Bhutan Journal of Animal Science (BJAS)
Volume 6, Issue 1, Page 22-27, March 2022

COMPARATIVE PERFORMANCE OF WEANER PIGS FED COMMERCIAL FEED AND *AZOLLA PINNATA* AS FEED SUBSTITUTE

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ABSTRACT: This study compared the growth performance and cost-benefit analysis (CBA) of weaner piglets fed 100% commercial feed versus 30% *Azolla pinnata* substitution. A total of 54 weaners were randomly assigned to two groups; A and B, in five batches. The average age of the weaners for both the groups were 35 days at the onset of feeding trial. The animals remained under the trial for 25 days, until they attained the age of 60 days. Weaners in group A were fed with 100% commercial feed while those in group B had 30% of their daily feed replaced by *Azolla pinnata.* Budhi Maya Gurung (*BMG)* commercial feed was used for the study. Weaners were fed at 5% of their body weight. The weaning weight was considered as an initial weight for all animals. Thereafter each weaner was weighed at an interval of five days using 20-kg capacity *SRK Analog* weighing scale. The piglets were weighed before feeding in the morning, and each weaner was weighed five times during the entire trial period. The final mean weights were 10.09 ± 1.79 kg for group A and 9.16 ± 1.40 kg for group B, and the mean difference was significant (p = 0.004). The average daily gain (ADG) was 0.11 ± 0.43 kg and 0.08 ± 0.03 kg, at (p=.000) and feed conversion ratio (FCR) was 1.0 and 1.82, respectively, for group A and group B, during the 25 days trial period. We conclude, feeding 100 % commercial feed is superior to substituting 30% with *Azolla pinnata* in our study. Moreover, the cost benefit analysis showed higher net return from piglets fed completely on commercial feeds than 30% *Azolla pinnata* substitution. The less net return from animals fed partly with *Azolla pinnata* was due to higher initial investment incurred for *Azolla pinnata* cultivation. Therefore, in the long run, the feeding *of Azolla pinnata* may be considered as protein supplement but not to replace commercial feed completely as this could lead to insufficient energy provision in the feed. The recurrent cost of maintaining the *Azolla pinnata* unit would be much lesser in the succeeding years.

Keywords: Average daily gain; *Azolla pinnata*; commercial feed; cost-benefit-analysis; feed conversion ratio; weaning and final weight

1. INTRODUCTION

Azolla is a branched free-floating aquatic fern that rapidly grows on the surface of the water. There are 21 species of genus *Azolla* worldwide; of which seven species namely *Azolla anabaena, Azolla caroliniana, Azolla cristata, Azolla feliculoides, Azolla mexicana, Azolla microphylla* and *Azolla pinnata* that are popular. In particular, there are four varieties of fresh Azolla namely; duckweed fern, fairy moss, mosquito fern and water fern. Azolla cultivation is popular in countries like China, Vietnam, and the Philippines. The *Azolla pinnata* is a common species in India. Azolla is ideal sustainable feed for cattle, fish, pig and poultry, and it can also be used as bio-fertilizer in the farm (Azolla Cultivation Guide 2018). *Azolla* cultivation requires less investments and it is therefore a low-cost alternative for good feed. It fixes nitrogen and serves as an excellent source of nitrogen which can be used as green manure. Azolla is found to be effective as bio-fertilizer, weed control and mosquito control apart from nutritive value (Azolla Cultivation Guide 2018). Azolla can be used as an ideal source of feed for cattle, sheep, goats, pigs, rabbits and fish as an

alternate source to a concentrate feed and fodder. Azolla can be fed to animals without any adverse effects (Saini et al. 2018). Azolla can fix nitrogen in the soil and improve soil fertility. Besides, it is used as a protein source for feeding animals in some countries.

In Bhutan, the *Azolla pinnata* is currently under trial at Agriculture Research and Development Centre (ARDC), Bajo and being explored as green fertilizer for crops. Although, studies were conducted on the use of Azolla as animal feed in other countries, it is new in Bhutan. It is reported that, Azolla is most promising because of the ease of cultivation, high productivity and good nutritive value (Katole et al. 2017).

With ever increasing feed cost in the country, it would be wise to investigate the use of alternative cheaper feed resources for pig farmers. Promising results are reported in the literature on feeding livestock with *Azolla.* Majority of the Bhutanese pig farmers are resource poor and cannot afford to feed their pigs solely with concentrate feeds. Nearly 70% of the total investment is incurred on feed and feeding alone. As the growing of Azolla requires less investment, it would be a good alternative feed resource for pigs in Bhutan. The Azolla seed is available in Bhutan. Accordingly, this study is conducted with the objectives to assess the effect of feeding *Azolla pinnata* as feed supplement and to evaluate cost-benefit analysis on performance of weaner pigs on body weight gain.

