

## Effect of Feeding Velvet Beans (*Mucuna pruriens* L.) on the Performance and Lipid Profile of Broiler Chickens

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**ABSTRACT.** *The effect of feeding velvet bean (Mucuna pruriens L.) meal on the performance and lipid profile in broilers was investigated. Fourteen days old 200 broiler chicks were randomly allocated to five dietary treatments in a completely randomized design and feeding was continued for four weeks. Maize and soybean meal based control feed, and four test diets produced from the control feed by incorporating velvet beans at 10, 15, 20 and 25% levels served as five dietary treatments. Feed intake was not affected by velvet beans. Twenty and 25% velvet beans reduced weight gain by 17 and 23% and increased the feed conversion ratio by 23 and 17%, respectively. The final body weight of birds at 42 days decreased when velvet bean meal was included above 15%. Increase of inclusion level above 10% reduced the dressing percentage of broilers. Serum total cholesterol level decreased by 9.5, 9.7, 15 and 16%, respectively in birds fed with 10, 15, 20 and 25% velvet bean diets. Birds fed with 25% velvet bean diet showed an increase in the level of high density lipoproteins by 8%. Low density lipoprotein level decreased by 43.1, 36.5, 25 and 23.4%, respectively in birds fed with 25, 20, 15 and 10% velvet beans. Velvet beans reduced the serum triglyceride levels as well. Results suggest that velvet bean has a strong cholesterol lowering effect on broilers and it can be included up to 15% in the diet of broilers without any negative effect.*

### INTRODUCTION

Meat and other animal products can play a significant role in enhancing the nutritional status of the people. Meat contains mainly proteins of high quality. Foods of animal origin are therefore energy-dense and excellent sources of high-quality and readily digestible protein. They are also a good source of micronutrients (Layrisse *et al.*, 1990; Bender, 1992). Presence of cholesterol in meat and other foods of animal origin is a main factor discouraging the consumption of such foods. Today, people are more concerned about the nutritional quality and their possible health hazards related to dietary components. Most of the people restrict consumption of meat due to the fear of high cholesterol content in

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meat. This situation has led to missing of an excellent source of nutrients in the diet leading to protein malnutrition in Sri Lanka.

Therefore it is a timely need to find measures to produce meat with low cholesterol as it will make meat more attractive to people and consequently, meat consumption could be increased. Consumption of quality meat will have a significant effect on reducing the protein malnutrition as well as minimizing the health hazards due to consumption of meat. One method of lowering meat cholesterol is to incorporate cholesterol reducing substances into the diets of meat producing animals.

Some of the previous studies carried out with velvet beans (*Mucuna pruriens* L.) have shown a cholesterol lowering effect (Carew *et al.*, 2003; Del Carmen *et al.*, 1999; Carew *et al.*, 1998a; Iauk *et al.*, 1989). However, these claims have not been investigated in details.

Velvet bean is grown as a cover crop in many areas of the world for human food or as an animal feed and it is used as a food item in some parts of Sri Lanka. Though it can be grown very easily under the climatic conditions of the country (Ravindran, 1988), this valuable crop is not yet properly exploited in Sri Lanka. People traditionally consuming velvet beans claim various medicinal properties of velvet beans. Therefore, the present study was conducted to investigate the cholesterol lowering effect and its value as a protein source for broiler chickens.

## MATERIALS AND METHODS

This study was conducted in the Sabaragamuwa University of Sri Lanka. Two hundred unsexed day-old broiler chicks of Hubbard strain were obtained from the hatchery of the Miriswatta Farm, National Livestock Development Board. They were brooded together for 14 days in a floor brooder and fed on a commercial broiler starter feed *ad libitum*. On the 14<sup>th</sup> day, chicks were divided into 20 groups of 10 and transferred to 20 deep litter pens. Five dietary treatments were assigned to 20 groups with four replicates per treatment according to a complete randomized design (CRD).

