Effects of Moist Heat and Dry Heat on the Nutritional Value of Velvet Beans (*Mucuna pruriens* Var. Utilis) for the Laying Hen

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Abstract

A 112-day feeding trial was conducted to compare roasting and autoclaving as methods of heat treatment for improving the nutritional value of velvet beans ***(Mucuna pruriens)*** *for the laying hen. One batch of beans was autoclaved at 21 l for 30 minutes. Another batch was mixed with an equal amount of sand and evenly roasted in an open pan. Representative samples of both beans were analysed for crude protein, fibre, fat, ash, calcium, and phosphorus. The chemical analysis showed that velvet beans contained 27.1% CP, 3% CF, 8.9% Fats, 3.1% Ash, 4.6% Ca and 1.4% P. The beans were subsequently incorporated to constitute 10 and 20 percent of the experimental diets and fed to laying hens. The results revealed an overall improvement in the performance of laying hens when fed autoclaved beans. The addition of autoclaved beans up to the level of 20 percent had no detrimental effect on egg production and egg quality characteristics. But when roasted beans constituted 20 percent of the diet, there was a significant ($P<0.05$) reduction in egg production, egg mass out put and per cent marketable eggs. It was concluded that autoclaving was a better method of heat treatment than roasting, for velvet beans fed to the laying hens.*

Keywords: Heat treatment, velvet beans, nutrition, hens.

Introduction

Velvet bean is a vigorously growing, tailing vine grown mostly for green manuring or temporary pasture. The seeds are black (Mauritius bean) and glossy when mature, 1.2 to 1.5 cm long and 0.9 to 1.1 cm broad, with raised white hilum half as long as the seeds (Paul, 1951). Each pod contains three to five seeds with protein level ranging from 25 to 27 percent.

Proteins of plant origin, particularly those derived from legumes and oil seeds can provide a good source of protein for poultry production in the tropics. However, the nutritional value of such proteins is usually limited by the presence of substances which can produce negative effects on growth, digestion, metabolism and general health status of chickens. These anti-nutritional factors include protease inhibitors, lectins, goitrogens, cyanogens, phytate, alkaloid, tannin, vicine, covicine and have been extensively studied (Liener, 1962; 1983; 1987; Reddy *et al.*, 1982; Muduuli *et al.*, 1982; Conn, 1973; Hussein *et al.*, 1986; Gatel, 1994 and Ferwick *et al.*, 1983).

Preliminary studies in this laboratory (Olaboro *et al.* 1991) demonstrated that velvet beans contain 27% protein and is nutritionally better than the common beans (*Phaseoulus vulgaris*) for broiler chicks. It has a good amino

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acid profile, but is slightly deficient in sulphur amino acids, Methionine and Lysine. They also demonstrated the presence of heat labile trypsin inhibitors in the cotyledons of the beans. They reported that the level of the sulphur amino acid in the beans could be greatly increased, while trypsin inhibitors are markedly reduced by autoclaving the beans at 12°C for 30 minutes.

More recently, Sentumbwe (1997) fed roasted velvet beans to laying hens and obtained good layer performance when the beans constituted 10 per cent of the diet. She observed that as the amount of beans in the diet increased beyond 10 per cent, egg production, egg size, and egg mass output, and feed conversion efficiency all progressively decreased. Egg shell and internal egg quality deteriorated with increasing level of beans in the diet. She concluded that roasting did not provide sufficient heat to destroy all the anti-nutrients, to permit the inclusion of more beans in the layer diet.

Thus the objectives of the study reported herein were to:

(i) Study the performance of laying hens on autoclaved beans, and

(ii) compare roasting and autoclaving as methods of heat treatment for improving the nutritional value of velvet beans for laying hens.

Materials and Methods

(i) Velvet beans, procurement and treatment

The velvet beans used in this feeding trial were grown at the Makerere University Research Institute Kabanyolo (MUARIK) located 22 km North of the Makerere University campus. Soon after harvest, the dried beans were cleaned and stored in gunny bags under dried conditions to protect them against pest damages.

One batch was autoclaved using a Sentinel-Rodwell steam autoclave at a temperature of 211°C for 30 minutes. This temperature time combination is required to destroy the common anti-nutritional factors in beans (Kakade, 1974).

Another batch was mixed with an equal weight of sand and roasted in an open pan. The sand was used to ensure uniform heat distribution and even roasting of beans. It was later separated and beans cleaned. Both the roasted and autoclaved beans were stored in sacks under cool, dry and pest-free environment until used.

