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Evaluation of the nutritional value of boiled Java plum beans in broiler chick diets

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Abstract

In Uganda, the price of maize as the main source of energy in poultry feed is prohibitive due to its scarcity and competitiveness. Therefore, research is required to study the nutritional value of alternative energy feedstuffs such as Java plum (*Syzygium cumini*) beans (JPB). Chemical analysis and one feeding trial were conducted to assess the nutritional value of boiled Java plum beans (BJPB) in broiler chick diets. In the feeding trial, boiled Java plum bean meal (BJPBM) substituted maize meal (MM) by 0, 25, 50, 75 and 100% in broiler starter diets. The BJPB had dry matter (DM) content of 85.0±2.03%, nitrogen free extract (NFE) of 72.9±1.95%, calculated metabolisable energy (ME) of 13.3±0.25MJ/kg, crude protein (CP) of 4.23±0.48%, ether extract (EE) of 1.05±0.17%, crude fibre (CF) of 5.06±0.72%, ash of 1.75±0.11%, phosphorus (P) of 0.11±0.02% and calcium (Ca) of 0.05±0.01%.

In the feeding trial, diets with BJPBM significantly ($P < 0.05$) depressed chick growth. Feed intake was significantly ($P < 0.05$) reduced above 25% replacement rate whereas feed efficiency did not change much. There was no mortality in the control treatment and at 25% boiled Java plum bean-maize replacement rate. The study showed that BJPBM cannot replace MM in broiler starter diets without deleterious effects on the birds. The boiling treatment did not improve the nutritional value of JPB.

Key words: Boiling treatment, feedstuff, maize, poultry, Syzygium cumini, Uganda

Introduction

In any intensive livestock production system, feed costs amount to a considerable proportion of production cost (Mpofu 2004; Singh 2004). Feed constitutes about 60-80% of the total production costs of broiler meat (Teguia and Beynen 2005; Mpofu 2004; Smith 1990; Kekeocha 1984). With the present trend of rising prices of animal feedstuffs all over the world, considerable attention has been placed on the search for non-conventional livestock feedstuffs (Esmail 2002; Boda 1999; Mbugua 1989). One such non-conventional feedstuff, which could be of value for poultry feeding is the Java plum bean (seed). The Java plum bean is produced by the fruit of an evergreen tree called Java plum. Indians introduced the tree into Uganda in the early 1900's and mainly ate the juicy pulp as ordinary fruit or used the pulp for production of Java plum jam. However, the Java plum bean left after removal of the pulp was of little importance and was therefore

always discarded as waste. Presently, Java plum fruit is mainly eaten by young children who climb trees for fun and collect the fruits, which they enjoy eating. The beans are invariably discarded. The Java plum beans have the potential to be widely produced in Uganda because unlike other fruit trees, Java Plum trees thrive very well in a variety of soils that include loam, marl, sandy, and calcareous soils (Morton 1987).

The Java plum bean has received little research attention. The beans have a nutritional potential as an energy source because they are known to be rich in carbohydrates (Pankaj 2003). The starch component of Java plum beans is 41% (Morton 1987) as compared to maize that has a starch component of 68% (Ewing 1997). Although maize has a higher starch (energy) component than Java plum beans, the Java plum beans would have an advantage of being relatively cheap and less competed for than maize.

A preliminary study showed that phytochemical constituents of untreated Java plum beans were sterols, triterpenes, courmarins, tannins, glycosides (cardiac and steroids), alkaloids, reducing compounds, anthocyanin pigments and saponins, most of which are anti-nutritional factors (Ndyomugyenyi 2008). The study also showed that untreated Java plum bean meal could not replace maize meal in broiler starter and finisher diets without causing deleterious effects on the birds (Ndyomugyenyi 2008). The ability to incorporate Java plum beans in broiler diets can, therefore, depend on processing techniques that would eliminate anti-nutritional factors from the beans. Therefore, the objective of this study was to evaluate the nutritional value of boiled Java plum beans in broiler chick diets.

Materials and methods

Experimental site

The feeding experiment was conducted at Makerere University Agricultural Research Institute Kabanyolo located 17 km north of Kampala at latitude 0^{o} 28^{1} N and 32^{o} 37^{1} E, in the Lake Victoria Crescent. The altitude of the area is about 1.20 km above sea level.

Source and storage of boiled Java plum beans and other ingredients

Java plum beans from ripe fruits were obtained from Nakifuma Sub-County in Mukono district, Uganda. The beans were boiled for 50 minutes, sun-dried and stored in gunny bags on wooden stands. Maize, Soybean meal, Fishmeal, Lake Shells, Dicalcium phosphate, Salt, and Vitamin-mineral premix were obtained from the local market in Kampala, Uganda.