Dried velvet bean seeds were collected from shops and farms in Balangoda, Pelmadulla, Godakawela and Ratnapura areas. The whole beans were heated by keeping in a laboratory oven at 130°C for 30 min as described by Carew *et al.* (2003). Seeds were then ground using a laboratory mill to pass through a 0.25 mm screen and stored in airtight polythene bags at room temperature for further use. Samples of velvet beans were subjected to proximate analysis and the reference value of 2370 kcal/kg (Del Carmen *et al.*, 1999) was used as the metabolizable energy of velvet bean. The reference values were also used for amino acids and mineral contents of velvet beans (Del Carmen *et al.*, 1999) in formulating test diets.

A control diet based on maize and soybean meal was prepared to contain all the nutrients required by broiler finishers as recommended by National Research Council (1994). Four test diets were produced by including 10%, 15%, 20% and 25% velvet beans, respectively in to the control diet at the expense of soybean meal and coconut poonac (Table 1). Amounts of other ingredients were slightly adjusted to make the rations isoenergetic and

isoproteic. Experimental diets in mash form were offered to birds *ad libitum* during the four weeks of experimental period. Birds were given free access to drinking water.

**Table 1. Composition of experimental diets**

Ingredient (%)	Level of velvet bean in the diet				
	0%	10%	15%	20%	25%
Rice polish	21.5	21.3	23.0	24.0	24.0
Maize	38.0	35.3	31.0	27.7	24.0
Fish meal	4.0	4.0	4.0	4.4	5.4
Soybean meal	20.3	19.4	18.5	17.0	14.0
Coconut Poonac	10.0	3.7	1.9	0.0	0.0
Velvet beans	0	10.0	15.0	20.0	25.0
Calcium carbonate	1.8	1.9	1.9	1.9	1.9
Di-calcium phosphate(DCP)	0.7	0.7	0.7	0.7	0.7
Lysine HCl	0.05	0.05	0.05	0.05	0.05
DL-Met	0.15	0.15	0.15	0.15	0.15
Coconut oil	3.0	3.0	3.3	3.6	4.3
Salt	0.25	0.25	0.25	0.25	0.25
Vitamin mineral premix	0.25	0.25	0.25	0.25	0.25
<b>Calculated nutrient levels (per kg):</b>					
Metabolizable energy (MJ)	13.33	13.32	13.31	13.32	13.32
Crude protein(g)	200.32	200.18	200.22	200.32	200.24

Group feed intake was recorded daily and body weights of birds were measured in three day intervals. Weight gain and feed conversion ratio were calculated. Blood samples were collected from five randomly selected birds from each group on 21<sup>st</sup>, 28<sup>th</sup> and 35<sup>th</sup> day, and at slaughter. Samples were collected by venupuncturing the wing vein of birds. Blood was collected in to vacutainers with no additives for serum separation. The samples were stored at -20°C until further analysis. Birds were slaughtered on 42<sup>nd</sup> day by severing the jugular vein. Meat samples were obtained from the breast muscle and fat samples from the abdominal fat pad of three randomly selected eviscerated carcasses from each replicate group. They were stored in sealed, labelled polythene bags at -20°C until further analysis. Blood samples were collected on weekly basis and meat and fat samples were subjected to lipid profile analysis [Total cholesterol, high density lipoproteins (HDL), low density lipoproteins (LDL) and Triglycerides] by enzymatic diagnostic kits (Diasys diagnostic kits).

Data were subjected to analysis of variance (ANOVA) with  $p < 0.05$  being considered significant (SAS, 2000). Duncan's New Multiple Range Test (DNMRT) (Duncan, 1955) was used to compare mean values of treatments.

## RESULTS AND DISCUSSION

## Performance of broilers

Initial body weight of the birds was similar in all treatment groups. The average feed intake during the trial period varied from 117.8 to 119.3 g/bird/day without a significant difference ( $p < 0.05$ ) between treatments (Table 2). Del Carmen *et al.* (1999) and Carew *et al.* (2003) found significantly reduced feed intake when raw velvet beans were introduced in to broiler diets and it was partially but significantly reversed when velvet beans were heated before feeding indicating the presence of an anti-palatability factor and its possible removal by heat treatment. Iyayi and Taiwo (2003) also found that incorporating heated velvet beans up to 33.3% level had no effect on feed intake of broilers. Since heat treated velvet beans were used in the present study, a similar feed intake observed in all treatment groups agrees with the previous observations of Del Carmen *et al.* (1999), Carew *et al.* (2003) and Iyayi and Taiwo (2003).

