae are a low cost ingredients and rich both in protein and lipid (Bhuiyan *et al.,* 1989). It is also an important source of Crude protein (CP), Ether extract (EE), Crude fiber (CF), Nitrogen free extract (NFE), Ash, Calcium (Ca), Phosphorus (P), Lysine and Methionine (Habib and Hasan, 1995). From the above informations, it is evident that successful use of cheaper silkworm pupae as a substitute of costly FM might reduce the production cost of balanced poultry diets with a consequent increase in profitability of poultry production. With those considerations, the present study was designed to determine the effect of replacing FM by SWP in lieu of FM for optimum broiler performance and to assess the economic feasibility of replacing FM by SWP in the broiler diet.

Materials and Methods

The experiment was conducted at Bangladesh Agricultural University (BUA) Poultry Farm, Mymensingh for a period of 42 days, September and October 2000. The experiment was started with 144-day-old straight run Arbor Acres broiler chicks.

The experimental chicks were randomly distributed into four dietary treatments; D_0 (6% FM + 0% SWP), D_1 (4% FM + 2% SWP), D_2 (2% FM + 4% SWP) and D_3 (0% FM + 6% SWP) and each treatment had three replications. There were 36 birds in each treatment and 12 birds in each replication.

The feed was formulated according to the BSTI standard (BSTI, 1988) and the birds were fed *ad libitum* diet, kept on littered floor and vaccinated against Newcastle disease

and Gumboro disease as per schedule. Temperature and relative humidity (RH%) were recorded during the experimental period. Body weight and feed intake were recorded fortnightly and mortality was recorded daily. Production cost (Tk/broiler and Tk/Kg broiler) was calculated involving chick cost, feed cost, mortality, labour cost, vaccine and medicine cost, litter cost and electricity cost etc. Profitability (Tk/broiler and Tk/Kg broiler) was calculated on the sale and production cost.
The representative two birds from each replication had been selected and kept in fasting for 12 h. Therefore the birds were slaughtered and recorded the meat yield traits of individual male and female like dressing weight, blood weight, feather weight, shank weight, head weight, heart weight, viscera weight, liver weight and gizzard weight. All the meat yield traits were calculated as per centage.

Statistical analysis: All recorded and calculated data were statistically analyzed using analyses of variance (ANOVA) technique by a computer using a MSTAT Statistical Computer Package Program in accordance with the principle of the Completely Randomized Design (Steel and Torrie, 1960). Least significant differences (LSD) were calculated to compare variations among treatments where ANOVA shows significant differences.

Results and Discussion

Growth performance: The results of live weight, feed consumption, feed conversion and livability are presented in Table 1. Live weight at 28 and 42 days of age were almost linearly increased with increasing dietary SWP levels but SWP had little effect on live weight up to 14 days of age. Increased broiler growth performance on increasing levels of dietary SWP is supported by many previous findings Choudhury *et al.* (1998), Borthakur and Sarma (1998), Nandeeshi *et al.* (1989a), Jayaram and Shetty (1980), Rahman (1990), Habib *et al.* (1994), Shyma and Keshavnath (1993), Begum (1992), Shyma *et al.* (1993), Rahman *et al.* (1996) and Mahata *et al.* (1994). At 14 days of age, broilers had similar feed consumption (p>0.05) and feed conversion (p>0.05) regardless of dietary level of SWP but feed intake decreased (p<0.01) and efficiency of feed conversion increased (p<0.01) with the increasing levels of SWP in diet at 28 and 42 days of age. Improved feed conversion of broilers on diets with SWP in the current study coincides with the findings of Reddy *et al.* (1991), Venkatchalam *et al.* (1997), Choudhury *et al.*(1998), Ling (1967), Akiyama *et al.* (1984),

Table 1: Growth performance of broilers on diet with different levels of Silkworm pupae (SWP)

Variable	Age(day)	Dietary level of SWP (%) 0	2	4	6	SED(LSD) and significance
Live weight (g/ broiler)	Day old	49.72	49.17	47.91	48.86	0.482 NS
	14	254.45	276.39	273.05	281.39	37.310NS
	28	842.67^{c}	952.78^{b}	967.00^{ab}	983.33^{a}	(26.912)**
	42	1274.24^{c}	1425.00^{b}	1440.15^{ab}	1474.99^{a}	(29.233)**
Feed intake (g/broiler)	14	854.17	833.33	827.67	825.00	32.123NS
	28	1688.89^{a}	1588.67^{b}	1572.11^{b}	1458.03^{c}	(59.700)**
	42	2767.00^{a}	2688.89^{b}	2691.67^{b}	2585.60^{c}	(151.410)**
Feed conversion ratio (feed: live weight gain)	14	4.17	3.70	3.64	3.56	0.260NS
	28	2.13^{a}	1.76^{b}	1.71^{b}	1.61^{c}	(0.279)**
	42	2.25^{a}	1.95^{b}	1.93^{b}	1.81^{c}	(0.290)**
Survivability (%)	14	100.00	100.00	100.00	100.00	0.100NS
	28	97.22	100.00	100.00	100.00	1.962NS
	42	97.22	97.22	100.00	100.00	2.271NS

Table 2: Total cost of production (Tk./broiler and Tk./Kg broiler) and profit (Tk./broiler and Tk./Kg broiler) on different dietary levels of silkworm pupae

