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Effect of Feeding Sun Dried Banana Pseudostem as a Partial Replacement of Dietary Maize on Performance and Production Economics of Crossbred Grower Pigs

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ABSTRACT

Background: The usage of banana waste pseudostems has drawn more attention in recent years. Additionally, it is said that these banana waste components are rich in vitamins and minerals, notably dietary fibre. The objective of this study was to investigate the effect of substituting dietary maize with sun dried banana pseudostem (BP) in their feed on performances of crossbred grower pigs.

Methods: The current study was carried out between 2020-2021 on forty eight (48) Hampshire crossbred grower pigs, that were randomly divided and allotted to 4 compounded dietary treatments by replacing dietary maize with sun dried BP by 0% (T_0), 10% (T_1), 20% (T_2) and 30% (T_3) in their ration. By modifying the amounts of maize with BP, all compounded diets were rendered isonitrogenous and isocaloric.

Result: Results indicated significant ($p<0.05$) improvement in the total body weight gain and average daily gain (ADG) in both male and female crossbred pigs fed ration T_2 in comparison to the other groups. The performances of the both female and male pigs were significantly ($p<0.05$) lower when dietary levels of BP were increased up to 30% (T_3). The feed cost/kg live weight gain in group T_2 was significantly ($p<0.05$) lower than the control group in both the sexes. In conclusion, crossbred grower pigs can tolerate up to 20% dietary substitution of maize with BP in the ration without compromising their growth, blood biochemical parameters, reproductive performances and carcass quality. Incorporation of 20% sun dried BP resulted in lowered feed cost.

Key words: Banana pseudostem (BP), Carcass traits, Crossbred pigs, Production economics, Reproductive performance.

INTRODUCTION

Pigs are a valuable asset for smallholders in the subsistence agriculture system because they provide revenue that can be used to meet household financial requirements. The primary constraints to efficient pig production include a lack of feed supplies, both quantitatively and qualitatively, as well as the high cost of feed components. The use of non-conventional feed resources in livestock diets with appropriate and full feed technology that can utilize the feed sources with optimum efficiency might be a potential and perhaps the most practical option for sustenance of pig production. The stem of the banana plant, which is also called pseudostem produces a single bunch of bananas before dying and is replaced by a new pseudostem (Anhwange *et al*., 2009). Due to the fact that, each plant only produces one bunch of bananas, this crop creates a lot of waste. As a result, in recent years, the use of banana waste pseudostems has received increased attention. Furthermore, these banana waste components are said to be high in vitamins and nutrients, particularly dietary fibre (Mydhili *et al*., 2022). However, very little is known about the pseudostems composition. The conversion of discarded BPs into products might have a considerable environmental and economic advantage. However, this immense potential, has gone mostly untapped. As a result, there is a strong and pressing need to conduct a comprehensive investigation in this area. This would widen the possibilities of inclusion of BP in the conventional ration in pig feeding systems. In this regard, the present study was conducted with an objective to evaluate the effect of dietary substitution of maize with sun dried BP on performance and production economics of growing crossbred piglets.

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MATERIALS AND METHODS

The present study was reviewed and approved by the Institutional Animal Ethics Committee (IAEC) of ICAR RC for NEH Region, Umiam, India.

The experiment was carried out between 2020-2021 in the Livestock Farm, ICAR Research Complex for NEH

Region, Umiam, Meghalaya. A total of forty eight (48) Hampshire crossbred grower piglets (24 females and 24 males) with 75% inheritance, aged two months old, average body weight 10.65±0.12 and 10.58±0.37kg, respectively were selected and randomly divided into four groups. The pigs were allotted to 4 compounded dietary treatments by replacing dietary maize with sun dried BP powder by 0% (T_0), 10% (T_1), 20% (T_2) and 30% (T_3) in their ration. The BP was cut into small pieces, sundried and grounded prior to incorporation in the compounded ration. The feeding trial was carried for 210 days. The pigs were fed 3.5% of their average live body weight with *ad lib* water throughout the study period *i.e.* up to 9th month of their age.

