Research Article

Egg characteristics, hatch rate and early growth performance of keets post-hatch in guinea fowl (*Numida meleagris*) in the Western Highlands of Cameroon

[1]N. R. Banla[1,2], Guiekep N. A. J[1], Tansho A.[1,3], A. T. Niba[1]

[1]University of Bamenda, College of Technology, Department of Animal Production Technology, Bamenda, Cameroon.

[2]Technical School of Agriculture, Bambili, Cameroon

[3]SALI (Sustainable Agriculture/Livestock Enterprise) Mile 4 Nkwen Bamenda, Cameroon.

Corresponding author: ndzirogerbanla@gmail.com

ABSTRACT

A study was carried out to characterize guinea fowl *(Numida meleagris*) eggs, evaluate the effect of egg weight on hatchability, keet hatch-weight and early growth performance in the Western Highlands of Cameroon. One hundred and seventy-four (174) guinea fowl eggs were collected from a farm in the West Region of Cameroon and characterized. Length, width and weight of eggs were recorded. Using egg weight and egg shape indices, eggs were grouped into small (40-45 g); medium (46-49 g) and large (>50 g) categories and incubated for 32 days. Keets were collected at hatch as from 28 days of incubation from each group and weighed to determine their baseline weight post-hatch. Fertile and infertile eggs were separated through candling and breaking of unhatched eggs to count dead in shell embryos. Keets resulting from each category of small (T1), medium (T2) and large (T3) were maintained, with each treatment having 15 keets. Keets received water and a commercial diet containing 2900Kcal/kg of ME and 22% CP for the first 3 weeks of age and 2800 kcal/kg of ME and 20% of CP for the next 10 weeks of study *ad-libitum*. For 13 weeks, early growth performance (weight evolution, weight gain, Feed intake and FCR) were evaluated. Results revealed that egg weight ranged from 40 g to 59 g. The overall mean weight of guinea fowl eggs obtained was 48.52 g with mean egg weight of 43.75 g, 47.66 g and 51.60 g for small, medium and large categories respectively. Eggs in all treatments showed significant difference ($p<0.05$) in fertility rates with eggs in the large category showing the highest fertility. Eggs in the large category had the highest hatchability though not significantly different ($p>0.05$) compared with the small category. Highest mean keet weight at hatch were obtained with the large category and were significantly ($p<0.05$) higher compared with those of the small category. Regression analysis revealed that an increase in egg weight resulted in a corresponding significant increase in keet hatch rate ($r^2=0.95$) and that there exist a positive relationship between egg weight and keet hatch weight with a regression coefficient of $r^2=0.94$. The mean weekly and daily feed intake per bird were higher in the large category than in the other groups. Similar observations were obtained with the weight gains. However, the medium category showed the lowest overall mean feed conversion ratio. In conclusion egg size had significant effects on hatchability of guinea fowl eggs and post hatch keet weight. Larger sized eggs had higher hatchability and better keet weight at hatch with keets from the large and medium sized eggs showing better growth performances than those from the small egg sized category. Therefore, guinea fowl egg weight ranging from 45 g to 60 g is most suitable for incubation as it yields better hatchability and keet weight post hatch as well as post hatch growth performance.

Keywords: Egg characteristics, Growth performance, hatch rate, keet hatch weight, *Numida meleagris*

Received: 27/01/2024

Accepted: 01/04/2024

DOI: https://dx.doi.org/10.4314/jcas.v20i2.2

RESUME

Une étude a été réalisée pour caractériser les œufs de pintade (*Numida meleagris*), évaluer l'effet du poids des œufs sur l'éclosion, le poids d'éclosion des pintadeaux et les performances de croissance précoce dans les hauts plateaux de l'ouest Cameroun. Cent soixante-quatorze (174) œufs de pintade ont été collectés dans une ferme de la région de l'Ouest du Cameroun et caractérisés. La longueur, la largeur et le poids des œufs ont été enregistrés. À l'aide des indices de poids et de forme des œufs, les œufs ont été regroupés en petits (40 à 45 g); moyennes (46-49 g) et grandes (> 50 g) catégories et incubées pendant 32 jours. Les pintades ont été collectées à l'éclosion à partir de 28 jours dans chaque groupe et pesées pour déterminer leur poids à l'éclosion. Les œufs fertiles et stériles ont été séparés par mirage et cassage des œufs non éclos pour compter les embryons morts dans leur coquille. Les pintades issues de chaque catégorie de petite (T1), moyenne (T2) et grande (T3) ont été maintenues, chaque traitement comportant 15 pintadeaux. Les pintadeaux ont reçu de l'eau et un régime alimentaire commercial contenant 2 900 Kcal/kg de EM et 22 % de PB pendant les 3 premières semaines d'âge et 2 800 kcal/kg de EM et 20 % de PB pendant les 10 semaines de l'étude à satiété (*ad-libitum*). Pendant 13 semaines, les performances de croissance précoce (évolution du poids, gain de poids, consommation alimentaire et indice de consommation) ont été évaluées. Les résultats ont révélé que le poids des œufs variait entre 40 g et 59 g. Le poids moyen des œufs de pintade obtenus était de 48,52 g avec un poids moyen des œufs de 43,75 g, 47,66 g et 51,60 g pour les petites, moyennes et grandes respectivement. Les œufs de tous les traitements ont montré une différence significative ($p < 0,05$) dans les taux de fécondité, les œufs de grande taille ayant la fertilité la plus élevée. La grande catégorie avait le taux d'éclosion le plus élevé, mais sans différence significative ($p > 0,05$) par rapport à la petite catégorie. Les poids moyens les plus élevés à l'éclosion ont été obtenus avec la grande catégorie et étaient significativement ($p < 0,05$) plus élevés que ceux de la petite catégorie. L'analyse de régression a révélé qu'une augmentation du poids des œufs entraînait une augmentation significative correspondante du taux d'éclosion des volailles ($r^2 = 0,95$) et qu'il existe une relation positive entre le poids des œufs et le poids d'éclosion des volailles avec un coefficient de régression de $r^2 = 0,94$. La consommation alimentaire moyenne hebdomadaire et quotidienne par oiseau était plus élevée dans la catégorie des grands que dans les autres groupes. Des observations similaires ont été obtenues avec les gains de poids. Cependant, la catégorie moyenne a montré indice de consommation moyenne le plus basse. En conclusion, les fourchettes de taille des œufs ont eu des effets significatifs sur l'éclosion des œufs de pintade et sur le poids des pintades après l'éclosion. Les œufs de plus grande taille présentaient une plus grande capacité d'éclosion et un meilleur poids à l'éclosion, les pintadeaux des œufs de grande et moyenne taille présentant de meilleures performances de croissance que celles de la catégorie des œufs de petite taille. Par conséquent, un poids d'œufs de pintade allant de 45 g à 60 g est le plus approprié pour l'incubation car il donne une meilleure capacité d'éclosion et un meilleur poids de pintade après l'éclosion ainsi que de meilleures performances de croissance après l'éclosion.

