EGG QUALITY CHARACTERISTICS OF DOMESTIC LAYING HENS FED VARYING LEVELS OF PROCESSED TANNIA COCOYAM MEAL *(Xanthosoma sagittifolium)* AS ENERGY SOURCE

H. A. Abdulmumin[1], G. T. Iyeghe-Erakpotobor[2], M. Abdulrashid[3], A. Musa[3], I. Abdullahi[2], O. M. Daudu[3] and U. A. Umar[2]

Corresponding author: abdulmuminal99@gmail.com, +2348105819540

[1]Department of Animal Science, Federal University, Dutse

[2]National Animal Production Research Institute, Zaria

[3]Department of Animal Science, Ahmadu Bello University, Zaria

ABSTRACT

The study was conducted to evaluate the effect of cocoyam-based diet on egg quality characteristics of laying chickens. A total of 140 day old commercial chicks (Shika Brown) were allotted to seven dietary treatments (n=20 birds) in a factorial arrangement 2×3+1; 2 factors (raw and boiled cocoyam), 3 levels (25%, 50% and 75%) and 1 control 0% in a completely randomized design, 80 chicks for raw sun dried (RS) cocoyam and 80 chicks for boiled sun dried (BS) cocoyam. The rate of cocoyam inclusion comprises 4 diets from RS and another 4 from BS cocoyam, each replaced maize 0%, 25%, 50%, and 75% as T_1, T_2, T_3 and T_4 respectively. During the 12 months experimental period, the birds were given feed and water *ad libitum* and routine vaccinations/medications were administered appropriately. Data collected were subjected to analysis of variance and significant differences among treatments means were compared using Tukey test. The result of internal and external quality showed that egg weight and shell weight were found to decrease ($p<0.05$) with increased cocoyam levels, highest value was recorded at 0% level (55.73g and 5.24g, respectively). Albumen weight and yolk weight were also found to decrease ($p<0.05$) with increased cocoyam levels. However, with BS cocoyam, egg qualities were found to be better ($p<0.05$) with increased BS cocoyam t compared to RS cocoyam. Different response was observed in egg quality parameters in birds fed RS and BS cocoyam. It was concluded that up to 75% raw sundried cocoyam could be used in feeding laying chickens without deleterious effect on egg quality. For boiled cocoyam, lower level (50%) was required for better egg quality.

Keywords: Cocoyam, Shika Brown, Raw sundried, boiled sundried, egg quality

INTRODUCTION

There is an urgent need to explore a cost-effective avenue to enhance egg production and egg quality characteristics by using non-conventional feed resources to improve physiological responses in domestic laying chicken. Besides, limitations imposed by scarcity of maize and competition with human consumption have necessitated exploiting alternative sources of energy for poultry feed formulation, such as farm by products (maize straw, cocoa husk, maize-cob). Abdulrashid and Agwunobi (2009) revealed that cocoyam meal with proper processing will effectively replace maize at 50% level of inclusion as a major source of energy in finishing diet of broiler birds for maximum profit. However, its use in the feeding of monogastric animal could be encumbered by the presence of some anti-nutritional factors (calcium oxalate, saponin, tannins and trypsin inhibitions) which adversely affect protein and energy utilization in broilers (Onu *et al*., 2004).The ability of a processing technique to reduce the anti-nutritional factors present in any feedstuff to safe levels or improve its utilization potential will thus justify its continued use as a processing method in livestock feed processing. Therefore, it is imperative to investigate the effect cocoyam-based diet on the egg quality characteristics of laying pullets.

MATERIALS AND METHODS

Study Area: The study was carried out at the Poultry Research Program Section of the National Animal Production Research Institute, Shika, Zaria Nigeria.

Experimental Animals and Management: A total of 160 day-old layer chicks (Shika Brown) were used in this study. Birds were procured from hatchery section at artificial insemination unit of National Animal Production Research Institute, Shika (NAPRI), Zaria. They were raised on litter (wood shavings) of good absorbent quality and brooded for the period of two weeks at mean temperature of 35ºC. The chicks were vaccinated with intraocular vaccines against Newcastle Disease (ND) and to induce cross-reactive serum and mucosal antibody responses. Feed was given based on the nutritional requirement of the bird as starter, grower or layer. All vaccination schedules and management procedures were followed. Feed and water were provided *ad-libitum*.

