Growth Performance and Economics of Production of finisher broiler chickens fed diets supplemented with *Moringa oleifera-Carica papaya* mix leaf meal.

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Abstract

Moringa oleifera and Carica papaya leaves contains some functional properties that may act as growth promoters, antimicrobial, anti-parasitic factors, immunomodulatory and anti-inflammatory agents for poultry. The use of these unconventional feedstuffs can boost productivity in poultry production. The study was therefore conducted to evaluate the effect of supplementation on growth performance and economics of production of finisher broilers on Moringa oleifera and Carica papaya leaf meal. In this experiment, a 28 day feeding trial was conducted at the Teaching and Research farm of the Department of Agriculture, Alex Ekwueme Federal University Ndufu Alike Ikwo, Ebonyi State, to evaluate the growth performance and economics of production Four diets containing 0, 2, 4 and 6% levels of Moringa and Carica leaf meal (MCLM) coded T_1 ($MCLM_0$), T_2 ($MCLM_2$), T_3 ($MCLM_4$) and T_4 ($MCLM_6$) respectively were fed to 72 finisher broiler chickens of the Agrited strain of five (5) weeks of age. The broiler chickens were divided into 4 groups of 18 chickens per treatment replicated 3 times with 6 birds per replicate. The treatment diets were randomly assigned to experimental stocks in Completely Randomized Design (CRD). Results indicate that growth rate (51.78-54.64g) and feed conversion efficiency (2.27-2.10) was highest at 4 and 6% levels of inclusion and significantly different from the control group. From the economics of production, cost of feed and percentage gross margin was highest in T_4 based diet. In view of the above result, Moringa oleifera and *Carica papaya leaf meal should be included in the diet of finisher broilers as a meal supplementation at 6% levels for optimum performance and profit maximization and reduction of the cost of production hence a booster to animal protein intake in Nigeria.*

Keywords: Growth response, production economics, *Moringa oleifera*, *Carica papaya*, dietary supplement

Performance de Croissance et Économie de Production des Poulets de Chair en Finition Nourris avec un Mélange de Farine de Feuilles de *Moringa oleifera* et *Carica papaya*

Résumé

Les feuilles de Moringa oleifera et Carica papaya contiennent des propriétés fonctionnelles qui peuvent agir comme des promoteurs de croissance, des facteurs antimicrobiens, antiparasitaires, immunomodulateurs et anti-inflammatoires pour la volaille. L'utilisation de ces ingrédients alimentaires non conventionnels peut améliorer la productivité dans la production avicole. L'étude a donc été menée pour évaluer l'effet de la supplémentation en farine de feuilles de Moringa oleifera et Carica papaya sur la performance de croissance et l'économie de production des poulets de chair en finition. Dans cette expérience, un essai alimentaire de 28 jours a été réalisé à la ferme pédagogique et de recherche du Département d'Agriculture de l'Université Fédérale Alex Ekwueme Ndufu Alike Ikwo, dans l'État d'Ebonyi, pour évaluer la performance de croissance et l'économie de production. Quatre régimes contenant respectivement 0, 2, 4 et 6 % de farine de feuilles de Moringa et Carica (MCLM) codés T_1 ($MCLM_0$), T_2 ($MCLM_2$), T_3 ($MCLM_4$) et T_4 ($MCLM_6$) ont été donnés à 72 poulets de chair en finition de la souche Agrited âgés de cinq (5) semaines. Les poulets ont été divisés en 4 groupes de 18 poulets par traitement, avec trois réplicats, soit 6 oiseaux par réplicat. Les régimes expérimentaux ont été attribués de manière aléatoire aux stocks expérimentaux selon un plan complètement randomisé (PCR). Les résultats indiquent que le taux de croissance (51,78-54,64g) et l'efficacité de conversion alimentaire (2,27-2,10)

étaient les plus élevés avec des niveaux de supplémentation de 4 et 6 % et étaient significativement différents du groupe témoin. D'un point de vue économique, le coût de l'aliment et la marge brute en pourcentage étaient les plus élevés avec le régime T_4. Au vu des résultats ci-dessus, la farine de feuilles de Moringa et Carica papaya devrait être incluse dans le régime des poulets de chair en finition en tant que supplément alimentaire à un taux de 6 % pour une performance optimale, une maximisation des profits et une réduction des coûts de production, contribuant ainsi à augmenter l'apport en protéines animales au Nigeria.

