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Performance and Egg Production of Isa Brown Pullets Fed Diets with Groundnut Cake Protein Partially Replaced by Provitamin A Cassava Leaf Meal

By

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Abstract

This study investigated the impact of substituting groundnut cake protein with Pro-Vitamin-A Cassava Leaf Meals (PVACLM) on egg production and egg quality in layers. A total of 105 Isa Brown layers were used in this research, the birds where divided into 5 treatment groups of 21 birds per group. Each group was further divided into 3 replicates of 7 birds per replicate. Each group received diets with graded levels of PVACLM as a protein source varying from 0%, 5%,10% 15% and 20% represented as T1, T2, T3, T4, and T5 respectively, in a C completely R randomized D design. The experiment lasted for 30 weeks, and data on egg production parameters and egg quality were determined Layers fed diets containing 5% PVACLM showed similar egg production performance compared to the control group (0% PVACLM). However, when the level of PVACLM in the diet was increased to 15% and 20%, a significantly (P <0.05) increased egg production was observed. Layers in the 5% PVACLM group exhibited no significant differences in egg weight, shell thickness, compared to the control group, whereas higher levels of PVACLM (10% and 15%), slightly decreased egg weight and yolk height shell weight, yolk height and haugh unit increased with increased level of PVACLM. In conclusion, the partial substitution of groundnut cake protein with PVACLM up to 15% in layer diets appears to be a feasible and economically viable option, with no adverse effects on egg production and minimal impact on egg quality.

Keywords: *Groundnut Cake protein, Pro Vit. A Cassava Leaf, Pullets, Egg*

Introduction

The poultry industry is a vital sector of the economy, and egg production is a significant contributor to this industry. The industry is currently faced with a number of challenges, ranging from the availability of feed ingredients to the ability to produce high quality produce in a cost-effective manner. It has also been observed that the conventional feed stuffs such as maize, GNC, SBM etc. are very expensive and has led to increase in cost of production. These challenges results in low productivity and inefficiency in resource allocation and utilization (Ahaotu, 2018). The above backdrops led to the quest for alternative, non-conventional, readily available and cheaper feed stuffs such as cassava and its products. Cassava (Manihot esculenta) is an important tropical crop, widely grown for its starchy roots which are used for food, animal feed and industrial purposes. Though cassava is also becoming expensive too, but the leaves are readily available at little or no cost. Pro-vitamin-A Cassava leaf (Manihot esculenta) is a valuable source of also known as beta-carotene. Pro-vitamin A is essential for their overall health, as it plays a crucial role in maintaining good vision, promoting a strong immune system, and supporting proper growth and development Pro-vitamin-A Cassava leaf, in particular, is an excellent natural source of this essential nutrient for avian species (Herawati, Wibowo, and Kurnianingsih, 2009). When birds consume this leaf, their bodies can convert beta-carotene into active vitamin A as needed. This conversion is particularly important because many birds, such as poultry, pigeons, and songbirds, cannot synthesize vitamin A directly and must obtain it from their diet (Igiehon, and Ogbemudia, 2014). Cassava leaves are an attractive food source for birds due to their palatability and nutritional content. They are rich in protein, which is another critical component of a bird's diet, as it supports muscle growth, feather production, and overall vitality. The combination of pro-vitamin A and protein makes

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cassava leaf a well-rounded choice for avian nutrition (Hegsted, 1986). Cassava is a multipurpose plant that thrives well in the tropics, it is a very good energy source widely grown in Nigeria. It has a wide range of adaptability, resistance to drought and tolerance to poor soils (Tewe, 1994). Most available literature on cassava utilization in poultry centered on either the use of its root or leaf meal and its root sieviate (Tewe and Egbunike, 1992, Aderemi et al., 2000, Aderemi et al., 2006).

This paper looked at the effects of inclusion of pro-vitamin-A cassava leaf as a replacement to groundnut cake (GNC) in the diets of egg type and layers production. The output aimed at obtaining pro-vitamin-A cassava leaf rations that can be packaged for promotion to farmers' production/income in Nigeria and other tropical countries.

Materials and Methods Study Area

The research was conducted at the poultry unit of the teaching and research farm of Michael Okpara University of Agriculture, Umudike, Abia State. The university is located at latitude 05'27' North and longitude 07'32' East. The university area lies at an altitude of 122m above sea level. Umudike has ambient temperature of 22'c-37'c with annual rainfall of 2177 mm and relative humidity of above 50- 70%.