Chemical analysis of the boiled Java plum beans

The boiled beans were analyzed for the proximate composition, calcium and phosphorus using procedures described by AOAC (1990). Tannins in the beans were determined using modified Vanillin assay (Price et al 1978).

Estimation of metabolisable energy (ME)

Metabolisable Energy (ME) value of boiled Java plum beans and other ingredients used in ration formulation was estimated using the following formula developed by ARC (1977):

$$ME\ (kcal/kg) = 4.31 \times g.dCP + 9.28 \times g.dEE + 4.14 \times g.dNFE$$

Digestibility coefficient (d) estimates of 90% for CP, 90% for EE 90%, and 80% for NFE were assumed. In the calculation of ME, it was also assumed feedstuffs did not contain anti-nutritional factors. According to Moughan et al (2000), in feedstuffs that do not have anti-nutritional factors, digestibility coefficients are numerically the same.

Housing and management of broiler chicks

Day-old broiler chicks (Ross strain) were obtained from Biyinzika Enterprises (Farmers) Limited, Uganda. The chicks were randomly distributed into fifteen electrically heated cages. Each cage was 1.0 m x 0.5 m x 0.45 m. The chicks were vaccinated against Newcastle (first week), Gumboro (second week), and Infectious Bronchitis (third week). Soluble vitamins were provided in drinking water during the first week of brooding to correct any deficiencies from the breeder farm. A 24-hour lighting programme was followed using fluorescent tubes. Ample ventilation was ensured. In case of power failure, heat was provided by charcoal stoves and lighting by lanterns.

Feeding trial

The feeding trial that lasted three weeks was conducted to assess the responses of 180 broiler chicks to five broiler starter diets in which boiled Java plum bean meal was added to replace maize meal at levels of 0, 25, 50, 75 and 100%. The major protein supplements were roasted soybean meal and fish meal. The composition of the experimental diets is shown in Table 1.

Table 1. Composition of broiler starter diets used in the feeding trial (air-dry basis)

Diets	**1**	**2**	**3**	**4**	**5**
Substitution level[1]	**0%**	**25%**	**50%**	**75%**	**100%**
Maize	51.0	38.2	25.5	12.8	0.0
Java plum beans	0.0	12.8	25.5	38.2	51.0
Vegetable oil	0	1.0	2.0	2.0	2.5
Soybean (roasted)	40.0	35.5	33.5	33.0	30.5
Fishmeal	6.0	10.0	11.5	12.0	14.0
Lake shells	1.0	1.0	0.5	0.5	0.5
DiCalcium Phosphate	1.0	0.5	0.5	0.5	0.5
Salt	0.5	0.5	0.5	0.5	0.5
Vitamin-mineral premix[2]	0.5	0.5	0.5	0.5	0.5
Total	100	100	100	100	100
Nutrient composition (calculated)					
ME, MJ/kg	13.5	13.5	13.5	13.1	12.9
%CP	22.1	22.2	21.7	21.2	20.8
%EE	9.5	9.6	10.0	9.7	9.5
%CF	3.3	3.3	3.5	3.7	3.9
%Ca	0.93	0.95	0.81	0.83	0.9
%P	0.69	0.65	0.66	0.64	0.66
Tannins, % CE	0	0.03	0.06	0.1	0.13

[1]Levels at which Java plum beans replaced dietary maize.
[2] Premix provided per kg diet: Vitamin A 15,000 I. U., Vitamin D_3 3,000 I. U., Vitamin E 15 I.U., B_{12} 0.013 mg, Vitamin K 4 mg,
Riboflavin 10 mg, Folic acid 2 mg, Nicotinic acid 44 mg, Pantothenic acid 13 mg, Biotin 0.064 mg, Vitamin B_1 2.2 mg,
Vitamin B6 5.5 mg, Choline Chloride 350 mg, Copper 6.25 mg, Iodine 1.5 mg, Zinc 62.5 mg, Manganese 62.5 mg, Selenium
0.1 mg, BHT (Antioxidant) 100 mg, Zinc Bacitracin 10 mg.
Source: UNGA Farm Care (East Africa) Limited with technical assistance from Frank Wright Limited, part of BASSF Group

A completely randomized experimental design was used with three replicates. Each replicate contained twelve birds. Feed and water were provided *ad libitum*. Body weights of broiler chicks were taken at the start of experiment and at the end of each week for three weeks. All the feed provided was weighed. Feed consumption was determined weekly for each replicate. Mortality was recorded as it occurred.