Mots-clés : Réponse de croissance, économie de production, *Moringa oleifera, Carica papaya*, supplément alimentaire.

Introduction

Nigerian population is growing at an alarming rate and this calls for the need to strengthen the productivity of the poultry industry for more sustainable meat and egg production (FAO, 2019). Nigerian poultry production is on the increase and is projected to hit 263,410 tons by 2026 showing a fantastic upward production shift from 251,550 metric tons in 2021 and therefore representing 0.8% average growth rate (Nigerian Poultry Market Data and Forecasts, 2023).This industry comprises about 169-184 million birds (Statista, 2023) –producing 600,000 tonnes of eggs and 300,000 tonnes of meat yearly (Agriculture and Food, 2020). Despite the fact that Nigeria has the largest annual egg production and second largest chicken population in Africa, there is still acute shortage of animal protein in the Nigerian populace. Globally, in 2022 and 2023, there was distortion of food and markets by heightened risks of tighter food availability, unmet input demand and higher International food prices orchestrated by Ukraine-Russian war (FAO, 2022).

A closer look at the Nigerian Livestock Industry speaks volume of the detrimental rise of commercial feeds, fuels and labour costs (Mosaku, 2023; NAN, 2023). The cost of chicken in recent times has skyrocketed due to high cost of production emanating from conventional feed ingredients even before the emergence of Russian-Ukraine crisis which exacerbated the situation. High production cost reduces the profit margin of poultry farmers and many poultry farms are at the vantage of closure. Looking inwards into alternative feed ingredients to replace conventional ones will boost economic prosperity and enhance animal protein supply in the country. It is on this line of thought that *Moringa oleifera* and *Carica papaya* leaf meals are considered as valuable ingredients with wonderful nutritional profiles that can be used to reduce the cost of poultry production in Nigeria. The combination of *Moringa* and *Carica* papaya leaves appears to improve animal performance and boost broiler bird's immune response (Gupta, 2017; Oloruntola *et al*.,2018).*Moringa* possesses antioxidant, antibacterial, antifungal, antiulcer, non-tumorous and possesses immune stimulant properties (Raza, 2021) while *Carica papaya* is the power house of papain, chymopapain A and B, and papaya peptidaseA (Hasanah *et al*.,2023).

Growth response and economics of production on MCLM will provides information about the nutritional impact, profitability, as well as the animal's metabolic state subjected to this potential ingredient *vis-à-vis*, guaranteeing its wholesome acceptability as a feed raw material. Moreover, the combination of *Moringa* and *Carica papaya* leaves in the feeding of broiler birds is a new innovation geared towards optimum utilization of the synergistic positive impacts of the two phytochemicals. Since *Moringa* and *Carica papaya* leaves have valuable phytochemical composition, they have the potential to become a new functional food/neutraceutical or supplement in the livestock industry. Therefore, this study is aimed at unlocking the nutritional potential of these leaf meals for use as supplements in broiler production.

Materials and methods

Location of study

This study was conducted at the Poultry Unit of the Teaching and Research Farm of the Department of Agriculture, Alex Ekwueme Federal University Ndufu-Alike, Ebonyi State which lies between latitude $06^{0}15^{'}$N and longitude $08^{0}5^{'}$E of the Greenwich meridian and Altitude of 55m. The annual rainfall is between 1000-1500mm. The vegetation of the area is

predominantly derived Savannah and mean annual temperature is about 28^0C while relative humidity is between 50-60% (Climate-Data, 2023).

