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REVIEW ARTICLE

STUDIES ON EGG PRODUCTION AND EXTERNAL EGG QUALITY TRAITS OF FOUR TORTOISES FROM TWO DIFFERENT ECOLOGICAL ZONES IN DELTA STATE, NIGERIA

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ABSTRACT

Background: The studywas conducted to investigate the effect of age and body weight of first lay on egg number and egg weight among four breeds of tortoises in two different ecological zones. A total of sixty (60) tortoises were selected from two distinct ecological zones namely: Freshwater Swamp (Greek tortoise – *Testudo graeca*, and West African Black Mud tortoise –*Pelusioscastaneus)* and lowland Rainforest (Marginated tortoise – *Testudo marginata* and African Spurred tortoise – *Centrochelyssulcata*) and their external egg quality traits (EEQTs) were assessed.The results indicated that Age at first egg (AFE) and body weight at first egg (BWFE) were significant ($P<0.05$) affected by egg number (EN) and egg weight (EWT). EWTshowed a similar trend toBWFEin the various genotypes studied.*Testudo marginata*exhibited the maximumEN and AFE, with *Pelusioscastaneus*, *Testudo graeca*, and *Centrochlyssulcata* showing progressively lower values.BWFE was highest in *T.graeca* decreasing through *C.sulcata*, and *T.marginata*, to*P.castaneus*. Highest egg quality traits values were recorded in *T.marginata,* followed in descending order by *T. graeca, C.sulcata* and *P.castaneus*. These results illustrate the, potential of T. marginata for egg production and quality enhancement. In conclusion, the evidence demonstrates superior egg laying performance and quality traits in this humid region, highlighting their suitability for micro-livestock production.

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INTRODUCTION

The Nigerian breeds of tortoise turns out in form of egg and meat production in rural region. This is still considerably low and where available quite scarcely, thus leading to reduced animal protein intake (Odiko*et al.,* 2024). Various tortoise species, including *Centrochlyssulcata*, *Pelusiossinuatus,Testudo marginata,* and *Pelusioscastaneus*, are distributed across diverse ecological zones (e.g., lowland rainforest, freshwater swamp, mangrove swamp) and can tolerate extreme weather conditions. These populations, often harvested from the wild or rural areas, are subjected to environmental pressures, with their reproductive performance (egg production and quality) heavily influenced by habitat, climate, and nutrition (Kperegbeyi*et al.*, 2025). The external quality traits of tortoise eggs- including egg weight (EWT), egg length (ELT), egg width (EWD), eggshell surface (ESS), and egg shape index (ESI) – are critical factors in breeding, as they directly influence hatchery success, embryonic development, and the growth of hatchlings. Egg weight is a particularly significant trait, often showing a direct positive correlation with shell weight and yolk weight.

External egg quality is important for marketability and physical resilience, and can vary significantly between different tortoise species. These traits can be measured to assess the health and quality of an egg. Egg shape and size includes measurements of egg length and width, which can be used to calculate an egg shape index. Research indicates that environmental factors, including the dry and wet seasons, significantly affect both external and internal egg quality traits. Different ecological zones provide different resources, affecting the nutritional intake and, consequently, the egg production and size of the tortoises (Standford, 2020; Rugiero, 2021; Stemle, 2022 and Varela-Julio, 2023). Several factors can impact the external quality of tortoise eggs, though more specific research is needed. Justas with different chicken breeds, different tortoise species can have naturally varying egg characteristics. Kperegbeyi and Akaine, (2025) stated that a tortoise's diet plays a significant role in the nutrient composition and quality of its eggs. As with other egg-laying species, the age of the tortoise can influence egg production and quality. Factors such as storage conditions can impact egg quality, although these are more relevant to the collected eggs than the production phase itself (Elliot *et al.*, 2019; Richardson and Stiling, 2019; Rubin *et al.,* 2023). Research has indicated that environmental factors (seasons) impact external traits like egg weight (EWT), egg length (ELT), egg width (EWD), and shell surface, with better results in colder seasons. However, there is a lack of detailed, quantitative analysis of how specific, localized environmental factors – such as soil moisture, micro-temperature at nesting sites, and humidity variations- affect the egg shell thickness and shape index across different ecological zones.The objective of this study is to investigate the effect of age and body weight of first lay on egg number and egg weight among four breeds of tortoises in two different ecological zones.

