EFFECT OF *JATROPHA TANJERONSIS* LEAF EXTRACT ON PERFORMANCE AND EGG QUALITY CHARACTERISTICS OF LAYING HENS

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ABSTRACT

This study was conducted to evaluate the effect of the administration of Jatropha tanjeronsis leaf extract on the performance and egg quality characteristics of laying hens. A total of one hundred and sixty (Isa Brown) laying hens at six weeks of laying life were used for the research. The laying hens were randomly assigned to one of the four experimental treatments namely T_1 (JTLE 0 ml), T_2 (JTLE 100 ml), T_3 (JTLE 200 ml) and T_4 (JTLE 300 ml) in a Completely Randomized Design (CRD) in which each treatment was replicated four times with ten birds each. The experiment lasted for 12 weeks. Data collected on all the parameters examined were statistically analyzed. The result showed that the treatment did not have a significant influence ($p>0.05$) on body weight changes, feed intake, egg weight and feed conversion ratio of the birds. The hen day egg production of the laying hens showed a significant difference ($p<0.05$) in their values. Laying hens administered 300 ml of J. tanjeronsis leaf extract recorded the highest significant ($p<0.05$) hen day egg production value followed by 200- and 100-ml groups. All the egg quality characteristics of the laying hens were not significantly affected ($p>0.05$) by the treatments except the yolk colour. Therefore, it can be concluded that administration of J. tanjeronsis leaf extracts up to 300 ml to laying hens can enhance hen day egg production and increase yolk colour intensity in laying hens.

Keywords: *Jatropha tanjeronsis,* Leaf extract, Performance, Egg quality, Laying hens

INTRODUCTION

The high cost of conventional feed ingredients has greatly increased the cost of commercial poultry feed production and this has exerted a negative impact on the growth and expansion of the poultry industry in Nigeria.

The scarcity of these conventional feed ingredients occurred as a result of the competitive uses of these feed resources by man, animals and industries. This has compelled researchers or nutritionists to focus their research attention on the use of non-conventional feed materials that are readily available and affordable. Some plant leaves indigenous to our local environment could be incorporated into poultry feed.

The use of plant leaves in the diet of poultry has been reported to improve growth response and also lower the cost of production of poultry birds (Essien and Sam, 2018; Wudil *et al*., 2020). Most plant leaves are known to be rich in nutrients such as protein, vitamins, minerals, oxycarotenoids and phytochemical compounds which can enhance growth performance, prevent diseases or confer healing and prophylactic advantages when incorporated into the animal diet, thus acting on a dual capacity as nutritional and medicinal agent (Essien and Udoh 2021; Solomon *et al*., 2022). One such plant leaf is the *Jatropha tanjorensis* J. L. Ellis and Saroja (Malpighiales: Euphorbiaceae) leaf (Malik *et al*., 2022). *J. tanjorensis* is native to Central America and currently is naturalized in Africa, India and North America (Tarfa *et al*., 2021). It is a

multipurpose plant with every part of the plant providing beneficial effects depending on the part being used (Amaduruonye *et al*., 2023). The leaves of *J. tanjorensis* are cooked and eaten as a vegetable in the southern part of Nigeria and currently, there is a growing popularity of the leaf being used in local communities traditionally to treat several diseases ranging from anaemia, malaria, hypertension, cardiovascular disorders, diabetes, urinary tract infections and sexually transmitted diseases (Ebenyi *et al*., 2021).

The phytochemical screening of *J. tanjeronsis* mirrored the presence of bioactive principles such as alkaloids, tannin, flavonoids, cardiac glycoside, anthraquinones, terpenoids and saponins (Falodun *et al*., 2013; Tarfa *et al*., 2021). The pharmacological studies revealed that *J. tanjeronsis* exhibits a wide range of biological activities which include antioxidant, antimicrobial, antimalarial hypoglycemic, antihypertensive hypolipidemic and haematological activities (Falodun *et al*., 2013). The hypolipidemic and antioxidant properties of *J. tanjeronsis* leaf improve animal performance, quality and shelf-life of poultry products (meat and eggs) (Malik *et al*., 2022).