Experimental diets and ration formulation

Preparation of Moringa and Carica papaya leaf meal

Fresh leaves of *Moringa oleifera* and *Carica papaya* were collected within Ndufu-Echara and Ndufu-Alike community of Ebonyi State. The leaves were chopped, spread on a clean tarpaulin separately and shade-dried for 4-7 days until they became crispy to touch after which they were milled in an attrition mill of model SK-30-SS food gradefitted with 2-mm sieve to produce *Moringa* carica leaf meal (MCLM) mix. The *Moringa* leaf meal (MLM) and Carica *papaya* leaf meal (CLM) were thoroughly mixed together in a ratio of 1:1 to form *Moringa* leaf and C*arica papaya* leaf meal composite mix (MCLM).The *Moringa* and *Carica papaya* leaf meal mix were therefore included at the levels of 0% (T_1), 2% (T_2), 4% (T_3) and 6% (T_4) as shown in Table 1respectively. The control diet (T_1) did not contain MCLM mix. The test ingredient was subjected to proximate analysis using the AOAC, (2016) and carbohydrate calculated by difference method.

Experimental animals

The broiler birds were weighed at the beginning of the experiment and body weight changes taken thereafter on weekly basis for 28 days. Daily feed intake was determined by obtaining the difference between the quantity of feed given and the quantity leftover. Feed conversion ratio wascalculated as feed intake/animal weight gain while the economic efficiency was computed as feed cost per kg body weight (FC/kg BW) accordingly.

Table 1: Ingredients and calculated nutrient composition of experimental diets (kg as fed basis)

Ingredients	**INCLUSION MCLM$_0$**	**LEVEL OF MCLM$_2$**	**MCLM MCLM$_4$**	**MCLM$_6$**
Maize	52.00	52.00	52.00	52.00
Soyabeam meal	14.00	14.00	14.00	14.00
Groundnut cake	15.00	15.00	15.00	15.00
MCLM	0.00	2.00	4.00	6.00
Wheat offal	7.00	6.50	4.50	3.50
Palm kernel cake	5.50	4.00	4.00	3.00
Fish meal	3.00	3.00	3.00	3.00
Bone meal	2.50	2.50	2.50	2.50
Salt	0.25	0.25	0.25	0.25
L-lysine	0.25	0.25	0.25	0.25
DL-methionine	0.25	0.25	0.25	0.25
Vit/mineral premix	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00
Calculated Analysis				
Energy(kcal/kg)	2847.75	2867.53	2880.64	2874.13
Crude protein (%)	20.177	20.417	20.655	20.196
Crude fibre (%)	5.60	5.80	5.70	6.00
Calcium (mg/dl)	0.90	1.00	1.20	1.10
Ash (%)	2.50	2.55	3.00	2.80
Phosphorus (mg/dl)	0.40	0.40	0.50	0.45
Riboflavin (nmol/L)	5.80	5.85	5.90	6.00

*Premix per kg of diet: Vitamin A – 15,000.00IU, Vitamin D3- 3, 000,000IU, Vitamin E- 30,000IU, Vitamin K- 3,000mg, Vitamin B1- 3000mg, Vitamin B2-6000mg, Vitamin B-5,000mg, Vitamin B12-40mg, Biotin- 200mg, Niacin-40,000mg, Pantothenic acid- 15,000mg, Folic acid- 2,000mg, choline-

300,000mg, Iron- 60,000mg, manganese- 80,000mg, copper- 25,000mg, Zinc- 80,000mg, cobalt- 150mg, iodine- 500mg, selenium- 310mg, Primary antioxidants- 20,000mg.
MCLM = *Moringa Carica papaya* leaf meal

Statistical analysis

Data obtained from the study were subjected to one-way analysis of variance (ANOVA) (Steel and Torrie (1987) using Statistical Package for Social Sciences version 23 (SPSS, 2015), while mean value variance at 95% confidence level (P≤0.05) were separated using Duncan's Multiple Range Test as outlined by Onu and Igwemma (2000).