Statistical analysis

Data on feed intake, weight gain, and feed conversion rate were subjected to Analysis of Variance using the procedures of the GenStat (2003). Treatment means were separated using Least Significant Difference at 5% significant level.

Results and discussion

Chemical composition

The results of proximate composition, mineral and metabolisable energy value of boiled and unboiled Java plum beans are shown in Table 2. The composition of maize is also included for comparison purposes.

Table 2. Proximate composition, mineral and metabolisable energy value of Java plum beans before and after boiling, and maize (%DM).

Composition, %	Unboiled Java plum beans	Boiled Java plum beans	Maize
Dry matter	84.8±2.79	85.0±2.03	86.4±0.47
Crude protein	4.95±0.56	4.23±0.48	9.96±0.53
Crude fat	0.73±0.12	1.05±0.17	4.05±0.12
Crude fibre	4.52±0.68	5.06±0.72	2.26±0.21
Ash	2.13±0.34	1.75±0.11	1.51±0.05
Phosphorus	0.24±0.04	0.11±0.02	0.32±0.02
Calcium	0.07±0.01	0.05±0.01	0.05±0.01
Nitrogen free extract	75.2±2.44	72.9±1.95	70.8±0.42
Condensed tannins	0.91±0.12	0.30±0.02	-
Total phenolics	25.6±1.20	10.1±0.84	-
Calculated metabolisable energy, MJ/kg	13.4±0.35	13.3±0.25	14.4±0.07

Dry matter and nitrogen free extract of unboiled and boiled Java plum beans were comparable to those of maize. However, both unboiled and boiled Java plum beans were lower in crude protein and crude fat. There was a slight change in proximate composition, mineral and metabolisable energy value of Java plum beans before and after boiling. Condensed tannins and total phenolics reduced by 67.03% and 60.49% respectively after boiling the beans.

The CP, EE, CF, ash, Ca and P contents of boiled Java plum beans in the current study were lower than those reported by Morton (1987). The variations in composition may be attributed to differences in varieties, processing methods, geographical location and the conditions under which the Java plum trees were grown. The NFE content of boiled Java plum beans in the present study was comparable to maize, which according to Ewing (1997) was 70.0%. The calculated ME of boiled Java plum beans was less than that of maize and other common energy sources of poultry diets such as cassava meal (14.9 MJ/kg) and wheat (15.1 MJ/kg) (Ewing 1997) but was still within a reasonable range for use as a source of energy.

Feeding trial

Weight gain, feed intake, feed efficiency and mortality of the chicks are shown in Table 3.

Table 3. Response of broiler chicks to diets in the feeding trial (0-3 weeks)

Treatment[1]	Weight gain[2], g	Feed intake[2], g	Feed efficiency, g feed/g gain	Mortality, %
0	656[a]	901[a]	1.38[a]	0
25	497[b]	843[a]	1.70[a]	0
50	294[c]	620[b]	2.11[ab]	3
75	159[d]	379[c]	2.44[ab]	14
100	125[d]	348[c]	2.81[ab]	53
LSD (P < 0.05)	57.2	133	0.51	

[a, b, c, d, e] *Means within a column with different superscript differ significantly (P < 0.05)*
[1]*Proportion of maize meal replaced by boiled Java plum bean meal*
[2]*On per bird basis*

Replacing maize meal with boiled Java plum bean meal significantly (P < 0.05) depressed chick growth. Compared to the control diet, replacement of maize meal with boiled Java plum bean meal by 25% depressed chick growth by 24% while at 100% replacement, the growth rate was depressed by 81%. The effect of replacing maize meal with boiled Java plum bean meal on growth rate became severe with time of feeding (Figure 1).

