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RESEARCH ARTICLE
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Effect of inclusion of *Azolla pinnata* on the haematological and carcass characteristics of crossbred large white yorkshire pigs

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Abstract

Aim: To study the haematological and carcass parameters of pigs fed with Azolla based rations.

Materials and Methods: An experiment was done for 120 days using 18 crossbred Large White Yorkshire pigs fed with diets containing Azolla as protein replacement at 0, 10 and 20 percent, respectively. The mean haematological parameters of the three experimental groups were studied before start of an experiment, and during the grower phase and finisher phase. Two pigs from each group were slaughtered after 120 days of experimental feeding to study the carcass parameters.

Results: Haematological parameters like PCV, Hb, RBC, WBC, MCV, MCH, MCHC were studied and found that there were no significant ($P > 0.05$) differences between means of the three groups except for MCV and MCH during growing phase. There was no significant difference among the pigs fed different rations for the various carcass characteristics. A higher dressing percentage was observed in T3 pigs (83.45 percent) followed by T2 pigs (81.37 percent) and T1 pigs (81.18 percent). It was noticed that there was a significant difference ($P < 0.05$) between the means of fat percentage and it was observed that fat percentage was higher in T1 (2.11) followed by T2 (2.04) and T3 (1.27).

Conclusion: Sun dried Azolla inclusion upto 20 percent in the diets did not appear to affect the haematological and carcass parameters of pigs. Further it was observed that, inclusion of Azolla in the diets of swine helped to obtain higher dressing percentage and pork with less fat percentage when compared to that of pigs fed with conventional concentrates.

Keywords: azolla, carcass traits, crossbred, haematological parameters, Large White Yorkshire, pig diets.

Introduction

The increased trend towards urbanization and improved purchasing power has a prodigious effect on the people's food habits and making them opt for nutritionally rich foods, such as animal source foods [1]. This trend is creating a huge demand for foods of animal origin among the quality conscious middle income group of India. Meat and meat products not only provide nutrients but also ensures food security [2]. Pork is comparatively cheap source of animal protein of high biological value. The other animal source foods such as goat, beef and chicken alone cannot meet the protein requirements of the growing population. The fast growing pig may be one of the best choices to meet the nutritional demands of increasing human population. Maintaining and increasing the demand for pork mainly depends on the quality of the product which is largely affected by the feed that is fed to meat animals.

Pigs are fed with conventional cereal grains and hence, there is a need to explore alternate nutritive feed resources which are locally available. Water fern Azolla appears to be a potential source of nutrients and has a considerably high feeding value as it contains almost all essential amino acids and minerals such as iron, calcium, magnesium, potassium, phosphorus, manganese and also appreciable quantities of vitamin A precursor beta carotene and vitamin B_{12} [3, 4]. It is also found to contain probiotics and biopolymers [5]. In an experiment it was concluded that the PCV, RBC, Hb and WBC values were similar and within the normal range for the growing pullets fed with 0, 5, 10 and 15 percent Azolla meal based diets [6]. In a study on lambs it was reported that the average values of dressing percentage in lambs on live basis were 50.40, 59.63 and 58.51 in 0, 10 and 20 percent azolla incorporated diet fed groups, respectively and stated that incorporation of Azolla in weaner lambs ration had no adverse effects in carcass traits [7].

But very little information is available about the use of dried Azolla in pig diets. Hence, this study was planned to determine the effect of incorporation of dried Azolla as a protein replacer on the haematological and carcass characteristics of crossbred Large White Yorkshire pigs.

Materials and Methods

Ethical approval: The experiment was performed after the permission of Institutional Animal Ethics Committee.

Animals: A feeding trial was carried out by utilizing 18 crossbred Large White Yorkshire (LWY) pigs for a period of 120 days (60 days grower period + next 60 days finisher period) at the Department of Livestock

Figure-1. Splitting of carcass after evisceration

Figure-2. Carcass length (first rib to aitch bone)

Production Management, N.T.R College of Veterinary Science, Gannavaram. The pigs were randomly divided into three experimental groups (T1, T2 and T3) with six pigs in each group such that the group average weights were uniform.