Procurement and Processing of Cocoyam (*Xanthosoma sagittifolium*)

Cocoyam (*Xanthosoma sagittifolium*) corms were purchased at Dal market, Sumaila local government, Kano state. The cocoyam was clean from sand and external fibres manually using hand followed by chopping using knife. The chopped cocoyam corms were subjected to two different processing methods as a means of improving its nutritive value i.e raw[H1][h2] & sundried (RS) and boiled & sundried (BS). The method of Uchegbu *et al.* (2010) was used in preparing the sundried cocoyam meal. Cleaned cocoyam corms were sliced and spread on an even surface to sundry. Sun drying was done for five consecutive days until crisp textured. Chopped cocoyam corms were immersed in 75 liters of boiling water at 100ºC inside aluminum pot and allowed to boil continuously for fifteen minutes, cooled, drained and dehydrated. This method was previously described by (Olajide, 2010).

Experimental Diets and Design

A total of one hundred and fourty day-old layer chicks were sourced from incubation section at artificial insemination unit of National Animal Production Research Institute, Shika, Zaria and allocated into seven dietary treatments (n=20 birds) in a factorial arrangement 2×3+1; 2 factors (raw and boiled cocoyam), 3 levels (25%, 50% and 75%) and 1 control 0% in a completely randomized design 80 for raw cocoyam and 80 for boiled cocoyam. Seven experimental diets were formulated, comprising 3 diets from raw sundried and another 3 from boiled sundried form and control, each replaced maize 0%, 25%, 50%, and 75% as treatment 1 (T_1), treatment 2 (T_2), treatment 3 (T_3) and treatment 4 (T_4) respectively.

Egg Quality Parameters

Egg quality parameters were calculated using the following formulas and methods as summarized by Yoruk *et al.* (2004), egg shape index (%) = (egg width, cm/egg length, cm) × 100; The egg length (L) and width (W) were measured using Vernier calipers with the least count of 0.01 mm; shell thickness (mm) was determined in 3 different parts with a micrometer; albumen index (%) = (albumen height, mm/average of albumen length, mm and albumen width, mm) × 100; yolk index (%) = (yolk height, mm/yolk diameter, mm) × 100; yolk colour was determined with a commercially available "yolk colour fan" according to the CIE standard colourimetric system (Yolk Colour Fan, the CIE standard colourimetric system, F. Hoffman-La Roche Ltd., Basel, Switzerland), and Haugh unit = $100 \times \log(AH + 7.57 - 1.7 \times EW^{0.37})$, where AH = albumen height (mm) and EW = egg weight (g) (Haugh, 1937).

Egg weight was measured by placing an unbroken egg on a scale and recording the value. The individual eggs were weighed on a digital balance (Ohaus EX45 Explorer) to the nearest of 0.01 g accuracy. According to USDA (2000), egg weights were divided into six size categories. The minimum weight requirements for these categories are jumbo (68.6 g), extra-large (61.5 g), large (54.4 g), medium (47.3 g), small (40.3 g) and peewee (no minimum requirement), eggs were graded based on the category fallen.Albumen weight was calculated by subtracting yolk weight and shell weight from egg weight. Eggshell weight was determined after drying and weighing on digital scale. Albumen and yolk height were evaluated with vernier caliper. Yolk length and albumen length was evaluated using vernier caliper. Egg shell colour will be obtain using a scale of 1-5 range with 1; been excellent in brown shell colour, 2; very good, 3; good, 4; poor and 5; been very poor in brown egg shell colour.

Statistical Analysis and Model

The data were analysed by 2×3+1 factorial in completely randomize design (CRD) by a general linear model (GLM) procedure in SAS (2009) software 9.4 Version (SAS Institute Inc., Cary, NC, USA). Means were separated using Tukey test at 5% level of significance.

