Effects of Banana Peels on Chicken Weight Gain and Egg Production in the Urban and Peri-Urban Areas of Aksum City, Ethiopia

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Abstract
High feed cost of running urban-animal-agriculture and huge city wastes are challenges of the growing towns in modern Ethiopia. Egg production microenterprise is steadily growing due to its low initial investment and ready market in urban and peri-urban areas. However, cost of egg production is high due to the rising cost of corn, the main feed ingredient in poultry rations. Using banana peels, which forms a great proportion of city waste in Ethiopia, is seen as a way of not only reducing the waste, but also as an alternative low-cost feed supplement that could help enhance egg production by small-holder farmers. This study looked at the effect of feeding banana-peels-powder on weight-gain, egg-production and profit from rearing improved poultry breeds. Banana peels were air-dried, ground and used to re-formulate existing feed rations. The control was the ready poultry ration formulated with 52% maize and 48% other ingredients. Then four rations were formulated with 13%, 26%, 39% and 52% banana peels. One hundred, 5-month old Bovans Brown chicken breed were clustered into 4 blocks based on weight categories. Five treatments were applied randomly to the blocks and replicated 5 times in a RCBD cage battery system. The chickens were fed with 120g/chicken/day while water was provided *ad libitum*. Chickens' weight and eggs produced were recorded every two weeks and daily respectively. Whereas weight gain and egg production declined with increase in proportion of banana peels, 25% replacement resulted in a comparable daily weight gain (26.42gm) to the standard chicken ration (26.76gm). Increase of banana peels resulted in reduction of weight gain at 17.78, 16.67 and 15.11gm/day and egg production at 0.58, 0.4 and 0.22/day/chicken for 50, 75 and 100% replacements respectively. We conclude that 25% banana peels powder in corn-based feed ration gives optimum weight gain and egg production in chickens.

Introduction
Banana has many common names (Espino *et al*., 1991) and belongs to the genus *Musa* spp. and is a popular fruit worldwide. Banana peels are the outer envelopes and by-product of household consumption and banana processing, which is widely available in populated areas, especially in the vicinity of processing plants. Banana peels contain 6-9% crude protein and 20-30% NDF on dry matter basis (Emaga et al. 2011). Green plantain (close relative of banana) peels contain 40% starch that is fully transformed into sugars after ripening, while banana peels contain much less starch (about 15%) when green and end up with 30% free sugars when ripe. Lignin content also increases with ripening (from 7 to 15% DM). Plantain peels contain less fibre than bananas (Emaga et al. 2011).

Banana peels are widely used by smallholders as complementary feeds for cattle and small ruminants in the tropics (Onwuka et al., 1997; Emaga et al. 2011). In a study done by FAS et al. (2015) in Nigeria, feeding broilers on diets containing 10% banana peels caused no adverse effect on performance. Moreover, Aregheore (1998) in his research in Nigeria reported that dry ripe plantain peels can replace up to 100% maize without adverse effects on growth and performance of goats, and were found to be an economical source of carbohydrates. Nambi-Kasozi et al. (2014) also reported that dairy cows fed with 40-60% banana peels in their daily ration in Uganda showed higher dry matter intake than 0-20% inclusion with no significant difference on daily weight gain and milk yield. According to Oyedeji (2015), highest weight gain per bird (1432g) and the best feed/gain ratio (2.58) were recorded among broilers fed 50% ripe banana peels

in an experiment conducted in Benin University, Nigeria. In addition, live weight and feed conversion efficiency have been found to significantly increase when chickens were fed on 10% banana peel meal. However, growth performance decreased when the inclusion rate exceeded 10% (Sabutan 1996).

Banana peels form a large proportion of household and therefore municipal wastes in towns in the Tigrai region. For instance, according to the Trade, Industry and Urban Development Office (Personal communication) out of the approximately 10 tons of garbage generated in Aksum Town daily, a significant amount is banana peels and more than 30% of garbage rots uncollected on pavements, streets, sewerage outlets and water channels due to the high costs of collection and disposal. On the other hand, scarcity and high cost of animal feed lowers profit margins of small and microenterprises in the region. However, despite the availability of banana peels, empirical evidence is scarce on its potential as complementary animal feed that would provide a low-cost alternative for the small holder farmers in Tigrai, especially those living in the urban and peri-urban areas. This study, therefore, aimed at determining the effect of different proportions of banana peels on feed intake, weight gain, egg production, as well as costs saved in a poultry enterprise.