**Table 2. Effect of dietary velvet beans on feed intake, growth performance, feed conversion ratio and dressing percentage of broiler chickens.**

Parameter measured	Level of velvet beans in the diet				
	0%	10%	15%	20%	25%
Initial body weight (g)	316.6±2.4	317.4±2.4	317.7±1.2	317.1±2.2	317.3±2.5
Feed intake (g/hr/day)	119.3± 3.3	118.8±3.8	118.5± 4.5	117.8±3.2	117.6±4.2
Body weight gain (g/hr/day)	57.3 ± 1.1 <sup>c</sup>	54.8 ± 1.3 <sup>c</sup>	54.4 ± 1.5 <sup>c</sup>	47.7 ± 0.1 <sup>b</sup>	43.9 ± 1.8 <sup>a</sup>
Final body weight (g)	1920±20.9 <sup>c</sup>	1852±24.9 <sup>c</sup>	1841±30.9 <sup>c</sup>	1652±12.9 <sup>b</sup>	1547±14.9 <sup>a</sup>
Feed conversion ratio	2.08± 0.1 <sup>d</sup>	2.17±0.1 <sup>c</sup>	2.18± 0.1 <sup>c</sup>	2.47± 0.1 <sup>b</sup>	2.68±0.1 <sup>a</sup>
Dressing percentage	76.8±4.7 <sup>c</sup>	76.3±3.3 <sup>c</sup>	74.8± 6.6 <sup>b</sup>	73.7±0.75 <sup>b</sup>	73.2±1.9 <sup>a</sup>

**Note:** Mean±SE, Means followed by different letters in a row are significantly different at  $P < 0.05$ .

The average daily weight gain of birds significantly decreased ( $p < 0.05$ ) when the level of velvet beans in the ration exceeded 15%. The weight gain of chicks fed the diet containing 25% velvet beans reduced by 23% as compared to the control. The reduction in weight gain was 17% in the 20% velvet bean group. Accordingly the final body weight of birds on the 42<sup>nd</sup> day significantly decreased ( $p < 0.05$ ) with 20% and 25% velvet bean diets. Incorporation of velvet beans up to 15% in the diet decreased the weight gain by 4.6% but the effect was not significant. These results agree with the findings of Carew *et al.* (1998b), Del Carmen *et al.* (1999), Carew *et al.* (2002), Iyayi and Taiwo (2003) and Carew *et al.* (2003). The growth depression was evident from the early part of the experiment. The negative effect of velvet beans on growth is undoubtedly explained by one or more toxic factors present in velvet beans. The published literature suggests that the toxic factors in velvet beans will include tannins and cyanide (Ravindran and Ravindran, 1988; Vadivel and

Janardhanan, 2000), anticoagulants (Houghton and Skari, 1994), analgesic, antipyretic and anti-inflammatory factors (Iauk *et al.*, 1993), L-Dopa (Bell and Janzen, 1971; Daxenbichler *et al.*, 1971) and other unidentified substances (Siddhuraju *et al.*, 1996; Olaboro *et al.*, 1991). It has been reported that heated velvet beans contain 21 g/kg tannin, 82 g/kg hydrocyanic acid and 21 g/kg phytic acid (Iyayi and Egharevba, 1998). Tannin could have induced poor performance of the birds as reported earlier by Mitjavila *et al.* (1977) and D'Mello and Devendra (1995). Earlier findings of Griffith (1991) on the adverse effects of feeding tannins in poultry diets also support this conclusion. Other agents such as phytic acid and hydrocyanic acid (HCN) found in velvet beans could also have been responsible for the reduced weight gain (Iyayi, 1994). Lectins, possibly exert deleterious effects on the birds fed with higher levels of velvet beans as reported by Afolabi *et al.* (1985), Ravindran and Ravindran (1988), Pugalenthi *et al.* (2005), Carew *et al.* (2002) and Grant (1991).

