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Reproductive Performance of the Cameroon Kabir Chicken Fed Natural Feed Additives

Ngantu Harrison Ndzi[1]*, Keambou Tiambo Christian[1], Ngu George Tennyson[1] and Kenneth Jacob Ngoh Ndamukong[1]

[1]Department of Animal Sciences, Faculty of Agriculture and Veterinary Medicine, University of Buea, Buea, Cameroon

*Corresponding author: Ngantu Harrison Ndzi; Email: harrisonngantu@yahoo.com Tel: 671868663

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Abstract

Plant-based antimicrobial compounds could be used to replace some sub-therapeutic antibiotic growth promoters. The main objective of this study was to evaluate the effect of phytogenic feed additives as potential natural growth promoters, on reproductive performance in Kabir chicken. The study consisted 144 Cameroon Kabir roosters (24) and hens (120), fed diets containing graded levels of garlic, ginger, thyme (0.5% and 1%), euphorbia (0.75% and 1.5%) or moringa (2.5% and 5%) powders, a positive control diet with a commercial antibiotic and a negative control diet without any additive. The study utilized a complete randomized design. Feed and water were provided *ad libitum*. Zootechnical performances and egg characteristics were recorded until 3 months post-lay. Ginger treatments negatively affected egg production significantly (P<0.001), while the euphorbia treatments drastically affected (P<0.001) feed conversion during the laying period. The yolk colour score ranged from 7-11 and was not influenced by additives (P>0.05). Fertility (74%) and hatchability (<57%) rates were poor and not treatment related (P>0.05). Embryonic mortality was high (63%) and was among other factors affected by increasing levels of additives. Chick body weight at hatching was greatly improved by thyme at the 1.0% level of inclusion. The implications of such findings are discussed.

Keywords: feed additive, antibiotic, growth promoter, performance, Kabir chicken

1.0 INTRODUCTION

The long term use of antibiotics at subtherapeutic levels in livestock production for diseases control and growth promotion poses significant health risks on livestock product consumers, due to residue problems and the potential development of antibiotic resistant human pathogenic bacteria. Driven by the antibiotic resistance debate, the ban levied on subtherapeutic antibiotic utilization in animal production fuelled the search for non-antibiotic substances (alternatives), which might have similar effects in food-producing animals (Falcao et al., 2007). Recently, herbs, spices and various plant extracts have attracted great attention as potential substitutes to the currently used antibiotic growth promoters (Mountzouris et al., 2010).

A number of compounds have been isolated from ginger, garlic, moringa, euphorbia and thyme (Sarica et al., 2005; Shalaby and Hamoweih, 2010) and chemically characterized, but their potential in local poultry production has not been fully explored. The various therapeutic and nutritional indications of these plants potentially present an opportunity especially in family/backyard poultry production. The main objective of this study was to evaluate the effect of these plants currently being screened as potential natural growth promoters, on reproductive performance in the Cameroon Kabir chicken.

2.0 METHODOLOGY

This research was conducted at the Green Gold Poultry Research and Production Farm located 400m above sea level at Liongo village, Buea-Sub Division, in the South West Region of Cameroon.

The study was carried out on 144 Cameroon Kabir chicks of both sexes (24 males and 120 females) aged 7 days and were fed on 10 experimental diets formulated to contain graded levels of garlic, ginger, thyme (0.5% and 1%), euphorbia (0.75% and 1.5%) and moringa (2.5% and 5%) powders against two control diets (a positive control with a commercial antibiotic and a negative control without a plant powder or commercial antibiotic). The diets used in the experiment were those formulated by the Green Gold feed unit to meet the nutrient requirements of layer breeds. They varied with the age of the chicks and comprised formulations for pre-starter (30.04% CP and 3000kcal/kg), starter (24.05% CP and 3106 kcal/kg), grower (21.92% CP and 3118.06 kcal/kg), finisher (19.50% CP and 3205.72kcal/kg) and layer (19.76% CP and 2694.4kcal/kg).

Chicks were administered anti-stress (sugared solution and vitamins) on arrival, distributed according to the treatment groups, identified individually by means of wing tags, and allowed to acclimatize for a seven-day period. Prior to chick reception, the entire poultry house and its premises were thoroughly cleaned with water and disinfected with virunet® solution by means of a knapsack sprayer. The chicks were placed in the pens after 2 hours following the hygiene and sanitation activities, and were then followed up as described by Pelicano *et al*. (2005). Briefly, the chicks were distributed in pens measuring 3 m long by 2 m wide, and standard commercial management applied throughout the experimental period. The floors of the pens were provided with wood shaving approximately 5 cm thick, and the pens equipped with drinkers and feeders. Fluorescent lamps were used for lighting and tungsten filament lamps for heating as necessary. The conventional prophylaxis programme was applied. The chicks which were previously vaccinated against gumboro disease before purchase were vaccinated against Newcastle, infectious bronchitis, fowl cholera and typhoid diseases. Booster doses of these vaccines were given 3 weeks following first vaccinations. Water and feed were provided *ad libitum*. Animals in the treatment groups were balanced for sex, and their zootechnical performances recorded until 9 months post-treatment.