Experimental Animals and Management

Total of one hundred and five (105) Isa brown pullet birds were used for this research. The birds were divided into five treatment groups of 21 birds per group. Each group was further subdivided into 3 replicates of 7 birds per replicate in a completely randomized design. An experimental diet was given at the levels of 0%, 5%, 10%, 15% and 20% of pro-vitamin-A cassava leaf meal, representing T1 T2 T3 T4 and T5 respectively. The birds were brooded with starter mash for six weeks before grower mash containing the pro Vit. A cassava leaf meal was introduced. The research lasted for 30 weeks. Data Collection and Analysis Eggs were collected and counted on daily bases to determine the total numbers of eggs collected per day, per week and per month. Egg weight, egg width, Egg volume, Shell weight, Shell Thickness, Albumen Circumference, and Yolk Circumference were also measured.

Experimental Design

A completely randomized design (CRD) was used to carry out the experiment for all the treatments. The appropriate statistical method is as follows; Yij = µ + Di+ eij Where; Yiy= Single observation, µ= Overall mean, Di= Effect of diet, eij= Random error which is independently, normally distributed with zero mean and constant variance (eij = iind (0, Ɣ2))

Statistical Analysis

Data obtained were subjected to one way analysis of variance (ANOVA) as described by Steel and Torrie (1980). Significant difference between the means were separated by using Duncan's New Multiple Range Test (Duncan, 1955) and the level of significance was accepted at p

Results and Discussion

Table 1 below shows the experimental diet. The diets were divided into 5 groups which contain diets with graded levels of PVACLM as a protein source varying from 0%, 5%,10% 15% and 20% represented as T1,T2,T3,T4, and T5 respectively.

Table 1: EXPERIMENTAL DIET

INGREDIENT (%)	$T_{1(0\%)}$	$T_{2(5\%)}$	$T_{3(10\%)}$	$T_{4(15\%)}$	$T_{5(20\%)}$
Yellow maize.	47.00.	47.00.	47.00.	47.00.	47.00
Groundnut Cake.	16.20	15.39.	14.58.	13.77.	12.96
PVACLM	0.00	0.81	1.63	2.43	3.24
Palm ~~kernel~~ meal.	15.00.	15.00.	15.00.	15.00.	15.00
Wheat offal.	12.00.	12.00.	12.00.	12.00.	12.00
Bone meal.	3.00.	3.00.	3.00.	3.00.	3.00
Limestone.	6.00.	6.00.	6.00.	6.00.	6.00
L-lysine.	0.10.	0.10.	0.10.	0.10.	0.10.
DL methionine.	0.20.	0.20.	0.20.	0.20.	0.20
Salt.	0.25.	0.25.	0.25.	0.25.	0.25
Vitamin mineral premix	0.25.	0.25.	0.25.	0.25.	0.25
TOTAL.	100.00.	100.00.	100.00.	100.00.	100.00
			Calculated Analysis		
Crude protein.	16.73.	16.53.	16.32.	16.12.	16.00
ME/Kcal/kg.	2793.	2794.	2795.	2796.	2797

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Vitamin/Mineral premix (2.5kg) contains: Vit. A (12,500,000 I.U), Vit. D3 (2,500,000 I.U), Vit. E (40,000 mg), Vit. K3 (2,000 mg), Vit. B1 (3,000 mg), Vit. B2 (5,500 mg), Niacin (55,000 mg), Calcium Pantothenate (11,500 mg), Vit. B6 (5,000 mg), Vit. B12 (25 mg), Choline Chloride (500,000 mg), Folic Acid (1,000 mg), Biotin (80 mg), Manganese (120,000 mg), Iron (100,000), Zinc (80,000 mg), Copper (8,500 mg), Iodine (1,500 mg), Cobalt (300 mg), Selenium (120 mg), Anti-Oxidant (120,000 mg). PVACLM = Pro-vitamin-A Cassava leaf Meal