MATERIALS AND METHODS

Experimental Site: The research was conducted at theDepartment of Animal Production Research Farm (DAPRF), Southern Delta University (SDU), Ozoro. Latitude 5^0 32^I N and Longitude 6^0 15^IE of Greenwich meridian place the center in mid-western Nigeria's rainforest. Rainfall averages 2500-3000 mm per year and 27.4^0C and 85 % are the mean temperature and relative humidity (SDU, 2025).

Experimental Animal and Management Practices: A total of sixty (60) tortoises selected from two distinct ecological zones in Delta State namely: Freshwater Swamp (Greek tortoise, and West African Black Mud tortoise) and lowland Rainforest (Marginated tortoise and African Spurred tortoise) were used for this study. These tortoises were sexually matured randomly selected for egg production. Each dam strain was caged in an open sided pen providing a floor space of 12ft x 12ft. The study ranged between October 2024 and October 2025 for a laying phase that lasted for 52 weeks. Adult tortoises from each genetic group were properly identified by carapace tags T1, T2**,** T3, T4and so on. The tortoises were transferred into previously disinfected laying cages. Each tortoise was kept in individual cage to monitor the laying performance. They were fed on a grower's mash that supplied 24% crude protein and 2560kcal/kg ME. Thereafter they were fed with a commercial feed containing 30% crude protein and 3350 kcal/kg ME at the laying phase. Feed and water were supplied *ad libitum* throughout the period of the study. Feeding was done twice (8:00 am and 5:00 pm) per day.

Intensive housing system was used for this study. The house was ant proof to prevent ants not to invade the unit. The tortoises were given the same treatment throughout the experimental period under the same managerial conditions. Some routine preventive hygiene was done frequently such as providing fresh water, feeding, changing of water regularly at all times, observing the behaviour of the tortoises, signs or symptoms of any disease condition should be observed by physical examination.

Data Collection and performance characteristics: Laying performance of individual mature tortoises in each genetic group was monitored from first lay to 52 weeks in lay. The tortoises in each genotype were categorized based on their age at first egg (AFE days), and body weight at first egg (BWFE g). Eggs laid were collected daily and marked according to carapace tag of each tortoise. All eggs laid by each female tortoise were weighed and the length and width measured individually. Egg shape index was also determined. Thus, the following traits were taken.

Age at first egg: The number of days from hatch to the day the first egg was laid provided the second egg was laid in the next 10 days (Huque and Ukil, 1994).

Body weight at first egg: This was measured as weight of each live tortoise averaged over the number of tortoises' weight per genotype. A 5.0 kg scale was used to measure the body weight of the tortoises individually, beginning from the day the first egg was laid.

Egg number per week: This was taken as the total number of eggs laid by individual layer in each genetic group per week.

Egg weight per week: This was taken on individual egg on daily basis from each layer with the aid of an electronic balance having sensitivity of 0.01g.

Egg Length: A vernier caliper with an accuracy of 0.1mm was used to determine the egg length. It was taken as the longitudinal distance between the narrow and the broad ends.

Egg Width: It was measured to the nearest 0.1mm with a vernier. The egg width was taken as the diameter of the widest cross-sectional region.

Egg Shape Index: It was determined as the ratio of egg width to egg length.

Statistical Analysis: Egg were collected twice on each day and weighed along each genetic group. All percentage data were sine transformed and subjected to zero – way elimination of heterogeneity and means were separated using Duncan's Multiple Range Test Procedure (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Least square means and standard errors of egg number and egg weight as affected by age and body weight at first lay among four genotypes are presented in table 1 and 2. Age and body weight at first lay were found to have significantly ($P<0.05$) affected egg number and egg weight in this study. Observations on the effect of age and body weight at first egg on egg number and egg weight revealed that body weight at first egg actually determines egg production performance in captivity as it had positive and direct effect on the result. Egg weight followed the pattern of body weight at first egg exhibited by various genotypes considered. Egg number followed the principle of lower body weight at first egg. The practical significance of this is that egg production will commence as long as the tortoise attain the threshold level for body weight with minimum age. This observation is a general phenomenon because Abaci*et al.*, (2023) reported that specific values of age and body weight for a particular group of tortoises in a particular area are unique but other factors such as feeding programmes and management techniques could subject the value to modification. Booth *et al.*, (2022) in their study on comparison of some multi-trait selection indices tortoises concluded that, egg production and body weight were the most important trait for gain in aggregate genetic value. Gatto and Reina, (2022)) further reported that an egg weight is proportional to body weight. Big bodied tortoises eat more feed to maintain their body size. Therefore, the size of their egg is greater. Rugiero, (2021) also reported that egg weight is higher for heavy tortoises than light tortoises, the ranges and coefficient or variations indicated that selection for higher tortoise weight

