Original Research Article

Growth Performance and Economic Efficiency of Immature Lohmann Brown Layers fed Graded Levels of Undeshelled Defatted *Moringa oleifera* Seed Cake (UDMOSC)

ABSTRACT

In a 22-weeks experiment, the impact and economic efficiency of feeding Undeshelled defatted *Moringa oleifera* seed cake (UDMOSC) to Lohmann Brown layer chicks and pullets were investigated. The study had two phases, focusing on chicks (0-8 weeks) and pullets (9-22 weeks). A total of 150-day-old chicks and 8-week-old pullets were randomly assigned to five dietary treatments, each replicated three times,and each replicate containing ten(10) birds in a completely randomised design. In the initial phase, chicks feddietaryUDMOSC consumed less feed but had similar (p > 0.05) final body weight compared to the control group. Chicks fed the control, and 5 % UDMOSC gained more weight with better feed conversion. Chicks fed 10%UDMOSC had higher mortality.In the second phase, pullets fed the control diet and 15% UDMOSC with the enzyme ($UDMOSC^{15E}$) showed significantly higher (p = 0.01) feed intake. Final body weight and body weight gain were notably higher (p = 0.001) in pullets fed the control diet. Feed conversion ratio and mortality rate did not significantly differ (*P* > 0.05) among treatments. Dietary UDMOSC reduced feed cost per kilogram of body weight gain for starters and pullets. While dietary UDMOSC did not significantly affect starter growth, it lowered total feed cost per bird for starters and pullets except for $UDMOSC^{15E}$, accruing 20.54 – 27.81 %. and 25.39 – 40.19 % percentage profit range,respectively. Dietary UDMOSC depressed the growth of starters and pullets, but it was economically advantageous by reducing the cost per kilogram of body weight gain for both groups. The negative impact of dietary UDMOSC on thegrowth of starters and pulletssuggests that includingUDMOSC in the immature layer, diets should be cautiously approached for economic gain and, therefore, recommended for the pullet stage at an inclusion level not exceeding 10 % inclusion level.

Keywords: Pullets, Growth performance, Economic Efficiency, Brown Layers, Undeshelled Defatted Moringa oleifera seed cake

1. INTRODUCTION

Poultry production is essential in bridging the protein gap in developing countries where the average daily consumption is far below the recommended standards [1,2].The prospect of this vital industry today is undermined by the high cost of production due to the high prices of feed ingredients, especially protein sources [3,4,5]. According to Abdelnour*et al*. [6], scarcity and higher prices of conventional protein source ingredients limit poultry production in developing countries. Despite the associated higher costs, this vital nutrient in poultry nutrition plans remains imperative, given its indispensable role. It is well-established that protein, the primary building block for numerous bodily tissues and muscles, stands alone in its significance. According to Sá*et al*. [7], proteins are the primary sources of nitrogen for animals. Proteins play a vital role in poultry nutrition by supplying the essential amino acids necessary to grow and repair body proteins and tissues. As the study explores ways to enhance and sustain poultry production, seeking alternative protein sources that serve as valuable ingredients in poultry diets becomes increasingly essential. Among these potential resources, *Moringa oleifera* seed cake is a promising candidate.

Moringa oleifera has garnered substantial attention as a protein source for livestock worldwide, owing to its rich protein content and essential minerals [8,9,10]. Saa et al. [11]emphasised its significance in addressing global food grain shortages exacerbated by the burgeoning human population. Given its adaptability to arid conditions prevalent in sub-Saharan regions, where food crises often loom, *Moringa oleifera*is a promising conventional feed resource poised to alleviate food scarcity challenges. *Moringa oleifera* stands out as a remarkably versatile plant, with nearly all its parts finding valuable use in medicine [12] and nutrition [13,14]. Moreover, our findings highlight *Moringa oleifera* as a potent indigenous source of easily digestible protein and rich reserves of vital nutrients such as calcium, iron, vitamin C, and carotenoids [15].