Methods and Study Site

The study was conducted in Aksum University located in the Central zone of Tigrai, 784 kms north to Addis Ababa, Ethiopia's capital city. Banana peels were collected from Aksum town. Rations were formulated using different proportions of sundried banana peels powder mixed with a pre-formulated feed. Banana peels were sundried, ground and mixed with wheat bran (8%), middling (8%), meat and bone meal (8%), molasses (2%), protein sources (15%), minerals (8%) to form rations containing 0%, 13%, 26%, 39% and 52% banana peel powder (Table 1).

Experimental design

A total of 100 Bovans brown chickens of 5 months of age were used for the experiment. The birds were classified into four blocks based on the weight category. Weight difference categories were established at 150, 225 and 305 gms among groups. The 4 classes were randomly allocated to the 5 treatments and replicated 5 times in a RCBD cage battery system.

Data collection

A feeding trial was conducted for a period of 45 days with an acclimatization period of 15 days before starting data collection. The experimental birds were weighed before and then after every two weeks for 6 weeks, while egg production was recorded daily. During the experiment, 120g of feed/day/chicken was provided at 9:00 AM in the morning and 5:00 PM in the evening, while water was provided *ad libitum.* Fresh water made available with individual waterers *ad lib* throughout the trial period. All necessary health care services were provided to the experimental chickens.

Comparative cost saving analysis

Cost savings were analyzed using the method by (FAS *et al.* 2015). Feed cost was obtained through summing the cost of ingredients of the total feed in diet composition. Whereas, the cost of the feed per weight gain (kg) was calculated by multiplying the cost with feed conversion ratio. The cost of feed per egg was calculated through dividing the total number of experimental days (45) by the total number of eggs obtained within the 45 experimental days multiplied by cost of daily feed intake. The feed cost savings was calculated by subtracting supplementation by banana peels (final costs calculated from cost incurred to collect banana peels) from costs without supplementation by banana peels (initial costs) multiplied by 100 as follows:

$$Feed\ cost\ savings = (Initial\ cost - Final\ cost) * 100$$

The initial cost was also computed by multiplying cost of feed per kg by the amount (g) of daily feed intake as follows:

$$Cost\ of\ daily\ feed\ intake\ (per\ bird) = Cost\ of\ feed/Kg * Quantity\ of\ daily\ feed\ intake$$

SAS (2008) JMP release 8 Statistical package was used to analyze the data. Analysis of variance was used to determine if there were significant differences in weight gain and egg production between the treatments. The means in weight gain and egg production were separated using LSD.

Table 1: Ingredients and proportions (%) of the experimental diets

No.	Ingredient	Proportions of each ingredient (%) along the five diets				
		Diet 1 (Control)	Diet 2	Diet 3	Diet 4	Diet 5
1	Noug cake	6	6	6	6	6
2	Corn	52	39	26	13	0
3	Ground banana peels Ratio	0	13	26	39	52
4	Wheat bran	8	8	8	8	8
5	Wheat Middling	8	8	8	8	8
6	Limestone	8	8	8	8	8
7	Fishmeal	2	2	2	2	2
8	Molasses	2	2	2	2	2
9	Salt	0.2	0.2	0.2	0.2	0.2
10	Lysine	0.08	0.08	0.08	0.08	0.08
11	Methionine	0.028	0.028	0.028	0.028	0.028
12	Meat and bone meal	8	8	8	8	8
13	Layer premix	0.6	0.6	0.6	0.6	0.6
14	Soya bean	5	5	5	5	5
15	Choline Chloride	0.025	0.025	0.025	0.025	0.025

Source: Authors' feed ration formulation

Results

Weight gain

The average weight gain and egg production of the layers decreased as the proportion of banana peels in the chickens' diet increased (Table 2). The mean weight gain of birds fed on the ration without banana peels powder (1204 gm) was the highest, whereas, the feed ration with 100% banana peels (680 gm) had the lowest weight gain.

Table 2: Mean weight gain and egg production of layers by treatment

Variable	Treatment					
	T1	T2	T3	T4	T5	SE
Weight gain (g)	1204^{b}	1189^{b}	800^{a}	750^{a}	680^{a}	±50.6
Egg production (No)	36^{c}	32^{c}	26^{b}	18^{a}	10^{a}	±2.2

[a] Row treatment means with different superscript are significantly different ($P<0.05$)

Replacement of maize by banana peels up to a proportion of 25% did not affect the net weight gain significantly. Previous study conducted by Widjastuti and Hernawan (2012) in Indonesia indicated that replacement of maize with 20% of banana peels does not affect the net weight of broilers. The diets in which replacement of corn with 50, 75 and 100% banana peels powder was made showed significant net weight difference against T1 and T2. However, T3, T4 and T5 didn't show statistically significant difference.