Gross margin analysis

Gross margin is equal to the gross revenue minus total variable cost. It was calculated by the given formula as follows:

□□=∑□□□□−□□□□..1

Where: GM = Gross margin
□□ = Price per Kg of chicken
Yi = Total live weight in kilogram of chicken
Ci = Total variable cost incurred on bird
I…n = Total number of birds (Adeoti and Olawumi, 2013).

Results and discussion

Proximate analysis

Table 2: Proximate analysis of shade-dried *Moringa* and *Carica papaya* composite mix

Fractions	%
Dry matter	94.25
Crude protein	17.54
Ether extract	1.65
Ash	9.28
Crude fibre	22.76
Carbohydrate (NFE)	43.15
Energy value ((Kcal/kg)	2322.15

ME= Metabolizable energy calculated; ME (Kcal/kg) =37 × %CP+81 × %E.E+35 × %NFE (Pauzenga, 1985

The proximate composition of *Moringa* and *Carica papaya* leaf meal composite mix is presented in table 2. The ingredient contained 17.54% crude protein and 2322kcal/kg ME. The other fractions notably ether extract, crude fibre, ash, nitrogen free extract (NFE) recorded 1.65, 22.76, 9.28 and 43.15% respectively. The value of crude protein, ether extract, crude fibre and nitrogen free extract recorded in this study was lower than the value obtained by Zanu *et al.* (2012) who recorded 25.56, 3.33 and 47.25 for crude protein, ether extract and nitrogen free extract respectively in their study on possibilities of using *Moringa oleifera* leaf meal as partial substitute for fish meal in broiler chickens diets. However, Raza, (2021) reported that *Moringa oleifera* leaves on dry matter basis contain 27.2% protein, 38.60% carbohydrate, 17.10% fat and 5.9% moisture.

Growth performance

Table 3: Growth performance of finisher broiler chickens fed varying levels of air-dried *Moringa oleifera* and *Carica papaya* leaf meal supplementation

Parameters	**MCLM$_0$**	**MCLM$_2$**	**MCLM$_4$**	**MCLM$_6$**	**SEM**
Initial weight (g)	1340	1400	1310	1290	42.30
Final body weight (g)	2590^{d}	2660^{c}	2760^{b}	2820^{a}	65.90
Av. total weight (g)	1250^{b}	1260^{b}	1450^{b}	1530^{a}	96.70
Av. Daily weight gain (g)	44.64^{c}	45.00^{c}	51.78^{b}	54.64^{a}	2.80
Total feed intake (g)	3360^{a}	3248^{c}	3304^{b}	3220^{c}	45.40
Feed conversion ratio	2.68^{a}	2.57^{b}	2.27^{c}	2.10^{c}	0.20
Av. Daily feed intake (g)	120	116	118	115	1.30
Cost/kg feed (₦)	388	383	380	375	4.70
Cost of feed/kg weight gain (₦)	1043^{a}	987^{b}	866^{c}	789^{d}	135.60

Growth performance of finisher broilers (Table 3) is influenced by several factors such as the amino acid composition of the diet, the daily feed intake of the animal, the degree of dietary crude fibre in the ration, proper balance of nutrients (micro and macro) and the metabolizable energy derivable from the feed (;Alemneh and Getabalew, 2019; Thomas and Sastry, 2021).