A proximate analysis conducted by Sodamate et al. [16]asserted that *M. oleifera* seeds boast an impressive crude protein content of approximately 43.71±1.64 mg/100g. Furthermore, research by Alagbemide et al. [17], focused on the nutrient and mineral composition of *M. oleifera* seeds, reported a similarly substantial crude protein content of about 35.97%. This notably high crude protein content suggests that *M. oleifera* seeds could serve as a viable alternative or supplement to traditional plant protein sources like soya bean meal or groundnut cake in poultry diets. Beyond their rich protein content, the seeds are also enriched with essential vitamins such as A and B1, as highlighted by the work of Mbah et al. [18]. This nutritional profile implies that including Moringa seeds in poultry feed contributes to enhanced growth through protein supply and supports overall avian health by providing essential vitamins. Moreover, a report by Aderinola et al. [19] underscores the antioxidative properties of *M. oleifera*. A feed trial conducted by Lin et al. [20]further reinforces the positive effects of Moringa seed polypeptides to safeguard erythrocytes from oxidative damage. These findings strongly suggest that *M. oleifera* holds substantial promise as a valuable protein source ingredient for poultry nutrition, offering both growth-promoting protein and health-enhancing nutritional components.

2. MATERIALS AND METHODS

Feed source

The Undeshelled defatted *Moringa oleifera* seed cake (UDMOSC) was sourced from Ghana Permaculture Institute via Techiman and milled at the Poultry Section of the Department of Animal Science Akenten Appiah Menka University of Skills Training and Entrepreneurial Development (AAMUSTED Mampong campus).

Experimental design and feed formulation

Five experimental diets were formulated at UDMOSC 0% ($UDMOSC^{0}$), UDMOSC 5% ($UDMOSC^{5}$), UDMOSC 10% ($UDMOSC^{10}$), UDMOSC 15% ($UDMOSC^{15}$) and UDMOSC 15% with enzyme ($UDMOSC^{15E}$) for both starters (see Table1) and pullets (see Table 2). One hundred and fifty (150) starters (0 – 8weeks) and pullets (9 – 22weeks) were divided into five (5) groups, each containing three (3) replicates with ten (10) starters and pullets per replicate in a completely randomised design.

Table 1: Composition of starter diets (week 0-8)

Ingredients	UDMOSC^{0}	UDMOSC^{5}	UDMOSC^{10}	UDMOSC15	UDMOSC^{15E}
Maize (Kg)	56.5	55	53.5	53	53
Wheat bran (Kg)	13	12.5	12	10.5	10.5
Soybean (Kg)	9	6	2	0	0
UDMOSC (Kg)	0	5	10	15	15
Anchovy (Kg)	8.5	8.5	8.5	8.5	8.5
Tuna fish (Kg)	10	10	11	10	10
Dicalcium (Kg)	0.5	0.5	0.5	0.5	0.5
Vit/premix (Kg)	0.5	0.5	0.5	0.5	0.5
Oyster shell (Kg)	1.5	1.5	1.5	1.5	0.5
Salt (Kg)	0.5	0.5	0.5	0.5	0.5
Total	**100**	**100**	**100**	**100**	**100**
Calculated Analysis					
CP (%)	21.09	21.11	21.16	21.08	21.08
CF (%)	3.49	4.23	4.92	5.64	5.64
EE (%)	3.53	3.65	3.81	3.90	3.90
ME (Kcal/Kg)	2717.55	2713.90	2711.50	2727.10	2727.10

UDMOSC - Undeshelled defatted *Moringa oleifera* seed cake; CP-Crude protein; CF-Crude Fibre; EE-Ether Extract; ME-Metabolisable Energy; Vit premix-All Essential Vitamins

Table 2: Composition of pullet diets (week 9-22)

Ingredients	UDMOSC^{0}	UDMOSC^{5}	UDMOSC^{10}	UDMOSC^{15}	UDMOSC^{15E}
Maize(Kg)	60	60	59.6	60	60
Wheat bran(Kg)	20	18	16	13	13
Soybean(Kg)	7.5	5.5	3.5	2.3	2.3
UDMOSC(Kg)	0	5	10	15	15
Anchovy(Kg)	0	0	0	0	0

Tuna fish(Kg)	7.4	6.8	6.3	5	5
Dicalcium(Kg)	0.5	0.5	0.5	0.5	0.5
Vit/premix(Kg)	0.5	0.5	0.5	0.5	0.5
Oyster shell(Kg)	3.6	3.1	3.2	3.2	3.2
Salt(Kg)	0.5	0.5	0.5	0.5	0.5
Total	**100**	**100**	**100**	**100**	**100**
Calculated Analysis					
CP(%)	15.23	15.30	15.39	15.37	15.37
CF(%)	4.12	4.80	5.47	6.09	6.09
EE(%)	3.25	2.90	3.51	3.58	3.58
ME(Kcal/Kg)	2611.74	2526.99	2427.85	2348.19	2348.19

UDMOSC - Undeshelled defatted *Moringa oleifera* seed cake; CP-Crude protein; CF-Crude Fibre; EE-Ether Extract; ME-Metabolisable Energy; Vit premix-All Essential Vitamins

