EFFECTS OF DIETARY INCLUSION OF *MORINGA OLEIFERA* LEAF MEAL ON FEED CONVERSION RATIO AND PHYSICO-CHEMICAL CHARACTERISTICS OF PORK FROM LARGE WHITE AND KOLBROEK PIGS

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Abstract

Effects of different levels of *Moringa oleifera* leaf meal (MOLM) on growth, carcass and meat quality were determined for 24 male pigs, i.e., 12 Large White (LW) and 12 Kolbroek (KB) aged six weeks. Four pigs from each breed were allocated to one of three dietary treatments containing 0% (T1), 2.5% (T2) and 5% (T3) MOLM. The MOLM inclusion resulted in lower FCR in LW pigs than in the KB. The inclusion of MOLM resulted in higher back fat thickness in KB, with no effect on the LW pigs. There were no significant differences in pH_{45} between KB and LW pigs on T2 and T3 diets. Significant differences were observed in the control diet (T1), with LW having a higher pH_{45} than KB. The pH_u, L*, b*, Chroma values were not influenced by both breed and diet. Increasing MOLM inclusion in feed to 5% significantly reduced the WBSF values of KB and LW pigs, with LW having lower values up to 2.5% MOLM inclusion. MOLM in pig diets had no adverse effects on the growth performance and appeared to be effective in improving pork quality with marked improvement in the LW breed.

I. INTRODUCTION

Genotype and nutrition influence pig growth performance and the ultimate quality of pork produced [5]. Hence, there is great interest in the variation between breeds for pork quality aspects. Large White (LW) pigs are exotic to South Africa, have high growth rates and are good converters of feed into pork [2]. Local breeds such as the Kolbroek (KB) appear to have substantially more fat than commercial pig breeds [9]. Pork from these pigs is a poorly accepted by consumers and for commercial use. Manipulating the nutrient composition of pig diets offsets the negative effects on pork quality. Natural products with antibiotic properties such as *Moringa oleifera* Lam. leaves are used to enhance growth performance and improve meat quality [6]. *Moringa oleifera* Lam. leaves are a potential resource for animal nutrition. Due to their vast nutritional significance, with high levels of crude protein, vitamin E, amino acids, minerals and fatty acids, including notably high levels of *n*-3(α-linoleic acid) [6], they have been shown to improve the quality and oxidative stability of meat [6][11]. This study aims to assess the effects of inclusion of graded levels of *Moringa oleifera* leaf meal (MOLM) on feed conversion efficiency and physico-chemical meat quality of LW and KB pigs.

II. MATERIALS AND METHODS

Ethical principles were considered in this study (Certificate Reference Number: MUC011 SNDU01). Twenty four male pigs (12 Large White, 12 Kolbroek) aged six weeks were used in the feeding trial. The pigs were allocated into 3 groups of 4 for each breed, and the groups were subdivided to make each pig an experimental unit. A conventional maize-soya bean meal feed was used as the control (T1) and treatments 2 and 3 consisted of feed formulated to include 2.5% and 5% MOLM, respectively. All the dietary treatments were formulated and equally balanced for starter and grower phases. The feed conversion ratio (FCR) of the pigs were recorded and computed as an indicator of growth performance. After the feeding trial, all the pigs were slaughtered. Back fat thickness and pH readings were taken 45 minutes (pH_{45}) and 24 hours (pH_u), *postmortem*. Meat samples taken from the *Muscularis Longissimus thoracis et. lumborum* (LTL) were analysed for colour (L*, a*, b*), and these values were used to calculate the chroma value and hue angle. The LTL samples were also used to measure the Warner Bratzler Shear Force (WBSF).

