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Performance of improved indigenous grower chicken in Kenya fed enzyme-treated *Moringa (M. oleifera)* leaf meal-based diets

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Abstract

A feeding trial was done to investigate the impact of the inclusion of enzyme-treated *Moringa oleifera* leaf meal (MOLM) on feed conversion ratio, average daily gain, feed intake, and point of the lay of improved indigenous grower chicken. Ninety chickens were randomly allocated to six treatment diets in a completely randomized design with a factorial layout, with each treatment having five chickens per cage, replicated three times. The following were the dietary treatments used: T1-comprised of 0 kg MOLM and 0 g enzyme, T2-comprised of 0 kg MOLM and 0.035 g enzyme, T3-comprised of 20 kg MOLM and 0 g enzyme, and T4-comprised of 20 kg MOLM and 0.035 g enzyme, T5-diet comprised of 40 kg MOLM and 0 g enzyme, T6-diet comprised of 40 kg MOLM and 0.035 g enzyme of the diet, respectively. The statistical analysis system's general linear model (GLM) approach was used in the data analysis. Tukey's test ($p < 0.05$) was used to differentiate significant means. When comparing diets T5 & T6 to the control, the results showed that feed intake differed significantly ($p < 0.05$). The ADG of the MOLM-based diets was significantly ($p < 0.05$) lower in comparison to the control diet. The point of lay of the chicken-fed MOLM-based diets differed significantly ($p < 0.05$) from the control. The study recommended inclusion levels of enzyme-treated MOLM at 10-20% which would improve performance.

Keywords: Enzyme, improved indigenous chicken, *Moringa oleifera* leaf meal, performance

1. Introduction

The conventional protein feed ingredients e.g., soybean meal and fishmeal which are commonly used in chicken diets are expensive, thus posing a hurdle for the poultry sector in developing nations [1]. In most developing countries, the constant increase in the price of feed components has been a major limitation. As a result, non-conventional feed ingredients with a larger percentage of anti-nutritional factors (ANFs) are being evaluated. Feed additives containing ANFs may have a negative impact on poultry performance. Anti-nutritional factors such as -glucans in barley, pentosans in wheat, and some oligosaccharides in soybean meal reduce the utilization of nutrients, leading to a depressed performance in Chicken [3]. Commercial enzymes can improve the nutritional quality of crops that contain a lot of anti-nutritional factors [20].

Indigenous chicken contributes to the general well-being of households by creating jobs and generating revenue [14]. For most rural communities, indigenous chicken is a critical component in improving food security, socio-cultural development, and economic growth. The chicken is robust and can thrive in tough environments with minimal inputs. Chickens' productivity was shown to be improved by supplementing a high protein diet, providing housing, and controlling disease [10]. In terms of both quality and quantity, feed is the most significant limiting factor in indigenous chicken production [13]. As a result, this study was carried out to investigate how improved indigenous grower chicken responded to varied amounts of MOLM inclusion levels along with dietary supplementation with commercial enzyme preparation (Natuzyne®).

2. Materials and methods

2.1 Study location

The feeding experiment took place at the Kenya Agricultural and Livestock Research

Organization (KALRO) in Naivasha Poultry Research Unit. The Institute is in the Naivasha sub-county in Nakuru County. The Research Centre is located at an elevation of roughly 1,700 meters above sea level and receives an average annual rainfall of 1,100 millimetres. In the months of July and August, the lowest temperature is 8 °C, while in January and February, the highest temperature is 25 °C.

2.2 Experimental diets

Table 1: Composition of experimental diets

Ingredients (g/kg)	Treatments					
	T1	T2	T3	T4	T5	T6
Whole maize	61	61	51	51	40	40
Soybean meal	20	20	10	10	5	5
MOLM	0	0	20	20	40	40
Fishmeal	10	10	10	10	10	10
DCP	0.5	0.5	0.5	0.5	0.5	0.5
Limestone	7.5	7.5	7.5	7.5	3	3
Iodized salt	0.3	0.3	0.3	0.3	0.3	0.3
Premix	0.25	0.25	0.25	0.25	0.25	0.25
Vegetable oil	0.5	0.5	0.5	0.5	1	1
Enzyme	0	0.035	0	0.035	0	0.035
Calculated analysis						
ME (KJ/kg)	2607.6	2609.5	2605.5	2603.6	2600.02	2606.6
CP	16.4	16.65	16.95	16.8	16.76	16.9
CF	3.21	3.17	5.025	5.05	5.67	5.72
Recommended analysis						
ME (KJ/kg)	2600	2600	2600	2600	2600	2600
CP	16	16	16	16	16	16
CF	4	4	4	4	4	4