Management of experimental birds

All the birds were reared in a deep litter system and were fed the respective diets *ad libitum*during the experimental period of 8weeks for starters and 13weeks for pullets. Stringent adherence to standard management protocols guaranteed the optimal well-being of the experimental birds, ensuring they received appropriate care. Additionally, a continuous supply of clean drinking water was available *ad libitum* throughout the experimental period.To monitor the birds' growth effectively, individual weight assessments were conducted on both the chicks and pullets, using a precision electronic digital balance obtained from Zhejiang, China, renowned for its accuracy to the nearest 0.01 units. This process facilitatedthe precise recording of the initial and final body weights of birds. The feed given to the birds was carefully measured using a weighing balance and provided daily*ad libitum*. Any unconsumed feed was also weighed and documented daily to manage their diet effectively.

Economics of production

Fractions on as fed basis	Composition

The economic efficiency of UDMOSC in the production of starters and pullets was determined using the prevailing price per kilogram of conventional feed, price per kilogram of UDMOSC, kilogram body weight gain of starters and pullets, and uniform distribution of all other costs at the time of the experiment. The price per kilogram of conventional feed was multiplied by the total kilograms of conventional feed consumed per bird to get the cost of conventional feed per bird. The price per kilogram of UDMOSC was multiplied by the total kilograms of UDMOSC consumed per bird to get the cost of UDMOSC per bird. The cost of conventional feed per bird and the cost of UDMOSC per bird were summed up to get the total cost of feed per bird. The cost per kilogram body weight gain was determined by dividing the cost of feed per bird by the kilogram body weight gain per bird. The data on the various parameters were subjected to analysis of variance (ANOVA) using the GenStat statistical package (2008) and means separated by the Least Significant Difference (LSD) test at a 5% ($p < 0.05$) significant level.

RESULTS

Table 3. Proximate composition of UDMOSC

The Undeshelled defatted *Moringa oleifera* seed cake sample had a crude protein content of 31.67 %. Moisture, crude fibre, ether extract, ash, and nitrogen-free extracts were 9 %, 20.87 %, 4.30 %, 5.50 %, and 28.66 %, respectively. The metabolisable energy calculated for the test sample was 2841.63 Kcal/kg (Table 3).

Moisture (%)	9.00
Crude protein (%)	31.67
Crude fibre (%)	20.87
Crude fat (%)	4.30
Ash (%)	5.50
Nitrogen-free extract (NFE) (%)	28.66
Metabolisable energy (ME) (Kcal/kg)	2841.43

Effect of UDMOSC on the growth performance of starter chicks

The result showed that the starters responded differently to different inclusion levels of UDMOSC. Dietary treatment had a significant (*P* = 0.01) effect on total feed intake. The chicks receiving dietary UDMOSC treatment consumed similar lower (*P* = 0.01) feed, with the control group consuming the highest feed (Table 4). Final body weight was not affected by the treatment diet (*P*> 0.05). However, body weight gain was significantly affected (*P* = 0.02), with the chicks fed UDMOSC0 and UDMOSC5 diets gaining similar (*P*> 0.05) highest body weights, whilst those fed UDMOSC^{10}, UDMOSC^{15,} and UDMOSC^{15E} gaining a similarly (*P*> 0.05) lower body weight. The feed conversion ratio was also significantly (*P* = 0.03) betterfor chicks fed UDMOSC^{5}. A significant difference (*P* = 0.01) was also observed in mortality rate, with starter chicks on UDMOSC^{5}, UDMOSC^{10,} and UDMOSC^{15} diets having the highest (*P*> 0.05) mortality rate. The lowest mortality rate was recorded for starter chicks fed UDMOSC^{0} and UDMOSC^{15} (*P*> 0.05) (Table 4).

