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Effect of *Moringa oleifera* Leaf Meal Feeding on Haematological and Carcass Characteristics in Crossbred Pigs

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ABSTRACT

The present study was conducted to evaluate the effect of *Moringa oleifera* leaf meal (MOLM) supplementation on haematological parameters and carcass characteristics in crossbred pigs. Twenty-four crossbred pigs (75% Large White Yorkshire × 25% *Desi*) with an average initial body weight of 20 kg were randomly allotted to four dietary treatments with six animals in each treatment. All the experimental diets were iso-nitrogenous and iso-caloric containing *moringa* leaf meal at 0% (T1), 5% (T2), 7.5% (T3) and 10% (T4) in the rations and were offered for a period of five months until to reach approximate body weight of 80 kg. Blood samples collected at the end of the grower phase were analyzed for haematological indices. While, slaughter of animals was conducted at approximate body weight of 80 kg to study carcass characteristics. Results indicated that inclusion of MOLM in crossbred pig diets had no significant ($P>0.05$) effect on haematological parameters and all the values were within normal physiological ranges. Carcass traits such as pre-slaughter weight, dressing percentage, carcass length, loin-eye area, total meat weight, bone weight, and meat-to-bone ratio did not differ significantly ($P>0.05$) among the treatments. However, back fat thickness decreased and liver weight decreased linearly ($P<0.05$ and $P<0.01$ respectively) with increasing levels of MOLM, indicating reduced fat deposition and hypocholesterolemic effects. These findings suggest that *Moringa oleifera* leaf meal can be safely incorporated up to 10% in the rations of crossbred pigs without adverse effects on blood profile and carcass yield, while contributing to leaner pork production.

HIGHLIGHTS

- *Moringa* leaf meal can be included upto 10% level in diet of pigs
- *Moringa* feeding results in lean meat production in pigs.

Keywords: Crossbred pigs, back fat thickness, wholesale cuts, liver weightand lean meat

Swine farming plays a vital role in livelihood for rural and tribal households in India, particularly among smallholders and economically weaker groups. As per the 20th livestock census (2019), the swine population in India is 9.06 millions, with 90.29% reared in rural areas (Roy *et al.,* 2025). Despite its socio-economic importance, the sector has witnessed a decline in growth rate by 12.03% due to high feed costs, diseases, and poor infrastructure facilities. Since feed accounts for 70-75% of total production costs, identifying affordable, nutrient-rich and sustainable feed sources is essential for improving profitability and productivity in pig farming.

In recent years, considerable attention has been directed

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towards the use of non-conventional, plant-based feed additives with functional benefits and support the production of value-added meat. Among the different possibilities, *Moringa oleifera* has gained interest for its rich nutritional profile and therapeutic potential (Ashfaq *et al.,* 2012). India is one of the leading producers of *Moringa oleifera*, yielding 2.2-2.4 million tonnes of fruits annually from 43,600 hector (Sekhar *et al.,* 2017). Post harvest moringa leaves, of tentreated as agricultural waste, which are highly nutritious, containing 27.5 % protein, 19.2% crude fiber and significant levels of calcium, iron and vitamins A, B and C (Oduro *et al.,* 2008; Murro *et al.,* 2003).

Additionally, moringa leaves also rich in bioactive compounds such as flavonoids and saponins, which support bone health, possess antimicrobial and anticancer properties and contribute to cholesterol reduction (Gomes *et al.,* 2020; Bidura *et al.,* 2017). Owing to these functional properties, moringa leaves are widely used as dietary supplements in humans after processing which increases its cost. Therefore, direct inclusion of moringa leaves in livestock rations offers a cost-effective and sustainable alternative. Nevertheless, the presence of antinutritional factors like saponins and tannins may pose health risks and available literature on use of *Moringa oleifera* leaves in swine diets is limited. Hence, the present study was designed to evaluate the effect of feeding *Moringa oleifera* leaf meal on haematological parameters and carcass characteristics in crossbred pigs, with the aim of assessing its potential as a functional feed ingredient in swine nutrition.

MATERIALS AND METHODS

Experimental design and animals

The experiment was conducted at AICRP on pigs, SVVU, Tirupati, with prior approval from the institutional animal ethics committee. A total of 24 crossbred pigs (75% LWY × 25% Desi) with an average initial body weight of 20 kg were randomly allotted to four dietary treatments in a completely randomized design with sex pigs per each treatment. The experimental diets were iso-nitrogenous and iso-caloric consists of control diet without moringa leaf meal (T_1) and diets containing 5% (T_2), 7.5% (T_3) and 10% (T_4) *Moringa oleifera* leaf meal. The experiment was conducted for a period of 5 months to reach the approximate body weight of 80 kg.