The proximate composition of *J. tanjeronsis* showed that it contained 11.56% of crude fibre, 12.17% of fat, 11.73% of oil, 6.99% of crude protein and 51.73% of carbohydrate. The leaves of *J. tanjeronsis* are rich in vitamins A, B and C and also minerals which include iron, copper, manganese, molybdenum, potassium and sodium (Ochulor *et al*., 2018).

Plant leaves have been incorporated into the poultry diet through various forms which include leaf meal, infusions, biofortification and extract (Essien and Sam, 2018). Esiegwu (2021) reported that the use of leaf extract seems to be the best and most effective means of utilizing leaves in animal feed due to their high fibre content.

Gala *et al*. (2011) reported that the body of animals can absorb and assimilate 95% of nutrients contained in juice extract. Thus, offering poultry leaves of plants in the form of extract could promote growth, and enhance metabolism and productivity. Hence, this experiment was conducted to determine the effect of *J. tanjeronsis* extract on egg production, egg quality and haematological profiles of laying hens.

MATERIALS AND METHODS

Experimental Site: The experiment was conducted at the Poultry Unit of the Teaching and Research Farm of Akwa Ibom State University, Obio-Akpa Campus. Obio-Akpa is located between latitudes 5^0 17′N and 5^0 27^0N and between $7^0 27^0$N and 7^0 58^0E with an annual rainfall ranging from 3500 – 5000 mm and monthly temperature range of 24 – 26^0C and relative humidity between 60 – 90% (AKSG, 2024).

Source and Processing of *Jatropha tanjeronsis* Leaves Extract: *J. tanjeronsis* leaves were harvested within the university community. 300 g of the leaves were washed and crushed into a mash according to the method of Esiegwu (2021). One (1) litre of clean water was used to squeeze out the leaves extract, thereafter filtered using a muslin cloth. The *J. tanjeronsis* leaf extract was added to laying hens drinking water at 0, 100, 200 and 300 ml per litre of water.

Proximate and Phytochemical Analysis of *Jatropha tanjeronsis:* Before the commencement of the experiment, 50 g of *J. tanjeronsis* leaves were harvested, air-dried for three days and were ground using a hammer mill with a 2 mm screen to powdery form. The ground *J. tanjeronsis* leaf meal was taken to the laboratory and subjected to proximate and phytochemical composition analysis according to AOAC (2010).

Experimental Diets: The laying hens were fed a diet containing 18.23% crude protein and 2651 kcal/kg of energy. The ingredients and nutrient composition of the diet are presented in Table 1. A total of 160 Isa Brown laying hens at six (6) weeks of laying life were used for the research. The hens were divided into 4 groups of 40 birds forming T_1, T_2, T_3 and T_4. Each treatment was assigned drinking water containing an aqueous extract of *J. tanjeronsis* at 0, 100, 200 and 300 ml/L of drinking water respectively in a completely randomised design (CRD).

Table 1: Ingredient and nutrient composition of diet fed to laying hens administered *Jatropha tanjeronsis* leaf extract

Ingredient	Nutrient composition (%)
Maize	50.00
Soya beans meal	24.00
Fish meal	3.00
Palm kernel cake	5.00
Wheat offal	7.00
Bone meal	10.00
Common salt	0.25
Premix	0.25
L-lysine	0.25
L-methionine	0.25
Total	100
Crude protein	18.31
Crude fiber	4.01
Another extract	3.43
Ash	3.21
NFE	71.04
ME (Kcal/Kg	2871.32

NFE – nitrogen-free ether, ME – metabolizable energy

The hens in each treatment were further divided into four replicates of ten birds. After the exhaustion of water containing the aqueous extract of *J. tanjeronsis* freshwater was provided for the remaining day. Feed was provided *ad libitum*. The laying hens were housed in pens measuring 2 x 2 m^2 in a deep litter system of managing and wood shavings and used as litter materials. The birds were routinely vaccinated against Marek's disease, New Castle disease, infectious bursal disease and fowl pox (de Wit and Montiel, 2022). Uniformity in management practices was observed and maintained across treatment. The experiment lasted twelve weeks.