Mots clés : Caractéristiques des œufs, performances de croissance, taux d'éclosion, poids d'éclosion des pintadeaux, *Numida meleagris*

INTRODUCTION

Poultry has been and is still a major source of animal protein and income in most parts of the world and Cameroon in particular. The domestic chicken, *Gallus gallus domesticus* leads the chart of poultry species used as protein sources in Cameroon. With increasing population, animal production with much attention directed towards industrial livestock farming, seemingly unsustainable and fragile in the face of global changes (Wirngo and Kimengsi 2021a,b), there is need to look for non-conventional animal alternatives. There has been increasing incidences of disease outbreaks with the common domestic chicken however, demands for poultry meat has been on the rise. Yet non-conventional poultry species like the guinea fowl are better adapted and resistant to weather as well as to diseases in various environments (Djiotsa *et al*., 2023). Increase taste for game type poultry or at the least local breed chickens is the order of the day. The wild guinea fowl has had enormous pressure in recent times from human activities as there's been increasing preference and demand for bush meat (Njiforti, 1997; Djiotsa *et al*., 2023). Non-conventional poultry species and micro livestock have potentials as good sources of animal protein in the human diet (Merkramer 1992). The guinea fowl, considered as a non-conventional poultry species (Dongmo *et al*., 2020) with great production potential is a good candidate for this peri urban and urban animal agriculture system. Based on observed morphometric variability, Dongmo *et al*., (2017) suggested that indigenous guinea fowl could constitute a high potential food resource if provided appropriate breeding schemes. Phenotypic variability of the morphometric characteristics of common guinea fowls has been reported in Cameroon with a dominance of pearl gray coloring of the plumage, bluish red barbels, black eyes and tarsi, a genetic diversity usable in selection and breeding (Dongmo *et al*., 2023). In attempts to domesticate the guinea fowl, though large amount of guinea fowl eggs and meat are collected from the wild in Cameroon context, efforts towards production have remained in the traditional rearing system with little done regarding selection, breeding, housing, nutrition and health care (Dongmo *et al*., 2016; Massawa *et al*., 2020; Massawa *et al*., 2023). This is partly due to inadequate knowledge on the husbandry needs of this bird species already in domestication and considered as a non-conventional poultry species (Dongmo *et al*., 2020). Most of the production techniques adopted in its rearing are copied from the common domestic chicken as they are closely similar. The guinea fowl, however, can fall victim to almost all health and technical constraints encountered in village chicken farming. Although it is less susceptible to Newcastle disease, it remains an important reservoir. The guinea fowl is particularly susceptible to internal parasites (Nagalo, 1984; Susan, 1992; Sidibe, 2001; Bastianelli *et al*., 2002; Massawa *et al*., 2020, Djiotsa *et al*., 2023). Nevertheless, several researchers have opined that indigenous guinea fowl is one of the promising species of poultry due to its tolerance to heat and adaptation to harsh climate, although there are limited systematic studies (Oke *et al*., 2012) on the husbandry requirements and techniques. The guinea fowl is a galliform species, a rustic bird with a great laying potential. Djiotsa *et al*., (2023) as well as Meutchieye *et al*., 2023, reported that a female guinea fowl lays between 80-100 eggs of 43 g on average per year. Laying starts from the 8th month and the brooding period is 28 days. The production of guinea fowl in the rural and traditional systems of management faced with many problems including: diseases and internal parasites, inadequate feeding, unavailability of eggs for hatching in the dry season, low growth rate and lack of improved genetic materials (Djiotsa *et al*., 2023, Okaeme, 1984; Ayorinde, 1989; Nwagu and Alawa, 1995; Idi., 1997; Karbo *et al.*, 2002; Tanko, 2003), resulting in low productivity. Guerne-Bleich *et al.* (2005) as cited by Dei *et al.*(2012) stated that intensive rearing of guinea fowls (*Numida meleagris*) has proved to be profitable as well as important in ensuring food security in sub-Saharan Africa. Djiotsa *et al.*, 2023 further stated that there are no prohibitions as meleagriculture is practiced by all social classes. The principal production goal of guinea fowl is for sales (90%) and own consumption of eggs and meat; however, this species is also used for gifts and prestige. The guinea fowl has been identified as a candidate family poultry species which can contribute to reducing the gap between demand and supply of animal proteins (Djiotsa *et al.*, 2023). Originating in Africa, guinea fowl constitutes an alternative source of income and protein of animal origin that can be easily mobilized, mainly for rural populations (Djiotsa *et al.*, 2023). However, paucity of information on guinea fowl production, husbandry requirements and techniques is hampering the development of this industry. As a result, the potential of the guinea fowl industry has remained rudimentary and undeveloped for long a time (Karbo *et al.*, 2002; Oke *et al.,* 2012); Nobo *et al.*, 2012). Based on this background, this study set out to assess egg characteristics and its effect on hatchability and fertility of guinea fowl eggs, keet hatch weight and on subsequent growth performances of keets resulting from the eggs.

1. MATERIALS AND METHODS

1.1 Study period and site

This study was carried out from July to November 2023 at the poultry unit of SALI (Sustainable Agriculture/Livestock Enterprise) Mile 4 Nkwen Bamenda in the Western Highlands of Cameroon (Latitude 5° 98" N and longitude 10°19" E and an altitude of 1,258). The study area is characterized by a Sudano-Guinean climate of tropical type consisting of two distinct seasons, a wet season running from March to October and a dry season going from November to February. The mean annual rainfall stands at 2,145 mm and a mean annual temperature of 21.5 °C with the highest temperatures recorded in March (23° C) and the lowest temperatures recorded in the months of July and August. The average relative humidity stands at 75% with February recording the lowest mean relative humidity and July being the most humid month (Google maps, Tuncha *et al.*, 2021). The study was done in two phases with phase one involving collection, characterization and incubation of the guinea fowl eggs until hatching and phase two consisted of assessing early growth performance of the keets resulting from the incubation.