Table 2 shows the mean Egg Production Performance for all the treatments during the period of 20 weeks. There were no significant differences (P>0.05) in all the treatment groups in egg production except in Week 12, Week 15 and Week 18 where the highest number of eggs were layed in treatment group 5 in all the 3 weeks respectively. Despite the fact that there were no (P>0.05) significant difference in all other groups, T4 and T5 had the highest numerical values in all the treatment groups. Increased production with increased level of Pro-vitamin-A-Cassava leaf in their Diets was observed in this study. The result agrees with the work done by Rifat et al. (2023) who reported an increase in egg production with increased level of the test ingredients dietary Vit A. It also corroborates to the findings of Abdullah et al. (2018) who stated that Cassava Leaf Meal inclusion in layers diets led to improved in egg production. This could be attributed to sufficient levels of βeta-carotene and protein which influences egg laying performance, leading to increased egg production rate (Fitri et al., 2023).

Table 2: Egg Production Performance of Pullets fed Pro-vitamin-A Cassava Leaf Meal

WEEKS	T1	T2	T3	T4	T5	SEM
WK1	0.00	2.50	5.50	6.50	6.50	1.59
WK2	3.50	9.00	14.00	10.00	15.00	2.52
WK3	22.00	18.00	23.00	30.50	33.00	2.84
WK4	26.50	27.50	29.00	36.00	36.50	3.08
WK5	25.00	37.50	25.00	40.00	36.50	3.68
WK6	27.50	25.00	27.50	33.00	29.00	2.26
WK7	30.00	29.50	31.00	36.00	35.50	2.24
WK8	30.50	28.00	29.00	35.50	37.50	2.19
WK9	27.00	27.50	35.00	38.00	32.50	2.13
WK10	30.50	27.50	30.50	38.00	33.50	1.80
WK11	26.50	30.50	27.50	29.50	27.50	1.41
WK12	17.00[b]	28.00[ab]	26.50[ab]	32.00[ab]	34.00[a]	2.41
WK13	28.00	25.00	27.50	37.00	37.00	2.33
WK14	24.00	26.00	27.00	34.00	32.00	2.15
WK15	25.00[b]	25.50[ab]	21.00[b]	30.00[ab]	32.50[a]	1.64
WK16	33.50	20.50	23.50	33.50	32.00	2.39
WK17	25.00	24.50	27.50	28.50	35.50	2.31
WK18	25.00[b]	24.00[b]	27.50[ab]	34.00[ab]	34.50[a]	1.74
WK19	32.50	28.00	28.00	40.50	39.00	2.35
WK20	31.00	24.50	33.00	41.50	35.50	2.47

[abc]Means with different superscripts ([abc]) in a row indicates significan~~tly~~ differences (P<0.05); SEM = Standard Error of Mean

Table 3 showed no significant difference (P>0.05) across the treatment groups in Egg width. The result agrees with the findings of Abdullah et al., (2018) and Nworgu et al., (2020) who reported that Cassava Leaf Meal had no negative effect on egg size.

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Table 3: The mean Egg width of layer birds fed Pro-vitamin-A Cassava Leaf Meal

Parameters	$T_{1\ (0\%)}$	$T_{2\ (5\%)}$	$T_{3\ (10\%)}$	$T_{4\ (15\%)}$	$T_{5\ (20\%)}$	SEM
Week 20	41.72	40.19	40.78	43.05	41.59	0.77
Week 21	41.57	42.70	40.91	43.650	40.88	1.17
Week 22	43.83	43.42	43.93	45.09	44.99	3.02
Week 23	34.3	31.3	31.3	39.7	29.9	11.1

SEM = Standard Error of Mean

Table 4 showed no significant difference (P>0.05) observed among all treatment groups during the period of the four week. Larger eggs generally have larger volumes, although disparities can occur which can lead to other factor such as shell thickness and internal egg components to playing a major role (Abiola et al., 2008). The result of this study also agrees with the findings of Abdullah et al., (2018) and Nworgu et al. (2020).