Data Collection: The laying hens were weighed at the beginning of the experiment and at the end of the trial to determine their body weight changes. Feed intake was determined by subtracting the weight of the left-over feed from the weight of the feed fed the previous day. The feed conversion ratio was determined by dividing daily feed intake by daily egg weight (g feed/g egg). Hen day egg production (HDEP) was calculated by dividing the total number of eggs produced during the period by the total number of hen days in the same period multiplied by 100.

Data on the laying performance of the birds were collected weekly while those on egg quality were obtained five weeks to the end of the study. Egg collection was done twice daily.

External Egg Quality Evaluation: Six (6) eggs were collected weekly from each replicate for quality assessment.

Egg weight: Six eggs were taken weekly from each replicate. Individual eggs were labelled and weighed using an electronic weighing balance (SF-400) having a sensitivity of 0.01 g.

Egg length: The length of each egg was taken as the longitudinal distance between the pointed end to the broad end with the aid of a vernier calliper with an accuracy of 0.1 mm.

Egg width: Egg width was measured with a vernier calliper to the nearest 0.1 mm, measurement was taken as the diameter of the widest cross-sectional region.

Egg shape index: The egg shape index (ESI) was calculated as the percentage of egg width to the length.

Eggshell weight: Each egg was carefully broken in a small Petri dish. The shell was sun-dried for 2 – 3 days and the eggshell weight was determined using a top-loading electric weighing balance. The percentage eggshell weight was determined as follows: % eggshell weight = Eggshell weight (g)/ Weight of egg (g) x 100.

Eggshell thickness: The shell thickness was measured with a micrometre screw gauge to the nearest 0.01 mm. Shell thickness was recorded as the average value of the thickness taken from the broad end, narrow and equatorial part of the egg.

Egg-breaking strength: Egg-breaking strength (EBS) was calculated using the formula of Arad and Marder (1982) and presented as EBS = 50 – 86 x (EW) 0.919, where EW = egg weight (gram).

Internal Egg Quality Evaluation

Albumen weight: The albumen of broken fresh eggs was carefully separated from the yolk and weighed – the egg weight and recorded as percentage albumen for individual egg samples.

Albumen height: Albumen height was determined with the aid of a spherometer with measurement taken at the albumen's widest expanse and midway between the yolk edge and the external edge of the thick albumen.

Albumen index: The albumen index was recorded as the ratio of the albumen height to the diameter. Albumen index (AI) = H/0.5D, where h = height of the thick albumen at the boundary with the yolk and D = average of the long and short diameter of albumen measured on the smooth surface (Sogunle *et al.*, 2017).

Yolk weight: The yolk was separated from the albumen and weighed individually with an electronic-sensitive weighing balance to the nearest 0.01 grams

Yolk height: The yolk height was measured using a vernier calliper and calibrated in centimetres.

Yolk width: The yolk width was measured around the widest horizontal circumference using a calliper measured to the nearest 0.1 mm

Yolk colour: Yolk colour was determined with the aid of a Roche yolk colour fan (Vuilleumier, 1969). The egg yolk that was separated earlier from the albumen was placed on a plain surface and examined under normal daylight. The yolk colour fan was placed beside it and the number of the chart that matched a particular yolk colour was recorded.

Yolk index: The yolk index was calculated as the proportion of yolk height to the yolk diameter.

Yolk-albumen ratio: Yolk-albumen ratio was calculated as follows: Yolk-albumen ratio = Yolk weight ÷ Albumen weight.

Haugh unit: The Haugh unit was calculated using the methods described by Haugh (1937) expressed mathematically as Hu = 10010g (H + 7.57 – $1.7w^{0.37}$) Where, H= Height of the thick albumen in mm, W = Weight of egg in grams.

Statistical Analysis: Data collected from all the parameters measured were subjected to analysis of variance (ANOVA), using SPSS version 20.0 (IBM corporation, Armonk USA). Significant means were separated using Duncan's Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

The results of the proximate and photochemical composition of *J. tanjeronsis* leaf showed that it contains ether extracts (9.68%), ash (10.11%), crude fibre (9.58%), crude protein (18.03%) and NFE (152.60%) (Table 2).