RESULTS AND DISCUSSION

Effect of cocoyam (*Xanthosoma sagittifolium*) processing methods and levels as well as the interaction on internal and external qualities of eggs in laying hens

Higher albumen height indicates better quality of the egg in terms of freshness and foaming ability. The values on albumen height were better with birds fed raw and boiled cocoyam than the control, this indicates that cocoyam and selenium can be incorporated in laying birds diet and as well improve the quality of the egg with respect to albumen height. However, albumen length was found to decrease with increase in level of cocoyam in the diet. This is at contrary with the report of Okwonko (2020) who says albumen length increased ($P<0.05$) as cocoyam corn meal increased in the diet. Albumen weight was also found to decrease with increased level of cocoyam in the diet. This could be due decrease in energy and protein level in the diet required for egg formation due to the residual effect of anti-nutritional factors specifically Tannin and Phytase. The yolk height was significantly better in control when compared to other treatments ($p<0.05$). Eggs with higher yolk height indicate better egg quality and fresh egg. Decrease in yolk height could be due residual effect of anti-nutrient of factors present in cocoyam

corms. Yolk length and yolk weight were found to be significantly ($p<0.05$) better with control compared to other treatments.

Table 1: Effect of cocoyam (*Xanthosoma sagittifolium*) processing methods and levels on eggs internal and external qualities of laying hens

	Processing					Level of cocoyam (%)					
Parameters	**Control**	**Raw**	**boiled**	**SEM**	**Pval**	**0**	**25**	**50**	**75**	**SEM**	**Pval**
Internal											
Albumen H(cm)	0.75^{b}	0.78^{a}	0.78^{a}	0.005	0.0062	0.77	0.80	0.79	0.79	0.005	0.0966
Albumen L(cm)	7.97	7.89	8.01	0.031	0.2391	8.22^{a}	7.19^{b}	7.20^{b}	7.12^{c}	0.027	0.0001
Albumen Wt(g)	31.26	30.93	31.53	0.123	0.1006	31.90^{a}	28.81^{b}	29.40^{b}	29.50^{b}	0.117	0.0001
Albumen W(cm)	6.90^{a}	6.66^{c}	6.85^{b}	0.019	0.0001	6.81^{b}	6.73^{c}	6.60^{d}	6.87^{a}	0.019	0.0075
Albumen I (%)	9.58	10.06	9.94	0.083	0.0726	9.46^{c}	11.29^{a}	11.07^{b}	11.23^{ab}	0.079	0.0001
Yolk H (cm)	1.78	1.79	1.78	0.005	0.3722	1.81^{a}	1.69^{c}	1.72^{b}	1.71^{b}	0.005	0.0001
Yolk L (cm)	3.93	3.96	3.97	0.008	0.1435	4.02^{a}	3.75^{b}	3.77^{b}	3.75^{b}	0.008	0.0001
Yolk Wt (g)	15.04	15.15	15.28	0.074	0.4362	15.77^{a}	13.10^{c}	13.47^{b}	13.60^{b}	0.065	0.0001
Yolk Colour	3.63^{c}	4.02^{b}	4.21^{a}	0.065	0.0023	4.56^{a}	2.13^{c}	2.15^{c}	2.54^{b}	0.056	0.0001
Yolk I (%)	45.49	45.40	44.88	0.124	0.0894	45.15	45.20	45.67	45.55	0.124	0.5939
Haugh unit(Hu)	59.50	62.00	64.50	0.832	0.5634	59.50	62.00	63.56	66.50	0.723	0.5110
External											
Egg L (cm)	5.56^{b}	5.54^{b}	5.61^{a}	0.010	0.0034	5.63^{a}	5.39^{b}	5.41^{b}	5.42^{b}	0.009	0.0001
Egg W (cm)	4.22	4.18	4.17	0.006	0.9140	4.21^{a}	4.07^{c}	4.08^{bc}	4.09^{b}	0.006	0.0001
Shell T (mm)	0.49	0.48	0.48	0.002	0.4247	0.49^{a}	0.46^{b}	0.46^{b}	0.46^{b}	0.002	0.0001
Shell W (g)	5.24	5.19	5.16	0.023	0.4421	5.24^{a}	5.01^{c}	5.07^{b}	5.08^{b}	0.023	0.0066
Egg SI (%)	75.16^{b}	75.58^{a}	74.68^{c}	0.136	0.0152	75.00	75.52	75.46	75.69	0.136	0.3553
Shell Colour	2.20^{a}	2.17^{a}	2.03^{b}	0.029	0.0388	2.14^{b}	2.21^{a}	1.78^{c}	2.25^{a}	0.029	0.0025
Egg Wt (g)	53.94	54.06	54.71	0.196	0.2246	55.73^{a}	49.26^{c}	49.93^{c}	50.51^{b}	0.176	0.0001