At two weeks to expected first egg drop (5.5 months old), the chickens were introduced to a layer marsh, and laying cages placed in the pens. Excess males were withdrawn from the pens leaving only two males per pen. Fowl pox vaccine was administered and feed and water were continued to be provided *ad libitum*. The parameters evaluated included: feed intake, laying performance, feed conversion ratio, internal and external egg quality characteristics, fertility (%), hatchability (%) and embryonic mortality (%).

Feed intake and weight gain by the chicks in each group were monitored on a weekly basis and feed conversion ratio was calculated. Weight records were taken using a sensitive electronic balance (3kg x 0.5g). The formulae used in calculating weight gain and feed conversion ratio for each animal were as follows:

$$Weight\ gain = Initial\ weight\ of\ the\ bird\ (g) - final\ weight\ (g)$$

$$Feed\ conversion\ ratio = \frac{\text{Amount of feed consumed (g)}}{\text{Weight gain or egg mass (g)}}$$

The number of eggs laid was recorded daily and results expressed as a percentage of the number of hens in the pen. To determine the egg mass produced, all the eggs collected were weighed on a daily basis using a 0.5g precision scale. From the value obtained, feed conversion ratio was calculated. For egg quality evaluation, 15 eggs each (randomly collected) per treatment were used. Two eggs per week per treatment were collected starting from 21 days post-lay until the predetermined number of 15 eggs was reached. Prior to cracking the eggs, the weight, length and width (at equator) were recorded. Following the cracking of eggs, yolk and albumen were separated manually, weighed and expressed as a percentage of egg weight. Yolk thickness and diameter was measured at the middle on a flat surface using a vinear caliper. The egg yolk visual colour score was determined by matching the yolk with one of the 15 bands of the "1961, Roche Improved Yolk Colour Fan. Egg shells were first desiccated for three days at room temperature, after which their thicknesses were measured at the equator using a 0.01mm precision micrometer. From the above measurements made, the yolk and egg index (%) were calculated as follows:

$$Yolk\ index\ (\%) = (height\ /\ diameter)\ x\ 100$$
$$Shape\ index\ (\%) = (width\ /\ length)\ x\ 100$$

For fertility and hatchability evaluation, 30 or more eggs per treatment whose weights were greater than or equal to 45g were incubated in 4 different batches starting from 21 days post first egg lay. Incubation took place in an automatic egg turner incubator. The incubating humidity was set at 65% while the temperature was maintained at 38.0 ºC and later dropped by 2 ºC (36.0 ºC) at 2 days to expected hatching date. The total number of hatched eggs were counted and unhatched eggs were cracked open to check for the presence of any embryos (alive or dead). The data so collected was used to calculate fertility (%), hatchability (%) and embryo mortality (%) as follows:

$$Fertility\ (\%) = \frac{\text{Number of hatched eggs} + \text{Number of eggs with dead embryo}}{\text{Total number of eggs incubated}} \text{X} \frac{100}{1}$$

$$Hatchability\ (\%) = \frac{\text{Number of hatched eggs}}{\text{Number of fertile eggs incubated}} \text{X} \frac{100}{1}$$

$$Embryo\ mortality\ (\%) = \frac{\text{Number of eggs with dead embryo}}{\text{Number of fertile eggs incubated}} \text{X} \frac{100}{1}$$

Data management and analysis

All data collected (feed intake, weight gain, carcass and organ weights and haematological values) were entered into a spread sheet and analyzed with the Statistical Package for Social Sciences software (SPSS, IBM version 21.0). Prior to analysis, appropriate transformations were done to normalize the data following homogeneity of variance test results. Where significant, means were separated using the Duncan's New Multiple Range Test (DNMRT).