Table 2: Proximate and phytochemical composition of *Jatropha tanjeronsis* leaf

Component (% DM)	Value
Ether extract	9.68
Ash	10.11
Crude fibre	9.58
Crude protein	18.03
NFE	52.60
Anit-nutrients (mg/100g)	
Phenol	3.08
Saponin	3.23
Alkaloid	0.80
Fannin	0.31
Flavonoid	0.91

NFE – nitrogen-free ether

The crude protein value in this research was lower than the 24.60% obtained by Bello *et al*. (2008) but higher than the 4.75% and 6.99% reported by Egbon *et al*. (2013) and Ochulor *et al.* (2018) respectively. The crude fibre value was close to the value of 9.70% obtained by Bello *et al.* (2008) but lower than the 10.10 and 12.17% reported by Egbon *et al*. (2013) and Ochulor *et al.* (2018) respectively.

In this study the values for ether extracts were higher than 4.50% and 0.02% reported by Bello *et al*. (2008) and Egbon *et al*. (2013). The differences in proximate composition as reported by the various researchers could be due to disparities in soil characteristics, soil nutrients, stage of harvesting, climatic conditions of the

area of cultivation and differences in analytical procedure employed. However, the result of the proximate composition of *J. tanjeronsis* showed that it could be used as feed resources or ingredient livestock nutrition. The result portrays an appreciable crude protein content.

The phytochemical composition revealed the presence of saponin, alkaloid, tannin, flavonoid and phenol (3.23, 0.80, 0.31, 0.91 and 3.08 mg/100g) respectively (Table 2). These compounds are known as secondary plant metabolites and can be used as drug precursors (Mujeeb *et al.,* 2014). They have been reported to exhibit a wide range of pharmacological functions such as antioxidant, anti-inflammatory, antimicrobial, antiviral, anticarcinogenic antimalarial, hypolipidemic and hematological activities (Omoregie and Osagie, 2007).

The results of the performance of laying hens administered *J. tanjeronsis* leaf extract are presented in Table 3. The leaf extract had no negative effect on body weight changes, feed intake and feed conversion ratio of the laying hens. The feed intake of the birds administered the leaf extract was numerically higher than the birds in the control but did not differ statistically from the birds in the control ($p>0.05$). The result indicated that *J. tanjeronsis* leaf extract enhances the feed intake of the laying hens. *J. tanjeronsis* leaf has been reported to contain numerous minerals and elements which may have stimulated the appetite of the birds (Egbon *et al*., 2013) which resulted in effective utilization of the feeds. Low feed intake by laying hens has been reported to cause a reduction in the secretion of reproductive hormones and also deny stimuli by the target organs that will help to initiate and advance necessary physiological mechanisms controlling egg production (Oguntunji and Alabi, 2010).

Moreso, low feed intake by laying hens has been reported to inhibit functional ovarian activity, the effect being failure of the pituitary gland to produce or release gonadotrophin hormones (Campbell *et al*., 2009). Furthermore, low feed intake in laying hens may cause defective ovarian morphology which includes the production of a large number of small follicle atresia, smaller ovarian weight, reduced number of medium white follicles, large white follicles, small yellow follicles and large yellow follicles which are the major sources of gonadal steroids modulating egg production mechanism in female poultry (Renema *et al*., 1999).

A positive influence of *J. tanjeronsis* leaf extract was observed in hen day egg production of the laying hens. Birds administered 300 ml/L of *J. tanjeronsis* leaf extract recorded the highest significant ($p<0.05$) hen-day egg production value followed by 200 and 100 ml/L groups. While the control had the lowest hen-day egg production value. This result could be attributed to the beneficial effects of bioactive compounds present in *J. tanjeronsis* leaves. *J. tanjeronsis* has been revealed to contain secondary plant metabolites which include flavonoids, tannin, phenols, saponins, cardiac glycosides and anthraquinones (Omoregie and Sisodia, 2012). These plant metabolites are known for their wide range of medicinal activities such as antioxidant, antimicrobial, anti-inflammatory, hypoglycaemic, anticarcinogenic and antiallergic properties. Atansuyi *et al*. (2012) reported that the leaf of *J. tanjeronsis* is rich in both free and bound phenols and flavonoids which are widely known to exhibit antioxidant activities. The presence of antioxidants in laying hens' diet has been reported to enhance immune response and increase egg quality in laying hens (Asli *et al.*, 2007). Zhao *et al.* (2011) also reported improved antioxidant status of laying hens fed diets containing plant extracts. However, the result showed that nutrients required for egg formation were adequately utilized and absorbed by laying hens administered *J. tanjeronsis* leaf extract.

