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Original Research Article

Utilisation of locust bean (*Parkia biglobosa*) pulp as a natural egg quality enhancer in laying hens

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Abstract

This study was carried out to improve commercial egg production using parkia pulp which is usually washed off during the processing of parkia seed into spice. A total of 54 Hyline brown Agrited brand pullets were randomly allotted to 3 treatments, 6 birds per replicate. Parkia pulp was included in the birds' drink (0%, 1%, and 2% parkia pulp) from 08:00 h to 10:00 h followed by clean cool water daily from day 147 to day 245 (early egg production phase). At day 420 to 448 (late egg production phase) conventional multivitamins, 1% and 2% parkia pulp were included in drinking water for 3 days in a week 08:00 h to 17:00 h. Data on the growth of birds, egg production, and egg internal and external quality were measured and analysed using ANOVA at $p < 0.05$. The weight of birds in the early egg production phase was directly proportional to the quantity of parkia pulp included in the parkia pulp drink. The number of eggs produced per bird (64.85) was significantly higher from the birds on 1% parkia pulp drink, whereas from the egg quality indicators, egg weight (65.03 g), length (56.15 mm), shell weight (8.06 g), and albumen weight (41.75 g) were all significantly higher at 2% inclusion level of parkia pulp drink in the early stage of egg production. In the late phase there was no significant difference among the treatments in the internal and external egg qualities but the weight of birds on parkia drink was high at $p \leq 0.05$. The results of our study show that parkia pulp inclusion in commercial laying hen drink enhances the quality and quantity of egg production.

Keywords: Egg quality; improved egg production; natural antioxidant; natural supplement; organic agriculture; parkia pulp; waste utilisation.

INTRODUCTION

The locust bean tree (Parkia) is a large size perennial tree. *Parkia biglobosa* has pods that are 15–42 cm long, 2 to 3 cm wide with 20 seeds in a pod and it appears in long clusters (Afolayan et al., 2014). It is used as food, medicine, manure, tannin, shade, wind-breaks, bee food, stabilisation of degraded environment, livestock feeds, fuel, fibre, fish poison and other domestic uses (Sadiku 2010). The matured seeds are securely surrounded by sweet, yellow pulp, all enclosed in dark brown pod (Salim et al., 2002; Sacande and Clethero, 2007). In Nigeria, it is produced in mass quantity every year, seeds harvested undergo dehusking, shelling of pod, soaking of seed in water, washing, and drying to remove the pulp; seeds are fermented to produce a spice known as iru, ogiri or dawadawa by Yoruba, Igbo and Hausa (Onnyi et al., 2004; Sadiku 2010). Parkia pulp is the sweet yellow floury material that covers the seed embedded in the pod (Olorunmaiye et al., 2011). The pulp when washed off usually caused pollution to the environment. However, it could be well used in the management of poultry for better performance.

Poultry farming is one of the world's most profitable and important money-spinning businesses. Also in Nigeria, the contribution of poultry farming was about 25% Agricultural Gross Domestic Product to the country economy (USDA, 2013; Heise et al., 2015). Eggs supply quality protein to the human population in rural and urban areas because they are an easily accessible and affordable source of protein (Aboki et al., 2013). The egg gives a balanced nutrient for people of different ages. In livestock production next to feed is medication (supplements, multivitamins and drugs) that contributes to the high production cost of eggs. Synthetic drugs used in poultry are associated with residues in the products capable of causing negative side effects when consumed over a long period. Therefore, there is need to look inward and integrate into our farming system some non-conventional sources of additives that can activate and improve the productivity of livestock (poultry in particular) so as to ensure food security and reduce the cost of production. Horticultural plants: spices, trees, vegetables, and fruits such as locust pulp are sources of non-synthetic materials that could be considered for livestock production (Afolayan et al., 2014).

Most available additives and vitamins in the vet stores are synthetically produced, they are expensive, require some strategic mixing, and may not be available in rural areas, some have issues with public acceptance. Parkia fruits are available in all agroecological zones of Nigeria where it is processed into spice. The associated pulp is usually washed off, resulting in environmental pollution that can be put to good use. Therefore, the evaluation of *P. biglobosa* fruit pulp as a possible egg production enhancer will discourage its wastage, reduce environmental pollution, and encourage its utilisation in the livestock (poultry) industry. This study sought to evaluate the effect of *Parkia biglobosa* fruit pulp on egg production and egg quality parameters in commercial laying hens. The hypothesis is that the addition of parkia pulp will improve the egg quality.