The nutrient requirement for improved IC, 2600 KJ/kg ME, 120 g/kg CP^[9]. Canola oil contained 900 kcal, fat-91.2g was incorporated to enhance the energy content; *A Premix containing: vitamin A 750,600IU/kg, Vitamin E 30.61IU/kg, vitamin B 24000mg, biotin 30mg, copper 5000 mg, manganese 80000 mg, Iron 40000 mg, selenium 100 mg, zinc 50000 mg, lysine 0.42%, Methionine 0.5%, alanine 0.84, Arginine 0.93% and Cysteine 0.32% was added at 0.5% of the diet to supply minerals, vitamins, trace elements and amino acids to improve feed conversion ratio and performance.

Results from the *in-vitro* digestibility trial indicated that enzyme treatment was the best method to improve nutrient utilization of the meal. The experimental diets were therefore compounded by the inclusion of enzyme-treated MOLM at 0, 20, and 40kg of the total diet. The MOLM was collected from Makeni County.

2.3 Proximate analysis

The Animal Nutrition Laboratory at Egerton University performed a proximate analysis of the feed samples. Ash was determined by burning samples in a muffle furnace at 550 °C for 8 hours^[4], dry matter was determined by drying samples in a hot air oven at 105 °C for 24 hours^[4], and Ether extract was determined by using the Soxhlet method (with ether)^[4]. The micro-Kjeldahl method was used to determine crude protein (N x 6.25) by digestion, distillation, and titration^[4]. The Van Soest method^[21] was used to determine the constituents of the cell wall, acid detergent fibre, and neutral detergent fibre.

2.4 Management of experimental chicken (housing, feeding, and disease control)

Before the trial, the house was properly cleaned and disinfected using kupacide® disinfectant. Wood shavings were used as litter in a deep litter system for the growers, which was continuously aerated and changed whenever it

became damp. One hundred (100), twelve weeks old improved indigenous chicken were purchased from Kenya Agricultural Livestock Research Organization (KALRO) from which ninety (90) chicken were randomly sampled. The chicken was weighed and assigned to six dietary treatments. Feed was given at 8:00 a.m., and leftovers were collected before feeding the following day. The leftovers were weighed using a digital weighing scale, and the daily feed consumption was calculated. A digital weighing scale with a 5-gram precision was used to record the chicken body weight for each pen on a weekly basis. The body weight gains were calculated using the weekly weights recorded. Body weight gain and daily feed intake were used to compute the feed conversion ratio. The pullets were vaccinated against fowl typhoid at 8 weeks, 3rd dose Newcastle disease vaccine at 18 weeks, and deworming done using piperazine® at 19 weeks respectively.

2.5 Data collection

Feed intake (FI)

After 24 hours, feed intake was determined using the difference between the amount of feed supplied and the amount left over (refusal).

$$\text{Feed Intake (FI) per grower (g)} = \frac{\text{Feed given (g)} - \text{Feed leftover (g)}}{\text{Number of growers}}$$

Average daily gain (ADG)

Every week, the chicken in a cage was weighed together before being fed. The average daily increase was calculated by dividing the discrepancy between the weight of the chicken after 7 days and the weight of the chicken at the start of the 7 days.

$$\text{Average daily gain per grower (g)} = \frac{\text{Weight after 7 days (g)} - \text{Weight at the start of 7 days (g)}}{7 \text{ days}}$$

Feed conversion ratio (FCR)

The feed conversion ratio was determined by the average feed intake (g) consumed by the bird divided by the average weight gain per grower (g) during each week

$$\text{Feed conversion ratio (FCR)} = \frac{\text{Average feed intake per grower (g)}}{\text{Average weight gain per grower (g)}}$$

2.6 Experimental design

A completely randomised design (CRD) with a factorial layout with the initial weight fitted as a covariate was used. There were 18 experimental units with 5 growers per treatment, each replicated 3 times.