2. MATERIALS AND METHODS

2.1 Study site

The feeding trial on *Azolla pinnata* was conducted at National Piggery Research and Development Centre (NPiRDC) in Gelephu. The area falls under the wet sub-tropical agro-ecological zone. It has an average temperature of 26.63°C and average humidity of 62.27%.

2.2 Pond preparation and Azolla cultivation

Pond preparation and *Azolla pinnata* cultivation was carried out in the farm campus. Five ponds, each with dimension of 2mx 1m with depth of 25cm were constructed with bricks and plastic sheets (Jamiah et al. 2017). The ponds were constructed near the weaner shed under a shaded area to protect from direct sunlight. Bricks were laid as outer wall to support the plastic sheets. The sieved soil of 5-10kg, slurry made of 1kg pig manure, 20gm Single Super Phosphate (SSP) dissolved in 5 litres of water were added to each pond. The water level in each pond was maintained at 10cm depth at all times. After the pond preparation, mother culture of *Azolla pinnata* were sown at the rate of 0.5 kg in each pond. The matured *Azolla pinnata* was harvested every 10-14 days from different ponds for animal feeding.

2.3 Sampling and experimental design

A simple random sampling was adopted for the study (Turner 2020). The weaner sheds were used as research sheds for this study. All weaners were notched for individual identification on the day of weaning. The routine farm activities like iron injection, vaccination and clinical treatment were carried out as usual. Weaner piglets were randomly assigned to group A (control) and group B (treatment) through a simple lucky draw of individual identification number. Due to inadequate weaner piglets at the farm, weaners were assigned batch wise to each group. In each group, a total of 50 weaner piglets were assigned for the trial. Animals under group A were fed solely the commercial feed (concentrate) manufactured by BMG Feed Company. Animals under group B were fed 70% commercial feed from BMG feed company and 30% fresh *Azolla pinnata.* The 30% of Azolla was calculated considering 4.7 % dry matter content on fresh matter basis as reported (Anitha 2016). Animals under the trial were fed at 5% of their body weight for the entire trial period. On an average, the weaner piglets were 35 days of age when they were weaned and sampled for the study. The weaning weight was considered as an initial weight for each trial animals. Thereafter, each animal was weighed five times, five days apart until the piglets attained 60 days of age. The weaning piglets were subjected to treatments (**at 35 days**) irrespective of gender. The normal farm routines such as iron injection, classical swine fever (CSF) vaccine, foot and mouth disease (FMD) vaccine and other clinical treatments on these trial animals were carried out as usual based on the schedule. Information such as diarrhoea, morbidity and

mortality were maintained as secondary data and treatments were provided as usual for any clinical cases.

2.4 Data collection and Data analysis

A data recording format was developed in excel sheets to compile weight measurements records and feed consumptions. The compiled data was analysed with Statistical Package for Social Sciences (SPSS) version 23.0. The Independent Sample t-test was applied to assess the difference in body weight gain between the two groups. Relevant information was generated and reported in the form of graphs, figures and tables using Microsoft excel.

3. RESULTS AND DISCUSSION

3.1 Growth performance

There was no significant weight difference in initial mean body weight of animals in group A and B (Table 1). The final mean body weight was significantly (p<0.05) higher in group A (commercial feeds) than group B (fed 30% fresh *Azolla pinnata* and 70% commercial feeds). The result was in contrast with the findings of Kumar et al. (2014) and Saini et al. (2018) wherein increase of 10-15% in milk production, 8-10 % in meat by weight and 10-15 % in egg laying capacity were reported. Bocian et al. (2017) achieved a higher growth rate and faster slaughter weights in pigs when fed with complete mixture of cereal pellets and concentrate. However, the growth rate can depend largely on feed intake and feed waste (Chae 2000).

Table 1: Mean body weight of piglets at different measurement time points

Body weight measurement time point	Group		*p*-value
	Group A	Group B	
Initial weight (Kg)	7.22±1.19	7.31±1.01	0.676
Measurement 1 (Kg)	7.49±1.19	7.53±1.08	0.853
Measurement 2 (Kg)	8.11±1.30	7.88±1.10	0.335
Measurement 3 (Kg)	8.74±1.47	8.25±1.16	0.062
Measurement 4 (Kg)	9.4±1.65	8.74±1.24	0.023
Final measurement (Kg)	10.09±1.79	9.16±1.40	0.004

3.2 Feed Conversion Ratio (FCR) and Average Daily Gain (ADG)

The present study showed FCR of 1kg and 1.82 kg with average daily gain (ADG) of 0.11 kg and 0.08 kg for piglets fed only the commercial feeds and in combination of *Azolla pinnata* and commercial feeds, respectively, which is highly significant (p=.000). In contrast, average daily gain of crossbred pigs fed (5 months) with commercial feed and mixture of 70% commercial with 30% Azolla were 0.359 and 0.382 (Saini et al. 2018). It was also in line with the findings of Carter et al. (2017) which reported commercial diets was higher than that of pigs fed with the forage-based and silage based diets. Average daily gain were higher in animals fed with crude protein content of 16.13% in feed (Kumar et al. 2014).