Table 4: The mean Egg volume of layer birds fed Pro-vitamin-A Cassava Leaf Meal

Parameters	$T_{1\ (0\%)}$	$T_{2\ (5\%)}$	$T_{3\ (10\%)}$	$T_{4\ (15\%)}$	$T_{5\ (20\%)}$	±SEM
Week 20	46.00	42.50	47.00	56.50	49.00	3.24
Week 21	43.75	55.50	42.75	52.67	54.00	5.13
Week 22	50.60	41.00	48.00	50.50	54.00	3.82
Week 23	48.00	47.50	41.80	52.50	50.50	6.04

SEM = Standard Error of Mean

Table 5 shows Shell weight of layers fed Pro-vitamin-A Cassava Leaf Meal. The result shows significant difference in week 20, with the highest value (7.55) seen in T4, followed by T1 (7.09), T3 (7.02) and T5 (6.26), while the least value was recorded in T2. There was no significant difference (P>0.05) in all other treatment groups from week 21st to week 23rd. Shell weight was not negatively affected in this study, which were also the findings of Adullah et al. (2018) and Nworgu et al., (2020). Although Iji et al., (2008) stated that higher inclusion of PVACLM had some limitations on the egg shell weight. The increase in shell weight in week 20 could be as a result of the nutritive value of PVACLM which increased the weight of the egg shell.

Table 5: The mean Egg Shell weight of layer birds fed Pro-vitamin-A Cassava Leaf Meal

Parameters	$T_{1\ (0\%)}$	$T_{2\ (5\%)}$	$T_{3\ (10\%)}$	$T_{4\ (15\%)}$	$T_{5\ (20\%)}$	±SEM
Week 20	7.09^{ab}	5.74^{b}	7.02^{ab}	7.55^{a}	6.26^{ab}	0.30
Week 21	6.83	7.07	6.59	7.39	5.96	0.37
Week 22	6.66	6.76	7.12	7.21	7.54	0.60
Week 23	7.14	6.69	7.69	6.05	6.76	0.71

^{abc}Means with different superscripts (^{abc}) in a row indicates significan~~tly~~ differences (P<0.05); SEM = Standard Error of Mean

Table 6 shows the egg shell thickness of layer birds fed Pro-vitamin-A Cassava Leaf Meal. There was no significant different (P>0.05) observed in all treatment-group. The egg shell thickness was not significantly (P>0.05) affected in this study, which were was also in agreement with the findings of Adullah *et al.* (2018) and Nworgu *et al.*(2020). Iji *et al.*(2008) stated that higher inclusion of PVACLM had some limitations on the egg shell thickness

Table 6: The mean egg shell thickness of layer birds fed Pro-vitamin-A Cassava Leaf Meal.

Parameters	$T_{1\ (0\%)}$	$T_{2\ (5\%)}$	$T_{3\ (10\%)}$	$T_{4\ (15\%)}$	$T_{5\ (20\%)}$	±SEM
Week 20	0.36	0.35	0.350	0.36	0.34	0.03
Week 21	0.33	0.41	0.38	0.36	0.37	0.02
Week 22	0.40	0.39	0.42	0.36	0.39	0.03
Week 23	0.30	0.42	0.44	0.34	0.36	0.04

SEM = Standard Error of Mean

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Table 7 shows the Albumen weight of layer birds fed Pro-vitamin-A Cassava Leaf Meal. There were no significant differences (P>0.05) in all the treatment groups and in all the weeks tested. The results corroborate with that of Adullah *et al*. (2018) which reported no significant effect on albumin level of layers fed CLM. The albumen, rich in high-quality proteins, contributes to the overall nutritional value of the egg, supplying essential amino acids crucial for various physiological functions. In culinary contexts, albumen weight influences the texture and structure of baked goods (Roberts, 2004). The assessment of albumen weight, along with other parameters, serves as an indicator of egg freshness and quality. Factors such as egg age, hen breed, and nutrition can influence albumen weight, impacting both the nutritional content and culinary outcome of the egg. The result shows that PVACLM have a good nutritive value.

Table 7: The mean albumen weight of layer birds fed Pro-vitamin-A Cassava Leaf Meal

Parameters	$T_{1\,(0\%)}$	$T_{2\,(5\%)}$	$T_{3\,(10\%)}$	$T_{4\,(15\%)}$	$T_{5\,(20\%)}$	±SEM
Week 20	30.93	26.44	28.19	28.89	20.88	5.38
Week 21	34.17	35.54	36.27	40.44	37.51	4.00
Week 22	33.77	31.02	45.87	29.36	36.06	5.10
Week 23	28.58	29.28	28.02	28.31	36.02	5.78