Feeding and management

The animals were housed in individual pens under hygienic conditions. All the animals had free access to ad libitum clean drinking water through the day and fresh feed was offered twice a day at 9:00 AM and 3:00 PM. The experimental rations were prepared using locally procured ingredients as per NRC (2012) recommendations. The proximate analysis of the rations was analyzed as per AOAC (2019) standards. The ingredient and nutrient composition of experimental rations is presented in Table 1.

Table 1: Major feed ingredient and nutrient composition of experimental rations fed to crossbred pigs

Ingredients	T1	T2	T3	T4
Maize	63.0	61.5	61.0	59.8
Soybean meal	16.3	14.8	14.3	13.4
DORB	14.0	12.3	11	10.8
Moringa oleifera leaf meal	0	5.0	7.5	10.0
Vegetable oil	3.5	3.5	3.5	3.5
Lysine	0.4	0.35	0.35	0.32
Calcite	0.7	0.4	0.2	0.03
Di calcium phosphate	1.4	1.45	1.45	1.45
Salt	0.5	0.5	0.5	0.5
Trace min mix	0.2	0.2	0.2	0.2
Nutrient composition (as fed basis)				
Crude Protein	14.10	13.98	13.92	13.86
Calcium	0.57	0.68	0.65	0.63
Phosphorus	0.54	0.52	0.51	0.54
Lysine (%) *	0.99	0.97	0.98	0.97
Methionine (%) *	0.29	0.29	0.30	0.30
ME (cal/g)*	3290	3284	3292	3281

Each value is mean of three observations.

*Calculated values.

Haematological analysis

At the end of grower phase, blood samples were collected from the ear vein using sterile syringes into EDTA-coated vials and were analyzed for haematological parameters

such as red blood cell (RBC), haemoglobin (Hb), mean corpuscular volume (MCV), hematocrit (HCT), white blood cell (WBC), neutrophils, lymphocytes and platelets using an automated haematology analyzer (Mindray BC-2800 Vet).

Carcass traits

At the end of the finisher phase (approximately 80 kg body wt), three pigs from each treatment group were randomly selected and slaughtered for evaluation of carcass traits. Pre-slaughter weight of each pig was recorded prior to slaughter, and pigs were stunned, exsanguinated and allowed to bleed on the rail for 5-6 minutes. The carcasses were scalded in hot water at 60-65 °C to facilitate dehairing, followed by evisceration as per the procedure of Ziegler (1968).The internal organs such as intestines, stomach, liver, heart, lungs, bladder and spleen were removed and weighed individually. Dressing percentage was calculated as: Dressing percentage (%) = (Dressed weight / Pre slaughter weight) × 100. Carcass length was measured from the first rib to the aitch bone. Back fat thickness was measured at three anatomical points-first rib, last rib, and last lumbar vertebrae. The loin eye area was measured between 10^{th} and 11^{th} ribs on the cross-section of the *longissimus dorsi* muscle using a transparent grid and planimeter. Wholesale cuts(ham, loin, belly and shoulder) were separated and weighed to evaluate cutting yield and carcass distribution.

Statistical analysis

Data were analysed by one-way ANOVA using SPSS (Version 21.0) and treatment means were compared using Duncan's multiple range test at a 5% significance level.

RESULTS AND DISCUSSION

Nutrient composition of *Moringa oleifera* leaf meal

The nutrient composition (%) of moringa leaf meal revealed that moisture, organic matter, crude protein, ether extract, crude fibre, total ash, acid insoluble ash, calcium and phosphorus contents are 9.72, 79.68, 17.10, 6.51, 10.47, 10.60, 1.97, 1.90 and 0.21, respectively. The gross energy value was 3457 cal/g and total phenolic content found to be 29.15 mg TAE/g. All the experimental rations formulated are iso-caloric and iso-nitrogenous having approximately 14 % crude protein and 3300 kcal ME/kg as per NRC (2012) recommendations. The nutrient composition observed in this study is comparable with earlier reports of Oduro *et al.* (2008) and Moyo *et al.* (2011), who reported similar proximate values for moringa leaves. The relatively high protein, mineral, and energy content of MOLM indicates its potential as a nutritionally valuable ingredient in swine diets.

Haematological parameters

Haematological parameters of crossbred pigs fed different levels of MOLM are presented in Table 2 indicated that inclusion of moringa leaves in diets had no significant ($P > 0.05$) effect on red blood cell count (RBC), haemoglobin (Hb), mean corpuscular volume (MCV), haematocrit (HCT), white blood cell count (WBC), neutrophils, lymphocytes and platelets.