Three grower rations G1 (conventional), G2 and G3 (test rations) and similarly three finisher rations F1 (conventional), F2 and F3 (test rations) were prepared and fed to animals. Sun dried Azolla was incorporated as a protein replacement at 10 percent in G2 (900 grams (g) of conventional concentrate ration + 76.5 g of dried Azolla), F2 (900 g of conventional concentrate ration + 68.3 g of dried Azolla) and 20 percent levels in G3 (800 g of conventional concentrate ration + 153 g of dried Azolla), F3 (800 g of conventional concentrate ration + 136.6 g of dried Azolla). The rations were fortified with vitamin and mineral supplements. Feed was offered *ad libitum*. The concentrate ration and the required quantity of Azolla to be fed were weighed by using the electronic weighing balance with 150.00 kg capacity (Make: Settra, Accuracy: 0.01g) and were mixed thoroughly before offering to each group.

Haematological studies were carried out by collecting blood from experimental animals at the beginning of an experiment, at the end of grower phase and finally after the finisher phase as per the standard collection procedure [8] as approved by advisory committee and Sri Venkateswara Veterinary University. Pigs were restrained properly on the floor and about 3 ml of blood was collected aseptically from each pig through ear vein by using 6 ml syringe with 22 gauge sterile needle and was done during early morning hours. The blood was immediately transferred into vacutainer containing EDTA as anticoagulant at 5.4 mg (1.8 mg per ml). After collection, the samples were transferred for analysis. Analysis was done by using auto analyzer PE-6800, Procan Electronics Inc., China. Haematalogical parameters like Packed cell volume (PCV), Haemoglobin (Hb), Red blood cell (RBC), White blood cell (WBC), Mean corpuscular haemoglobin (MCH), Mean corpuscular haemoglobin concentration (MCHC) and Mean corpuscular volume (MCV) were studied.

After the study completion at 120 days, two pigs from each group were identified for carcass trait analysis and shifted to the Department of Livestock Production Technology (LPT). Identified pigs were fasted for 24 hours then slaughtered as per the standard slaughter procedure of USDA [9] for carcass analysis at the Department of LPT. After evisceration, the carcasses were cleaned thoroughly with running tap water and the water was allowed to drain by hanging the carcasses. The eviscerated carcass was split longitudinally (Fig.1) through the vertebrae midline and hot carcass (including feet and head) weight was recorded. Carcass length (Fig.2) was measured from the forward edge of the first rib to the forward edge of the aitch bone using measuring tape. The back fat depth was recorded at the tenth rib which was used to obtain estimated average back fat thickness. The dressing percentage was calculated from hot carcass with intact head and feet on. Loin eye area at the tenth rib was traced on transparent sheet. The traced area was measured on a graph paper and expressed in square centimeters. Weights of edible and inedible offals were recorded and quantity of meat, bone and fat was weighed to estimate the percentage.

Statistical analysis: The data were analyzed by using standard statistical procedure [10], two-way ANOVA to arrive at the conclusions.

Results

Haematological parameters at the initial stage: The mean haematological parameters of the three experimental groups were studied initially before the start of an experiment and are presented in Table-1. MCV and MCH values were found to be higher than the reference values in all the three animal groups while MCHC, PCV, RBC, WBC values were within the normal range.

Haematological parameters of growers and finishers: The mean haematological parameters of the three grower groups and finisher groups are shown in Table- 2 and 3, respectively. PCV, Hb, RBC, WBC values in pigs fed with G1, G2 and G3 rations showed no

Table-1. Mean haematological parameters of pigs before the start of experiment

Blood parameters	Standard Values**	T1	T2	T3
PCV (%)	32.0-50.0	34.83 ± 1.68	32.67 ± 1.50	30.83 ± 0.95
HB (g/dl)	10.0-16.0	11.10 ± 0.48	10.55 ± 0.49	10.00 ± 0.30
RBC (10^6/ul)	5.0-8.0	3.97 ± 0.17	3.75 ± 0.18	3.60 ± 0.11
MCV (fl)	50.0-56.0	87.68 ± 1.50	87.10 ± 0.31	85.60 ± 0.31
MCHC (g/dl)	25.0-36.0	31.88 ± 0.44	32.25 ± 0.06	32.40 ± 0.04
MCH (pg)	16.0-19.0	27.93 ± 0.09	28.10 ± 0.09	27.80 ± 0.11
WBC (10^3/ul)	11.0-22.0	21.67 ± 0.99	33.17 ± 9.46	35.50 ± 9.29

** Essentials of Veterinary Haematology by Jain N C 1993.

Table-2. Mean haematological parameters of pigs fed with Azolla based diets during grower phase