The feed conversion ratio (Feed/gain ratio) was also higher in birds fed with velvet bean containing diets and the effect was greater with the increasing level of velvet beans. The feed conversion ratio was higher by 23% and 17% in broilers fed 20% and 25% velvet bean diets, respectively compared to the control. Dressing percentages were also significantly decreased ( $p < 0.05$ ) with velvet bean levels above 10%. Carew *et al.* (2002 and 2003) reported that the weight of organs such as heart, liver, pancreas and intestine significantly increased in broilers fed with diets containing velvet beans above 20%. This might be the reason for the poor carcass recovery observed in the present study.

**Table 3. Effect of dietary velvet beans on serum lipid profile and total cholesterol in meat and abdominal fat of broiler chickens.**

Lipid fraction (mg/dl)	Level of velvet beans in the diet				
	0%	10%	15%	20%	25%
<b>Serum lipids:</b>					
Total cholesterol	162.0±4.34 <sup>c</sup>	146.6±6.21 <sup>b</sup>	146.7±2.34 <sup>b</sup>	138.6±4.75 <sup>a</sup>	136.3±5.37 <sup>a</sup>
HDL	70.9±3.98 <sup>a</sup>	72.1±4.75 <sup>b</sup>	72.8±2.52 <sup>b</sup>	74.2±6.38 <sup>c</sup>	76.6±5.72 <sup>c</sup>
LDL	59.7±2.29 <sup>c</sup>	45.8±3.15 <sup>b</sup>	44.8±1.75 <sup>b</sup>	37.9±4.13 <sup>a</sup>	33.9±3.65 <sup>a</sup>
HDL/LDL ratio	1.2±0.53 <sup>a</sup>	1.6±0.59 <sup>b</sup>	1.6±1.87 <sup>b</sup>	2.0±1.12 <sup>c</sup>	2.3±0.95 <sup>c</sup>
Triglycerides	160.4±14.34 <sup>b</sup>	144.1±20.45 <sup>a</sup>	141.5±17.83 <sup>a</sup>	132.8±15.67 <sup>a</sup>	130.0±13.33 <sup>a</sup>
<b>Total Cholesterol in:</b>					
Breast muscle	0.59±0.15 <sup>c</sup>	0.57±0.65 <sup>b</sup>	0.56±0.45 <sup>b</sup>	0.49±0.75 <sup>a</sup>	0.47±0.83 <sup>a</sup>
Abdominal fat	0.90±0.16 <sup>c</sup>	0.87±0.71 <sup>b</sup>	0.85±0.23 <sup>b</sup>	0.80±0.57 <sup>a</sup>	0.79±0.71 <sup>a</sup>

**Note:** Mean ± SE, Means followed by different letters in a row are significantly different at  $p < 0.05$ .

### Serum lipid profile

There was a negative correlation between the level of velvet beans in the diet and total cholesterol ( $r = 0.97$ ), LDL ( $r = 0.97$ ) and triglycerides ( $r = 0.97$ ) concentration in serum. Serum HDL had a positive correlation ( $r = 0.77$ ). As shown in Table 3, serum total cholesterol concentration was significantly lower ( $p < 0.05$ ) in birds received velvet bean diets compared with the control group. Velvet beans at 20% and 25% reduced the serum

