phosphate (ALP). The 30 mins BBSM recorded higher (P<0.05) creatinine compared the other treatments.The control, 60, 90, and 120 mins BBSM had similar (P>0.05) creatinine content. Alkaline phosphate content was higher (P<0.05) for the control and 30 mins BBSM compared to 120 mins BBSM. The 60 and 90mins BBSM had similar (P>0.05) alkaline phosphate with both the control and 30 mins BBSM and the 120 mins BBSM.

Table 4: Serum Biochemical Indices of Turkey Fed Experimental Diets

	TREATMENT					
PARAMETERS	**T1**	**T2**	**T3**	**T4**	**T5**	**SEM**
Total protein	3.07	3.90	3.60	3.40	3.60	0.26
Albumins	35.33	37.33	35.67	37.33	38.00	3.46
Globulins	37.00	42.00	35.67	35.67	34.00	4.31
Serum glutamate oxaloacetate (SGOT)/(AST)	17.67	21.00	19.67	19.33	15.00	6.31
Serum glutamate phosphate (SGPT)	7.67	6.50	7.33	10.67	4.50	3.98
Creatine	23.33 ^{b}	54.00 ^{a}	28.00 ^{b}	30.00 ^{b}	17.50 ^{b}	6.76
Alkaline phosphate (ALP)	67.67 ^{a}	66.67 ^{a}	52.67 ^{ab}	48.33 ^{ab}	43.50 ^{b}	6.80
Total serum protein (TSP)	72.33	56.33	71.33	73.00	72.00	7.91

a,b,c,d means in the same row with different super scripts are significantly (P<0.05) different
SEM – Standard error of means

Conclusion and Recommendation

From the results of this study it can be concluded that boiling reduces the content of anti-nutritional factors (tannin, phytate and trypsin inhibitors) of raw baobab seeds. Boiling of raw baobab seeds for more than 30 mins assisted the growing turkey in handling the anti-nutritional factors. Hence, monocyte count and serum creatinine content decreased with increased boiling time. It is recommended that 10% raw baobab seeds boiled for a minimum of thirty minutes can be used to replace soyabean meal in diets of growing turkey.

Acknowledgement

The Authors gratefully acknowledge Tertiary Education Trust Fund (Tetfund) and Federal University Dutsin-ma for sponsoring these research work.

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EFFECTS OF CAGE LOCATION AND TIER LEVEL ON PERFORMANCE AND EGG QUALITY CHARACTERISTICS OF ISA BROWN HENS

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Abstract
This study was carried out to determine the effects of cage location and tier-level on performance and egg quality characteristics of Isa Brown hens. One-hundred and eighty laying hens of similar body weights at 40 weeks of age were housed inside 3-tier cages denoted as Top (T), Middle (M) and Bottom (B) tiers in cages placed facing the Open side (OS) and the Corridor side (CS) of a battery cage pen. The 70-day long experiment was a Randomized Complete Block Design with a 2 x 3 factorial arrangement of treatments. Data on feed consumption and egg production were recorded daily and egg quality was determined at 5-weeks interval. Cage location had no effect on feed consumption and feed efficiency throughout the experimental period. However, the effects of cage location and tier level and their interaction were significant (p<0.05) on hen-day production throughout the experiment. Although cage location and tier level did not have any statistical influence on egg weight, other quality indices such as shape index, yolk index, albumen index and Haugh unit responded significantly (p<0.05) to the treatments. It is therefore recommended that poultry farmers should pay due attention to cage location and tier level as part of key determinants of egg production and quality.

Keywords: cage location, tier-level, performance, egg quality

Introduction
Egg production occupies a key position in the quest to meet the demand for the much-needed animal protein of the teeming population of most communities especially in the low-income food deficit countries. A lot of concerns have been raised by poultry scientists about the dynamics of egg production and its quality after oviposition.