1.2 Egg collection, characterisation and Bird management

1.2.1 Egg collection and characterisation

One hundred and seventy-four (174) guinea fowl (see photo 1) eggs were collected from a farm with an intensive system of production in the West Region of Cameroon. The strain of guinea fowl was most likely the pearl grey based on color of plumaged. The laying hens had age range of 9 to 16 months and the farmer affirmed to have imported eggs from France which were incubated to obtain the flock. The sex ratio in the flock was 1 male to 4 females. Characteristics of eggs collected were registered. The length and width of each egg were taken with the aid of a vernier calliper (150±0.2 mm) before incubation (see photo 2). Eggs were also weighed on a digital electronic balance (accuracy of g±0.01 g) according to procedures followed by Banla *et al.*, 2021. The egg shape indices were then computed according to the formula used by Panda, 1996 and Alasaha and Copur, 2016. Based on the weight and the egg shape indices, the eggs were placed into three groups of small (40-45 g); medium (46-49 g) and large (>50 g) prior to transfer to a 1000 egg capacity automated incubator (Trademark, Ecochicks Poultry Ltd) for 32 days following standard incubation procedures (egg rotation, temperature (37.2!), humidity (55 – 65%) and ventilation control etc.). Characterization and incubation was done in two shifts with 100 eggs incubated in the first set followed by 74 eggs. Keets were collected on hatch from each group from day 28 to 31 of incubation. The hatchlings were weighed with a sensitive digital electronic balance with an accuracy of ±0.01 g (see photo 3) to determine their baseline weight post-hatch and transferred to the brooding boxes (see photo 4). Eggs that didn't hatch by day 32 were considered as unfertile or dead in shell embryos. Fertile and unfertile eggs were separated through candling and breaking of unhatched eggs. Dead in shell embryos were checked through breakage of fertile eggs that didn't hatch. Dead-in-shells or dead at hatch were counted.

$$Shape\ index\ (SI)\ (\%) = \frac{Width}{Length} \times \frac{100}{1}$$

Photo 1: First set of eggs characterized and numbered (each number had the corresponding characteristic registered)

Photo 2: Length and width measurement with a vernier calliper

Photo 3: Egg weight measurement

Photo 4: Keets in brooding boxes

1.2.2 Bird management

To evaluate the egg characteristics and post hatch early growth performances, keets resulting from each category of small, medium and large were maintained each as a treatment i.e. small category (T1), medium category (T2) and large category (T3) with each treatment having 15 keets.

With the initial eggs groupings maintained, hatched keets were fed SPC commercial diet containing 2900Kcal/kg of ME and 22% CP for the first 3 weeks of age and 2800 kcal/kg of ME and 20% of CP for the next 10 weeks of study. SPC feed was chosen as it is the most available and popular commercial feed available on the market. The birds had access to feed and water *ad-libitum*. The birds were weighed every week for 13 weeks to evaluate early growth performance (weight evolution, weight gains, Feed intake and FCR). Known weight of feed were served at each feed and leftovers were weighed prior to the next feeding and subtracted from feed served to determine feed intake.

1.3 Data collection

1.3.1 Fertility, embryonic mortality and Hatchability

Data were collected through counting of the number of eggs incubated, number of hatchlings obtained, and number of eggs not hatched with and without embryos. The counts obtained were used to evaluate the following parameters according to procedures used by Oke et al., 2012; Banla et al., 2021 and Zibi et al., 2022.

Fertility:

$$Fertility\ (\%) = \frac{No\ of\ fertile\ eggs\ (w)}{Total\ No\ of\ eggs\ incubated\ (x)} \times \frac{100}{1}$$

Where w=No. of eggs that hatched + number of dead-in-shell

Hatchability:

$$Hatchability\ (\%) = \frac{No\ of\ eggs\ that\ hatched\ (z)}{No\ of\ fertile\ eggs\ (w)} \times \frac{100}{1}$$

Embryo mortality:

$$Embryo\ mortality\ (\%) = \frac{No\ of\ dead-in-shell\ eggs\ (y)}{No\ of\ fertile\ eggs\ (w)} \times \frac{100}{1}$$

1.3.2 Early growth performance parameters

Early growth performance characteristics evaluated in this study were Feed intake, weight gain and feed conversion ratio. These characteristics were evaluated using the formulas used by Nobo *et al.*, 2012, Ngwarh *et al.*, 2021, Nguefack 2022, Oke *et al.*, 2012.

Feed Intake = Feed served - Leftovers
Weight gain = Final weight - Initial Weight

Average daily weight gain (ADWG)

$$ADWG = \frac{\text{Weight gain}}{\text{Duration of the Experiment}}$$

Feed Conversion Ratio (FCR)

$$FCR = \frac{\text{Feed Intake}}{\text{Total weight gain in the keets}}$$

1.4 Data Analysis

Collected data were subjected to descriptive statistics (means, percentages) and analysis following statistical procedures described by Steel and Torrie (1980). Data on hatchability and embryo mortality resulting from the various treatments were equally subjected to one-way ANOVA to test significant differences in the hatchability and embryo mortality means. Means that showed significant differences were separated using the Duncan Multiple Range Test. Correlated analyses were equally done to check the effect of egg weight on hatchability and keet hatch weight. A linear regression analysis was done to determine the degree to which the predictor variable (egg weight) influenced each of the dependent variables, hatchability and keet hatch weight. Statistical Analyses were done using MS Excel 2010 and SPSS 20.