Moreover, the leaf extract was able to boost the hen-day egg production of the laying hens. There was a significant difference ($p<0.05$) in egg weight values of the laying hens across treatment.

The results of the external and internal egg quality characteristics of the laying hens are presented in Table 4. The administration of *J. tanjeronsis* leaf extract to laying hens did not affect egg length, egg width and egg shape index. The value for egg shape index in this study was higher than 0.75 which is regarded as the most satisfactory for eggs packaged in containers for transportation (Peters *et al.,* 2007; Duman *et al*., 2016).

Table 3: Performance characteristics of laying hens administered *Jatropha tanjorensis* leaf extract

Parameters	T_1 (0 ml JTLE)	T_2 (100 ml JTLE)	T_3 (200 ml JTLE)	T_4 (300 ml JTLE)
Initial body weight (kg)	1.70 ± 0.02	1.72 ± 0.01	1.71 ± 0.21	1.72 ± 0.03
Final body weight (kg)	1.81 ± 0.04	1.85 ± 0.21	1.87 ± 0.21	1.87 ± 0.02
Body weight changes (kg)	0.11 ± 0.01	0.13 ± 0.12	0.16 ± 0.21	0.15 ± 0.02
Feed intake (g)	117.13 ± 0.03	118.04 ± 0.03	118.91 ± 0.13	119.41 ± 0.01
Egg weight (g)	56.57 ± 0.22	57.34 ± 0.21	57.84 ± 0.02	58.63 ± 0.01
Hen day egg production %	78.11 ± 0.51^a	78.53 ± 0.12^a	82.31 ± 0.03^b	84.51 ± 0.01^c
Feed conversion ratio	2.07 ± 0.25	20.5 ± 0.02	2.05 ± 0.02	2.04 ± 0.02

JTFE – Jatropha tanjeronsis leaf extract, abc – means along the same row with different letter superscripts are significantly different (p<0.05)

Table 4: Egg quality indices of laying hens administered *Jatropha tanjeronsis* leaf extract

Parameter	T_1 (0 ml JTLE)	T_2 (100 ml JTLE)	T_3 (200 ml JTLE)	T_4 (300 ml JTLE)
Egg length (cm)	5.74 ± 0.07	5.73 ± 0.03	5.81 ± 0.02	5.88 ± 0.06
Egg width (cm)	4.47 ± 0.05	4.44 ± 0.02	4.63 ± 0.04	4.68 ± 0.03
Eggshell thickness (mm)	0.51 ± 0.04	0.53 ± 0.02	0.55 ± 0.03	0.51 ± 0.04
Eggshell weight (g)	5.31 ± 0.03	5.44 ± 0.01	5.53 ± 0.01	5.60 ± 0.03
Egg breaking strength	1883.41 ± 10.01	1887.56 ± 11.02	1893.11 ± 10.00	1893.50 ± 11.00
Albumen weight (g)	33.41 ± 1.03	34.52 ± 0.01	33.61 ± 0.13	34.32 ± 0.02
Albumen height (mm)	8.41 ± 0.01	8.63 ± 0.02	8.75 ± 0.12	8.88 ± 0.02
Albumen index	1.24 ± 0.03	1.27 ± 0.03	1.29 ± 0.02	1.29 ± 0.03
Albumen diameter (cm)	6.79 ± 0.02	6.81 ± 0.03	6.77 ± 0.03	6.87 ± 0.04
Yolk weight (g)	14.53 ± 0.03	15.48 ± 0.02	14.78 ± 0.02	15.47 ± 0.03
Yolk height (cm)	3.41 ± 0.02	3.53 ± 0.01	3.61 ± 0.03	3.70 ± 0.02
Yolk diameter (cm)	3.32 ± 0.03	3.57 ± 0.02	3.75 ± 0.04	4.01 ± 0.03
Yolk albumen ratio	0.43 ± 0.03	0.45 ± 0.04	0.44 ± 0.01	0.45 ± 0.01
Yolk index	10.3 ± 0.02	1.01 ± 0.02	10.4 ± 0.02	1.08 ± 0.02
Yolk colour	5.44 ± 5.02^a	5.73 ± 3.02^a	6.50 ± 2.25^b	7.71 ± 5.30^b
Haugh unit	80.43 ± 1.02	80.51 ± 1.31	81.11 ± 1.05	80.33 ± 1.20