Proximate analysis and gross energy (GE) of sundried BP was determined according to the Association of Official Analytical Chemists Procedures (AOAC, 1995). All rations were made isonitrogenous and isocaloric by adjusting the levels of BP against maize per NRC (1998), recommendation. All analyses were performed in duplicate for 12 samples and were presented on % DM basis.

The body weight at the beginning and completion of the feeding trial was measured at 60 and 270 days, respectively. The average daily weight gain (ADG) (g/day) during the trial period was calculated by dividing the body weight gain by the number of days in that time. The female crossbred pigs were then artificially inseminated with liquid sperm from the farm's superior boars and the reproductive performances, including age at puberty (days), age at first mating (days), age at first farrowing (days) and subsequent litter size at birth (Nos.), were recorded. Male growth performances were monitored at the same intervals as females. At the end of the trial, three representative male pigs from each treatment group were chosen at random and slaughtered for carcass quality measurement *viz*., weight at slaughter (kg), carcass weight (kg), carcass length (cm), dressing percentage (%) and back fat thickness (BFT, cm). For economic analysis parameters such as average feed intake (g/day), feed conversion ratio (FCR), feed cost/kg ration (`) and feed cost/kg live weight gain (`) in both sexes were assessed.

Blood sample was collected aseptically from the anterior vena cava using 10 ml syringe at the onset of the feeding trial and once in every fortnightly interval and serum samples were separated for estimation of different biochemical parameters namely total proteins (g/100 ml), glucose (mg/100 ml), cholesterol (mg/100 ml), urea (mg/100 ml) and creatinine (mg/100 ml) using commercially available kits (Bioline Diagnostics, Delhi, India).

Experimental data were expressed as Mean±SE and analysed using Analysis of variance (ANOVA) followed by post-hoc comparison test, employing Statistical package for social sciences programme version 26 (IBM SPSS). Tukey's test was used to compare the means of the treatment with probability of 5% ($p<0.05$).

RESULTS AND DISCUSSION

Proximate and nutrient composition of sun dried banana pseudostem

The result on the chemical composition of sundried BP (n=12) is shown in Table 1. The proximate principles (% DM basis) *i.e.* dry matter (DM), crude protein (CP), crude fibre (CF), ether extract (EE), total ash (TA) and nitrogen free extract (NFE) were 7.45±0.78, 5.09±0.63, 28.90±2.46, 3.50±0.61, 15.40±1.26 and 45.46±2.28, respectively. The GE (kcal/kg) content was 3284±4.16. The estimated CP (%) of the grower pig ration in the treatments replacing 0, 10, 20 and 30% BP were 17.96, 17.88, 17.78 and 17.80 respectively. The Metabolisable Energy (ME) (kcal/kg) in the above mentioned treatment groups was 3288, 3370, 3316 and 3188 as depicted in Table 2.

The CP (%) and CF (%) content in sun dried BP is comparable to the reports of Sokchea *et al*. (2018) who reported a CP (%) and CF (%) content of 6.42 and 32.64 in fresh BP. In contrast, the CP value in the current study is much lower than the values reported by Viswanathan *et al*. (1989). Reasons for this inconsistency are unclear. However, several differences existed between the two studies. Firstly, the forages were grown in two different locations and stage of maturity, fertilization and environmental conditions might also be reasons for change of CP. The reported DM (%) values were in close association with the reports of Wang *et al*. (2016) and Sokchea *et al*. (2018) who reported it to be 7.02 and 9.77, respectively. The EE (%) are inconsistent with the reported values of Wang *et al*. (2016). Such differences might due to the harvest time, because the relative proportion of the cell wall components of a plant rises with increased maturity, as the comparative proportion of the cell contents declines.

Growth and reproductive performances in female grower pigs

The results of the effect of feeding sun dried BP (0-30% DM basis) replacing maize on growth and reproductive performances of female crossbred pigs are presented in Table 3. Results indicated that, there was significant ($p<0.05$) improvement in the final body weight gain, ADG and

Table 1: Chemical composition of sun dried banana pseudostem (on % DM basis).