Several factors have been identified to militate against the performance of laying hens housed in battery cages. Awoniyi (2003)) reported that, because there is an unavoidable variation in light intensity among multi-tier cage systems, a balance is needed between providing sufficient light at the bottom tier and avoiding excessive light intensity at the top tier. In another study, Yildiz *et al*., (2006) found that the lack of a homogenous light intensity in multi-tier system and each cage location in semi confined laying hen houses adversely affects egg production and quality. Karaman *et al*., (2013) reported that environmental conditions are not the same in every part of the caged layer house, and differences in micro-environments such as in ventilation,lighting and temperature might occur among cage tiers.

Cage location within the battery cage house and cage tier-level has been of serious research concern to poultry scientists. Poultry products and their quality are affected significantly by genetic and ecological conditions such as the indoor environment of the poultry house (Ahmed and Singh, 2007) Earlier researchers (Vovensy, 1990 and Sahin, 2012) investigated the effects of cage location and tier levels on performance of layers and reported great variability among the groups caged at different tier levels facing windows and located at corridor.External and internal quality of eggs are dependent on genotype and environmental factors such as housing system, oviposition time, age, ambient temperature and nutrition as well as their interactions (Tunova and Gous, 2012). Although diverse variations in performance and egg quality have been recorded among hens subjected to different housing coditions, more work is needed particularly considering the fact that existig reseaches on the subject were undertaken outside Nigeria and with no specific genotype in mind. Therefore, the present study was conceived to determine the effects of cage location and tier-level on performance and egg quality characteristics of Isa Brown hens reared in tropical Rain forest of Nigeria.

Materials and Methods

Birds and Management

This study was carried out at the Department of Agricultural Education Poultry Unit, Federal College of Education (Technical), Akoka, Lagos, Nigeria.The experiment was a randomized complete block design with a 2x3 factorial arrangement of treatments. A total of 180 Isa Brown layers of similar body weights at 40 weeks of age were blocked into location: Open side (OS) and Corridor side (CS) and cage (40 x 36 x 40cm, width x depth x height) as Top (T), Middle (M) and Bottom (B) tiers. Each treatment was replicated 5 times in 10 cells in each tier level of the 2 location types with each cell containing 3 hens. The experiment lasted 70 days aside from 14 days adaptation period (20 March to 29 May, 2017). Average daylight and darkness during the experimental period were 12.30 and 11.30h/d respectively, with no artificial lightening.

Data collection

Feed consumption and egg production were recorded daily and egg quality was determined at 5-weeks interval. Egg production was expressed as hen-day egg production; feed consumption was calculated as daily feed consumption. Feed efficiency was calculated as kilogram of feed consumed per kilogram of egg produced. A total of 60 eggs were randomly picked with 2 eggs per replicate at week 40 and subsequently at weeks 45 and 50 respectively for the determination of quality parameters such as shape index, shell thickness, albumen index, yolk index and Haugh unit. Apart from egg weight, formulas and methods as reported by Ergum *et al*., (1987) were used to determine other egg quality traits. Similarly, Haugh unit was calculated using the values recorded for the egg weight and albumen height as expressed by Haugh (1937) and enunciated by Asuquo *et al.* (1992) in the formula thus: $HU = 100 \log (H + 7.5 - 1.7W^{0.37})$ Where H = Albumen height in mm, W = Egg Weight in g. The data obtained were subjected to analysis of variance (ANOVA) according to SAS (1998) while differences between groups were determined by Duncan multiple –range test.