Egg production

Replacement of maize by banana peels exceeding 75% significantly reduced egg production (Table 2), whereas replacing 25% of maize by banana peels did not cause any significant change in egg production. In addition, replacing maize by 50% banana peels resulted in a slight decline in egg production.

Comparative cost analysis of feed ingredients

The analysis of feed cost per kg indicated that T1 was most expensive (Birr 10.6) of the four rations (Table 3). The cost of formulating T2, T3, T4 and T5 were Birr 9.98, 9.74, 8.87 and 7.78 per Kg ration, respectively. These results show that the cost of chicken feed decreased with the increase of proportion of banana peels in the ration. The decrease in feed cost was associated with replacement of cheap source of feed stuff (banana peels) instead of the alternative and comparatively expensive feed ingredient (corn) in the balanced poultry ration. Similar results have been reported from experiments conducted on broilers by (FAS et al. 2015) in Indonesia. The cost of feed intake per chicken was significantly higher ($p<0.05$) for T1 (Birr 1.45) than all other treatments.

The results show that T5 had the highest (Birr 34.12) cost of feed per body weight gain, while the lowest cost was incurred for T1 (Birr 29.45) and T2 (Birr 29.33). The high cost incurred per body weight gain for T4 and T5 might be associated with low feed conversion ratio as proportion of banana peels in the chickens' diet increased.

Table 3: Cost savings benefit analysis of banana peel replaced poultry diet (Birr)

Parameter	T1	T2	T3	T4	T5	SD
Cost of feed/kg of diet (Birr)	10.6^{a}	9.98^{b}	9.74^{ab}	8.87^{ab}	7.78^{c}	±0.689
Cost of feed intake per chicken (Birr)	1.45^{a}	1.26^{a}	1.19^{b}	1.13^{b}	0.99^{c}	±0.443
Cost of feed/kg weight gain (Birr)	29.45^{a}	29.33^{a}	30.12^{b}	32.12^{ab}	34.12^{c}	±1.208
Cost of feed/egg (Birr)	1.812^{a}	1.77^{a}	2.05^{b}	2.825^{ab}	4.45^{c}	±1.117
Feed cost savings (%)	-	5.84^{c}	8.11^{c}	16.32^{b}	26.6^{a}	±0.089

Means within same row with different superscripts differ significantly ($P < 0.05$)

This result is in agreement with the findings of FAS et al. (2015) who reported that feed efficiency ratio decreased as the level of peel meal inclusion increased from 0%, 10%, 20% and 30% in broilers diet in Nigeria. Similarly, the analysis of feed cost per egg production revealed that the highest cost incurred per single egg produced was observed in T5 (Birr 4.45). The expense incurred per egg for T4, T3, T2, were Birr 2.825, Birr 2.05, Birr 1.77 and Birr 1.87, respectively. The low cost for T2 could be linked to the low cost incurred for the feed without any significant decrease in egg laying observed for feed ration with 25% replacement of corn by banana peels. Similarly, the low cost of feed/kg weight gain for T2 may be associated with low feed cost incurred as a result of 25% replacement of banana peels with maize in the balanced ration without any significant impact in body weight gain as compared to control group. The analysis made on feed cost saving revealed that T5 had the highest (Birr 26.6) feed cost saving compared to Birr16.32, Birr 8.11, Birr 5.84 for T4, T3 and T2 respectively. This is attributed to the low cost of banana peels with the only requirement of labor cost for collection, drying, grinding and packaging as compared to maize in the balanced feed of poultry ration formulation.

Discussion [Conclusions/Implications]

The results show that whereas weight gain and egg production declined with increase in proportion of banana peels powder in the diet of chickens, the feed ration with 13% banana peel (25% corn replacement) did not adversely affect weight gain, egg production, incurred lower cost per kg of weight gain and per egg produced. The cost savings were found to be highest for the 100% replacement of corn with banana peels due to low cost of feed. On the other hand replacement of corn by over 75% banana peels adversely affected egg laying ability of birds and showed high cost per weight gain and per egg produced. We conclude that banana peels powder can replace up to 25% of corn in chicken diet without causing adverse effects on their performance. Inclusion beyond 13% of the whole ration of chicken is not recommended.

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