Treatment 4(54.64g) at 6% inclusion level and treatment 3 (51.78g) at 4% inclusion level recorded the highest average daily weight gain which were however significantly different ($P<0.05$) from the control diet (44.64) and diet two (45.00) respectively. The final body weight (FBW), average daily weight gain and feed conversion ratio increased significantly ($P<0.05$) with the dietary inclusion of MCLM. These findings disagrees with the report of Zanu *et al*. (2012) that dietary increase of *Moringa* in broiler diets decreased weight gain and feed conversion ratio. Nevertheless, Du *et al*. (2007) observed no significant reductionin growth performance of 3 weeks old broilers (*Arbor Acres*) that were fed on diets substituted with 0.5, 1.0, 2.0 and 3.0% levels of *M. oleifera* leaf meal. In this present study, *Moringa oleifera* was combined with *Carica papaya* leaf meal to generate a composite mix and combining leaf meals enhances bioactivity, nutritional profile and health status of broiler birds (Hasanah *et al*., 2023). Weight gain is a function of feed utilization for the formation of adipose tissues. Increase in the growth rate of birds fed with MCLM based diets may be attributed to proper combination of supplements which due to their phytochemical inclination increases the productivity and health of chickens (Ewoola and Emenike, 2008). Moreover, the enzyme, *papain* in the *papaya* leaf has the potential to impact body weight gain due to its ability to enhance the digestion and absorption of nutrients, hence potentially leading to an increase in body weight (Hasanah *et al.*, 2023). Leaf meals are nutritionally proactive in the release of enzymes such as *chymopapain*, *papain*, and lipase which aids the breakdown and release of nutrients in rations leading to improved digestibility and increased efficiency in nutrient utilization (Kiha *et al*., 2012; Palanisamy and Basalingappa, 2020). The *papain* enzyme has the ability to decrease the viscosity of the intestine, leading to an increased number of smaller intestines and enhanced height of the villi. This positively influences the nutrient absorption of the intestinal villi ultimately leading to higher rate of body weight (Fitasari, 2011) as observed in T_4 (54.64g) and T_3 (51.78gm) respectively (Iheukwumere *et al.,* 2008; Isa, 2010; Oloruntola *et al.,* 2018).

Feed conversion ratio (FCR) in broiler production means the amount of feed which a broiler consumes to acquire a certain amount of weight or muscle. According to Sinurat *et al.* (2022) there is a positive correlation between the efficiency of livestock in converting feed into muscle form and the degree of the ration conversion value. In their experiment on the effect of papaya leaf meal on broiler productivity compared to other works. Hasanah *et al.* (2023) reported r FCR ranging from (1.62-1.82) while Banjoko *et a*l. (2020) recorded (2.19-2.2.9) compared to the present study range of (2.10-2.68). Finisher broilers on 6% ($MCLM_4$) recorded the best FCR of (2.10) while the control group recorded the poorest FCR of (2.68) as shown in Table 3. The lower the feed conversion ratio, the more efficient the animal is in converting feed to meat or other products. From the result, the FCR ratio increased ($P\leq0.05$) as dietary MCLM increased in the experimental diets. FCR of T_4 and T_3 is statistically the same ($P\geq0.05$) but different from T_1 and T_2. Conversion of feed to muscle is associated with adequate nutrient utilization occasioned by the relatively low dietary fibre and reduced anti-nutritional factors (NRC, 2012). The impact of treatment on the conversion value is equivalent to its impact on body weight, as feed conversion is influenced by feed consumption and body weight gain. Improvements in feed utilization efficiency will decrease the amount of feed required for broiler growth, which will directly lower production costs, boost profitability, and ultimately result in less manure being produced since feed makes up a significant component of total production expenses (Partha, 2023).According to Rahman(2022) a feed conversion ratio of 1.5 is ideal in broiler chicken performance while poor feed utilization is doubly costly since unutilized protein enters the hindgut and ferments into harmful biogenic amines and ammonium (Poultry World, 2022).

On daily feed intake, broiler birds in the control diet recorded the highest daily feed intake of (120g) (table 3) when compared with MCLM based diets with lowest average weight gain of 116g. The result of the present study aligns with the findings of Atuahene *et al.* (2008) who reported no significant effect of diets containing *Moringa* leaf meal at 0%, 2.5%, 5%, and 7.5% levels on feed intake of broiler chickens. However, these findings disagrees with the report of Banjoko *et al.* (2020) who observed reduced feed intake across treatment means when finisher broilers were fed with 200-600g of *C. papaya* leaf meal as a supplemental ingredient. The marginal feed intake observed across the MCLM based diets may be due to the optimum combination of the two phytochemicals as indicated in the report of Sharma and Gupta. (2015) and Sharma *et al.*, *(*2022) in their study on the importance of papaya leaf extract in human nutrition where it was extensively used to raise the nutritional composition of beverages, prepare nutraceuticals and herbal medicinal formulations..