Parameters	Banana pseudostem (n=12)[1]
Dry matter (DM)	7.45±.0.78
Crude protein (CP)	5.09±0.63
Crude fibre (CF)	28.90±2.46
Ether extract (EE)	3.50±0.61
Total ash (TA)	15.40±1.26
Nitrogen free extracts (NFE)	45.46±2.28
Gross energy (kcal/kg)	3284±4.16

[1]n= Number of observation.

Table 2: Ingredient and nutrient composition of grower pig ration (% on DM basis).

Ingredient composition (%)	T_0 (Control)	T_1 (10% replacement)	T_2 (20% replacement)	T_3 (30% replacement)
Maize	55.00	45.00	35.00	25.00
Banana psedeostem (BP)	0.00	10.00	20.00	30.00
Wheat bran	19.00	16.00	14.00	12.00
Ground nut cake	13.50	16.50	18.50	20.50
Soybean meal	10.00	10.00	10.00	10.00
Mineral mixture	2.00	2.00	2.00	2.00
Salt	0.50	0.50	0.50	0.50
	100	100	100	100
Calculated				
CP (%)	18.15	18.02	18.08	18.14
CF (%)	18.22	17.97	18.13	24.21
ME (kcal/kg	3209	3217	3074	2988
Estimated				
CP (%)	17.96	17.88	17.78	17.80
CF (%)	18.01	16.80	17.70	22.15
ME (kcal/kg)	3288	3370	3316	3188

All rations were prepared considering protein-energy requirement as per BIS standard.

Table 3: Performance of crossbred grower female pigs fed with ration replacing maize with sun dried banana pseudostem at different levels.

Parameters	T_0 (Control)	T_1 (10% replacement)	T_2 (20% replacement)	T_3 (30% replacement)
Growth performances				
Initial body weight (kg)	10.53±0.58	10.63±0.56	10.68±0.47	10.57±0.60
Final body weight (kg)	76.43^{a}±0.22	75.83^{a}±0.59	78.78^{b}±0.42	64.00^{c}±0.47
Total body weight gain (kg)	65.90^{a}±0.38	65.20^{a}±0.63	68.15^{b}±0.53	53.43^{c}±0.30
ADG (g/d)	310^{a}±1.30	310^{a}±3.05	320^{b}±2.70	250.00^{c}±2.11
Reproductive performances				
Age at puberty (days)	257.17^{a}±2.46	261.50^{ac}±1.09	237.00^{b}±3.92	264.17^{c}±1.58
Age at first mating (days)	278.67^{a}±2.50	282.83^{a}±1.00	258.33^{b}±4.00	285.33^{a}±1.50
Age at first farrowing (days)	393.00^{a}±2.60	397.33^{a}±1.10	372.50^{b}±3.90	399.83^{a}±1.50
Litter size at birth (No.)	8.00±0.60	7.67±0.40	8.33±0.40	7.67±0.40

^{a,b,c}Means for different groups in the same row having different superscript differ significantly (P<0.05).

Table 4: Performance of crossbred grower male pigs fed with ration replacing maize with sun dried banana pseudostem at different levels.

Parameters	T_0 (Control)	T_1 (10% replacement)	T_2 (20% replacement)	T_3 (30% replacement)
Growth performance				
Initial body weight (kg)[1]	10.32±0.19	10.48±0.30	10.50±0.32	10.57±0.32
Final body weight (kg)[2]	82.33^{a}±0.56	83.07^{a}±0.73	86.93^{b}±0.59	68.13^{c}±0.54
Total body weight gain (kg)	72.02^{a}±0.73	72.58^{a}±0.67	76.43^{b}±0.86	57.57^{c}±0.74
ADG (g/d)[3]	312^{a}±1.38	316^{a}±2.16	328^{b}±2.48	242^{c}±3.02
Carcass traits				
Weight at slaughter (kg)	$83.00±0.58^{ab}$	$83.07±0.35^{b}$	$85.97±0.42^{a}$	$69.13±0.41^{c}$
Carcass weight (kg)	55.32±0.36	55.93±0.93	56.16±0.26	45.17±0.36
Carcass length (cm)	80.00±1.15	79.80±0.58	82.33±1.15	79.00±0.68
Dressing percentage (%)	66.67±0.88	65.33±0.33	67.33±1.20	65.30±0.34
BFT (cm)[4]	$2.66±0.05^{c}$	$2.53±0.06^{ac}$	$2.48±0.05^{a}$	$2.42±0.07^{b}$