Results and Discussion

The results of performance indices from the experimental groups are presented in Table 1. The results of this study indicated that cage location had no effect on feed consumption and feed efficiency throughout the experimental period. However, hen day production was significantly ($p < 0.05$) influenced at 40th and 50th weeks old. A sharp contrast in HDP was observed as tier-level significantly ($p<0.05$) increased egg yield at 45th week old. Birds housed in the bottom tier produced more eggs ($p < 0.05$) than those in other tiers. The effects of cage location, tier level and cage location by tier level interaction on HDP were significant ($p < 0.05$) throughout the experimental period while such effects did not exist in other performance parameters investigated. This finding agrees with that of Sahin (2012) who reported that hens at location Facing Window had greater egg production than hens at Corridor side. The improved egg yield observed with birds on the open side of the pen at 40th and 50th weeks could be attributed to better exposure to light intensity as reported by earlier researchers (Awoniyi 2003; Yildiz *et al*., 2006; and Karaman *et al*., 2013). Vovensy (1990) and Ahmed and Singh (2007) also posited that environmental conditions are not the same in every part of the caged layer house, and differences in micro-environments such as ventilation, lighting and temperature might occur among cage tiers. Tier-level effect on egg yield at 45th week old contradicts the findings of Karaman *et al*., (2013) who reported that hens at the top-tier produced more eggs as a result of better exposure to lightning than those at the lower tiers. The significant interactive effects of cage location and tier level observed for HDP in the present study is consistent with the findings of Vowensy (1990) who reported great variability among the groups caged at different tier levels facing windows and located at corridor.

Table1: Performance parameters of Isa Brown hens at different cage locations and tier levels

Treatments		Feed consumption (g/day)			Feed efficiency (Kg feed/Kg eggs)			Hen day production (%)		
Cage location	Tier level	40th week	45th week	50th week	40th week	45th week	50th week	40th week	45th week	50th week
Open side		103.35	104.00	103.91	1.72	1.82	1.76	76.04[a]	73.64	40.72[a]
Corridor side		104.14	103.98	104.02	1.71	1.79	1.71	71.06[b]	70.72	34.79[b]
	Top	103.61	104.12	104.02	1.72	1.82	1.80	73.35	70.72[b]	39.90
	Middle	104.02	103.88	104.04	1.72	1.77	1.69	74.20	70.00[b]	38.82
	Bottom	104.31	103.98	104.58	1.70	1.81	1.71	73.10	75.83[a]	39.05
ANOVA								Probability		
L		NS	NS	NS	NS	NS	NS	*	NS	*
T		NS	NS	NS	NS	NS	NS	NS	*	NS
L X T		NS	NS	NS	NS	NS	NS	*	*	*
SEM		0.03	0.19	0.33	0.02	0.02	0.03	1.16	1.14	0.52
R^2		0.03	0.01	0.05	0.01	0.06	0.11	0.16	0.24	0.30

[a,b;] means on the same column with different superscripts are significantly different (p<0.05)

L = Cage location; T = Tier-level

The results of egg weight (g), egg shape index (%) and egg shell thickness (mm) are presented in Table 2. Cage location, tier level and cage location by tier level interaction did not have significant impact ($p > 0.05$) on egg weight throughout the experimental period. Tier level and cage location by tier level interaction ($p < 0.05$), but not cage location, affected egg shape index at 45th week of age. Hens caged in top tier recorded higher shape index (82.32%) than those in middle and bottom tiers with mean values of 78.59% and 78.59% respectively. This suggests that high light intensity prevalent at the top tier level might have resulted in superior shape index. However, this trend is at variance with the findings of Yildiz *et al.,* (2006) and Awoniyi (2003) who reported that neither cage location nor tier level affected shape index, yolk colour or yolk index. Moreover, cage location and cage location by tier level interaction had significant ($p < 0.05$) effect on shell thickness at 40th week of age. Hens in cages on open side produced eggs with thicker shells (0.31mm; Table 2) than those at corridor side (0.26mm). The effect of location and tier level on shell quality is largely unknown. However, Leeson and Lewis (2004) posited that egg shell quality was independent of light intensity or cage location and tier effect of cage level in other studies including hens.