3.0 RESULTS

With some few exceptions, the general egg laying trend in all the groups showed a linear increase in the first 5 weeks, peaked between weeks 6 and 9, dropped between weeks 10 and 11, and rose again for a short period in weeks 12 and 13 before falling back in week 14. Highly significant differences ($P<0.001$) were noticed regarding egg production percentage, egg weight and egg mass per hen (Tab. 1). The highest egg masses (g/per hen/98 days) were produced by the 2.5% (2703.18±26.34) and 5% moringa (2674.34±23.90) treatments while the 0.5% garlic produced the least (962.50±49.09). Feed intake (g/hen/day) during the egg laying period was not significantly ($P>0.05$) affected by the feed additives. However, it was highest (166.22±16.56) in the 1.5% euphorbia and lowest (130.18±12.08) in the 1.0% garlic treatments. The daily egg production feed conversion (feed intake/egg mass/day) significantly varied ($P<0.05$) across treatments. It was very poor (> 9) in the negative control, the 0.75 & 1.5% euphorbia, and the 0.5 &.1.0% ginger treatments, but was better (<5) in the 0.5 & 1.5% garlic and the 1.0% thyme treatments. The Kabir hens with their inherent growth potentials gained considerable weight during the laying period but this was not significantly ($P>0.05$) affected by treatment differences. However, hens in the 0.5% ginger (1573.00±328.51g), the 1.5% euphorbia (1415.00±164.68g) and the 2.5% moringa (1215±168.89g) treatments had weight gain advantages over the others. This gain in weight, however, only weakly correlated with feed intake (R= 0.119) and egg mass (R= 0.019).

Table 1: Effect of experimental treatments on productive performance parameters

Treatment	Egg production (%)	Egg weight (g)	Egg mass (g/hen/98days)	Feed intake (g/hen/day)	Feed conversion [(FI/EM)/day]
0.5% ginger	39.06±4.22^{bcde}	49.77±0.65^{bc}	1633.00±14.69^{bcd}	139.76±12.66	11.73±6.03^{bcd}
1.0% ginger	41.88±8.20^{bcde}	45.97±1.86^{a}	1347.75±26.38^{bc}	149.12±11.06	10.34±2.67^{cd}
0.5% garlic	25.98±11.89^{a}	48.11±0.67^{b}	962.50±49.09^{a}	140.03±5.66	4.40±1.15^{a}
1.0% garlic	47.42±7.18^{cde}	48.87±0.34^{bc}	1297.66±24.57^{ab}	130.18±12.08	4.63±1.13^{ab}
0.5% thyme	49.51±5.27^{cde}	45.40±0.82^{a}	1730.75±16.74^{bcd}	135.86±10.60	6.64±1.90^{abc}
1.0% thyme	61.65±7.30^{d}	55.47±0.54^{d}	2872.75±28.36^{cd}	146.79±12.33	3.80±0.42^{a}
2.5% moringa	55.72±7.60^{cde}	49.50±0.44^{bc}	2703.18±26.34^{d}	148.26±4.86	5.30±0.90^{abc}
5.0% moringa	55.73±6.97^{cd}	48.97±0.60^{bc}	2674.34±23.90^{d}	157.32±9.21	5.25±0.80^{abc}
0.75% euphorbia	37.34±3.91^{bcde}	47.53±0.42^{ab}	1366.69±13.02^{bcd}	159.29±6.23	9.44±1.83^{cd}
1.5% euphorbia	28.47±2.06^{bc}	50.90±0.58^{c}	1318.85±7.32^{bcd}	166.22±16.56	12.74±1.64^{d}
Positive control	32.34±3.76^{bcd}	47.53±0.42^{ab}	1506.15±12.51^{cd}	131.54±6.89	6.85±0.72^{abcd}
Negative control	25.23±4.00^{a}	50.90±0.58^{c}	1168.50±14.24^{bcd}	140.73±8.39	9.07±1.53^{cd}
SEM	±2.05	±0.26	±7.30	±3.00	±0.72
Sig.	P=0.0001	P=0.0001	P=0001	NS	P=0.0001

NS: Not significant (P >0.05), SEM: standard error of the mean
a,b,c,d: Duncan's new multiple range test-Pairs with the same letters within a column are not significantly different at 0.05 level of significance

External egg quality (shell weight, shell thickness and shape index) was significantly (P<0.001) influenced by the experimental treatments. The percent shell weight ranged from 11.06±0.26 in the 1.0% thyme to 12.70±0.26 in the 1.0% garlic treatments. Egg shells (mm) were thickest (0.543±0.0011) in the negative control, followed by the 0.75% euphorbia (0.541±0.001), and thinnest in the 0.5% garlic (0.535±0.0015) treatments. Egg shape index values (%) revealed that eggs were closer to spherical in shape (index >73%). This was more pronounced in the 5.0% moringa (79.02±0.69) and the 0.5% thyme (78.08±0.73) than the other experimental treatments. In addition, shell colour was seen to be influenced by the thyme, moringa and euphorbia dietary treatments.

There were significant differences (P<0.001) between treatments regarding albumen weight (%), yolk weight (%) and yolk index (%). The yolk colour score ranged from 7 to 11, but was however not affected (P>0.05) by dietary treatments. No observable trend was found regarding additive levels and internal egg quality. However, the 1.0% thyme treatment (60.22±0.38) appeared to have greatly enhanced albumen weight than any other treatment. In line with this, the addition of 0.5% ginger improved albumen weight and decreased yolk weight. Finally the yolk thickness to diameter ratio was highest (33.09±1.98) in the 0.5% garlic and lowest (25.02±0.42) in the 0.5% ginger treatments relative to the others.