^{a,b,c} Means for different groups in the same row having different superscript differ significantly (P<0.05).

reproductive performance of crossbred female pigs in T_2 in comparison to the other groups. The performances of the female pigs were significantly ($p<0.05$) lower when dietary levels of sundried BP were increased up to 30% (T_3) in place of maize in the ration. The animals fed ration T_2 attained early puberty than the animals fed T_1 and T_3.

Optimal growth performance was recorded in female crossbred pigs with 20% BP replacement against maize. Final body weight, total body weight gain and ADG showed a positive response to inclusion of BP in the diet with the optimal level of 20%. These responses are in close proximation with the reports of Tien *et al*. (2013) who observed significant improvement in live weight gain when banana stem taro silage replaced rice bran up to 30-40% level in the diet of ducks. Pigs lack fiber-degrading enzymes, which are required to digest complex carbohydrates found in fibrous diets such as rice bran and banana stems (Swain *et al*., 2014). However, some fibre is advantageous at an ideal rate of 7-10%; otherwise, the passage of nutrients through the digestive tract is too rapid, resulting in more faecal nutrient loss and less absorption (Kass *et al*., 1980). Higher fiber in the diet may reduce palatability, thereby reducing ADG and increasing FCR (Ngoc *et al*., 2013). Our results indicated that, the inclusion level at 20% had higher ADG and lower FCR. Furthermore, it is more economical to feed female crossbred pigs to a ration up to 20% BP without hampering the reproductive performances. This means that, up to 20% of BP can be fed to growing/ finishing pigs without any adverse effects on growth performance and FCR. Our reports are consistent with other works performed by Dhema *et al*. (2022) and Theit *et al*. (2022) in growing finishing pigs, that reported a gradual decrease in both ADG and FCR when incorporation level of BP increases in the ration. Substituting maize on an equal weight basis with banana stem might result in overestimation of energy value of banana meal with negative effects on growth performance. Thus, the major part of digestible amino acids was provided by soybean meal. Accordingly, it can be hypothesized that the linear decline in growth performance found in the literature with increasing amount of BP might also be attributed to a dietary amino acid deficit. It may be argued that the 30% BP diet was less appealing when compared to the other three diets. Solà-Oriol *et al*. (2009) suggested that feed characteristics such as texture, taste or odor may be responsible for the change in feed preference in pigs.

Table 5: Production economics of crossbred grower pigs fed ration replacing dietary maize with sun dried banana pseudostem at different levels.

Parameters	Male				Female			
	T_0 (Control)	T_1 (10%replacement)	T_2 (20%replacement)	T_3 (30% replacement)	T_0 (Control)	T_1 (10% replacement)	T_2 (20%replacement)	T_3 (30% replacement)
Average feed intake (g/d)	1210.40±51.40	1129.80±45.32	1244.60±51.60	1199.82±45.22	1280.20±51.70	1112.78±45.11	1180.70±50.90	1210.86±45.38
FCR[1]	3.87[a]±0.04	3.64[a]±0.04	3.93[a]±0.03	3.87[a]±0.04	3.91[a]±0.03	3.48[b]±0.03	4.88[b]±0.06	4.84[d]±0.04
Feed cost/kg ration (`)	30.26	30.26	29.31	29.31	29.85	29.85	28.78	28.78
Cost of production on feed basis (FCR × cost of feed/kg `)	117.10	110.14	115.18	113.42	116.71	103.87	140.44	139.29

[a,b,c] Means for different groups in the same row having different superscript differ significantly ($P<0.05$).