total cholesterol by 15% and 16%, respectively. Total cholesterol reduced by 9.6% up to 15% velvet beans in the diet. Similar cholesterol depressing effects due to feeding velvet beans in broilers have been observed by Carew *et al.* (1998a, 2002 and 2003). This is also in agreement with results reported on rats by Pant *et al.* (1968) and Iauk *et al.* (1989). Various effects on concentrations of insulin and glucagons (Ham *et al.*, 1993; Sanchez and Hubbard, 1991; Beynen *et al.*, 1990; Barth *et al.*, 1990; Scholz- Ahrens *et al.*, 1990; Forsythe, 1986) have been reported due to feeding soy protein. Similar hormonal changes have been reported in rats after feeding velvet beans (Iauk *et al.*, 1989; Pant *et al.*, 1968). Sanchez and Hubbard (1991) found that the lower lysine:arginine ratio of soy protein decreases the secretion of insulin and increases the secretion of glucagon. As velvet bean also contains a similar lysine:arginine ratio, the same changes in insulin and glucagons in birds fed with velvet beans can be expected. It is therefore suggested that lowering of insulin:glucagon ratio may have reduced cholesterol synthesis in birds and responsible for the hypocholesterolemic effect of velvet bean. Nagata *et al.* (1982) and Sugano *et al.* (1990) observed reduced serum cholesterol levels in rats fed with soy proteins due to increased faecal steroid excretion, particularly in bile acids. They found that this effect was partially caused by the binding of bile acids to soybean saponins. Similar mechanism can be expected in animals fed with velvet beans, due to availability of saponins.

All the birds that received velvet bean diets had significantly lower ( $p < 0.05$ ) levels of LDL concentrations compared to the control group and the level decreased by 43.1%, 36.5%, 25% and 23.4%, respectively in birds fed with 25%, 20%, 15% and 10% velvet beans. Kirk *et al.* (1998), Beynen *et al.* (1990), Van der Meer *et al.* (1988), Nagata *et al.* (1982), Thanaka *et al.* (1984), Huff and Carrol (1980) and Kim *et al.* (1980) revealed that isoflavones in soy protein increase LDL receptor activity in animals and as a result, total and LDL cholesterol levels get decreased. Considering the same content of isoflavones in soybean and velvet beans, similar mechanism can be expected with velvet beans too.

The serum HDL levels in birds fed with 20 and 25% of velvet beans were significantly higher ( $p < 0.05$ ) by 4.5% and 8% respectively compared with the control group. Fifteen percent and 10% velvet bean diets increased the HDL level ( $p < 0.05$ ) by 2.6% and 1.7%, respectively compared with the control.

The serum triglyceride concentration was lower ( $p < 0.05$ ) in all the birds fed with velvet beans compared with the control group. But there was no significant ( $p < 0.05$ ) difference in serum triglyceride concentration among birds that received different levels of velvet beans. Khosla *et al.* (1991) and Lovati *et al.* (1992 and 1991) reported that soy protein increases the removal of very low density lipoproteins (VLDL) from the blood. VLDL is the vehicle of transport of triglycerides in the body. Therefore removal of VLDL from the blood causes a reduction in triglyceride content as well. However according to the results, it is clear that the triglyceride lowering effect of velvet beans is similar up to 25% inclusion in the diet.

### **Lipid profile in meat and fat**

The cholesterol content in broiler breast muscle was significantly lower ( $p < 0.05$ ) in birds fed with velvet bean diets than those on the control diet (Table 3). Compared to the control group, the total cholesterol contents in broiler meat of birds given 10%, 15%, 20% and 25% velvet beans decreased by 4.1%, 4.8%, 17% and 20%, respectively showing a

negative correlation ( $r = 0.90$ ) between the two factors. This clearly shows the increasing hypocholesterolemic effect with increasing level of inclusion of velvet bean. The same pattern was observed in the cholesterol content of abdominal fat as well. This effect could be a result of reduced cholesterol synthesis in the body due to hormonal changes caused by velvet beans.

## CONCLUSIONS

It is concluded that heated velvet beans can be used as a source of protein in broiler diets up to 15% without affecting performance of broilers. Velvet beans possess a strong cholesterol lowering effect which seems to be heat tolerant. It reduces total cholesterol, LDL and triglycerides while increasing HDL levels in broilers. This medicinal property of velvet beans will be of great interest to meat producers and consumers. Further studies are needed to test this effect on other meat producing animals and directly on humans.

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