Table 2: Effect of dietary treatments on haematological parameters in crossbred pigs

Parameters	Treatment groups				P-Value
	T_1	T_2	T_3	T_4	
RBC ($\times 10^6$/µl)	5.01 ± 0.22	5.24 ± 0.28	5.53 ± 0.13	5.30 ± 0.16	0.410
Hb (g/dl)	14.80 ± 0.44	14.83 ± 0.50	16.00 ± 0.73	15.58 ± 0.41	0.345
MCV (fl)	62.10 ± 1.78	62.55 ± 0.85	59.85 ± 1.66	62.33 ± 0.81	0.488
HCT (%)	30.95 ± 0.94	31.13 ± 1.00	33.10 ± 1.60	32.93 ± 0.70	0.402
WBC ($\times 10^3$/µl)	13.10 ± 0.82	14.20 ± 0.78	13.34 ± 0.99	13.25 ± 0.66	0.716
Neutrophils (%)	32.43 ± 0.71	33.73 ± 2.44	31.33 ± 2.02	34.63 ± 1.51	0.596
Lymphocytes (%)	62.40 ± 0.65	60.93 ± 1.98	62.53 ± 2.21	59.20 ± 1.74	0.521
Platelets ($\times 10^3$/µl)	314.50 ± 85.83	217.50 ± 78.10	175.50 ± 35.83	283.00 ± 55.07	0.475

Each value is mean of six observations.

The present findings are in agreement with that of Lakshmi *et al.* (2020) and Ketpanyapong and Marupanthorn (2023), who also reported no significant difference in

haematological indices of pigs fed with moringa leaves in their diets. In contrast, Serem *et al.* (2017a) observed significantly higher RBC, Hb and WBC counts in pigs fed with diets containing moringa leaf meal. The haematological values recorded in the present study are within the normal physiological range reported by Sriraman (2009), suggesting that moringa leaves inclusion up to 10% had no deleterious effect on blood profile or physical health of animals.

Carcass characteristics

The carcass characteristics of pigs fed different levels of moringa leaf meal is presented in Table 3. The inclusion of moringa leaf meal hand no significant (P > 0.05) effect on pre-slaughter weight, dressing percentage, carcass length, loin-eye area, total meat weight, total bone weight and meat to bone ratio among dietary treatments. The observations are concurrent with findings of Cauich *et al.* (2022), Chen *et al.* (2021) and Oduro-Owusu *et al.* (2015), who also reported no significant difference in carcass traits among the pigs fed varying levels of moringa leaf meal. However, Gomes *et al.* (2020) observed a significant improvement in dressing percentage of pigs fed with 6% moringa leaf meal. Similarly, El-kashef (2022) and Karikari *et al.* (2024) also reported significantly ($p<0.05$) higher dressing percentage in rabbits supplemented with moringa leaf meal. The lack of significant variation in carcass parameters in the present study suggests that moringa leaf meal can be safely incorporated up to 10% in grower pig diets without adverse effects on carcass yield or composition.

Backfat thickness decreased linearly ($p<0.05$) with increasing levels of moringa leaf meal in diets. However, no significant difference was observed among the moringa fed groups. The decrease in the back fat thickness indicates reduced fat deposition in swine carcass suggesting a beneficial effect of moringa leaf meal for lean pork production. Similarly, linear decrease in back fat thickness was reported by Gomes *et al.* (2020) and Oduro-Owusu *et al.* (2015), while Mukumbo *et al.* (2014) found no differences by feeding moringa based diets. The variations among the studies could be due difference in level of moringa leaf meal inclusion, diet composition and processing methods. The reduced back fat thickness observed in study might be attributed to suppression of lipogenic gene expression and increased β-oxidation of fatty acids as influenced by bio active compounds and high PUFA in moringa leaves (Akib *et al.,* 2024; Cui *et al.,* 2018; Abu Hafsa *et al.,* 2020).

Table 3: Effect of dietary treatments on carcass characteristics of crossbred finisher pigs

Parameters	Treatment groups				P-Value
	T_1	T_2	T_3	T_4	
Pre-slaughter weight (kg)	79.50 ± 2.40	83.20 ± 2.25	82.03 ± 2.14	82.13 ± 1.57	0.662
Dressing percentage (%)	69.77 ± 0.67	71.05 ± 0.51	70.81 ± 1.19	70.52 ± 0.49	0.683
Carcass length (cm)	83.86 ± 0.80	85.36 ± 0.53	84.43 ± 0.56	83.53 ± 0.63	0.272
Back – fat thickness (cm)*	2.14 ± 0.01^{a}	2.00 ± 0.04^{ab}	1.93 ± 0.06^{b}	1.85 ± 0.06^{b}	0.020
Loin-eye area (cm^2)	30.91 ± 0.37	36.03 ± 2.03	32.71 ± 0.96	31.83 ± 1.12	0.091
Total meat weight (kg)	45.08 ± 2.06	48.46 ± 1.80	47.07 ± 0.08	46.34 ± 0.77	0.450
Total bone weight (kg)	10.42 ± 0.24	10.67 ± 0.36	10.96 ± 0.59	11.57 ± 0.71	0.470
Meat: Bone	4.32 ± 0.17	4.54 ± 0.21	4.32 ± 0.25	4.03 ± 0.24	0.499

Each value is mean of three observations.