Growth and carcass quality in male grower pigs

The results of the effect of feeding sun dried BP (0-30% DM basis) in place of maize on growth and carcass characteristics of male crossbred pigs are presented in Table 4. Results indicated that, there was significant ($p<0.05$) improvement in the final body weight gain and ADG of male crossbred pigs fed ration T_2 in comparison to the other groups. The performances of the crossbred pigs were significantly ($p<0.05$) lower when dietary levels of BP were increased up to 30 % (T_3) against maize in the ration.

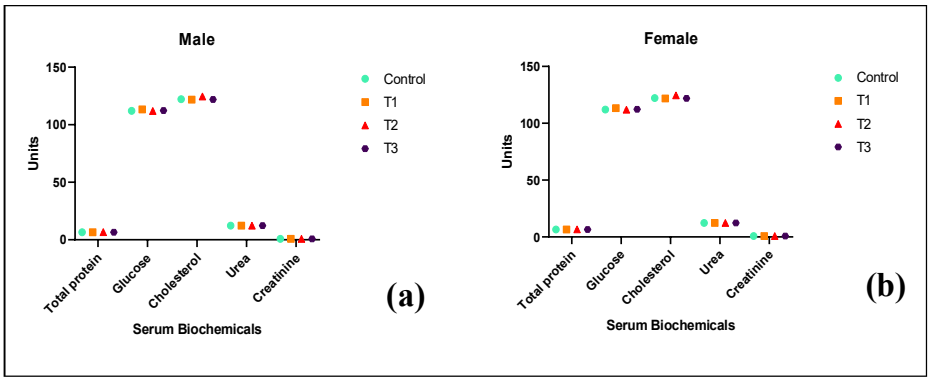

Fig 1: Serum biochemicals of grower pigs fed sun dried banana pseudostem at different levels in the treatment groups (1a- Male; 1b- Female).

The growth performances in males were optimal with 20% BP (T_2) incorporation in the ration. Results were similar with that of female crossbred pigs. There were no significant differences ($p>0.05$) in all the carcass parameters studied except the fat parameters such as BFT. This showed that pigs used a large portion of their meal calories to build muscular tissue rather than fat. The BFT was inversely proportional to the levels of BP in the ration. Huy *et al*. (2021) reported that, there was no correlation between the inclusion level of fermented banana stem and the carcass quality, which was in contrast to previous research which reported that increasing fibrous dietary co products reduced carcass weight as per Jha *et al*. (2013).

Production economics

The production economics in terms of average feed intake (g/day), FCR, feed cost/kg ration (`) and cost of production on feed basis (`) has been depicted in Table 5.

The feed cost/kg live weight gain increased with increased incorporation of BP (lowest in T_2) in the conventional ration for feeding crossbred pigs in both sexes. Furthermore, the inclusion of BP at 20% (T_2) also resulted in lower feed cost/kg ration (`) and FCR than control, T_1 and T_3. In similarity, Amaefule *et al*. (2006) and Rijal *et al*. (2009) reported a reduction of feed cost when up to 20% and 35% brewers spent grain (BSG) substitution was used for crossbred weaner pigs without any adverse effect on performance respectively.

Serum metabolite profile

The serum metabolite profile for both female and male crossbred pigs were non-significant ($p>0.05$) during the sampling period, irrespective of different dietary treatments and were within the physiological range of pigs (Fig 1 a and b).

Serum metabolites particularly total proteins, glucose, urea and creatinine are good indicators of the state of health of body tissues and organs. The non-significant ($p>0.05$) difference in the concentration of serum metabolites of experimental animals may be as a result of adequacy of dietary protein and energy offered by BP which probably limits tissue protein degradation and a consequent rise in serum urea and creatinine levels.

CONCLUSION

Crossbred grower pigs can tolerate up to 20% dietary substitution of maize with BP without compromising their growth, blood biochemical parameters, reproductive performances and carcass quality.

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Conflict of interest

We certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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