Table 2: External quality parameters of Isa Brown hens' eggs at different cage locations and tier levels

Treatments		Egg weight (g)			Egg shape index (%)			Egg shell thickness (mm)		
Cage location	Tier level	40th week	45th week	50th week	40th week	45th week	50th week	40th week	45th week	50th week
Open side		60.57	57.43	59.64	76.86	80.83	78.75	0.31[a]	0.25	0.23
Corridor side		61.48	59.51	61.45	78.72	78.72	76.84	0.26[b]	0.25	0.21
	Top	60.80	57.25	58.15	78.17	82.32[a]	78.28	0.28	0.26	0.22
	Middle	60.60	59.32	62.08	77.93	78.59[b]	77.36	0.28	0.24	0.24
	Bottom	61.68	57.50	61.40	77.27	78.59[b]	77.74	0.29	0.26	0.22
ANOVA						Probability				
L		NS	NS	NS	NS	NS	NS	*	NS	NS
T		NS	NS	NS	NS	*	NS	NS	NS	NS
L X T		NS	NS	NS	NS	*	NS	*	*	NS
SEM		1.02	0.89	1.03	0.62	0.72	0.62	0.01	0.01	0.01
R^2		0.01	0.05	0.12	0.09	0.28	0.10	0.07	0.16	0.07

[a,b;] means on the same column with different superscripts are significantly different ($p<0.05$)

Table 3 summarizes the effects of cage location and tier level on internal quality parameters of Isa Brown hens' eggs. Significant cage location and cage location by tier level interaction ($p < 0.05$) effects existed in yolk index at 50th week of age. Hens in cages on open side had superior yolk index (52.02%) to those on corridor side (47.39%). Conversely, Haugh unit responded ($p < 0.05$) to tier level and cage location by tier level interaction at 50th week of age. Mean value of 87.29 recorded for hens in top tier was higher than 81.28 and 81.20 obtained for those in bottom and middle tiers respectively. Furthermore, significant cage location by tier level interaction effects ($p < 0.05$; Table 3) occurred in all the internal parameters at different periods of the experiment. For instance, albumen index (45th week), yolk index (40, 45 and 50th weeks) and Haugh unit (50th week) all responded to cage location by tier level interaction effects. This implies that, while cage location and tier level did not significantly affect internal egg quality indices, cage location by tier level interaction did. This corroborates the findings of Yildiz *et al*., (2006) who reported that despite a lack of effect of tier level, there were significant cage location by tier level interaction effects on albumen index and Haugh unit. Since albumen index and Haugh unit are key determinants of inner egg quality, the outcome of the present study suggests that these parameters should not be ignored when considering environmental factors militating against egg production and quality.

Table 3: Internal quality parameters of Isa Brown hens' eggs at different cage locations and tier levels

Treatments		Albumen index (%)			Yolk index (%)			Haugh unit		
Cage location	Tier level	40th week	45th week	50th week	40th week	45th week	50th week	40th week	45th week	50th week
Open side		86.93	95.23	77.99	44.62	49.44	52.02[a]	89.35	88.62	83.99
Corridor side		92.61	89.43	76.43	47.21	45.70	47.39[b]	88.56	86.94	82.50
	Top	86.10	95.23	83.57	47.10	46.25	49.92	88.80	87.40	87.29[a]
	Middle	90.93	88.42	73.51	45.60	48.68	48.13	89.00	86.86	81.20[b]
	Bottom	92.27	93.33	74.55	45.06	47.78	51.07	89.08	89.08	81.28[b]
ANOVA							Probability			
L		NS	NS	NS	NS	NS	*	NS	NS	NS
T		NS	NS	NS	NS	NS	NS	NS	NS	*
L X T		NS	*	NS	*	*	*	NS	NS	*
SEM		3.01	2.43	2.39	0.92	0.95	0.86	0.92	0.97	1.13
R^2		0.06	0.10	0.13	0.01	0.17	0.31	0.01	0.06	0.23

[a,b;] means on the same column with different superscripts are significantly different ($p<0.05$)

Conclusion and Recommendation

The findings of this study revealed that cage location and tier level as well as their interaction had significant effects on egg production with hens in cages facing the open side producing more eggs than those facing the corridor side at 40 and 50 weeks old. Generally, cage location and tier level did not have any statistical influence on egg weight but other quality indices such as shape index, yolk index, albumen index and Haugh unit responded significantly to the treatments. It is therefore recommended that poultry farmers should pay due attention to cage location and tier level as part of key determinants of egg production and quality.

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