Blood parameters	Standard Values**	Azolla levels (%) in experimental diets		
		G1 (0%)	G2 (10%)	G3 (20%)
PCV (%)	32.0-50.0	34.50 ± 1.91	32.67 ± 1.33	30.83 ± 0.65
HB (g/dl)	10.0-16.0	11.15 ± 0.62	10.55 ± 0.44	9.98 ± 0.21
RBC (10^6/ul)	5.0-8.0	3.98 ± 0.22	3.78 ± 0.14	3.45 ± 0.08
MCV (fl)*	50.0-56.0	86.55 ± 0.46^{ab}	86.27 ± 0.39^{a}	89.35 ± 0.41^{c}
MCHC (g/dl)	25.0-36.0	32.28 ± 0.04	32.25 ± 0.04	32.35 ± 0.05
MCH (pg)*	16.0-19.0	27.97 ± 0.18^{ab}	27.82 ± 0.15^{a}	28.88 ± 0.15^{c}
WBC (10^3/ul)	11.0-22.0	22.00 ± 0.68	31.67 ± 6.88	34.5 ± 9.63

** Essentials of Veterinary Haematology by Jain N C 1993, Means with different superscripts differ significantly (P < 0.05)

Table-3. Mean haematological parameters of pigs fed with Azolla based diets during finisher phase

Blood parameters	Standard Values**	Azolla levels (%) in experimental diets		
		F1 (0%)	F2 (10%)	F3 (20%)
PCV (%)	32.0-50.0	34.67 ± 1.80	32.5 ± 1.43	31.0 ± 0.73
HB (g/dl)	10.0-16.0	11.22 ± 0.58	10.5 ± 0.47	10.05 ± 0.24
RBC (10^6/ul)	5.0-8.0	4.0 ± 0.21	3.73 ± 0.17	3.53 ± 0.09
MCV (fl)	50.0-56.0	86.62 ± 0.41	87.05 ± 0.29	87.72 ± 0.83
MCHC (g/dl)	25.0-36.0	32.33 ± 0.02	32.26 ± 0.06	32.38 ± 0.04
MCH (pg)	16.0-19.0	28.03 ± 0.12	28.1 ± 0.09	28.42 ± 0.25
WBC (10^3/ul)	11.0-22.0	21.83 ± 0.70	33.17 ± 9.47	34.33 ± 9.57

** Essentials of Veterinary Haematology by Jain N C 1993.

significant difference between the means. PCV and Hb values of F1, F2 and F3 rations fed groups also showed no significant differences between means of the three groups (P > 0.05). Mean and SE of RBC count of F1, F2 and F3 were 4.0 ± 0.21 X 10^6 per µl, 3.73 ± 0.17 X 10^6 per µl and 3.53 ± 0.09 X 10^6 per µl and found to be lower than the normal values but the differences between the means were non-significant (P > 0.05). It was seen that the WBC count in pigs fed with F1, F2 and F3 rations showed no significant difference between the means.

Carcass characteristics: Two pigs from each group were slaughtered after 120 days of experimental feeding as mentioned earlier. There was no significant difference among the pigs fed with different rations for the various carcass characteristics such as carcass weight, dressing percentage and carcass length. Though the differences were non-significant, the carcass weight of pigs from T1, T2 and T3 groups were 50.75, 53.5 and 55.5 kilogram (kg), respectively. A higher dressing percentage was noticed in T3 pigs (83.45 percent) followed by T2 pigs (81.37 percent) and T1 pigs (81.18 percent). The carcass length was more in pigs from group T3 (73.5 cm), followed by T2 (71.5 cm) and T1 (69.5 cm).

Loin eye area was found to be higher in T3 with 33.76 square centimeter (cm^2) followed by T1 with 30.5 cm^2 and then T2 with 28.25 cm^2 but with no significant difference between the means (P > 0.05). The mean back fat thickness of pigs from T1, T2 and T3 groups was 2.00, 1.94 and 1.88 centimeter (cm), respectively with no significant differences between means. It was noticed that there was a significant difference between the means of fat percentage and observed that fat percentage was higher in T1 (2.11) followed by T2 (2.04) and T3 (1.27). The percentage of meat and bone was 82.07 and 15.18 in T1, 82.20 and 15.00 in T2 and 81.81 and 15.81 in T3 with no significant difference between the means.