JTFE – Jatropha tanjeronsis leaf extract, ab – means along the same row with different letter superscripts differ significantly (p<0.05)

Eggs with good shape promote marketing and profitability while poorly shaped eggs (elongated) are prone to breakage (Roberts, 2004; Talking Hens, 2024).

The shell weight and shell thickness were not affected by the treatment. Diet composition is one of the major factors that influence shell quality. The non-significant variations in the value of shell weight and shell thickness in this study could suggest adequate calcium in the diet. The result could also indicate non-interference in the calcium metabolism of the laying hens. *J. tanjeronsis* leaves have been unveiled to be rich in minerals such as calcium, phosphorous, sodium, magnesium, manganese, iron, zinc, copper and potassium (Egbon *et al.*, 2013). These minerals are known to perform different physiological functions in the body. Dietary supplementation of manganese has been reported to improve egg quality by enhancing the glycosaminoglycans and uranic acid synthesis in the eggshell gland which can exert its effect on the ultra-structure of eggshell, promote the process of eggshell calcification and improve laying bird's physiological status (Xiao *et al.*, 2014). It has been reported that zinc enhances calcium deposition in the shell gland by elevating carbonic anhydrase and osteopathic mRNA expression thus increasing carbonic anhydrase activity which contributes to the improvement of eggshell quality (Zhang *et al.*, 2022).

Albumen height, albumen weight, albumen diameter and albumen index values of the laying hens were not significantly affected (p>0.05) by the treatments. Firmness of the albumen is used as an indicator for eggs of high quality. Albumen constitutes 60% of the total egg content (Kaushish, 2009). Similarly, there was no negative impact of *J. tanjeronsis* leaf extract on yolk weight, yolk diameter, yolk height, yolk

index and yolk albumen ratio across treatment while significant variations ($p<0.05$) were observed in yolk colour as the level of the leaf extract administration increases. The high yolk colour intensification observed in this study might have been induced by *J. tanjeronsis* leaf. Leaves of plants are known to contain carotene which enriches the yolk colour of eggs (Aderemi *et al*., 2012). Ross (2005) reported that laying hens cannot synthesize egg yolk pigment and egg yolk colour but depend on fat-soluble vitamin pigments such as xanthophylls lutein, zeaxanthin and B carotene. The result is similar to the findings of Ogundeji and Akinfala (2020) where laying hens fed a cassava plant meal-based diet recorded significant differences in yolk colour egg-breaking strength and the Haugh unit was not significantly affected ($p>0.05$) by the treatment. Egg-breaking strength is an important factor when determining or examining egg quality, especially during transportation, packaging and hatching of eggs. The value for the Haugh unit in this research was higher than 72 which is used as the baseline for the freshness of eggs. Haugh unit of 72 and above is used to indicate freshness in eggs and with egg-graded AA (Wikipedia, 2024). Essien (2021) observed enhanced Haugh unit of an egg when laying hens were fed an *Icacinia manni*-based diet processed in alum water.

Conclusion: Based on the results of this study, it was concluded that the administration of *J. tanjeronsis* leaf extract to laying hens enhanced hen day egg production and yolk colour of the birds at 300 ml/L level. Moreover, *J. tanjeronsis* leaf extract did not have any negative impact on the performance and egg quality characteristic of laying hens.

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