Table 1. Least Square Means ± SEM of Egg number and Egg Weight of Four tortoises' genotypes as Affected by Age at First Lay

Ecological Zone	Genotype	AFE (Days)	N	Egg number	Egg Weight (g/clutch)
Freshwater Swamp	Greek tortoise	4,777.85[c]	18	3.32±0.03[c]	19.54±0.15[d]
	West African Mud tortoise	6,562.76[a]	12	5.76±0.03[a]	22.87±0.53[c]
Lowland Rainforest	Marginated tortoise	3,971.20[d]	14	3.16±0.02[c]	38.35±0.12[a]
	African Spurred tortoise	5,192.52±[b]	16	4.05±0.04[b]	28.21±0.35[b]

[a,b,c,] Means in the same row with different superscripts are significantly different (P<0.05)

Table 2. Least Square Means ± SEM of Egg number and Body Weight of Four tortoises' genotypes as Affected by Age at First Lay

Ecological Zone	Genotype	WFE (g)	N	Egg number	Body Weight (g/clutches)
Freshwater Swamp	Greek tortoise	19.54±0.15[c]	13	5.04±0.03[b]	1427.36±7.26[a]
	West African Mud tortoise	22.87±0.53[d]	17	6.94±0.02a	1390.34±6.07[b]
Lowland Rainforest	Marginated tortoise	38.35±0.12[a]	16	4.63±0.01[c]	1254.08±4.06[c]
	African Spurred tortoise	28.21±0.35[b]	14	4.24±0.01[c]	1306.43±6.14[b]

[a,b,c,] Means in the same row with different superscripts are significantly different (P<0.05)

Table 3. Overall Least Square means ± SEM of Effect of Genotype on External Egg Traits

	Freshwater swamp		Lowland rainforest	
Traits	Greek tortoise	West African Mud tortoise	Marginated tortoise	African Spurred tortoise
Egg Weight (g)	15.96±0.05[d]	16.86±0.06[c]	18.94±0.06[b]	20.52±0.04[a]
Egg Length (cm)	3.85±0.01[b]	3.98±0.02[b]	4.02±0.01[a]	4.36±0.03[a]
Egg Width (cm)	2.83±0.02[b]	2.94±0.01[b]	3.68±0.01[a]	3.78±0.02[a]
Egg Shape Index	0.73±0.01[c]	0.74±0.01[c]	0.91±0.01[a]	0.87±0.01[b]

[a,b,c,] Means in the same row with different superscripts are significantly different (P<0.05)

would yield positive result on egg weight. Significant (P<0.05) difference was also observed in external egg quality traits of the tortoises studied (Table 3). The variation in length and width of the eggs among the genetic groups studied could be due to their genetic make-up. Environmental factors in terms of diet, water intake, temperature, humidity and management practices may also contribute to the variability observed. Many reasons could have been attributed to the variation in egg shape index of the tortoise genotypes considered in this study, since egg shape index is the ratio of egg width to egg length. The difference in length and width of the egg laid is an important factor which could be as a result of variation in genetic make up of the tortoises. Body weight at sexual maturity seems also to have influenced the egg shape. In sophisticated markets eggs that egg weight and shell weight to a large extent positively correlated. Apart from grading, egg shape index could also affect hatchability in laying female tortoises as egg within the range of 0.75-0.78 hatches better than the combined groups of the extremes which could result in embryonic mortality or dead-in-shell. Good egg shape index enhances marketing and profitability, in that short round eggs do not make the best appearance and long eggs are much likely to be broken during packaging and transportation, since they do not fit squarely in convenient containers. Thus, the highest egg shape index observed in marginated tortoise and African spurred tortoise is a reflection of high genetic value for shell strength which can make it withstand environmental stress. The low value of egg shape index observed in Greek tortoise and West African mud tortoise therefore, shows that eggs of these breed are more prone to breakage compared to Marginated tortoise and African spurred tortoise. This is in agreement with findings ofBelyavin, and Boorman, (1981) andRotimi *et al.*, (2024) who observed that elongated (Low index) and heavier eggs were more prone to cracking.

CONLUSION

It can be concluded from the results obtained in this study that genetic differences due to age and body weight at first lay of tortoise strain significantly (P<0.05) affected egg number and egg weight. In the same vein, external egg quality traits were also influenced as a result variability layer tortoise. From the results obtained in this study, it is therefore recommended that Nigerian tortoise can still be improved upon and incorporated in tortoise production programme.

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