(ii) Chemical analysis

Representative samples of the roasted and autoclaved beans were analysed for crude protein, fibre, fat, ash, calcium, and phosphorus using standard procedures laid down by the Association of Official Analysis Chemists (A.O.A.C 1984). The chemical analysis showed that the velvet beans contain 27.1% CP, 3% CF, 8.9% Fat, 3.1% Ash, 4.6% phosphorus. These data were used in the formulation of the experimental diets.

(iii)Experimental design and animal management

Roasted and autoclaved beans were each added to constitute 10and 20 percent of the experimental diets formulated to contain approximately 15 percent crude proteins and 2900 Kcal ME/kg. A group of birds was fed roasted beans and a similar group was fed autoclaved beans. A maize/soyabean diet was used as a control. The composition of the experimental diets is shown in Table 1.The laying hens used in the experiment were obtained from Makerere University Agricultural Research Institute Kabanyolo (MUARIK) when they had reached peak production at 32 weeks of age. One hundred and twenty of them were assigned in groups of 8 birds each and allocated to five treatment in a completely random design. Each treatment was replicated three times. The birds were individually weighed at the beginning of the experiment and at the end of each 28-day period. Average weights were recorded for each pen. Daily egg production and individual egg weight record were kept.

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Table 1: **Composition of diets used to test roasted and autoclaved velvet beans**

Ingredient %	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5
Maize	60.41	54.57	54.57	50.50	50.51
Oil (kg)[a]	0.003	0.014	0.014	0.025	0.025
Soyabean mean	22.50	18.33	18.33	12.37	12.37
Velvet beans	0.00	10 (Rvb)	10 (Avb)	20 (Rvb)	20 (Avb)
Fish meal	2.00	2.00	2.00	2.00	2.00
Bone ash	4.36	4.36	4.36	4.36	4.36
Lake shells	9.73	0.73	9.73	9.73	9.73
Salt	0.5	0.5	0.5	0.5	0.5
Premix[b]	0.5	0.5	0.5	0.5	0.5
Total	100	100	100	100	100
Calculated Analysis					
Cre protein	15.0	15.5	15.5	15.5	15.5
ME Kcal/kg	2900	2900	2900	2900	2900
Calcium	3.6	3.6	3.6	3.6	3.6
Phosphorus	0.55	0.55	0.55	0.55	0.55

[a]Vegetable oil was added to make up the required amount of energy in the diets.

[b]Provide per kg diet: Vit A-8,000,000 IU; Vit D -2,000,000 IU; Vit E-5g; Vit K-1.5g, Vit B- 2g;Vit B 12-3 mg; Nicotic Acid-5g; Panithotenic Acid-3g; Choline Choride-75g; Manganese-70g; Zin-50;Iodine-0.1g; Yolk pigmenter (to give Roche 6).

Rvb=Roasted velvet beans

Avb=Autoclaved velvet beans.

Shell quality was determined by the number of eggs and cracked shells in each treatment, while internal quality characteristics were determined though candling and breaking representative samples of eggs, and counting the number of meat and blood spots present.The amount of food consumed was recorded and feed conversion efficiency was calculated by dividing the total feed consumed by the number of dozen eggs produced. Egg mass was expressed as the product of per cent hen-day production and average egg weight in grams. Hen-day per cent production was found by dividing the total number of eggs with total hen-days and expressing it as a per cent.

Mortality was recorded as it occurred. Post-mortem examinations were conducted on birds that died during the experiment, and on some randomly selected live ones from each treatment, at the end of the experiment. This was considered necessary to detect and document any pathological changes in the intestines, liver, gizzard, gull bladder and pancreas that may have been caused by the beans.

Statistical analysis

The data collected were subjected to the analysis of variance and differences among treatment means were determined using Duncan's Multiple Range Test (Snedecor and Cochran, 1973).

Result and Discussion

The effect of autoclaving beans on egg production, feed consumption and conversion efficiency is shown in Table 2. A significant reduction ($P<0.05$) was observed in the total number of eggs, egg mass and per cent marketable eggs produced from birds fed 20% roasted beans as opposed to those fed 20% autoclaved beans. Egg mass was significantly reduced by the addition of 20% autoclaved beans (Table 2)

There was no significant difference ($P>0.05$) in feed consumption at both levels of inclusion of velvet beans between birds fed roasted and those fed autoclaved beans.