^{ab} Values bearing different superscripts in a same row differ significantly *P < 0.05.

Wholesale cuts (table 4) revealed that jowl, boston butt, picnic shoulder, ham, loin and bacon did not differ significantly (P>0.05) among treatments.

Table 4: Effect of dietary treatments on wholesale cuts of crossbred pigs

Parameters	Treatment groups				P-Value
	T_1	T_2	T_3	T_4	
Jowl (kg)	1.42 ± 0.04	1.63 ± 0.08	1.50 ± 0.03	1.49 ± 0.03	0.095
Boston butt (kg)	7.49 ± 0.19	7.46 ± 0.25	7.27 ± 0.20	7.62 ± 0.34	0.823
Picnic shoulder (kg)	9.85 ± 0.35	10.31 ± 0.18	10.72 ± 0.26	10.51 ± 0.74	0.571
Ham (kg)	13.62 ± 0.73	14.94 ± 0.58	15.01 ± 0.23	14.91 ± 0.31	0.239

Loin (kg)	15.23 ± 0.64	16.37 ± 0.95	15.59 ± 0.43	15.36 ± 0.32	0.602
Bacon (kg)	7.89 ± 0.42	8.40 ± 0.46	7.92 ± 0.44	8.02 ± 0.06	0.783

Each value is mean of three observations.

These findings were agreement with that of Gomes *et al.* (2020) and Oduro-Owusu *et al.* (2015) who found similar results in pigs fed with moringa leaf meal. Likewise, Balarabe *et al.* (2021) also observed no variation in prime cuts of poultry fed with moringa leaf based diets.

Organ weights (table 5) *viz.,* head, lungs and trachea, heart, kidney, spleen, testicles and tail in different treatments did not differ significantly among the treatments. However, liver weight decreased significantly ($P < 0.01$) with increasing levels of moringa leaf meal in diet of pigs. Similar trends were reported by Akib *et al.* (2024) and Essien *et al.* (2022) in poultry; Serem *et al.* (2017b) and Oduro-Owusu *et al.* (2015) in pigs. Reduced liver weight of pig fed with moringa leaf meal-based diets may be related to hypo-cholesterolemic effect of moringa leaf meal, which limits hepatic fat accumulation (Oduro-Owusu *et al.,* 2015).

Table 5: Effect of dietary treatments on organ weights of crossbred pigs

Parameters	Treatment groups				P-Value
	T_1	T_2	T_3	T_4	
Head weight (kg)	5.70 ± 0.21	6.16 ± 0.28	6.38 ± 0.28	6.13 ± 0.40	0.486
Lungs and Trachea weight (kg)	0.84 ± 0.009	0.92 ± 0.009	0.84 ± 0.01	0.98 ± 0.08	0.159
Heart weight (kg)	0.37 ± 0.01	0.32 ± 0.03	0.30 ± 0.01	0.33 ± 0.004	0.233
Kidney weight (kg)	0.37 ± 0.02	0.30 ± 0.02	0.32 ± 0.009	0.33 ± 0.01	0.137
Liver weight (kg)**	1.61 ± 0.01^{a}	1.44 ± 0.008^{b}	1.35 ± 0.007^{c}	1.28 ± 0.02^{d}	<0.001
Spleen weight (kg)	0.12 ± 0.01	0.14 ± 0.009	0.13 ± 0.008	0.14 ± 0.005	0.835
Testicles weight (kg)	0.67 ± 0.008	0.62 ± 0.01	0.62 ± 0.03	0.66 ± 0.007	0.166
Tail weight (kg)	0.19 ± 0.008	0.21 ± 0.01	0.19 ± 0.01	0.20 ± 0.007	0.508

Each value is mean of three observations; ^{abcd}Values bearing different superscripts in a same row differ significantly ** $P < 0.01$.

CONCLUSION

Based on the results of the present study, inclusion of *Moringa oleifera* leaf meal upto 10% in the diets of crossbred pigs had no adverse effects on haematological profile and carcass characteristics. A significant decrease in back fat thickness in moringa leaf meal fed groups indicating reduced fat deposition and potential application in designer pork production. Therefore, *Moringa oleifera* leaf meal can be safely incorporated up to 10% in swine diets as a functional feed ingredient. Further studies are warranted to elucidate its detailed effects on meat quality attributes and lipid metabolism in swine

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