III. STATISTICAL ANALYSIS

Data for growth performance, carcass and meat quality traits were analysed using PROC GLM procedures of SAS (2003) and pair wise comparisons of LSMeans were done. The statistical model used for growth performance was $Y_{ijk} = \mu + \alpha_i + \beta_j + \gamma_k + \alpha\beta_{ij} + \alpha\gamma_{ik} + \beta\gamma_{jk} + \varepsilon_{ijkl}$; and the model used for carcass and meat quality traits was $Y_{ijk} = \mu + \alpha_i + \beta_j + \alpha\beta_{ij} + \varepsilon_{ijk}$

IV. RESULTS AND DISCUSSION

The 2.5% and 5% MOLM inclusion level resulted in lower FCR in the LW pigs than in the KB (Figure 1). The LW pigs had a lower, and therefore, a better FCR compared to the KB pigs. This implies that the KB pigs were less efficient in converting feed into body mass than the LW pigs and the inclusion of MOLM in the diet did not indicate better feed conversion efficiency in these KB pigs (FCR was low in 0% MOLM). This is in agreement with the observations made by [1], where the Basque pigs showed lower growth and higher feed conversion efficiency than LW pigs.

Significant differences ($p<0.05$) on the pH_{45} were observed among KB and LW pigs that received 0% MOLM, where KB pigs had a lower pH_{45} value (Table 1). In LW pigs, increasing the inclusion of MOLM in the diet reduced pH_{45}. The results of the current study do not agree with the findings of [8], who observed no significant differences for BFT and pH_{45}, in pigs that received 0%, 2.5%, 5% and 7% MOLM. The results of the current study showed that the pH_u, L*, b*, Chroma and Hue value measures were not significantly ($p>0.05$) influenced by breed. In terms of colour, there were no significant differences in the L* and b* values within breeds in this study. [4], however, found Chinese pig meat to be darker than that of foreign breeds. The KB pigs had a significantly ($p<0.05$) lower thawing and cooking loss compared to the LW pigs.

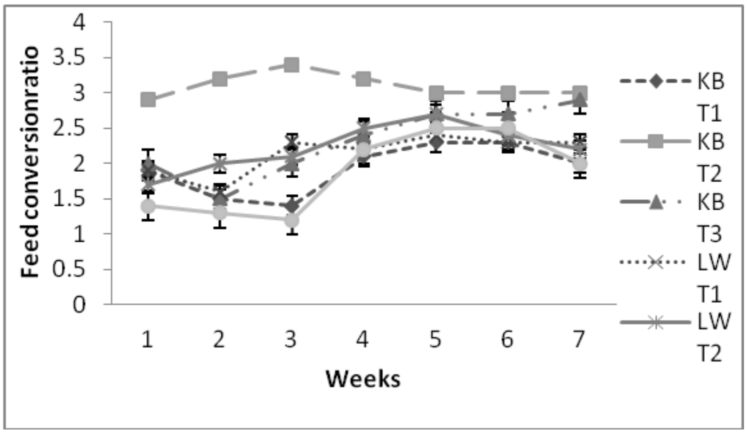

Figure 1 Feed conversion ratio of Kolbroek and Large White pigs receiving different levels of MOLM over a period of seven weeks

This is supported in a study by [14] where tenderness was affected by breed, being higher in Large White pigs than in indigenous Tamworth pigs. Animals exposed to pre-slaughter stress tend to have tougher and darker meat due to the depletion of glycogen in the muscle [7]. The way these animals react to stress depends on the genetic background and prior history of the animal [12]. Animals which are more excitable to stress are more expected to produce tougher meat [13]. In comparisons across treatments, there were significant differences in a*, hue (º) and WBSF values within KB and LW pigs across treatments. The 2.5% and 5% MOLM inclusion levels in the feed resulted in significantly ($p < 0.05$) higher a* and hue values than in the pigs that received 0% MOLM and those that received. The higher a* values of meat from pigs that were fed 2.5% and 5% MOLM could be attributed to the high levels of dietary iron in the MOLM used in this study. The results showed that the thawing loss of KB pigs that received 0% MOLM was significantly higher ($p < 0.05$) from KB pigs that received 2.5% and 5% MOLM. In terms of cooking loss, significant differences were observed in the LW pigs that received 0% and 2.5% MOLM and those that received 5% MOLM, where pigs that received 5% MOLM had a higher cooking loss. The WBSF values between KB pigs that were fed 0% and 2.5% MOLM were significantly higher ($p < 0.05$) than pigs fed 5% MOLM. Inclusion of MOLM in the pig feed resulted in decreased WBSF values, and thus increased tenderness. The LW pigs had WBSF values that were not significantly different ($p > 0.05$) across all treatment groups.