2. RESULTS AND DISCUSSION

2.1 Results

2.1.1 Egg characteristics of guinea fowl (*Numida meleagris*)

Table 1: Egg characteristics of *N. meleagris*

Category	Egg characteristics	Range	Mean ± STD*
Small (S)	Egg Length (cm)	4.3 - 5.0	4.75 ± 0.16 ^{1}
	Egg width (cm)	3.6 - 3.9	3.72 ± 0.09*
	Egg weight (g)	40 – 45	43.75 ± 1.53 ^{a}
	Egg Shape Index (%)	72.00 - 86.00	78.42 ± 3.00
Medium (M)	Egg Length (cm)	3.8 - 5.2	4.86 ± 0.21 ^{2}
	Egg width (cm)	3.5 - 4.8	3.82 ± 0.23 *
	Egg weight (g)	46 – 49	47.66 ±1.02 ^{b}
	Egg Shape Index (%)	70.59 - 96.00	78.68 ± 5.34
Large (L)	Egg Length (cm)	4.5 - 5.6	5.03 ± 0.18^{3}
	Egg width (cm)	3.2 - 5.0	3.99 ± 0.37 **
	Egg weight (g)	50 – 59	51.60 ±1.79 ^{c}
	Egg Shape Index (%)	60.58 - 98.00	79.32 ± 7.16
Overall	Egg Length (cm)	3.8 - 5.6	4.91 ± 0.22 ^{2}
	Egg width (cm)	3.2 - 5.0	3.87 ± 0.29*
	Egg weight (g)	40 – 59	48.52 ± 2.92 ^{b}
	Egg Shape Index (%)	60.58 – 98.00	78.91 ± 5.82

^{a,b,c} means with different superscript in the same column are significantly (p<0.05) different
*,** means with different superscript in the same column are significantly (p<0.05) different
^{1,2,3} means with different superscript in the same column are significantly (p<0.05) different;
Shape indices showed no significant differences for all categories (p<0.05); n=193
**STD: Standard deviation*

Egg weight of guinea hens ranged from 40 g to 59 g. The overall mean weight of guinea hen eggs obtained for this research was 48.52 g with mean egg weights of 43.75 g, 47.66 g and 51.60 g for small, medium and large categories respectively. Overall mean egg shape index was 78.91 with no significant differences (p<0.05) observed in the egg shape indexes of each category (Table 1). A variation in egg shell coloration from white through bare to brown (see photo 1) was observed in all three categories.

2.1.2 Fertility, hatchability and Keet weight at hatch

Table 2: Effect of egg size on the Fertility, Hatchability and Keet weight at hatch

Category	Fertility (%)	Hatchability (%)	Dead in shells (%)	Average keet weight at hatch	Incubation duration	Total number of eggs incubated (n)
Small (S)	69.77±1.25^{a}	73.33±0.88^{a,b}	26.67±0.22^{a,b}	24.27±0.17^{a}	28.33±**1.53**^{a}	43
Medium (M)	59.30±1.90^{b}	72.55±0.70^{a,}	27.45±0.24^{a}	32.32±3.57^{b}	28.33±**2.52**^{a}	86
Large (L)	75.00±0.40^{c}	74.47±0.79^{b}	27.08±0.54^{b}	34.83±3.17 ^{b}	28.00±**1.00**^{a}	64
Overall	66.32±0.23^{d}	73.43±0.68^{a,b}	27.08±0.54^{a,b}	31.54±3.35 ^{b}	28.00±**1.00**^{a}	193

^{a,b,c,d} means with different superscript in the same column are significantly (p<0.05) different
**STD: Standard deviation*

Eggs in all categories showed significant differences (p<0.05) in fertility rates with large having the highest fertility. The large category had the highest hatchability though no significantly difference (p>0.05) when compared with small category (table 2). Similar results were obtained with embryonic mortality (dead – in – shells). Highest mean keet weight at hatch were obtained with the large category though not significantly different ($p>0.05$) from those obtained with the medium category but were significantly higher ($p<0.05$) compared with those of the small category.

2.1.2 Regression of egg weight on hatchability and keet weight at hatch

Regression analysis of egg weight on hatch rate revealed that an increase in egg weight will result in a corresponding significant increase in keet hatch rate ($r^2=0.95$). Regression analysis of egg weight on keet weight at hatch showed that there exists a positive relationship between egg weight and keet hatch weight with a regression coefficient of $r^2=0.94$ indicating the statistical significance of the regression model that was run. This shows that the egg weight of guinea hens predicts hatchability. This implies that the higher the egg weight the better the hatchability and subsequently the keet hatch weight.

2.1.3 Growth performance parameters

Table 3: Effect of egg characteristics on growth parameters

Category	Total FI per bird in 13 weeks (g)	AWFI Mean SEM	ADFI ± Mean ± SEM	AWWG Mean ± SEM	ADWG Mean SEM*	Average ±weight at 13 weeks per bird (g)	FCR Mean ± STD*
Small (S)	2938.63	211.47 24.87^b	± 30.21 ± 10.25^b	56.38 ± 6.10^b	8.07 ± 1.16^b	700.8	3.68 ± 0.5^b
Medium (M)	3821.33	264.60 47.19^a	± 38.34 ± 23.46^a	97.53 ± 20.32^a	13.93 ± 2.91^a	1222.39	2.96 ± 1.05^a
Large (L)	4517.40	315.32 56.75^a	± 45.28 ± 28.03^a	107.16 ± 23.31^a	15.29 ± 3.33^a	1408.36	3.21 ± 1.39^a

Means in same column with same superscript letters showed no significant differences ($p<0.05$). Means with different superschipt letters are significantly different ($p<0.05$)

**STD: Standard deviation*

**SEM: Standard error of the mean*

FI: Feed Intake; AWFI: Average weekly feed intake; ADFI: average daily feed intake; AWWG: average weekly weight gain; ADWG: Average daily weight gain; FCR: Feed Conversion ratio

The mean weekly and daily feed intake per bird was higher in the large category than in the other groups. Similar observations were obtained with the weight gains. However the medium category showed the smallest overall mean feed conversion ratio. The evolution of these parameters is better appreciated on figures 1, 2, 3 and 4.

The mean weekly and daily feed intake per bird was higher in the large category than in the other groups. Similar observations were obtained with the weight gains. However the medium category showed the smallest overall mean feed conversion ratio. The evolution of these parameters is better appreciated on figures 1, 2, 3 and 4.