^{a,b,c,d,e}Means within the rows with different superscripts are significantly different ($p<0.05$)
Cntrol= control; Pval= probability value; SEM= standard error of mean; H=height; L=length; Wt=weight; W=width; I=index; T=thickness

Table 2: Interaction effect of cocoyam (*Xanthosoma sagittifolium*) processing methods and levels on internal and external qualities of eggs in laying hens

Processing	**Control**	**Raw cocoyam**			**Boiled cocoyam**				
Treatment	**0**	**25**	**50**	**75**	**25**	**50**	**75**	**SEM**	**P value**
Internal									
Albumen Height (cm)	0.78	0.79	0.80	0.75	0.81	0.78	0.82	0.005	0.0828
Albumen Length (cm)	8.23^{a}	7.24^{c}	7.35^{b}	7.10^{ef}	7.14^{de}	7.06^{f}	7.14^{de}	0.026	0.0267
Albumen Weight (g)	31.94^{a}	28.58^{e}	29.78^{c}	28.31^{e}	29.03^{d}	29.03^{d}	30.69^{b}	0.115	0.0483
Albumen Width cm	6.68	6.62	6.58	6.63	6.83	6.618	7.12	0.019	0.0838
Albumen Index (%)	9.64^{d}	11.03^{bc}	10.95^{c}	10.74^{c}	11.56^{a}	11.18^{b}	11.71^{a}	0.079	0.0417
Yolk Height (cm)	1.84	1.71	1.73	1.68	1.67	1.71	1.74	0.005	0.0968
Yolk Length (cm)	4.05	3.75	3.81	3.76	3.74	3.73	3.73	0.007	0.0793
Yolk Weight (g)	16.07^{a}	13.08^{c}	13.72^{b}	13.17^{c}	13.11^{c}	13.22^{c}	14.03^{b}	0.063	0.0113
Yolk Colour	4.90^{a}	2.08^{e}	2.17^{e}	2.50^{b}	2.17^{e}	2.14^{e}	2.58^{b}	0.052	0.8585
Yolk Index (%)	45.50^{c}	45.69^{b}	45.39^{c}	44.54^{d}	44.71^{d}	45.95^{b}	46.56^{a}	0.123	0.0047
Haugh unit (Hu)	59.50	62.00	63.56	66.50	62.00	64.50	64.50	0.832	0.563
External									
Egg Length (cm)	5.60^{a}	5.37^{c}	5.47^{b}	5.38^{c}	5.41^{c}	5.36^{c}	5.46^{b}	0.009	0.0121
Egg Width (cm)	4.23	4.06	4.08	4.06	4.07	4.08	4.12	0.006	0.4957
Shell Thickness (mm)	0.50	0.45	0.46	0.46	0.46	0.46	0.46	0.002	0.8604
Shell Weight (g)	5.23	5.06	5.14	5.17	4.97	5.00	5.00	0.023	0.6097
Egg shape index (%)	75.69^{b}	75.76^{b}	74.74^{d}	75.61^{b}	75.28^{c}	76.18^{a}	75.76^{b}	0.135	0.0144
Shell Colour	2.17	2.31	1.92	2.25	2.11	1.64	2.25	0.029	0.7861
Egg Weight (g)	56.29^{a}	49.56^{d}	50.39^{c}	48.86^{d}	48.97^{d}	49.47^{d}	52.17^{b}	0.172	0.0512

^{a,b,c,d,e,f}Means within the rows with different superscripts are significantly different ($p<0.05$)
SEM=standard error of mean; P=probability

This showed that birds fed the control had higher egg weight. This might be due to higher plain of nutrition received when fed the control diet as when compared to the other treatment. From the result of this study, yolk length and yolk weight are positive correlated and this also similar with yolk weight and albumen weight. This varies with reports of Abang *et al*. (2017) & Essien and Ekanem (1990) who noted that, albumen weight is negatively correlated with the yolk weight in Japanese quails fed fermented taro cocoyam.