Table 1 Effect of different levels of *Moringa oleifera* leaf meal (MOLM) on carcass and meat quality traits of Kolbroek and Large White pigs

Carcass and meat quality trait		Dietary treatments		
		T1	T2	T3
	BFT (mm)			
Breed	KB	14.1^{Aa}±2.3	21.5^{Bb}±2.3	21.9^{Bb} ±2.3
	LW	9.3^{Aa}±2.3	11.7^{Aa}±2.7	11.5^{Aa} ±2.7
	pH$_{45}$			
Breed	KB	6.3^{Aa}±0.11	6.5^{Aa}±0.11	6.4^{Aa}± 0.11
	LW	6.9^{Bb}±0.11	6.4^{Aa}±0.12	6.2^{Aa}± 0.12
	pH$_u$			
Breed	KB	5.6^{Aa}±0.08	45.2^{Aa}±2.26	46.3^{Aa} ±2.26
	LW	5.7^{Aa}±0.08	49.7^{Aa}±2.60	51.3^{Aa} ±2.60
	L*			
Breed	KB	51.3^{Aa}±2.26	45.2^{Aa}±2.26	46.3^{Aa} ±2.26
	LW	54.2^{Aa}±2.26	49.7^{Aa}±2.60	51.3^{Aa} ±2.60
	a*			
Breed	KB	4.3^{Aa}±0.77	7.2^{Ab}±0.77	6.7^{Ab}± 0.77
	LW	4.5^{Aa}±0.77	6.7^{Aa}±0.89	5.2^{Aa}± 0.89
	b*			
Breed	KB	7.8^{Aa}±0.75	7.8^{Aa}±0.75	7.8^{Aa}± 0.75
	LW	7.1^{Aa}±0.75	8.3^{Aa}±0.87	8.2^{Aa}± 0.87
	Chr			
Breed	KB	9.0^{Aa}±0.90	10.7^{Aa}±0.90	10.3^{Aa} ±0.90
	LW	8.5^{Aa}±0.90	10.7^{Aa}±1.04	9.7^{Aa}± 1.04
	Hue			
Breed	KB	61.0^{Ab}±3.37	48.0^{Aa}±3.37	49.2^{Aa} ±3.37
	LW	49.2^{Aa}±3.37	51.5^{Aa}±3.89	58.1^{Aa} ±3.89
	TL			
Breed	KB	3.5^{Ab}±0.54	1.4^{Aa}±0.54	0.8^{Aa}± 0.53
	LW	3.4^{Aa}±0.54	3.0^{Aa}±0.62	2.7^{aB}± 0.62
	CL			
Breed	KB	15.4^{Aa}±4.98	14.4^{Aa}±4.98	15.5^{Aa} ±4.98
	LW	21.3^{Aa}±4.98	22.6^{Aa}±5.75	47.8^{Bb} ±5.75
	WB SF			
Breed	KB	22.7^{Ab}±1.68	20.7^{Ab}±1.68	12.1^{Aa} ±1.68
	LW	16.3^{aB}±1.68	14.5^{aB}±1.94	12.8^{Aa} ±1.94

^{AB}Means in the same column per carcass traits with different superscripts are significantly different (p<0.05)
^{ab}Means in the same row with different superscripts are significantly different (p<0.05)
Moringa oleifera leaf meal (MOLM); back fat thickness (BFT); Lightness (L*); redness (a*); yellowness (b*); Chroma (Chr); thawing loss (TL); cooking loss (CL);Warner Bratzler Shear Force (WBSF).