Average Daily Feed Intake guinea hen keets in the first thirteen weeks of age

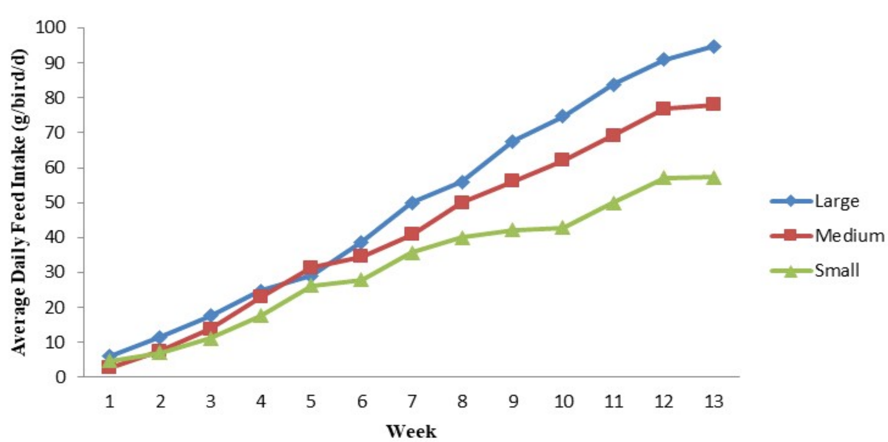


Figure 1: Average daily feed intake per bird according to egg size.

Average daily feed intake per bird and total feed intake increased steadily in all three categories (figures 1). The feed intake increased gradually up to six weeks of age then had a sharp gradient within the next six weeks. The feed intake in the small category increased at a lower rate compared to the medium and large category. This increase in feed intake coincides with the rapid weight increase phase in all categories.

Weekly Weight and weight gain of guinea hen keets in the first thirteen weeks of age

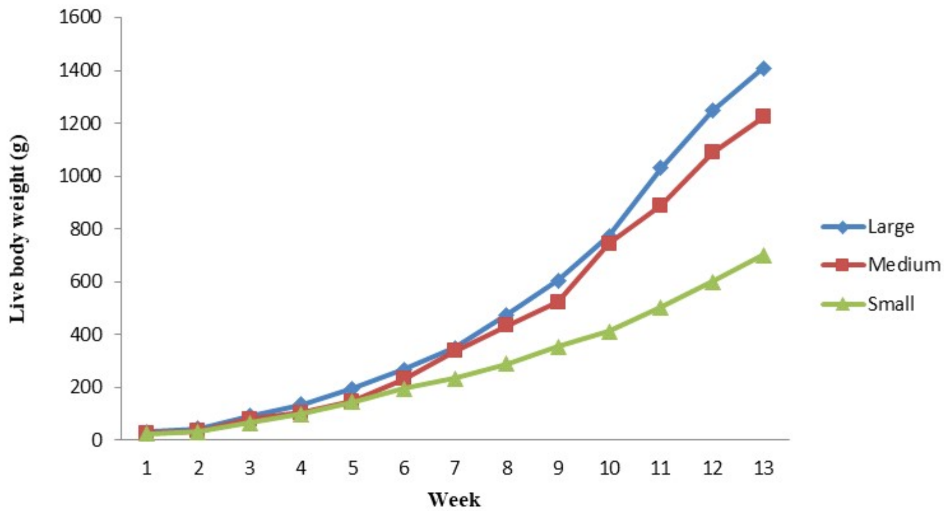
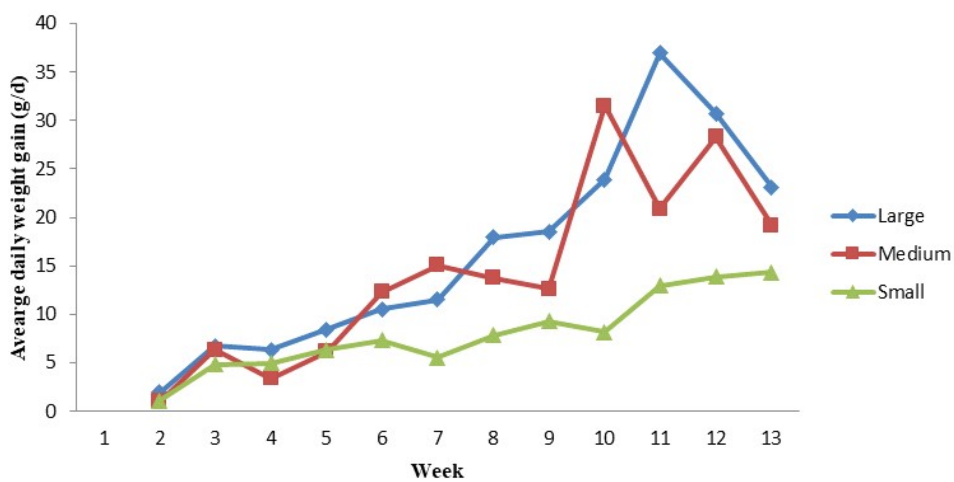


Figure 2: Weekly weight evolution of keets according to egg size

The average weekly weight of the keets increase gradually up to 7 weeks with an average of 400 g for the medium and large categories and 300 g for the small category. This was followed by a sharp increase in the large and medium categories up to 1400 g in the large, 1200 in the medium category. The small category however lagged behind and only attained an average weight of about 800 g at the 13th week of age (figure 2).



***F*igure 3:** Evolution of average daily weight gain of keets according to egg size

The average daily weight gain of keets increased in a zigzag manner in all three categories. The small category still showed lower average daily weight gain compared to the medium and large categories. Keets from the medium and large categories reached average daily weight gain of up to 35 g whereas keets from the small category barely went above 15 g.

Feed Conversion ratio of guinea hen keets in the first thirteen weeks of age

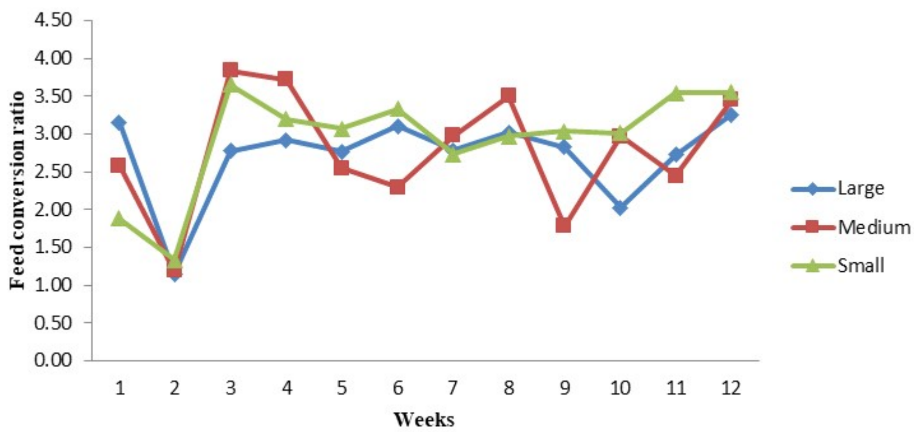


Figure 4: Effect of egg size on the weekly evolution of feed conversion ratio

The feed conversion ratio (figure 4) fluctuated across the weeks in all three categories. Keets from the large and small categories however showed more stable feed conversion compared to keets from the medium category. Overall, keets from the large category showed better feed conversion compared to those from the medium and small categories. Feed conversion ratios as low as 1.14 was obtained in the second week of age. This however increased with the age of the birds.

