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Effect of *Moringa oleifera* leaf meal on growth performance, apparent digestibility, digestive organ size and carcass yield in broiler chickens

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ABSTRACT

The effects of dietary supplementation of *Moringa oleifera* leaf meal (MOLM) as a growth promoter on the growth performance, apparent digestibility, digestive organ size, and carcass yield of broiler chickens were investigated. A total of 2400 one-day-old Cobb-500 broiler chicks of mixed sex were randomly allocated to five dietary treatments in six replications of 80 birds per pen. Fresh, green and undamaged mature *M. oleifera* leaves were collected from a number of trees from the same village to avoid variations in soil micronutrient content; and were grinded to produce MOLM. Dietary treatments were as follows: positive control (+C) with 668 g salinomycin and 500 g zinc bacitracin per kg of feed; $MOLM_{low}$ (ML; 1, 3 and 5); $MOLM_{medium}$ (MM; 3, 9 and 15 g); $MOLM_{high}$ (MH; 5, 15 and 25 g)] per kg of feed; and a negative control (−C; without supplementation). Diets were fed for 35 d in starter, grower and finisher phases; and birds were provided feed and water *ad libitum*. At 35 d of age, 12 birds per treatment, two from each replicate pen, were randomly selected, electrically stunned at 70 V and killed by cervical dislocation for determination of carcass and organ weights. Bird weight at 7 and 21 d of age, birds fed MH had the highest BW, while +C had the lowest ($P<0.05$). No significant differences were observed in FI between treatments during periods from 0 to 21 d and 0 to 35 d; FCR was the highest ($P<0.05$) in birds supplemented with MOLM, except for MM; and was the lowest in those on the +C. Birds in ML had the highest thigh weights, and MH had the lowest ($P<0.05$). Gizzard erosion score was the lowest in MH and the highest in MM ($P<0.001$). Mortality rate was the highest ($P<0.05$) in MH from day 22 to 28 and was the lowest in ML and MM (1.3% vs. 0.21%); and was mainly due to sudden death. There were no significant differences in apparent digestibility for ash, ether extract (EE), crude fiber (CF), crude protein (CP), acid detergent fiber (ADF) and neutral detergent fiber (NDF) among treatments. It was concluded that supplementation of *M. oleifera* leaf meal up to 25 g per kg of feed did not impair nutrient utilization efficiency, but enhanced the bird's genetic potential for growth performance.

1. Introduction

Poultry research advances have pooled knowledge of biochemical and physiological mechanisms geared towards improving the efficiency of feed utilization and increasing desired carcass attributes in response to

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changing dietary constituents (Kidd, 2009). Modern broilers require 9.4 g of feed to produce 1 g of breast meat, whereas broilers that were unselected in 1957 required 28 g of feed for an equivalent response (Leeson, 2008). For decades, the use of in-feed antibiotic growth promoters (AGP) at sub-therapeutic levels has been effective in enhancing growth performance of broiler chickens. However, following the AGP ban within the European Union in 2006, consumer perceptions have more weight on the quality and safety of animal products making feed manufacturing exponentially complex in terms of accountability and traceability of feeds and their component ingredients (Leeson, 2008).

To date, various plants have been researched, and many are reported to contain aromatic properties that have an impact on gut micro-flora, nutrient digestibility, intestinal morphology and meat quality of poultry, as with AGPs (Cross et al., 2007). Furthermore, broilers require a minimal amount of fiber in the diet to maintain gizzard activity and gastrointestinal tract (GIT) functionality (Jiménez-Moreno et al., 2010). *Moringa oleifera* Lam (Moringaceae), a highly valued plant, distributed in many countries of the tropics and subtropics, is one such plant with an impressive range of medicinal uses, including growth promotion, antimicrobial and antioxidant effects (Makkar and Becker, 1997; Moyo et al., 2011; Mbikay, 2012). The nutritional profile of dried *M. oleifera* leaves has shown high levels of lipids and amino acids important in poultry productivity (Makkar and Becker, 1997). Ten of the 19 observed amino acids in *M. oleifera* are categorized as essential; threonine, tyrosine, methionine, valine, phenylalanine, isoleucine, leucine, histadine, lysine and tryptophan; and 17 fatty acids, including α-linolenic acid, heneicosanoic, g-linolenic, palmiteic and capric acid having been identified (Moyo et al., 2011). Moringa leaves are quite rich in minerals; however, their bioavailability is likely to be reduced by the presence of oxalates and phytates at concentrations of 4.1% and 3.1%, respectively (Foidl et al., 2001).