Feed conversion efficiency under these treatments were also similar ($P>0.05$) except for 20% roasted beans which was inferior to the control ($P<.05$)

The influence of autoclaving beans on egg weight and quality is shown in Table 3. No significant differences were observed among mean weights.

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Table 2: Effects of autoclaving velvet beans on egg production, feed consumption and feed utilization

Treatment 1	Total egg production	Egg mass g/hen/day	Egg production		Feed g/hen/day	Feed/doz eggs
			% Production	% marketable		
Control	530a	40.5a	73.6	97.0	112.0	2.6a
10% roasted beans	547a	38.6a	73.2	95.0	113.5	2.4a
20% roasted beans	485b	29.8b	63.5	97	112.5	2.8ab
10% autoclave beans	545a	39.6a	74.1	96.0	114.6	2.5a
20% autoclaved	545a	34.2b	76.0	96.0	114.6	2.5b
LSDP < 0.05	43.09	4.07	-	-	10.55	0.32

NB: Means within a column not followed by the same letter(s) are significantly different.

Table 3: Effects of aoutclaving velvet beans on egg weight and quality

Treatment	Cracked shell %	Egg Egg size	Meat and Blood Spots %
Control	1.98	55.1	0.0
10% roasted beans	2.04	52.8	0.0
20% roasted beans	1.99	26.9	0.0
10% aoutoclaved beans	2.05	53.7	0.0
20% autoclaved beans	2.00	44.8	0.0

No Significant differences were observed among treatment means.

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The addition of velvet beans up to a level of 20% had no effect on egg shell and internal egg quality. Autoclaving also did not significantly reduce body weight or cause mortality in laying hens at all levels of bean addition.

The feeding trial clearly demonstrated a general improvement in the performance of laying hens when fed autoclaved beans as opposed to roasted beans. This was obvious when the beans constituted 20% of the diet. At that level, roasted beans significantly reduced ($P<0.05$) egg production, egg mass output and per cent marketable eggs. The data showed that autoclaving was a better method of heat treatment for velvet beans.

A similar observation was made by Olaboro *et al.*(1991), and Olaboro,(1993) who fed velvet beans to broiler chicks. They reported that autoclaving whole velvet beans and cotyledons greatly improved growth and feed conversion in broiler chicks, markedly reduced the level of trypsin inhibitor activity from 11.5 TIU/mg to 2.3TIU/mg; and increased the level of methionine by 36 per cent. They (Olaboro *et al.*, 1991) concluded that better performance of chicks on autoclaved beans was due to increased level of methionine in the diet.

Marquardt and Campbell(1994), reported that autoclaving of faba beans was most effective in improving efficiency of feed utilization and growth rate of chicks when the level of sulphur amino acids, and particularly methionine, was limiting for growth. Kakade (1974) reported that protein hydrolysis is considerably affected by its tertiary structure. Any change in this structure through denaturing agents such as heat, which would expose enzyme susceptible bonds, would result in an increased rate of protein hydrolysis.

It is probable that the improvement in layer performance on autoclaved beans was due to better digestibility and availability of its amino acids, including methionine resulting from better hydrolysis of its proteins.

Analysis of the data in Table 3 revealed that the addition of 20% autoclaved beans to the diet, caused a slight reduction in average egg size (44.8gm compared to 55.1gm on the control). Since egg mass is a function of percent production and average egg size, the reduction in egg size may explain why a significant ($P<0.05$) reduction in egg mass output was observed when autoclaved bean constituted 20 per cent of the diet.

The fact that there was a reduction in egg size, after feeding autoclaved beans also implies that autoclaving probably did not destroy all the anti-nutrients in the beans. Velvet beans are known to contain a subsistence 2-3, 4-dihydrozyphenylalanine (L-DOPA), an amino acid. This substance and its is glucosides are heat stable and have some anti-nutritional activity (Mayer *et al.*, 1969). Josephine and Jonardhanan (1992) reported that all the anti-nutrients detected in velvet beans except (L-DOPA are heat labile and could be eliminated by heating. Further research is needed to eliminate all the anti-nutrients in velvet beans to make it a possible substitute for soyabean meal in poultry rations.

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Table 4: Effects of aoutlaving velvet beans on body weight and mortality in hens

Treatment	Body weight kg/bird	Mortality %
Control	1.98	0.00
10% roasted beans	2.04	0.00
20% roasted beans	1.99	0.00
10%autoclaved beans	2.05	0.00
20%autoclaved beans	2.00	0.00

No significant differences were observed among treatment means.

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