2.2 Discussion

2.2.1 Egg characteristics

Egg weight of guinea fowl under this study ranged from 40 g to 59 g. The overall mean weight of guinea hen eggs obtained for this research was 48.52 g with mean egg weight of 43.75 g, 47.66 g and 51.60 g for small, medium and large categories respectively. Egg weight obtained in this study fall within the range reported by Panda 1996, Kouame *et al.*, 2019, Ivanova *et al.*, 2020. Other researchers have also reported much lower weight ranges of guinea fowl eggs from 32 g to 42 g per egg, while the average egg weight was 38 g/egg (Khairunnesa *et al.*, 2016), and 38 to 45 g/egg (Ayorinde *et al.*, 1989; Fani *et al.*, 2004). Ivanova *et al.*, 2020 also reported shape indices between 76% and 78% whereas in this study indices of 78.42 ± 3.00, 78.68 ± 5.34 and 78.42 ± 3.00 for Small, Medium and Large categories respectively. The guinea hen eggs are characterized by a more rounded shape compared to the local chicken eggs which are oval in shape. This translates to the higher egg shape indices obtained in the study. These findings were corroborated by Ivanova *et al.,* 2020.

2.2.2 Effect of egg characteristics on Fertility and hatchability

Eggs in all categories showed significant differences ($p<0.05$) in fertility rates with large having the highest fertility. The large category had the highest hatchability though no significantly different ($p<0.05$) when compared with small category. Similar results were obtained with embryonic mortality (dead – in – shells). Highest mean keet weight at hatch were obtained with the large category though not significantly different ($p<0.05$) from those obtained with the medium category but were significantly higher ($p<0.05$) compared with those of the small category. Naandam and Issah (2012) obtained hatchability values of 72.8% and 73.6% which are similar to those obtained with the small (73.33%) and medium (72.55%) categories in the current study. Larger weight category showed significantly higher fertility rates (75 %) and slightly higher hatchability rates (74.74%) compared to eggs in the small and medium categories. Fertility rates obtained in the present study were slightly lower than that (80%) reported by Khairunnesa et al. (2016) who on the contrary reported lower hatchability rates (68.0%).

Ramaphala (2013) in a similar study, cobb 500 domestic broiler chickens with weight ranges of small (< 49 g), medium (50-59 g) and large (60-69 g), showed a reverse trend with small category showing higher hatchability and fertility rates of (92.43%) and 92.40% respectively and the large and medium categories recording 90.90% fertility rates and 90.92 hatchability rates. It's however clear that these hatchability and fertility values were much higher than those recorded in the current study on guinea hen eggs. No effect of egg characteristics has been detected on fertility and hatchability parameters in quails (*Coturnix coturnix japonica*) by Ziba *et al.*, (2022) and Alasahan & Copur (2016).

2.2.3 Relationship between egg weight g/ egg) on hatchability and keet-hatch weight

Correlating egg weight on hatch rate revealed that an increase in egg weight will result in a corresponding significant increase in keet hatch rate with a very strong regression coefficient (r^2=0.95). Furthermore, regression analysis of egg weight on keet- hatch weight showed that there exists a very strong positive relationship between egg weight and keet-hatch weight with a regression coefficient of (r^2=0.94). This shows that the egg weight of guinea hens predicts hatchability and keet-hatch weight. Thus, implying that the higher the egg weight the better the hatchability and subsequently the keet weight at hatch. Oke *et al.*, (2012) reported that eggs with higher weight (larger sizes) had better fertility and hatchability as opposed to smaller egg sizes. They also revealed a positive relationship between the egg size and average keet weight at hatch similar to the results obtained in the present study. Ramaphala(2013) obtained a negative relationship between egg weight and hatchability rates in Cobb 500 broiler chicken egg weight (g/egg) as oppose to the strong positive relationship obtained in this study (r^2=0.95) with guinea hen eggs. It should be noted that the small egg weight range used by Ramaphala in his research correspond to the large category in this current study. Nevertheless, Ramaphala (2013) reported a very strong positive relationship (r^2=0.995) between Cobb 500 broiler chicken egg weight (g/egg) and chick-hatch weight. This corroborates what was obtained in this present study with guinea hen eggs and keet-hatch weight (r^2=0.94). It would seem that egg weight positively affect hatchability up to a certain optimum weight and then turn to negatively affect hatchability. It can also be seen that the egg weight will always positively affect keet (or chick) weight at hatch when they successfully hatch. These results are similar to those earlier reported by Tellet & Burton (1982). Abiola *et al.*, (2008), Shananwany (1987) in broiler chickens and in poults as reported by Bray (1965). Also Ramaphala (2013) also reiterated that heavier eggs contain more nutrients than small or medium sized eggs as earlier stated by Williams, 1994 and hence as a result, chicks from heavier eggs tend to have more yolk attachment at hatching as stated by Hassan *et al.*, 2005 and Woanski *et al.*, 2006.

2.2.4 Effect of egg characteristics on growth parameters

2.2.4.1 Feed intake, weight gain and feed conversion ratio of keets post hatch

Keets from the medium and large weight categories showed higher find intake values with an overall feed intake of 2938.63, 3821.33 and 4517.40 g for keets from the small, medium and large egg weight groups respectively. The keets from small egg weight categories probably had slow development of their guts leading to poor digestion and hence low feed intake. No significant differences ($p < 0.05$) in overall feed intake, weight gain and feed conversion ratios were obtained during the test period (1 – 13 weeks) in this study between the medium and large egg category groupings but were significantly higher compared to the small category. Oke *et al.*, (2012) similarly reported that keets resulting from eggs with higher weight had significantly better feed intake, weight gains and feed conversion ratios. This could be as a result of the small hatch weight as reported by Oke *et al.*, (2001), cited by Oke *et al.*, (2012) that egg size is known to have a positive effect on the growth on subsequent weight of domestic fowls. This result suggests that the guinea fowl eggs weight determine the early growth of the keets it produces.