SEM = Standard Error of Mean

Table 8 shows the mean yolk weight of layer birds fed Pro-vitamin-A Cassava Leaf Meal. There was no significant difference (P>0.05) among the treatment groups. However, T1 (12.98 and 12.74) had the lowest in weeks 1 and 3 while also having the highest (18.33) in week 2. T4 (19.9) had the highest value in week 1 and also the lowest (11.88) in week 4. In week 3, the highest value was seen in T2 (14.28). This result concurs with the work of Nworgu et al. (2020) who reported no adverse effect on egg qualities in layers fed cassava leaf meal---. The numerical improvement in treatments with inclusion of PVACLM agrees with the findings of Abdullah et al. (2018) who stated that CLM improves egg qualities. This could be attributed to the nutritive value of PVACLM and also the age at which the leaves were harvested as younger leaves have more nutritive value.

Table 8: The mean egg yolk weight of layer birds fed Pro-vitamin-A Cassava Leaf Meal

Parameters	$T_{1\,(0\%)}$	$T_{2\,(5\%)}$	$T_{3\,(10\%)}$	$T_{4\,(15\%)}$	$T_{5\,(20\%)}$	±SEM
Week 20	12.98	17.21	13.51	19.90	15.94	1.91
Week 21	18.33	15.49	17.93	14.59	14.49	1.47
Week 22	12.74	14.28	12.75	12.93	13.19	0.68
Week 23	14.15	13.27	14.16	11.88	13.71	0.73

SEM = Standard Error of Mean

Table 9 shows the mean albumen height of layer birds fed Pro-vitamin-A Cassava Leaf Meal. There was no significant difference (P>0.05) observed in all treatment groups over the 4 weeks. Albumen height is a crucial indicator of egg freshness and quality (Roberts, 2004). This shows that PVACLM has no significant effect on albumen height. This finding corroborates with the report of Abdullah et al. (2018) and Nworgu et al. (2020).

Table 9: The mean Albumen height of layer birds fed Pro-vitamin-A Cassava Leaf Meal

Parameters	$T_{1\,(0\%)}$	$T_{2\,(5\%)}$	$T_{3\,(10\%)}$	$T_{4\,(15\%)}$	$T_{5\,(20\%)}$	±SEM
Week 20	7.04	6.63	6.73	7.40	6.75	1.52
Week 21	6.43	8.68	5.68	6.89	7.49	1.04
Week 22	8.41	9.39	9.48	10.48	8.07	1.34
Week 23	7.74	8.95	8.79	7.96	10.57	2.02

SEM = Standard Error of Mean

Table 10 shows the Yolk Height of layer birds fed Pro-vitamin-A Cassava Leaf Meal. There was significant difference (P0.05) difference, but was significantly (P0.05) observed in all treatments. This result corroborates with the findings of Ogundeji and Akinfala, (2020) who stated that Cassava Plant Meal had no negative effect on egg qualities. The evaluation of yolk weight, height, and circumference collectively aids in assessing the nutritional density and market value of the egg. Changes in these parameters over time may indicate variations in egg quality or the impact of factors such as hen diet and age (Jones et al., 2006).

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Table 10: The mean Yolk Height of layer birds fed Pro-vitamin-A Cassava Leaf Meal

Parameters	$T_{1\ (0\%)}$	$T_{2\ (5\%)}$	$T_{3\ (10\%)}$	$T_{4\ (15\%)}$	$T_{5\ (20\%)}$	±SEM
Week 1	12.63	15.00	15.15	15.01	15.23	0.53
Week 2	9.80^{b}	18.46^{a}	12.87^{ab}	14.02^{ab}	16.96^{a}	1.033
Week 3	16.90	14.79	17.29	20.06	15.77	3.14
Week 4	14.95	16.69	13.47	15.01	16.05	2.00

^{abc}Means within row with different superscripts are significantly different (P<0.05); SEM = Standard Error of Mean

Table 11 shows the Albumen circumference of layer birds fed Pro-vitamin-A Cassava Leaf Meal. In all treatments across the 4 weeks, there was no significant difference (P>0.05) observed, although there was slight variation in values. In week 1, T1 (88.33) was the highest in value while T2 (84.10) was the lowest, in week 2 T4 (90.12) and T2 (83.64) were the highest and lowest respectively. In week 3, T3 (96.27) and T2 (90.23) were the highest and lowest respectively. In week 4, the highest and lowest values were observed in T2 (94.71) and T4 (86.43) respectively.