Although the leaves of the *M. oleifera* tree have been extensively researched for their potential nutritional and pharmacological benefits for human consumption, they may also provide benefits in livestock feed. Recent research has noted that synergistic properties between individual bioactive compounds in *M. oleifera* leaves act in broad aspects of physiology, such as nutrient absorption and processing, and antioxidant action that have potential therapeutic effects (Anwar et al., 2007; Mbikay, 2012; Wallace et al., 2010). The effect of *M. oleifera* leaf meal on growth performance, nutrient utilization efficiency gut integrity and/or carcass yield have been assessed in several studies at graded levels as either an alternative protein source or an extract used individually or in combination with extracts from other plants (Ogbe and Affiku, 2012; Olugbemi et al., 2010; Tesfaye et al., 2012; Zanu et al., 2012). Similar studies in fish, Nile tilapia, resulted in poor growth performance (Dongmeza et al., 2006). In ruminants, dietary supplementation of *M. oleifera* leaf meal was reported to promote rumen microbial protein synthesis due to the substantial contents of readily fermentable N and energy (Soliva et al., 2005). To our knowledge, this study is unique in its attempt to assess the effect of supplementing *M. oleifera* leaf meal (MOLM) at very low additive levels comparable with AGP inclusion rates in broiler diets. Therefore, the aim of this study was assess the beneficial effects of *M. oleifera* leaf meal as a growth promoter on the growth performance, apparent digestibility, digestive organ size and carcass yield of broiler chickens from 1 to 35 d of age.

2. Materials and methods

2.1. Preparation of M. oleifera leaf meal

Fresh, green and undamaged mature *M. oleifera* leaves were collected during the month of June from a number of trees from the same village of Grootfontein, Polokwane, Limpopo Province of South Africa; to avoid variations in soil micronutrient content. The leaves were air-dried during the day with no direct sunlight exposure, with constant turning over to avert fungal growth. After 5 d of drying the leaves were grinded to a fine powder to pass through a 0.15-mm sieve. The leaf meal was tightly packaged in polythene plastic bags, sealed and kept at room temperature until required. The analyzed nutrient, mineral, ADF and NDF composition of ground *M. oleifera* leaves is shown in Table 1.

2.2. Dietary treatments

The feeding program consisted of starter (from 0 to 21 d), grower (from 22 to 28 d), and finisher (29–35 d) basal diets (Table 2) that were formulated to meet the bird's dietary nutrient requirements (NRC, 1994). Five dietary treatment groups were produced from the basal feed as follows: positive control (+C) with 668 g salinomycin and 500 g zinc bacitracin per kg of feed; $MOLM_{low}$ (ML; 1, 3 and 5); $MOLM_{medium}$ (MM; 3, 9 and 15 g); $MOLM_{high}$ (MH; 5, 15 and 25 g)] per kg of feed; and a negative control (−C; without supplementation). All diets from starter to finisher were pelleted. Proximate analysis

Table 1
Moringa oleifera leaf meal (MOLM) composition.

Analyzed nutrient composition	
Metabolizable energy (MJ/kg)	11.4
Crude protein (g/kg)	267.6
Crude fiber (g/kg)	157.2
Ether extract (g/kg)	56.3
Moisture (g/kg)	78.3
Ash (g/kg)	108.1
Acid detergent fiber (g/kg)	137.9
Neutral detergent fiber (g/kg)	200.8
Analyzed mineral composition	
Phosphorus (g/kg)	3.2
Potassium (g/kg)	24.3
Calcium (g/kg)	28.1
Magnesium (g/kg)	10.1
Sodium (g/kg)	8.0
Iron (mg/kg)	192.0
Copper (mg/kg)	5.7
Zinc (mg/kg)	23.8
Manganese (mg/kg)	86.8
Boron (mg/kg)	33.1
Aluminum (mg/kg)	160.0