The growth curve and phase of growth clearly shows that feed intake, and weight progressively increase with age. This is however not the case with weight gain and feed conversion. Weight gain and feed conversion evolve in a more "zigzag" manner. Keets from the medium and large egg sizes had better growth performances than keets hatched from smaller egg weight corroborating the position of Oke *et al.*, (2001). Feed conversion ratios were somewhat higher in the present study compared to those obtained by Oke *et al.*, (2012). It's therefore evidenced that lower egg weight at incubation will affect the keet weight at hatch and reduce subsequent growth performances of the young birds (Figures 1, 2, 3 and 4). Nguefack *et al.*, (2022) reported much lower live weight (< 500 g in all treatments) at 8 weeks of age with varied levels of crude protein in diet of guinea fowl compared to what was obtained in this present study. Keets from small egg weight category had even better live weight (512.5 g) at 8 weeks of age, followed by those from the medium category (522.9 g) and the large category (605.42 g) compared to the average live weight reported by Nguefack and co. The average weight per keet at 13 weeks were 700.8 g, 1222.39 g and 1408.36 g for keets from the small, medium and large egg weight categories respectively.

The average live weight at age 13 weeks of keets from the medium and large egg weight categories were 1222.39 g and 1408.36 g respectively. These are higher than those reported by Nobo *et al.*, (2012) while testing Phane meal as subtstitute for fish meal in guinea fowl diet. Keets from the smaller category however had slightly lower average weight (1030.75 g) at 13 weeks compared to those reported by Nobo and co (figure 3). Khairunnesa et al., (2016) also reported final weight of 1142.42 g, higher than weight (700.8 g) obtained with keets from small egg weight category but lower than those from the medium and large categories at the 13^{th} week of age. They also reported fluctuating feed conversion ratios as those obtained in this current study (Figure 5).

3. CONCLUSIONS AND RECOMMENDATIONS

Egg size ranges used in this study had significant effects on hatchability of guinea fowl eggs and post hatch keet weight. Larger sized eggs had higher hatchability and better keet weight at hatch than medium sized eggs which also had better hatch and keet hatch weight than small sized eggs. Similarly, keets from the large and medium sized eggs showed better growth performances (Feed intake, weight gain, feed conversion ratio and overall growth) than those from the small egg sized category revealing a positive effect of egg weight on post hatch growth performances.

Therefore, guinea fowl egg weight ranging from 45 g to 60 g are most suitable for incubation as they yield better hatchability and keet weight post hatch as well as post hatch growth performance.

Conflict of Interests

Authors declare no conflict of interest.

REFERENCES

Abiola, S. S., Afolabi, A. O., & Dosunmu, O. J. (2008). Hatchability of chicken eggs as influenced by turning frequency in hurricane lantern incubator. African Journal of Biotechnology, 7(23): 4310-4313.

Alasahan S. & Copur A.G. (2016). Hatching Characteristics and Growth Performance of Eggs with Different Egg Shapes. Brazilian Journal of Poultry Science. v.18 / n.1 / 001-008 http://dx.doi.org/10.1590/1516-635x1801001-008.

Alvah, Z., Niba, A. T., & Guiekep J. A. N., (2022). Effect of Egg Weight on Hatchability and Subsequent Growth and Laying Performance of Japanese Quails (*Coturnix coturnix japonica*). International Journal Of Livestock Research, 12(7), 28-36.

Ayorinde, K. L., Ayeni, J.S.O. & Oluyemi J.A., (1989). Laying characteristics and reproductive performance of four indigenous helmeted guinea fowl varieties (*Numidia meleagris galeata pallas*) in Nigeria. Tropical Agriculture (Trinidad), 66: 277-280.

Banla, N. R., A. T. Niba, N. P. Tuncha, Guiekep N. A. J. , Helvia T. & Fonteh F. (2022). Factors affecting the hatchability of snail eggs (*Archachatina marginata*) in the Western Highlands of Cameroon. International Journal of Livestock Production Vol. 13(3), pp. 56-65, http://www.academicjournals.org/IJLP DOI: 10.5897/IJLP2021.

Bray, D. F., (1965). Embryonic weight as a selection criterion in alteration of growth curves of domestic birds. Data from the domestic turkey. Can. J. Genet. Cytol. 7:1–11.

Dei, H. K., T. Tindan & A. Mohammed (2012). Effect of wet feeding on performance of guinea fowl Family Poultry Communications. Vol.21, No.1, 11 -14.

Djiotsa D.F., Meutchieye F., Massawa J., Djitie Kouatcho F. & Mingoas K.J.P. (2023). Production systems and phenotypic variability of the guinea fowl (*Numida meleagris*) in Sub Sahara Africa. *Black Sea Journal of Agriculture* 6(6): 718-725 Doi: 10.47115/bsagriculture.1339905.

Dongmo D. F., Meutchieye F. & Manjeli Y. (2016). Caractéristiques de production de la pintade locale (*Numida meleagris*) dans la zone soudano-sahélienne du Cameroun. Science et technique - Sciences naturelles et agronomie. Spécial hors-série n° 2 (décembre 2016) : 221-232.

Dongmo Djiotsa F, Meutchieye F., Fotsa J.C., Mingoas J.P. & Manjeli Y. (2020). Analyses multi variées des populations de pintade commune (*Numida meleagris*) dans la zone soudano-sahélienne du Cameroun. *World Family Poultry Journal | Journal Mondial de l'Aviculture Familiale | Diario Mundial de la Avicultura Familiar*, 1(1) :20-32.

Dongmo Djiotsa F., Meutchieye F., Tegadjoue Sindze A., Manjeli Y. (2017). Diversité biométrique de la pintade locale (*Numida meleagris*) en zone soudano-sahélienne du Cameroun. *Family Poultry Communications* Vol. 25 (1&2) :15-26

Dongmo, F. D., Meutchieye, F., Massawa, J. and Kilekoung, J. P. M. (2023). Morphometric Assessment of Common Guinea Fowl (*Numida meleagris*) in Cameroon. Open Journal of Animal Sciences, 13, 478-495. https://doi.org/10.4236/ojas.2023.134034.