The findings of this study are in agreement with that of Abdullah *et al*. (2018) who reported no significant difference in albumen parameters. Albumen circumference is the measurement of the width of the egg white. It is another parameter used in the evaluation of egg quality. Together with albumen height, it provides insights into the structural properties of the egg white (Jones *et al*., 2006; Zhang *et al*., 2017)

Table 11: The mean Albumen circumference of layer birds fed Pro-vitamin-A Cassava Leaf Meal

Parameters	$T_{1\ (0\%)}$	$T_{2\ (5\%)}$	$T_{3\ (10\%)}$	$T_{4\ (15\%)}$	$T_{5\ (20\%)}$	±SEM
Week 20	88.33	84.10	84.59	84.70	86.06	1.87
Week 21	84.24	83.64	87.01	90.12	88.5	7.94
Week 22	93.57	90.23	96.27	95.82	90.90	3.78
Week 23	88.65	94.71	87.95	86.43	87.31	4.17

SEM = Standard Error of Mean

Table 12 shows the Yolk Circumference of layer birds fed Pro-vitamin-A Cassava Leaf Meal. There was no significant difference (P>0.05) observed in all treatments across the groups in the 4 weeks. But in values, T5 (37.52) and T4 (33.39) had the highest and lowest respectively. In week 2, T5 (32.7) and T4 (45.05) were the lowest and highest respectively. T4 (40.96) and T3 (29.72) were the highest and lowest respectively in week 3. In week 4, T5 (37.18) and T3 (25.35) were the highest and lowest respectively.

Nworgu *et al*. (2020) in a similar study stated that CLM had no adverse effect on Egg Yolk. This result could be attributed to the presence of βeta carotene in Cassava Leaf.

Table 12: The mean Yolk Circumference of layer birds fed Pro-vitamin-A Cassava Leaf Meal

Parameters	$T_{1\ (0\%)}$	$T_{2\ (5\%)}$	$T_{3\ (10\%)}$	$T_{4\ (15\%)}$	$T_{5\ (20\%)}$	±SEM
Week 20	35.09	35.37	34.72	33.39	37.52	3.43
Week 21	33.86	38.27	37.12	45.05	32.70	4.32
Week 22	34.20	39.65	29.72	40.96	33.17	5.74
Week 23	30.24	34.65	25.35	35.45	37.18	7.36

SEM = Standard Error of Mean

Table 13 shows the Haugh unit of layer birds fed Pro-vitamin-A Cassava Leaf Meal. Significant difference (P0.05) observed in weeks 20,21,22 and 23.The mean haugh unit of the layers in this study, though did not any significant (P>0.05) difference, is higher numerically in the diets with PVACLM than that of the control. This result agrees with the findings of Nworgu et al. (2020) and Abdullah et al. (2018) who reported that CLM did not negatively affect internal egg quality parameters such as Haugh unit and albumen height.

Table 13: The mean Haugh unit of layer birds fed Pro-vitamin-A Cassava Leaf Meal

Parameters	$T_{1\ (0\%)}$	$T_{2\ (5\%)}$	$T_{3\ (10\%)}$	$T_{4\ (15\%)}$	$T_{5\ (20\%)}$	±SEM
Week 20	110.95	119.20	119.11	117.82	119.24	1.60

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Week 21	100.02^{c}	126.66^{a}	111.86^{bc}	114.15^{ab}	124.13^{ab}	2.52
Week 22	123.54	115.68	124.12	130.64	118.63	8.78
Week23	117.74	123.06	114.18	119.34	121.43	5.53

^{abc}Means within row with different superscripts are significantly different (P<0.05); SEM = Standard Error of Mean

CONCLUSION AND RECOMMENDATION

In conclusion the egg weight, egg length, egg width, egg volume, shell thickness, albumen weight, yoke weight, albumen height, albumen circumference, and yolk circumference were not significantly influenced by Pro-vitamin-A Cassava Leaf Meal in layer birds. However, Pro-vitamin-A Cassava Leaf Meal significantly influenced egg production, at higher inclusion level (15%) as observed in weeks 12, 15 and 18. It is therefore recommended that the test ingredients could be used at 15% inclusion level for optimum production as it appears to be a feasible and economically viable option, with no adverse effects on egg production.

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