3.3 Cost benefit analysis

The details of cost involved for each trial group was as shown in the Table 2. The overall expenditure was slightly higher for group B (fed with 30% *Azolla pinnata* and 70% commercial feeds) when compared to group A (fed solely commercial feed) primarily due to the initial investment costs incurred in *Azolla pinnata* cultivation.

Similar findings were reported by Cherryl et al. (2014). A higher net return was obtained from the animals fed solely commercial feeds compared to animals fed with 30% *Azolla pinnata* and 70% commercial feeds. The higher net return from piglets in group A was due to greater growth rates resulted from feeding solely the commercial feeds to the animals. However, in the long run, the feeding *of 30% Azolla pinnata* as commercial feed substitute is expected to save the recurrent cost incurred on purchase of commercial feeds. In this study, piglets were reared under the trial only for 25 days due to inadequate research sheds to hold the large number of growers at the farm. In addition, due to increased demand for piglets from the Big-Ticket Initiatives (BTI) clients and Cottage and Small Industries (CSI) loan proponents, the piglets were supplied to the pig farmers to meet the demand. The present study is supported by Saini et al. (2018) who recommended feeding *Azolla*

pinnata to the growing crossbred pigs considering its positive effect on overall growth performance.

Table 2: Cost-benefit-analysis for group A and B

Parameters	Group	
	Group A	Group B
1. Feed cost		
i. Starter feed	18880	16166
ii. Fresh Azolla	0	3115
2. Labour cost	3343	3343
A. Total Expense	**22223**	**22623**
Total Live weights (in Kg)	545	495
Average final live weights (in Kg)	10.09	9.16
Revenue estimates value (in Nu.)	98100	89100
B. Return	**98100**	**89100**
Cost per piglet rearing during the trial period (25 days)	412	419
Cost per kilogram meat production	41	46
Net income in Nu. (B - A)	**75877**	**66477**

3.4 Clinical cases and mortality during the trial period

Despite taking care during the trial, a few piglets in both the groups suffered from Arthritis and Bowel oedema. During the entire research period, a total of 5 piglets died from sudden death without clear clinical signs leading to reduction in sample size and loss of the corresponding data on those animals.

4. CONCLUSIONS & RECOMMENDATION

The present study indicated that supplementing concentrate feed with 30 % fresh Azolla feed do not contribute substantially in the overall growth performance of weaner pigs when compared to feeding full concentrate BMG feed. Moreover, the net return from weaner pigs fed with concentrate feed was higher when compared to the pigs fed with fresh Azolla feed. This is because of the fact that Azolla production had higher initial investments considering labour and materials required for ponds construction. In general, since the trial duration was too short and assignment of animals to treatment groups were in batches, the findings from the current study cannot be generalized for wider application in the field. In view of this, the following conclusions are deduced from the current study;

- There is a need to conduct in-depth study in feeding fresh Azolla in weaner pigs for one complete cycle of production (fattening period) to fully exploit its potential as protein supplement in the feed
- The level of incorporation of fresh Azolla as feed supplement in weaner pigs has to be properly determined as 30 % supplementation in the current study needs further validation
- In the future study, the assignment of animals must be in one lot prior to feeding trial and not in batchwise to reduce experimental error and increase the precision of result
- Feeding fresh Azolla as alternative protein feed supplement may give better returns in the subsequent years in piggery farming as initial investment and other costs can be minimized

Ethical issues & limitations

Ethical approval was obtained from the Livestock Research Committee (LRC) of Bhutan prior to the commencement of this study. Accordingly, issues related to animal welfare were taken care during the entire study period. Considering its invasive nature utmost care was taken while cultivating *Azolla pinnata* to not let this plant species into the natural river and ecosystem.

Acknowledgements

The authors are thankful to Mrs. Tangka Maya Pulami (Sr. Research Officer), ARDC, Bajo, Mr. Tashi Phuntsho (Sr. LPS), NNPBC, Yoeselpang, Mr. Tashi Jamtsho (Sr. LPO), NPRDC, Sarpang, Mr. Doku Tshering, Farm Manager, National Piggery Research and Development Centre (NPiRDC), and Mr. Pema Thinley, Sr. LPO, National Research Development Centre for Aquaculture (NRDCA), Gelephu, whose invaluable assistances made this study possible.

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