Fani A. R, Lotfollan H. & Ayazi A. (2004). Evaluation in economical traits of Iranian native guinea fowl (*Numida meleagris*). The Joint

Agriculture and Natural Resources Symposium, Tabriz-Ganja, Iran.

Guerne-Bleich, E., Rhissa, Z. & Mack, S. (2005). The FAO special programme for food security: livestock diversification- a case study in Chad. World's Poultry Science Journal 61: 23-30.

Ivanova, R., M. Nikolova, and P. Veleva (2020). Study on Egg Productivity of Guinea-Fowls (*Numida meleagris*). Iranian Journal of Applied Animal Science (2020) 10(4): 727-734.

Khairunnesa, M., S. C. Das, A. Khatun (2016). Hatching and growth performances of guinea fowl under intensive management system. Progressive Agriculture 27 (1): 70-77.

Kouame Y. A. E., Nideou D., Kouakou K. & Tona K. (2019). Effect of guinea fowl egg storage duration on embryonic and physiological parameters, and keet juvenile growth. Poultry Science, Volume 98, Issue 11, 1 November 2019, Pages 6046-6052 https://doi.org/10.3382/ps/pez264.

Massawa J., Dogmo D. F., & Meutchieye F. (2020). Exploitation of the common guinea fowl (*Numida meleagris*) in the Northern Region of Cameroon. Gen. Biodiv. J: 4 (1), 11-22.

Massawa, J., Francis, D.D., Simo, G. and Teguia, A. (2023). Indigenous Breeding Practices in Guinea Fowl (*Numida meleagris*) as Influenced by Plumage Features in Northern Cameroon. Open Journal of Animal Sciences, 13, 443-457. https://doi.org/10.4236/ojas.2023.134032Merkramer (1992). Golden snail as food and feed. Proceedings of Seminar on Invertebrate ECC Philippines; p. 244.

Meutchieye F, Massawa J, Dongmo F. (2023). L'œuf de pintade, une bonne opportunité (Fiche animale Cameroun). *Afrique Agriculture • Magazine d'information sur l'agriculture, l'élevage, la Pêche et la Forêt en Afrique*. N°452: 42-43.

Naandam, J. and G. Issah (2012). Hatchability of guinea fowls eggs and performance of keets under the traditional extensive system in Tolon-Kumbungu District of Ghana. Online Journal of Animal and Feed Research 2(3): 253-257.

Nguefack G. D., Herve Kuietche Mube, Agwah Dayan Ebile & Fonteh F. A. (2022). Effects of the level of ration of proteins on growth performance of local pearl gray guinea fowl (*Numida meleagris*) from Cameroon in starter phase (0-8 weeks). International Journal of Biological and Chemical Sciences. 16(6): 2715-2725.

Ngwarh, P. T., A. T. Niba & N. R. Banla (2021). Effect of feeding different levels of protein supplementation on the growth performance of young snails (*Archachatina marginata*) in the western highlands of Cameroon. Animal Husbandry, Dairy and Veterinary Science. Volume 5: 1-6. doi: 10.15761/AHDVS.1000186.

Njiforti, H. L. (1997). The Biology and management of wild helmeted guinea fowl (*Numida meleagris galeata* Pallas) in the Waza Region of North Cameroon. Ph.D. Thesis. Wageningen Agricultural University.

Nobo, G. J.C., Moreki and S.J. Nsoso (2012). Feed Intake, Body Weight, Average Daily Gain, Feed Conversion Ratio and Carcass Characteristics of Helmeted Guinea Fowl Fed Varying Levels of Phane Meal (*Imbrasia belina*) as Replacement of Fishmeal under intensive system. International Journal of Poultry Science 11 (6): 378-384.

Nobo, G., J. C Moreki and S. J. Nsoso (2012). Feed Intake, Body Weight, Average Daily Gain, Feed Conversion Ratio and Carcass Characteristics of Helmeted Guinea Fowl Fed Varying Levels of Phane Meal (*Imbrasia belina*) as Replacement of

Fishmeal under internship system. International Journal of Poultry Science 11 (6); 378-384.

Oke, U.K., C.A Ariwodo, U. Herbert, S.N. Ukachukwu, I.A. Ukweni, A.H. Akinmutimi, I.I. Ezeigbo & D.O Chukwu, (2012). Impact of egg size on the fertility, hatchability and early growth traits of two varieties of guinea fowl in a humid tropic environment. Journal of Animal Science Adv., 2 (Suppl. 3.2): 299-305

Panda, P. C. (1996). Shape and Texture. *In* Textbook on Egg and Poultry technology. First Edition, New Delhi, India.

Ramaphala, O. (2013). Effect of egg weight on hatchability and chick hatch-weight of Cobb 500 Broiler chickens. Masters of Science in Agriculture dissertation, Department of Agriculture and Animal Health, University of South Africa.

Shananwany, M.M. (1987). Hatching weight in relation to egg weight in domestic birds. Journal of World Poultry Science 43: 107-115.

Steel R.G.D & Torrie J.H. (1980). Principles and procedures of statistics. Abiometric approach. 2nded. McGraw-Hill, New York (NY), USA.

Tullett, S. G. & Burton, F.G. (1982). Factors affecting the weight and water status of the chick at hatch. British Poultry Science 23: 361-369.

Tuncha, N. P., A. T. Niba & N. R. Banla (2021). Effect of feeding different levels of protein supplementation on the growth performance of young snails (Archachatina marginata) in the western highlands of Cameroon. Anim. Husb. Dairy Vet. Sci, 2021. doi: 10.15761/AHDVS.1000186.

Wirngo H. M. & J. N. Kimengsi. (2021a.) Community Based Actors and Participation in Rangeland Management. Lessons from the Western Highlands of Cameroon. *Sustainability*, **13**: 1700. https://doi.org/10.3390/su13041700.

Wirngo H. M. & J. N. Kimengsi. (2021b.) Governance dynamics in rangelands: An evaluation of the applicability of Ostrom's principles in the Western Highlands of Cameroon. *Scientific African*. **12**: ttps://doi.org/10.1016/j.sciaf.2021. e00837.