$$Y_{ijk} = \mu + A_i + B_j + AB_{ij} + \beta(X_{ij} - \bar{x}) + \varepsilon_{ijk}$$

Assumptions were that x_{ij} is not affected by treatment

x_{ij} is deviated from the mean of the covariate, \bar{x}

Y_{ijk} = Response variable of interest (feed conversion ratio, feed intake, weight gain, point of lay)

μ = Overall mean

A_i = Effect associated with the i^{th} level of MOLM

B_j = Effect associated with the j^{th} level of enzyme

AB_{ij} = Effect associated with the i^{th} level of MOLM and j^{th} level of enzyme

X_{ij} = Initial body weight of an individual bird (covariate)

\bar{x} = Overall mean for initial body weight

ε_{ijk} = Random error

2.7 Statistical analysis

Data were analysed using the general linear model (GLM) procedure of the statistical analysis system version 9.0. Tukey's test was used to differentiate significant means at $p < 0.05$.

3. Results and discussions

3.1 Chemical composition of the experimental diets and MOLM

The results of proximate analysis of the diets and MOLM are presented in Tables 2 and 3.

Table 2: Chemical composition of MOLM

Nutrient component (%)	MOLM
Dry matter	93.29
Ash	10.26
Gross energy (MJ/kg)	17.14
Crude protein	26.80
Crude fat	12.23
Ether extract	7.58
Nitrogen free extract	42.13
Lysine	0.1033
Methionine	0.1142
Neutral detergent fibre	55.83
Acid detergent fibre	32.95
Acid detergent lignin	10.94
Hemicellulose	22.90
Cellulose	21.99

Table 3: Chemical composition of the experimental diets

Nutrient (%)	Treatments					
	T1	T2	T3	T4	T5	T6
Dry matter	90.39	90.05	90.06	91.1	90.89	90.21
Gross energy (MJ/kg)	11.4	11.4	11.1	11.1	10.9	10.9
Ash	11.13	9.22	11.72	14.12	14.31	14.41
Crude Protein	16.42	16.38	16.49	16.3	16.18	16.23
Crude fibre	3.3	3.07	3.42	3.39	5.45	5.25
Ether extract	4.77	4.63	6.52	6.32	7.28	7.17
Neutral detergent fibre	30.28	30.23	32.03	32.19	35.44	35.13
Acid detergent fibre	11.32	11.42	12.1	11.96	14.47	14.84
Hemi-cellulose	18.96	18.81	19.93	20.23	20.97	20.29

As the amount of MOLM in the diet was increased, the proximate analysis showed that an increase in crude fibre, acid detergent fibre content, and neutral detergent fibre,

The feed intake in diets T5&T6 (40% MOLM) was significantly different ($p < 0.05$) compared to the control. The ADG was significantly ($p < 0.05$) lower for the MOLM-based diets in comparison to the control diets.

3.2 Performance of the chicken

Table Error! No text of specified style in document.: Effect of diet and enzyme interaction on performance of improved grower IC

Parameters	T1	T2	T3	T4	T5	T6	SEM	P value
Feed intake	83.51 ^a	88.92 ^b	83.99 ^a	88.91 ^b	76.62 ^c	73.72 ^d	0.57	<.0001
Feed conversion ratio	3.58	2.67	1.72	1.76	1.58	1.49	0.82	0.41
Average daily gain	70.14 ^a	74.34 ^a	60.95 ^b	69.37 ^b	50.09 ^c	40.43 ^d	4.14	0.007

^{abc, d} Means in the same row without common superscripts are different at $p < 0.05$; SEM=Standard error of means

3.3 Feed intake

As levels of MOLM increased, feed intake reduced significantly ($p < 0.05$) in comparison to the control diet. The feed intake of chicken fed T5 & T6 (40 percent) MOLM in the diet was significantly reduced. This could be attributed to high CF and reduced diet palatability [7]. The phytochemical substances and anti-nutritional components found in MOLM could be responsible for the chickens' poor performance [17]. Leaf meals have a bitter flavor, therefore, including MOLM in the diets may have lowered palatability and consequently feed consumption in broiler diets.

that growing pullets fed diets containing 2, 4, and 6% *Centrosema pubescens* leaf meal had lower FCR. Decreased FCR was seen in diets with more than 20% leaf meal, as reported by [6], who also found high feed utilization in layers given 20% *M. oleifera* leaf meal. This could be as a result of a decrease in voluntary feed intake combined with an increase in the amount of leaf meals included in the diet, which have a high energy content. This is consistent with [11], who reported that voluntary feed intake is explained by the palatability of diets and Metabolisable energy content.