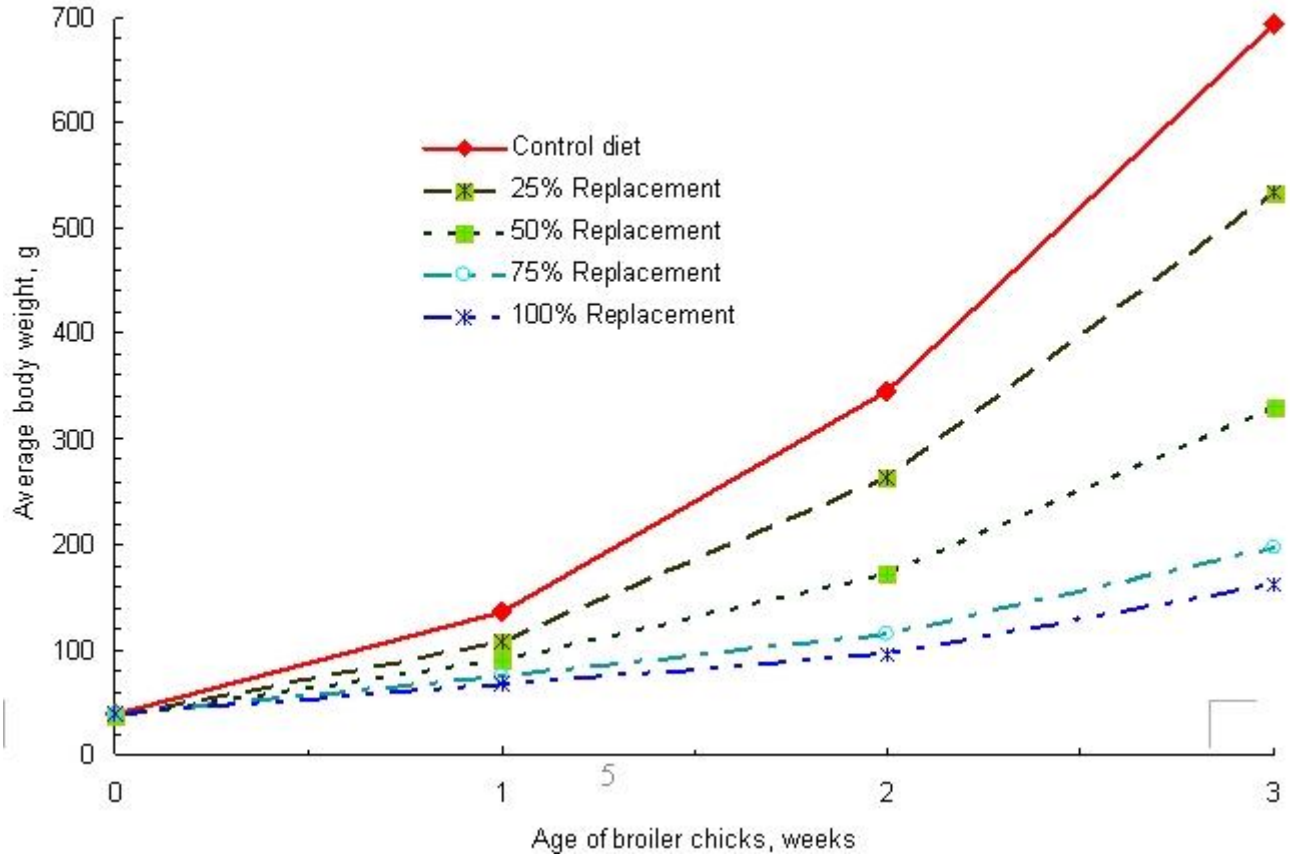

Figure 1. Body weight changes of broiler chicks fed varying levels of boiled Java plum bean meal through three weeks

Replacing maize meal with boiled Java plum bean meal (above 25%) significantly ($P < 0.05$) reduced feed intake and feed efficiency. Mortality rate increased with increasing levels of boiled Java plum bean meal.

The decrease in weight gain with increase in level of boiled Java plum meal in the starter diets could be attributed to the low feed consumption and poor feed utilization by the birds. The low feed consumption was probably caused by astringency of Java plum meal. According to Brown (2001); Reed (1995) and Van Soest (1994), tannins are responsible for an astringent taste of feedstuffs and chemical analysis indicated the presence of tannins in Java plum beans (Ndyomugyenyi 2008). Studies on the effect of sorghum tannins on broiler growth (Kyarisiima 2002; Okot and Mujabi 2001) similarly showed that tannins caused growth depression. The growth depression observed in the present study could not be solely attributed to the tannins present in the beans, considering that tannin content of the broiler chick diets was between 0.03 - 0.13% CE (catechin equivalent). Some studies have reported no significant effect on body weight when dietary level of broiler diets was over 1.0% CE while on the other hand according to Brown (2001), levels of tannins from 0.5 - 2.0% CE caused growth depression of poultry and levels from 3 - 7% CE caused death. Apart from tannins, other phenolic compounds or phytochemical compounds such as alkaloids, saponins and triterpenes could have played a role in depressing growth of birds (Zdunczy et al 1997). Feed efficiency decreased while mortality increased with increasing levels Java plum bean meal in the diet. This could be attributed to the presence of anti-nutritional factors such as alkaloids and tannins in Java plum beans and the effects of prolonged consumption of these anti-nutritional factors.

Conclusions

- Substitution of maize with boiled Java plum beans depressed the performance of broiler chicks.

- The boiling treatment is not an effective method to improve the nutritional value of Java plum beans in broiler chick diets. Maize remains a better energy source in broiler diets.

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