Table 4: Effect of UDMOSC on the growth performance of starter chicks

Parameters	**UDMOSC^{0}**	**UDMOSC^{5}**	**UDMOSC^{10}**	**UDMOSC^{15}**	**UDMOSC^{15E}**	**LSD**	**P- value**
MIBW(g/bird)	34.53	33.77	33.93	33.63	33.77	1.09	0.06
MFI(g/bird)	2781^{a}	2316^{b}	2242^{b}	2326^{b}	2187^{b}	303.80	0.01
MFBW(g/bird)	416	348	401	399	357	82.70	0.33
MBWG(g/bird)	440.30^{a}	392.60^{ab}	368.40^{bc}	368.40^{bc}	324.50^{c}	64.61	0.02
FCR	6.30^{ab}	5.57^{b}	6.13^{ab}	6.33^{ab}	6.70^{a}	1.01	0.03
MM	0.00^{b}	1.67^{ab}	3.00^{a}	0.67^{b}	1.33^{ab}	1.99	0.01

Means within rows with different superscripts are significantly (p < 0.05) different. UDMOSC= Undeshelleddefatted Moringa oleifera seed cake, MIBW= mean initial body weight, MFI= mean feed intake, MFBW= mean final body weight, MBWG= mean body weight gain, FCR= feed conversion ratio, MM= mean mortality rate, LSD= least significance difference.

Effect of dietary UDMOSC on growth performance of pullets

The final weight for phase 1 (Table 4), which served as the initial weight of the pullets, did not vary significantly (*P* = 0.07) (Table5). The feed conversion ratio and the pullets' mortality rate were not significantly affected (*P*> 0.05). However, feed intake (*P* =0.01), final body weight (*P* = 0.001) and body weight gain (*P* = 0.001) of the pullets were affected significantly. The pullets fed UDMOSC^{0} inclusion level performed better regarding feed intake, final body weight and body weight gain (Table 5). Pullets fed UDMOSC^{15E} also performed better (*P* = 0.01) in terms of feed intake, outperforming those birds fed UDMOSC^{5}, UDMOSC^{10} and UDMOSC^{15,} which consumed less feed (*P*> 0.05). Dietary energy regulates feed intake, with birds consuming more feed when energy is low and less when energy is high. However, birds fed UDMOSC consume less feed when the energy level is lower than the control (refer to Table 2).Final body weight was lowest for pullets fed UDMOSC^{10}, UDMOSC^{15,} and UDMOSC^{15E} (*P*> 0.05). Pullets observed significantly (*P* = 0.001) the highest final body weight gain (1758 g) when fed UDMOSC^{0,} followed by pullets fed UDMOSC^{5} (1477 g, *P* = 0.001). On the contrary, pullets fed UDMOSC^{15E} had the lowest final body weight gain (1113 g, *P* = 0.001) (Table 5).

Table 5: Effect of dietary UDMOSC on the growth performance of pullets

Parameters	**UDMOSC^{0}**	**UDMOSC^{5}**	**UDMOSC^{10}**	**UDMOSC^{15}**	**UDMOSC^{15E}**	**LSD**	***P*-value**
MIBW (g/bird)	416	348	401	399	357	82.70	0.07
MFI (g/bird)	8337^{a}	6536^{b}	6222^{b}	5874^{b}	7370^{a}	1333.50	0.01
MFBW (g/bird)	1758^{a}	1477^{b}	1349^{bc}	1194^{bc}	1113^{c}	252.5	0.001
MBWG (g/bird)	1342^{a}	1129^{b}	948^{c}	915^{c}	756^{d}	155.10	0.001
FCR	6.20	5.83	6.53	6.00	6.17	0.82	0.45
MM	1.67	2.33	2.33	1.33	2.33	1.76	0.60

Means within rows with different superscripts are significantly (p < 0.05) different. UDMOSC= Undeshelled defatted Moringa oleifera seed cake, MIBW= mean initial body weight, MFI= mean feed intake, MFBW= mean final body weight, MBWG= mean body weight gain, FCR= feed conversion ratio, MM = mean mortality rate, LSD= least significance difference.

Economic efficiency of UDMOSC in the production of starter layer chicks

Analysis of the economic efficiency of UDMOSC (as presented in Table 6) reveals notable findings. Specifically, when producing layer chicks, it is evident that the control diet incurred a higher feed cost, totallingGHC 15.82thanthe test diets. These test diets (UDMOSC^{5}, UDMOSC^{10}, UDMOSC^{15}, and UDMOSC^{15E}) demonstrated reduced feed costs per bird, amounting to GHC12.57, GHC11.56, GHC11.42, and GHC11.39, respectively. Notably, the mean total feed cost showed a consistent decrease with increasing UDMOSC levels, with one exception in the case of UDMOSC^{15E}, attributed to including an enzyme. Interestingly, the cost per kilogram of body weight gain is higher when UDMOSC is incorporated, as opposed to the control diet,thus challenging the economic benefits of utilising dietary UDMOSC when total feed cost is lower (Table 6).