V. CONCLUSION

The inclusion of MOLM as an additive on pig diets had no adverse effects on the growth performance, carcass and meat quality traits of KB and LW pigs and appeared to be effective in improving thawing, loss, WBSF and cooking loss. It was however observed that the inclusion of MOLM in the diet was more effective in the LW pigs than in the KB pigs. Therefore, it can be concluded that the inclusion of MOLM in pig feed can be used in pig diets as an additive with a potential to improve the quality of pork.

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REFERENCES

1. Alfonso, L., Mourot, J., Insausti, K., Mendizana, J. A. &Arana, A. (2005). Comparative description of growth, fat deposition, carcass and meat quality characteristics of Basque and large White pigs. Animal Research 54: 33-42.
2. Hoffman, L. C., Styger, W. F., Brand, T. S. & Muller, M. (2005). The growth, carcass yield, physical and chemical characteristics of two South African indigenous pig breeds. South Africa-Animal Science, vol 6: http://www.sasas.co.za/Popular/Popular.html
3. Jiang, Y. Z., Zhu, L., Li X. W. & Si, T. (2011). Evaluation of the Chinese indigenous pig breeds Dahe and crossbred Dawu for growth and carcass characteristics, organ weight, meat quality and intramuscular fatty acid and amino acid composition. Animal 5: 1485-1492.
4. Kang, S. N., Chu G. M., Song, Y. M., Jin, S. K., Hwang, I. H. & Kim, I. S. (2012).The effects of replacement of antibiotics with by-products of oriental medicinal plants on growth performance and meat qualities in fattening pigs. Animal Science Journal 83:245–251.
5. Lebret, B. (2008). Effects of feeding and rearing systems on growth, carcass composition and meat quality in pigs. Animal, 2(10): 1548-1558.
6. Moyo, B., Masika, P. J., Hugo, A. &Muchenje, V. (2011). Nutritional characterization of Moringa (MoringaoleiferaLam.) leaves. African Journal of Biotechnology 10(60): 12925-12933.
7. Muchenje, V., Dzama, K., Chimonyo, M., Strydom, P.E. &Raats J.G. (2009). Relationship between pre-slaughter stress responsiveness and beef quality in three cattle breeds. Meat Science 81:653–657.
8. Mukumbo, F. E. (2014). The effect of dietary inclusion of Moringa oleifera Lam leaf meal in finisher pig feed on feed conversion efficiency, meat quality, fatty acid composition and shelf life of pork. MSc dissertation, Department of Livestock and Pasture Science, Faculty of Science and Agriculture, University Of Fort Hare, Alice, South Africa.
9. Nicholas, G. (1999). Kolbroek – The unique local breed. Farmer's Weekly, August.
10. Okeudo, N. J., Aladi, N. O., Okoli, I. C. &Akanno, E. C. (2007). Comparative study of the Growth and Carcass Characteristics of the Nigerian Indigenous and Large White pigs. Asian Journal of Animal Sciences 1(20): 57-66.
11. Qwele, K, Muchenje, V., Oyedemi, S. O., Moyo, B. & Masika, P. J. (2013). Effect of dietary mixtures of moringa (Moringa oleifera) leaves, broiler finisher and crushed maize on anti-oxidative potential and physic-chemical characteristics of breast meat from broilers. African Journal of Biotechnology 12(3): 290-298.
12. Terlouw, C. (2005). Stress reactions at slaughter and meat quality in pigs: genetic background and prior experience. A brief review of recent findings. Livestock Production Science 94:125–135.
13. Voisinet, B. D., Grandin, T., Tatum, J. D., O'Connor, S. F. & Struthers J. J. (1997). Feedlot cattle with calm temperaments have higher average daily gains than cattle with excitable temperaments. Journal of Animal Science 75:892–896.
14. Wood, J. D., Nute, G. R., Richardson, R. I., Whittington, F. M., Southwood, O., Plastow, G., Mansbridge, R., Costa, N. & Chang, K. C. (2004). Effects of breed diet and muscle on fat deposition and eating quality in pigs. Meat Science 67: 651–667.