The weight of edible offal in T1, T2 and T3 was 2.79, 2.53 and 2.04 kg respectively. It was observed that inedible offal weighed 9.88, 9.81 and 10.32 in T1, T2 and T3 respectively. But the differences observed between the means were non-significant.

Discussion

Haematological parameters: Blood represents an important index of physiological, pathological and nutritional status of the organism. The haematological values recorded at different intervals i.e, at the beginning, during and at the end of an experiment for all the treatment groups are presented in Table-1, Table- 2 and Table-3 respectively.

The values obtained at three different stages of the experiment viz., initial, during and final were more

Table-4. Carcass traits of crossbred pigs under different feeding regimes

Parameters	Azolla levels (%) in experimental diets		
	T1 (10%)	T2 (10%)	T3 (20%)
Carcass weight (kg)	50.75 ± 2.25	53.5 ± 0.50	55.5 ± 1.50
Dressing percentage (%)	81.18 ± 0.35	81.37 ± 0.17	83.45 ± 1.63
Carcass length (cm)	69.5 ± 0.50	71.50 ± 0.50	73.50 ± 0.50
Back fat thickness (cm)	2.00 ± 0.03	1.94 ± 0.03	1.88 ± 0.03
Loin eye area (cm^2)	30.5 ± 0.50	28.25 ± 0.75	33.76 ±0.76
Total edible offal (kg)	2.79 ± 0.44	2.53 ± 0.06	2.04 ± 0.01
Total inedible offal (kg)	9.88 ± 0.07	9.81 ± 0.18	10.32 ± 0.41

or less nearer to the reference values mentioned by Jain [11]. Moreover, there was no significant ($P > 0.05$) difference between the PCV, Hb, RBC, WBC and MCHC mean values. Similar observations were reported by Alalade *et al.* [6] where layer birds fed with ration containing 0, 5, 10 and 15 percent Azolla meal showed no significant difference between the mean values of PCV, Hb, RBC and WBC. Further, in the present study it was observed that the MCV and MCH means showed significant difference among the three groups during grower phase only. The haematological values obtained in the present study were in close agreement with the haematological values of grower pigs fed on low and high fiber diet obtained by Alu *et al.* [12]. It could be concluded that the crude fiber intake had no effect on the haematological parameters in pigs.

The analysis of initial and final haematological values further confirmed that the blood values were similar in all the three groups with no significant difference between the means. Thus, it could be concluded that inclusion of Azolla in pig diets had no influence on the haematological parameters of crossbred Large White Yorkshire pigs.

Carcass characteristics: It could be concluded from the present experiment that there was no significant difference among the means of various traits such as carcass weight, dressing percentage, carcass length, back fat thickness, loin eye area, total edible offals, total inedible offals, meat and bone percentage of the pigs fed with three different rations (Table-4). Thus, carcass parameters of pigs were not affected by different dietary treatments (0, 10 and 20 percent Azolla). These observations were similar to that observed by Duran [13] in pigs, Becerra *et al.* [14] in ducks and Dhumal *et al.* [15] in broiler birds.

In the present study it was found that a significant difference ($P < 0.05$) was observed between mean fat percentage in pigs fed with control ration and in pigs fed with test rations. The mean fat percentage in control group pigs was higher than the test ration pigs. To substantiate this observation further studies are required as no literature was available to compare the results. This study results indicate that dried Azolla could be used as a protein replacement source upto the level of 20 percent without affecting the carcass parameters of pigs.

Conclusion and Recommendation

Inclusion of sun dried Azolla upto 20 percent in the pig diets did not appear to affect the haematological and carcass parameters of pigs. Further it was observed that, inclusion of Azolla in the diets of swine helped to obtain higher dressing percentage and pork with less fat percentage, compared to that of pigs fed with conventional concentrates. It is inferred that the incorporation of sun dried Azolla had beneficial effects on the carcass characteristics of crossbred Large White Yorkshire pigs.

Authors' contributions

CDM carried out the experiment, analysis and also initiated the preparation of manuscript, RMVP provided valuable scientific suggestions, guidance to carry out the research and corrected the manuscript, SJR participated in scientific discussion and provided support during the conduct of experiment, PJ guided to carry out the statistical analysis and also contributed in writing the manuscript and BER provided permission and guided to study the carcass parameters during the slaughter of pigs in Department of LPT. All authors read and approved the final manuscript.

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Competing interests

The authors declare that they have no competing interests.

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