Table 6: Economic efficiency of UDMOSC in the production of starter layer chicks

Parameters	**UDMOSC^{0}**	**UDMOSC^{5}**	**UDMOSC^{10}**	**UDMOSC^{15}**	**UDMOSC^{15E}**
CCI (GHC/Kg/bird)	5.69	5.42	5.16	4.90	5.20
MFI (Kg/bird)	2.78	2.32	2.24	2.33	2.19
TFC (GHC/bird)	15.82	12.57	11.56	11.42	11.39
MBWG (kg)/bird	0.44	0.39	0.37	0.37	0.32
Cost/kg BWG	21.09	32.24	31.24	30.86	35.59

GHC10.1=1$ at the time of the experiment, UDMOSC= UndeshelleddefattedMoringa oleifera seed cake, CCI= Cost of conventional ingredients, GHC = Ghana cedis, MFI = Mean feed intake, TFC= Total feed cost, MBWG = mean body weight gain, E = enzyme.

Economic efficiency of dietary UDMOSC in the production of pullets

The analysis of the economic efficiency of UDMOSC in pullet production reveals that the conventional diet is more costly (GHC40.53) compared to the test diets (GHC30.34, GHC27.43, GHC 24.24, and GHC 38.25 for UDMOSC^{5}, UDMOSC^{10}, UDMOSC^{15}, and UDMOSC^{15E} respectively). The mean total feed cost decreases with increasing UDMOSC levels, except for pullets fed the UDMOSC^{15E}diet, which incorporates an enzyme. Notably, pullets fed UDMOSC^{15E} had the highest cost per kilogram of body weight gain, followed by those on UDMOSC^{0}.Pullets feddietary UDMOSCat graded levels 5 %, 10 % and 15 % accrued the most cost-effective weight gain,thus making UDMOSC economically beneficial for pullets compared to the starter layer chicks (Table 7).

Table 7Economical efficiency of UDMOSC in the production of pullets

Parameters	**UDMOSC^{0}**	**UDMOSC^{5}**	**UDMOSC^{10}**	**UDMOSC^{15}**	**UDMOSC^{15E}**
CCI (GHC)	4.86	4.64	4.41	4.18	5.19
MFI (GHC/Kg/bird)	8.34	6.54	6.22	5.87	7.37
TFC (GHC/bird)	40.53	30.34	27.43	24.24	38.25
MBWG (kg)/bird	1.34	1.13	0.95	0.92	0.76
Cost/kg BWG	30.24	26.85	28.87	26.67	50.33

GHC 10.1=1$ at the time of the experiment,UDMOSC= UndeshelleddefattedMoringa oleifera seed cake, CCI= cost of conventional ingredients,GHC = Ghana cedis, MFI = Mean feed intake,TFC=Totalfeed cost, MBWG = mean body weight gain, E = enzyme

DISCUSSION

Effectof UDMOSC on the growth performance of starters

The performance of starter layer chicks fed graded levels of UDMOSC shown in Table 4 indicates that chicks fed UDMOSC^{15} had the lowest initial body weight, though the difference was insignificant (P> 0.06). The similar but slightly different initial body weight of chicks used for this experiment could be attributed to differences in their weight at hatch. Chicks on the control diet consumed significantly higher feed than their counterparts on the test diets. The marked reduction in feed intake of the starters on the test diets could be attributed to the hard and sticky nature of the seed cake, which resulted in visible vent sticking in starters that received higher levels of the cake. The reduced feed intake of chicks on the test diet could further be attributed to the reduced palatability of the test diet [21]. Onu and Otuma[22] reported that the unpalatable nature of a feed will eventually prevent chicks from consuming an adequate quantity of the feed.

Final body weight did not vary significantly (P> 0.05) between chicks; however, body weight gain varied significantly (P = 0.02), with chicks on the control diet and UDMOSC^{5} having the highest body weight gain. Body weight gain of chicks on UDMOSC^{10}, UDMOSC^{15} and UDMOSC^{15E} did not vary significantly (P> 0.05), suggesting that the addition of the enzyme (Burgazyme) did not have a notable impact on nutrient digestibility and did not enhance the conversion of nutrients, especially proteins, into a form that the birds could readily utilise. According to Zanella *et al.*[23], enzyme supplementation could not improve overall crude protein digestibility, and this could have occurred to chicks that received the enzyme supplementation. The reduced weight gain of chicks on UDMOSC^{10}, UDMOSC^{15} and UDMOSC^{15E} could partly be attributed to the high crude fibre content of UDMOSC, which might have impaired feed digestion and nutrient absorption [24,22]and Onu(2010), as cited in [25]. The relatively higher body weight gainby chicks fed UDMOSC^{5} could be attributed to reduced fibre in the UDMOSC^{5} compared to UDMOSC^{10}, UDMOSC^{15} and UDMOSC^{15E}. Chicks on UDMOSC^{0}, UDMOSC^{5}, UDMOSC^{10}, and UDMOSC^{15} had the best feed conversion ratio, suggesting that the chicks adequately utilised the nutrients from the feed regardless of consuming slightly less feed. The mortality rate was significantly high (P = 0.01) in chicks fed UDMOSC^{10}, and this did not vary considerably with chicks fed UDMOSC^{5} and UDMOSC^{15E}. The high mortality rate could, however, be attributed to neonatal infections that might have predisposed the chicks to fatal disease conditions.