3.4 Feed conversion ratio (FCR)

The FCR patterns for MOLM-based diets were similar to those of the control diet, which could be as a result of diets' high levels of accessible energy and protein. This demonstrated a high level of nutrient use efficiency [15] found

3.5 Average daily gain (ADG)

Control diet (T₁) and T₃ & T₄ (20 percent MOLM) had similar ADG patterns. In comparison to the control diet, the ADG for T₅ & T₆ (40 percent MOLM) was considerably ($p < 0.05$) lower. This is as a result of increased fibre content in the diet, which leads to reduced feed intake. This contrasted with the

findings of [5], who found that including MOLM in the broiler's feed significantly ($p < 0.05$) increased their weight gain at a 1 percent level, which was greater compared to the control diet. The chicken fed a diet containing 20% MOLM gained considerably more weight ($p < 0.05$) than those fed a diet containing 40% MOLM. This could be due to increased crude fibre that reduced nutrient digestion and absorption [2]. The detrimental effect of anti-nutritional factors e.g., tannins, saponin, oxalates, and phytates, might have led to decreased weight gains of chicken fed a 40% MOLM diet despite its

high crude protein content [18]. The tannin content of Moringa leaves ranges from 0.001-0.023 percent per kilogram [7]. Tannins bind proteins, thus inhibiting protein digestion [16]. They are responsible for the feed's astringent taste, which leads to lower feed intake due to decreased palatability [19].

3.6 Point of lay

The point of lay of chicken fed enzyme-treated MOLM-based diets and those fed control diet differed significantly ($p < 0.05$).

Table 5: Effect of diet on body weight, point of lay, and egg weight of improved indigenous grower chicken

Parameters	T1	T2	T3	T4	T5	T6	p-value
Body weight (kg)	2.04±0.09	2.07±0.16	1.87±0.05	1.84±0.01	1.86±0.08	1.86±0.04	0.106
Point of lay (days)	149 ^a ±0.00	139 ^b ±0.00	156 ^c ±0.00	152 ^d ±0.00	172 ^e ±0.00	172 ^e ±0.00	<.0001
Egg weight (g)	47.6±1.59	43.03±2.26	44.6±1.53	47.5±3.21	46.8±4.5	46.6±0.81	0.614

Means in the same row without common superscripts are not different at $p < 0.05$.

Chicken fed on T₁ & T₂ (0% MOLM) started laying at 149 and 139 days, respectively compared to those on MOLM-based diets. Chicken fed on T₃&T₄ (20% MOLM) laid at 156 and 152 days, respectively compared to diets containing 40% MOLM (T₅ & T₆) which started laying at 172 days. The average point of lay of improved indigenous chickens is 143 days of age [8]. The inclusion of 40% MOLM (T₅ & T₆) negatively affected point of lay of the chickens in this study in comparison to the control diet (Table 5). The delay in laying could be explained by the lower feed intake due to impaired palatability due to the existence of anti-nutritive factors e.g., saponins which impart a bitter taste, and high crude fibre content that affects digestibility compared to control. In the gastrointestinal tract, structural carbohydrates e.g., cellulose and hemicellulose are poorly digested and absorbed. Due to their chemical and physical properties, increased levels of dietary fibre might lead to digestible energy loss, reduced availability of minerals, reduced digestion and absorption of other feeds that make up the diet and negatively affect bio-productive indicators for non-ruminant species. [12]. The egg weight was lower which could have been due to the fact that laying chicken used in this study were within the first phase of egg production [6].

4. Conclusion

It was concluded that inclusion levels of 20-40% enzyme-treated MOLM in improved indigenous grower chicken diets did not improve feed intake, feed conversion ratio, body weight gain, point of lay and egg weight in comparison to the control diet therefore addition of lower levels between 10-20% of enzyme-treated MOLM in diets of improved IC diets might improve growth performance.

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