MATERIALS AND METHODS

The research work was carried out at the poultry unit of Aquatech College of Agriculture and Technology, Ibadan Oyo State Nigeria. The birds were Hyline brown Agrited brand, sourced from a reputable farm in Ibadan, housed in a battery cage, and fed with commercial feed. This breed is known to start laying at around 154–163 days of age. A total of 116-day-old 54 Hyline brown Agrited brand pullets were purchased and acclimatised to the premises. On day 147, the birds were randomly allotted into three treatments, with 6 birds per replicate. The experiment was replicated thrice, in a completely randomised design. Birds were fed *ad libitum* twice daily (morning and afternoon) with layer mash: crude protein 16.5%, crude fat 5%, crude fiber 7%, NFE 65.44%, Ca 3.6%, available phosphorus 0.45%, lysine 0.87%, methionine 0.44%, methionine + lysine 0.7%. The experiment covered two main phases of egg production; early and late phases. Clean drinking water was used as a control in the early phase while conventional multivitamin drink was given as a control in the late phase.

Early phase treatment: The inclusion of parkia pulp into the water for the birds commenced on day 147 (aged 21 weeks) and lasted for fourteen weeks. The parkia pulp daily treatment was as follows; T2: 20 g of parkia pulp + 1 litre of water (2%), T1: 10 g of Parkia pulp + 1 litre of water (1%), T0: 0 g of parkia pulp + 1 litre of water (0%). The birds were given the treatment for two hours in the morning, after which clean drinking water was given for the remaining hours of the day. The relative humidity of 88.15 ± 5.58% to 89.77 ± 8.53% and temperatures of 25.80 ± 2.20 °C to 26.87 ± 1.55 °C were measured during the period of administration of the parkia pulp drink.

Late phase treatment: Inclusion of parkia pulp into the water for the birds commenced at 420 days of age of the birds and lasted for four weeks. The parkia pulp treatment; T2: 20 g of parkia pulp + 1 litre of water (2%), T1: 10 g of parkia pulp + 1 litre of water (1%), T0: conventional multivitamins at the recommended dose. The treated drinks were available to the birds throughout the period of administration. The birds were given the solution for three days a week and clean drinking water four days a week for four weeks. The relative humidity of 83.74 ± 5.17% to 82.68 ± 5.94% and the atmospheric temperature of 25.89 ± 2.34 °C to 28.16 ± 2.42 °C were measured in the morning (08:00 h) and evening (17:00 h) during the period of administration of the parkia pulp solution. Data on the weight of birds, egg production, and egg internal and external quality traits were collected.

External egg quality: Egg Weight (EW) and Egg Shell Weight (ESW) were measured using a Camry LSD digital kitchen scale (Model: EK5350). Egg Length EL (along the longitudinal axis), Egg Width EWT (along the equatorial axis), and eggshell thickness were measured with a sensitive LCD electronic digital vernier caliper (Model: 150 mm (6”)) which was set to 0.00 mm.

Internal egg qualities: Albumen Height (AH), Albumen Width (AW), Yolk Length (YL), and Yolk Width (YW): These were measured with an LCD electronic digital vernier (Model: 150mm (6”)). Yolk Weight: Each

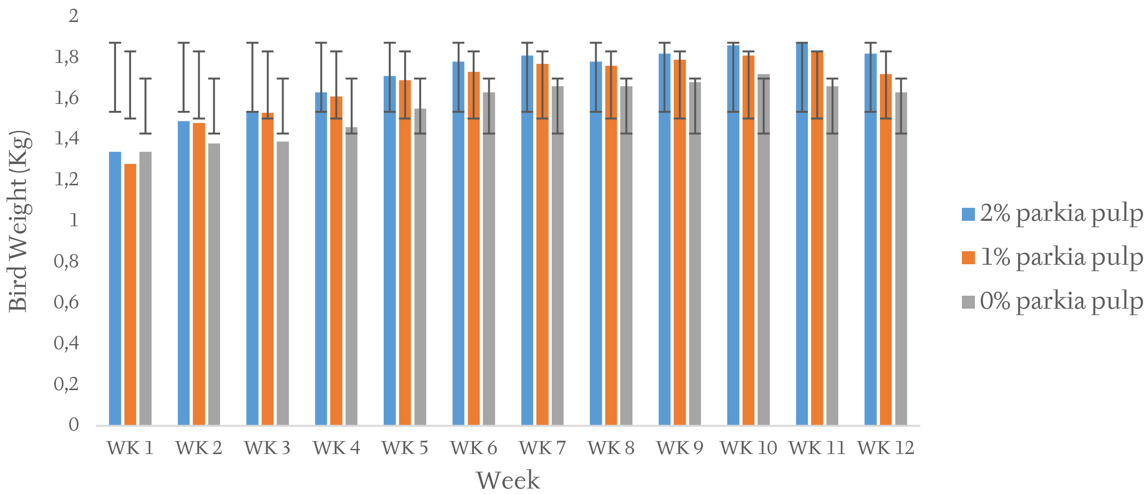

Figure 1. Weight of birds on parkia pulp drink (early phase)