Effect of UDMOSC on the growth performance of pullets

The final body weight of the chicks, which served as the initial body weight of the pullets, did not vary significantly (*P*> 0.05). However, the chicks on the control diet had slightly higher final body weight. This can be attributed to the fact that chicks on the control diet consumed feed better than those on the test diets. Feed intake was significantly higher in pullets fed UDMOSC^{0} and UDMOSC^{15E}(Table 5), suggesting that the pullets fed UDMOSC15^{E} accepted the feed at this growth stage. The fact that only growers fed UDMOSC^{15E} performed better in feed intake further indicatesthat the hard and sticky nature of the UDMOSC reduced the palatability of the feed and affected the feed intake. The pattern of feed intake observed is lower than expected. Dietary energy levels regulate avian feed intake. Birds typically consume more feed when energy is low and less when it's high. However, birds fed UDMOSC show reduced feed intake even at lower energy levels than the control group (Table 2). This could be attributed to reduced palatability of the feed, which did not allow the birds to consume higher amounts as regards the energy level (Classen, 2017)

According to Ginindza*et al*. [27], lower dietary crude fibre levels optimised growth rate, whereas higher dietary crude fibre levels resulted in lower feed intake and digestibility of unsexed Venda chickens. The relatively lower body weight gained by pullets on the test diets could, therefore, be attributed to the high crude fibre content in the test diet, which could have impaired digestibility and nutrient absorption. Feed conversion ratio did not vary significantly ($p > 0.05$) between birds on the control diet and their counterparts on the test diets, and this was in line with the results of Molepo [28],who found no significant effect on feed conversion ratio when he investigated the effects of *Moringa oleifera* whole seed meal in broilers. Similarly, there was no significant difference in mortality rate between growers on the control and those on the test diets, suggesting an equal health status for all the growers at this stage.

Effect of UDMOSC on economic efficiency in production starters and pullets

The results on the economic efficiency of dietary UDMOSC in producing starters and pullets showed that it would cost less with the inclusion of graded levels of the test diet (UDMOSC) of starters (Table 6) and pullets (Table 7); conversely, a relatively higher cost was incurred to gain per kilogram body weight of starters but not for pullets with dietary UDMOSC inclusion. This suggests that UDMOSC can potentially reducethe feed cost of producing starters and pullets; however, to achieve a corresponding gain per kilogram body weight at a relatively reduced feed cost, it is advisable to incorporate the test diet (UDMOSC) at the pullet rather than starter stage to achieve efficiency and economise production cost. The consistent decrease in feed cost per kilogram body weight of starters (Table 6) fed UDMOSC^{5}(GHC 32.24), UDMOSC^{10}(GHC 31.24) and UDMOSC^{15} (GHC 30.86), as compared tobirds fed UDMOSC^{15E} (GHC 35.59) suggeststhat the surge in feed cost per kilogram weight gain of starters and pullets fed UDMOSC^{15E}(GHC 50.33) cannot be attributed to the cost of UDMOSC but their inability to make efficient use of feed as corroborated by Amevor[29]as well as the cost of the enzyme supplemented[30].The cost per kilogram body weight gainis economically effective when dietary inclusion of UDMOSC ispractised at the pullet production rather than the starter stage of growth due to the ability of the pullets to manage fibre and palatability of the feed better than the chicks.

CONCLUSION

Includinggraded levels of dietary UDMOSC depressed growth and affected the efficiency of feed utilisation but was economically viable at the pulletstage. Dietary endogenous enzymes did not influence growth performance positively and economically. Dietary Undefatted *Moringa oleifera* seed cakeis therefore recommended for the pullet stage at an inclusion level not exceeding 10 % inclusion level.

CONSENT

All authors declared that written informed consent was obtained from the approved parties for publication of this article.

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