Shell thickness was found to be better with the control when compared to other treatments levels. This could be due to residual effect of anti-nutritional factors present in cocoyam corms. This was also confirmed by Boakye *et al*. (2016) who reported that high calcium oxalates and other anti-nutritional factors in the cocoyam corms affect the corm palatability conferring acidity and other bitter astringent taste which cause health hazards to human beings and poultry if not well processed. In addition, Abang *et al.* (2017) showed that shell thickness of quails fed control diets and 25% inclusion levels of cocoyam had significantly ($P<0.05$) thicker shells than quails fed other diets. Shell weight was also found to be higher with the control when compared to other treatment levels. Egg weight was found to be better with control when compared to other treatments. This could be due to residual effect of anti-nutritional factors present in cocoyam corms. ANFs are known to decrease the dietary energy across the treatments with control better than all levels of cocoyam.

CONCLUSION

In conclusion, the result of this study revealed that cocoyam processing either by boiling or sun drying has a great potential to improved egg production and egg quality parameters. Up to 75% level of raw sundried cocoyam could be used in feeding laying chickens without deleterious effect on egg quality. For boiled cocoyam, lower level (50%) was required with better egg quality.

REFERENCES

Abang, F. B. P., Ayuk, A. A. and Okon, B. I. (2017). Egg Quality Characteristics of Japanese Quails *(Coturnix coturnix japonica*) Fed Varying Levels of Fermented Taro Cocoyam *(Colocasia esculenta var esculenta)* Meal. *Journal of Experimental Agriculture International* 15(6): 1-6; Article no.JEAI.29324; ISSN: 2231-0606.

Abdulrashid, M. and Agwunobi, L. N. (2009). Tannia (*Xanthosoma sagittifolium*) Cocoyam as a dietary substitute for maize in broiler chicken. *Nigerian Society for animal production.34th Annual Conference*, 402-3.

Boakye, A. A., Kissi, A. K., Wireko-Manu, F. D., Chronakis, I., Guðjónsdóttir, M. and Oduro, I. (2016). Enhancing the food utilization of cocoyam: Development of Ɛtɔ-mix. Nanning Guangxi, China: *World Congress on Root and Tuber Crops*.

Essien, A. I. and Ekanem, E. O. (1990). Effect of the age of layers, rate of egg produce and time of oviposition on some initial egg shell quality indices in a humid tropical environment. *BeitragezurTropischen land wirl*. Shaft veterinary medicine; 28:125-131.

Okonkwo, V. N. (2020). Egg quality characteristics of layer hens fed varying levels of yellow cocoyam corm meal *(Xanthosoma sagittifolium)* as energy source. *Journal of Agriculture and Food Sciences*, 18(1):1-10. www ajol.info/index.php/jafs

Olajide, R., Akinsoyinu, A. O., Afolabi, K. D., Owosibo, A. O., Fakolade, P. O. and Akinleye, S. B. (2010). Digestibility of nutrients by hybro broilers as affected by contents of anti-nutritional factors in wild cocoyam corm-based diets. *Proceedings of 14th Annual Conference of Animal Science Association of Nigeria*, Ogbomoso, Nigeria; 202-205.

Onu, P. U., Madubuike, F. U., Uchewa, E. N., Otuma, M. O. and Asogwu, M. O. (2004). Effect of cooking on the nutritive value of wild cocoyam (Caladium bicolour) in broiler starter ration. *Proc 9th Annual conf Animal Sci AGS of Nig (ASAN).* Ebonyi state University Abakalike: 42-48.

SAS, (2009). User's guide: Statistics. Version 12.1. SAS Institute, Inc. Cary. NC, USA

Uchegbu, M. C., Omede, A. A., Chiedozie, J. C., Nwaodu, C. H. and Ezeokeke, C. T. (2010). Performance of Finisher Broilers fed varying levels of raw and sun-dried Cocoyam (*Xanthosoma sagittifolium*) corm meals. *Report and Opinion*, 2 (8): 22-25.

Yoruk, M. A., Gul, M., Hayirli, A. and Macit, M. (2004). The effects of supplementation of humate and probiotic on egg production and quality parameters during the late laying period in hens. *Journal of Poultry Science*, 83, 84–88.