egg yolk was gently separated from the egg albumen with a dessert spoon and then placed gently on the dessert plate to be weighed. Yolk colour was determined using Pinterest mix color chart. Data collected for the egg quality parameters were subjected to Analysis of Variance (ANOVA) in a Completely Randomised Design (CRD) while means were separated using the Duncan multiple range F-test of the SAS (1999).

RESULTS AND DISCUSSION

The effect of parkia pulp drink on bird weight in the early laying phase is shown in Figure 1. Birds on 1% and 2% parkia pulp consistently increased in weight from week 1 to week 11 while birds on 0% parkia pulp drink had a lower growth rate.

Parkia pulp clearly enhanced the growth of birds. The weight of birds at the early phase from week 2 (Figure 1) followed the trend of an increase in the amount of parkia pulp in the drink of the birds which was significant as the weeks progressed. Parkia pulp is high in micronutrients and so its inclusion in poultry nutrition is of great benefit (Kenneth-Obosi et al., 2019). The total antioxidant (5.03 mg/g) and vitamin C (0.091 mg/g) contained in the parkia pulp (Table 1) helped the birds cope with environmental stress. Hence, it accelerated the growth rate of the birds. Birds on 0% parkia pulp drink experienced cloacal prolapse, and this may be a result of the accumulation of fat tissue among other causes, On the contrary, antioxidants present in the parkia prevented the accumulation of fat in birds on parkia pulp drink (Ray et al., 2013). The higher weight of birds on parkia pulp drinks (Figure 1) was the result of good health condition and muscle build-up (Kenneth-Obosi et al., 2019). The effect of parkia pulp drink on bird weight in the late phase is shown in Figure 2. Birds on conventional multivitamins had the height weight increase compared to birds on parkia drink. The rate of weight gain of birds on 1% parkia pulp drink seemed to be controlled by the antioxidants present, prevented fat deposit,

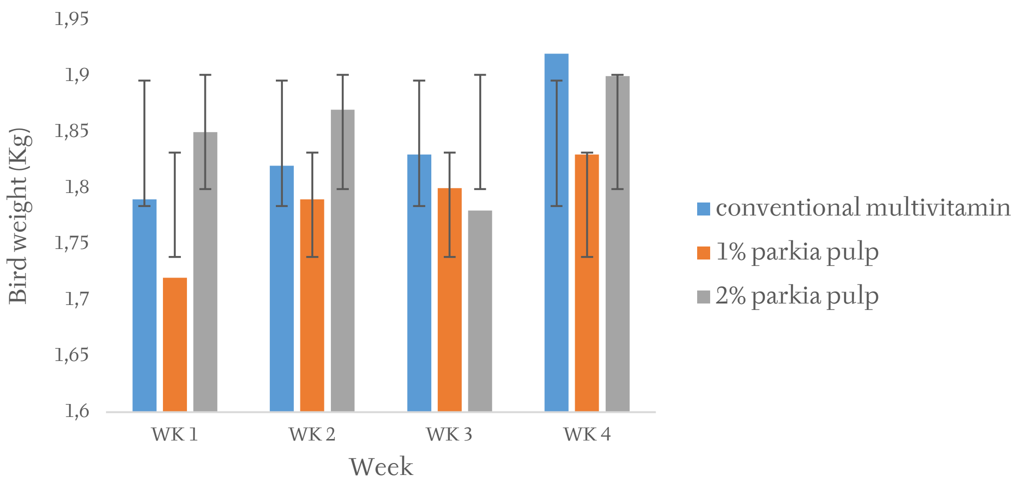

Figure 2. Weight of birds on parkia pulp drinks (late phase)

Table 1. Selected nutrient composition of parkia pulp

Parameter	Quantity
Ca (%)	1.220
Mg (%)	0.216
K (%)	1.163
Na (%)	0.127
Fe (mg/kg)	34.80
Cu (mg/kg)	6.60
Vit C (Mg/g)	0.091
Total Carotenoids (Ug/g)	30.55
Total Antioxidant (Mg/g)	5.03

and enhanced controlled muscle growth. Minerals (macro and microelements) needed for the proper functioning of laying birds' bodies were high in parkia pulp (Table 1). Ash content was a reflection of minerals in feedstuff, and was reported to be high in parkia pulp: 15.4%, 8.05%, and 6.86% by Sotolu and Byanyolu (2010), Dahouenon-Ahoussi et al. (2012) and Afolayan et al. (2014), respectively.