Cost/benefit	Age(day)	Dietary levels of SWP (%) 0	2	4	6	SED (LSD) values and significance
Total cost	28	47.61^{b}	47.56^{b}	46.80^{b}	46.35^{a}	2.725NS
(Tk./broiler)	42	61.94^{b}	61.30^{b}	59.34^{a}	58.07^{a}	3.210**
Sale value	28	57.27^{c}	65.75^{ab}	64.78^{b}	66.86^{a}	3.882**
(Tk./broiler)	42	86.64^{c}	97.93^{b}	96.89^{b}	100.30^{a}	5.772**
Profit	28	9.66^{c}	18.19^{b}	17.98^{b}	20.51^{a}	0.933**
(Tk./broiler)	42	24.77^{c}	36.63^{b}	37.55^{b}	42.23^{a}	1.733**
Total cost	28	50.99^{a}	48.34^{b}	47.33^{bc}	46.62^{c}	1.824**
(Tk./Kg broiler)	42	55.95^{a}	52.18^{b}	51.03^{b}	49.46^{b}	2.103**
Sale value	28	68	68	68	68	-
(Tk./Kg broiler)	42	68	68	68	68	-
Profit	28	17.01^{c}	19.66^{ab}	20.67^{ab}	21.38^{a}	1.022**
(Tk./Kg broiler)	42	12.05^{c}	15.82^{b}	16.97^{b}	18.54^{a}	1.563**

Figures in the same line superscripts with similar alphabet do not differ significantly; NS: Non significant; ** P<0.01; * P<0.05; all SED's are against 8 df.

Table 3: Meat yield of broilers on different levels of Silkworm pupae (SWP)

		Dietary levels of SWP (%)					SED (LSD) Values and significance		
Variables	Sex(s)	0	2	4	6	Mean	D	S	D × S
Dressing (%)	M	60.20	65.00	71.50	72.95				
	F	57.31	71.30	67.25	73.15	67.33	5.733**	1.782NS	2.873NS
	Mean	58.75c	68.15b	69.37b	73.05a				
Blood weight (%)	M	4.23	4.45	4.50	6.40				
	F	3.10	4.95	5.03	5.25	4.74	2.120**	0.576NS	2.407*
	Mean	3.67c	3.73c	4.77b	5.83a				
Feather weight (%)	M	4.20	4.50	4.99	5.79				
	F	4.50	5.41	5.38	5.48	5.07	0.820NS	0.552NS	1.400NS
	Mean	4.35	4.95	5.34	5.64				
Shank weight (%)	M	3.60	3.80	3.9	4.11				
	F	3.20	3.41	3.6	3.91	3.69	0.152NS	0.098NS	0.143NS
	Mean	3.40	3.62	3.75	4.00				
Head weight (%)	M	3.25	3.30	3.33	3.40				
	F	2.91	3.00	3.2	3.20	3.20	0.185NS	0.133NS	0.254NS
	Mean	3.08	3.15	3.27	3.33				
Shank length (cm)	M	7.10	7.20	7.40	7.61				
	F	7.00	7.12	7.20	7.33	7.25	0.349**	0.100NS	0.210NS
	Mean	7.05c	7.16b	7.30a	7.47a				
Heart weight (%)	M	0.39	0.37	0.40	0.40				
	F	0.38	0.30	0.42	0.39	0.43	0.036NS	0.024NS	0.052NS
	Mean	0.39	0.52	0.41	0.41				
Viscera weight (%)	M	12.96	12.98	11.10	11.00				
	F	11.89	12.95	11.50	11.25	11.96	1.123NS	0.781NS	1.592NS
	Mean	12.43	12.97	11.30	11.12				
Liver weight (%)	M	3.20	3.21	3.33	3.50				
	F	3.40	3.02	3.22	2.91	3.22	0.203NS	0.138NS	0.283NS
	Mean	3.30	3.11	3.28	3.22				
Gizzard weight (%)	M	2.10	2.40	2.2	2.62				
	F	2.01	2.13	2.3	2.43	2.26	0.175NS	0.122NS	0.254NS
	Mean	2.05	2.25	2.25	2.54				

Figures in the row superscripts with similar alphabet do not differ significantly; ns: Non significant; ** P<0.01; *P<0.05; all SED's are against 8 df.

Mahata *et al.* (1994). No significant difference in the livability was found which could be attributed to the dietary SWP levels. Shyma *et al.* (1993) studied that livability of fish was highest on 50% defatted silkworm pupae diets.

Production cost and profitability: Total cost in rearing broilers on different dietary levels of silkworm pupae is shown in Table 2. Total cost (Tk/broiler and Tk./Kg broiler) at 28 and 42 days of age gradually declined on increasing dietary levels of SWP (P<0.01). Therefore, profit (Tk/broiler and Tk/Kg broiler) were significantly higher (P<0.01) as the level of dietary SWP was increased. These findings coincide with the findings of Reddy *et al.* (1991), Choudhury *et al.* (1998), Timur (1982), Rahman *et al.* (1996), Chakrabarty *et al.* (1971), Narang and Lal (1985), Nandeesh *et al.* (1989b) and Habib *et al.* (1994). They reported that silkworm pupae was to be useful economical protein rich feed and reduced production cost when FM replaced by SWP.

Meat yield characteristics: The meat yield characteristics of male and female broilers on different dietary levels of SWP are presented in Table-3. The dressed yield were increased almost linearly on increasing dietary levels of SWP. Sex had little effect on any meat yield characteristics. Similar findings were observed by Kumar *et al.* (1992).

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