Voluntary feed intake (VFI) has been shown to be influenced by such factors as growth rate of the animal, nutrient balance, energy content, crude protein levels, and chemical composition of the feed, texture and palatability (Kil *et al*., 2013).

Feed cost of the diets reduced significantly (P ≤0.05) as dietary levels of MCLM increased progressively. The cheapest cost (₦)/kg diet was obtained from T_4 (6%) with the value of N789 while the control diet T_1 (0% MCLM) recorded the highest value of N1,043. There were significant differences (P ≤0.05) among the control diet (T_1) and T_2, T_3 and T_4relative to feed cost.

Economics of production

Table 4: Economics of production of broiler finishers fed graded levels of sun-dried Moringaoleifera and Carica papaya leaf meal supplementation

Parameters	$MCLM_0$	$MCLM_2$	$MCLM_4$	$MCLM_6$	SEM
Cost/kg feed (₦)	388	383	380	375	10.80
Cost of feed consumed (₦)	1304^a	1244^b	1256^b	1208^c	32.60
Cost of feed/kg weight gain (₦)	1043^a	987^b	866^c	789^d	179.30
Cost of brooded bird (₦)	700	700	700	700	0.10
Operational cost (₦ /bird)	502	502	502	502	0.10
Cost of production (₦)	2506^a	2446^b	2458^b	2410^c	49.50
Total Revenue (₦)/bird	4250^c	3750^d	4500^a	4450^b	230.4
Gross margin (₦)	1744^b	1304^c	2044^a	2040^a	220.20
Percentage Gross Margin	41.04^b	34.77^c	45.42^a	45.84^a	4.63

The economics of production of finisher broiler birds fed *Moringa oleifera* and *Carica papaya* leaf meal dietary supplementation (Table 4) was estimated using the budgeting technique analysis (Chaudhry et al., 1995; Adeoti and Olawumi, 2013). The budget analysis involves the deduction of the total variable cost (Naira) from the total revenue of live birds (in Naira) to obtain the gross margin for each bird. The total variable costs of production are the cost of day old chicks, labour, feed, veterinary service, medication and other miscellaneous expenses. The analysis revealed that feed cost per kilogramme of the diets were highest in the control diet $MCLM_0$ compared with the MCLM based diets. The cost of production was also highest in the control diet (₦2,506) indicating lower gross profit margin of 41.04% while the profit margin of *Moringa oleifera* and *Carica papaya* leaf meal based diets ranged from 45.42-45.84% except T_2 birds that recorded lower margin (34.77%) respectively. Highest profit margin was recorded by T_4 fed 6% MCLM mix. This could be attributed to moderate value recorded for cost of diet per kg. According to Alawa and Ummuna(1993), economic optimization is one of the major reasons for the use of alternative feed. For a reasonable farmer, the primary objective could be efficient production at least cost to boost chance of profitability. This observation aligns with the findings of Augustine *et al*., (2019) and Ragab *et al.* (2012) who recorded similar cost reduction on the feeding of layers with processed sickle pod (*Sennaobtusifolia*) seed meal based diets.

Conclusion

This study has revealed that supplementation of *Moringa oleifera* and *Carica papaya* leaf meal at optimal levels will promote optimal performance of finisher broilers. Growth rate and feed conversion efficiency was highest at 4 and 6% levels of inclusion and significantly different from the control group. From the economics of production, cost of feed and percentage gross margin was highest in T_4 based diet. The results shows that T_4 (6% inclusion) performed better than other levels of inclusion.

Recommendation

In view of the above result, *Moringa oleifera* and Carica papaya leaf meal should be included in the ration of finisher broilers as a supplement at 6% level for optimum performance and production efficiency so as to make animal protein available at a reduced cost and maximized profit.

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