Birds on 2% parkia pulp drink had the highest eggshell dry matter: 85.10% (Table2). The weight of eggshells increased but not significantly as the concentration of parkia pulp increased in the solution administered to the birds. The calcium content of parkia pulp (12.2 mg/g) was high, and Afolayan et al. (2014) reported a value of 221.77 mg/litre. This helped to ensure adequate eggshell thickness and prevent shell-less eggs and eggshell cracks, which were occasionally experienced by birds on 0% parkia pulp. The eggshell thickness determines the ability of the egg to withstand rough handling and transportation.

In the early phase (Table 2), birds given 0% parkia pulp solution laid the least number of eggs ($p < 0.05$) whereas those given 1% parkia pulp solution laid the highest number of eggs. At 2% inclusion of parkia drink, there was an inverse relationship between the egg weight and the number of eggs produced. This was in agreement with the work of Afolayan et al. (2014) who reported an inverse relationship between the egg weight and the number of eggs produced

Table 2. Egg production, weight and the dry matter of the egg shell in the early phase of commercial laying birds on parkia pulp drink

Treatment	No of egg produced/bird (n = 144)	Cumulative average egg weight (g; n = 144)	Dry matter of eggshell (g; n = 36)
0% parkia pulp	56.65^{b}	58.91^{c}	83.85
1% parkia pulp	64.85^{a}	61.50^{b}	84.64
2% parkia pulp	61.15^{ab}	65.03^{a}	85.10
S.E.M.	0.74	1.40	0.39

S.E.M.: Standard Error of the Mean; ^{a,b,c} means with different superscripts within the a column differ significantly ($p < 0.05$).

Table 3. Egg production and egg weight in the late phase of commercial laying birds on parkia pulp drink

Treatment	No of egg produced/bird (n = 138)	Cumulative average egg weight (g; n = 138)
Conventional multivitamin	24.00^{a}	58.60^{b}
1% Parkia pulp	22.95^{a}	60.25^{a}
2% parkia pulp	21.95^{a}	60.98^{a}
S.E.M.	0.40	0.05

S.E.M.: Standard Error of the Mean; ^{a,b} means with different superscripts within the a column differ significantly ($p < 0.05$)

Figure 3. Whole egg and egg yolk of layers on Parkia pulp drinks (early phase)

as the level of inclusion of parkia pulp increased in replacement of maize. The inverse relationship in a higher concentration of parkia pulp drink may be due to the high content of phytonutrients present in the parkia pulp such as alkaloids, saponins, and flavonoids (Kenneth-Obosi and Babayemi 2017). Farmers desire big eggs from their farms which will attract high economic value, parkia pulp inclusion in the drink of laying birds has a positive relationship with the weight of the egg and the size of the egg. The same trend was observed in the late laying phase (Table 3); hens on conventional multivitamins laid more eggs but not significantly different from parkia pulp-treated birds. However, the weight and number of eggs from hens treated with parkia pulp were significantly higher than those given conventional multivitamins. The vitamin C (0.091 mg/g) in parkia pulp (Table 1) helps to enhance the immune functions and performance of laying hens in times of heat and cold stress, similar to the data of Lin et al. (2002); Gernah et al. (2007) reported a high value of 1.9120 mg/g vitamin C preventing the influence of seasonal stress and laying challenges. The content of parkia pulp inclusion in the drink of the laying hens is also directly proportional to the weight of the egg. The nutritional status of birds determined the egg weight (Lin et al., 2004).

The yellow colour of parkia pulp indicates the presence of phyto-nutrients/antioxidants called carotenoids (Gernah et al., 2005), important precursors of retinol (vitamin A). In Nigeria, golden yellow eggs are highly desirable by consumers, the yolk colour follows the trend of parkia inclusion in the drink. The carotenoid (vitamin A) helps to ensure better eggshell quality and golden yellow yolk colour

Table 4. Internal and external qualities of eggs from birds on parkia pulp drinks (early phase n = 36)

Egg parameters	0% Parkia pulp	1% Parkia pulp	2% Parkia pulp	SEM
Egg weight (g)	58.91^{c}	61.50^{b}	65.03^{a}	1.40
Egg length (mm)	54.19^{b}	54.84^{ab}	56.15^{a}	1.17
Egg width (mm)	42.16^{a}	42.87^{a}	43.61^{a}	1.05
Yolk length (mm)	39.04^{a}	39.30^{a}	39.98^{a}	0.77
Yolk width (mm)	36.17^{a}	36.74^{a}	37.40^{a}	0.81
Shell weight (g)	7.47^{b}	7.94^{a}	8.06^{a}	0.23
Egg weight without shell (g)	50.52^{c}	53.44^{b}	56.71^{a}	1.40
Albumen weight (g)	36.30^{c}	39.07^{b}	41.75^{a}	1.26
Albumen length (mm)	110.48^{bc}	113.27^{ab}	114.29^{a}	2.84
Albumen width (mm)	94.55^{a}	97.15^{a}	98.77^{a}	3.33
Yolk weight (g)	14.16^{a}	14.06^{a}	14.56^{a}	0.39
Shell thickness (mm)	0.51^{a}	0.53^{a}	0.58^{a}	0.11

S.E.M.: Standard Error of the Mean; a,b,c means with different superscripts within the row differ significantly ($p < 0.05$).

Table 5. Internal and external qualities of egg from birds on parkia pulp drinks (late phase n = 36)

Egg parameters	Conv Mult	1% Parkia pulp	2% Parkia pulp	SEM
Egg weight (g)	58.25^{a}	60.75^{a}	60.50^{a}	0.45
Egg length (mm)	56.20^{a}	56.62^{a}	56.97^{a}	0.20
Egg width (mm)	42.73^{a}	43.67^{a}	43.18^{a}	0.20
Yolk length (mm)	41.05^{a}	39.68^{a}	42.09^{a}	0.54
Yolk width (mm)	40.66^{a}	37.15^{a}	40.66^{a}	0.50
Shell weight (g)	7.33^{a}	7.58^{a}	7.25^{a}	0.11
Egg weight without shell (g)	50.83^{a}	50.25^{a}	52.83^{a}	0.54
Albumen weight (g)	58.27^{a}	74.66^{a}	63.15^{a}	2.24
Albumen length (mm)	104.40^{a}	107.48^{a}	95.89^{a}	1.24
Albumen width (mm)	64.82^{a}	57.53^{a}	65.38^{a}	2.52
Yolk weight (g)	13.92^{a}	14.17^{a}	13.83^{a}	0.11
Shell thickness (mm)	0.50^{a}	0.55^{a}	0.55^{a}	0.01

S.E.M.: Standard Error of the Mean; Conv Mult: Conventional Multivitamin; a,b means with different superscripts within the row differ significantly ($p < 0.05$).

(Afolayan et al., 2014). This is an indication that carotenoids, especially B-carotene and xanthophylls were contained in parkia pulp (Donald, 2010)

Paralysis, cloacal prolapse, cannibalism, and stress behaviour were also experienced by birds on only water in the early phase but no deaths were recorded. The health status and productivity of the birds on parkia pulp drink were, no doubt, a result of its nutrient and medicinal benefit.

From Table 4 it follows that the internal and external egg quality at the early laying stage showed a significantly higher value as parkia pulp inclusion increased in the drink in terms of egg weight, albumen length and albumen weight compared to birds in the control group (0% parkia pulp). This is an indication of the better and more desirable egg for consumption. The shell strength was also higher, thus preventing easy breakage of the eggs (Table 5). The conventional multivitamin-treated birds with high economic implications for farmers did not have any significant difference in the egg qualities.

CONCLUSION

The study showed that Parkia pulp 'waste' could be used as a supplement in commercial egg production. Laying hens on 1% parkia pulp drink laid more eggs than birds on the water and conventional multivitamin in both the early and late phases, respectively. The addition of parkia pulp to laying birds' nutrition improved their health status, egg production, and egg external and internal qualities. The use of the pulp will also contribute to lower production costs and better profit.

CONFLICT OF INTEREST

The authors declared no conflicts of interest with respect to the research, authorship, and publication of this article.

ETHICAL COMPLIANCE

The authors have followed ethical standards in conducting the research and preparing the manuscript.

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