Results of the reproductive performance (fertility, hatchability, mortality, body weight of hatched chicks) of the Kabir chicken are presented in Tab. 2. With the exception of egg fertility (P<0.001) and chick body weight at hatching (P<0.05), the rest of the reproductive parameters were not significantly influenced by the experimental treatments. Fertility results were generally better (>60%), hatchability percentages very low (<57%), and embryonic mortality very high (>48%). The addition of 1.0% thyme (75.81±4.14) and 0.5% ginger (74.94±2.44) in basal diet significantly induced fertility, while the 1.0% garlic treatment (46.48±5.00) however appeared to significantly hamper fertility compared to the other treatments. Though not significant, hatchability was slightly improved in the 0.5% thyme (56.67±4.08) and the 2.5% moringa (54.73±7.22) treatments. On the other hand, the addition of 1.0% ginger and 1.5% euphorbia in the basal diet negatively affected hatchability and embryonic mortality. The body weight of chicks hatched from eggs of the 1.0% thyme treatment (37.55±0.90g) surpassed all the other treatments. Chick weight at hatching was, however, negatively affected by the 1.0% ginger treatment (32.39±0.73g).

Table 2: Effect of experimental treatments on fertility, hatchability and chick's weight at hatching

Treatments	Egg incubation statistics±SEM			
	Fertility (%)	Hatchabiliy (%)	Embryonic mortality (%)	Chick body weight (g) at hatching
0.5% ginger	74.94±2.44[c]	43.70±2.57	56.30±2.57	35.33±0.73[bc]
1.0% ginger	67.05±0.83[bc]	36.16±12.71	63.84±12.72	32.39±0.73[a]
0.5% garlic	65.74±5.63[bc]	41.11±4.84	58.89±4.84	34.86±1.22[abc]
1.0% garlic	46.48±5.00[a]	46.04±17.73	62.29±16.40	34.06±0.97[ab]
0.5% thyme	66.19±2.35[bc]	56.67±4.08	43.33±4.08	32.92±0.80[ab]
1.0% thyme	75.81±4.14[c]	46.53±8.18	53.47±8.18	37.55±0.90[c]
2.5% moringa	71.23±7.01[bc]	54.73±7.22	45.27±7.22	34.14±0.58[ab]
5.0% moringa	67.42±3.45[bc]	43.53±5.94	56.47±5.94	34.00±0.86[ab]
0.75% euphorbia	63.98±4.71[bc]	51.55±10.08	48.45±10.08	34.08±0.58[ab]
1.5% euphorbia	67.46±1.92[bc]	36.67±1.93	63.34±1.93	34.06±1.08[ab]
Positive control	60.49±0.88[b]	44.58±2.12	55.42±2.12	34.60±0.77[ab]
Negative control	65.59±0.63[bc]	37.91±2.35	62.09±2.35	34.12±0.86[ab]
SEM	±1.43	±2.29	±2.25	±0.26
Sig.	P=0.0001	NS	NS	P=0.003

NS: Not significant (P >0.05), SEM: standard error of the mean
a,b,c: Duncan's new multiple range test-Pairs with the same letters within a column are not significantly different at 0.05 level of significance.

4.0 DISCUSSION

The addition of feed additives to the basal diet significantly increased the productive parameters in Kabir hens (though not in the same ways and magnitude), corroborating the results obtained by earlier investigators. Boluckbasi and Erhan (2007) showed that feeding laying hens with diet containing 0.1 and 0.5 % thyme improved egg production and feed conversion. Radwan et al. (2008) found out that dietary supplementation of 0.5% thyme, oregano or rosemary leaves to laying hen diets numerically increased egg weight, egg mass, body weight gain and egg production, and improved feed conversion. Incharoen and Yamauchi (2009) showed that White Leghorn laying hens fed dried fermented ginger (1% and 5%) showed better egg production and mass in comparison to those of control birds. Feeding ginger at the rates of 0.5 and 0.75%, Akbarian et al. (2011) reported improvements in egg production although egg weight did not differ between the control and treated groups. Ali et al. (2007) reported that the addition of 0.25% thyme in the diet of laying hens improved feed conversion and egg production. Finally, Mansoub (2011) stated that laying hens fed thyme powder improved egg production and quality.

The perceived benefits of these feed additives by other researchers have never been the same. Zhao et al. (2011) reported that laying hens fed with ginger at the rates of 5, 10, 15 and 20 g/kg of feed had no effect on laying rate and average egg weight; however, egg mass increased significantly in supplemented groups. Ghasemi et al. (2010) using thyme at 0.1 and 0.2% dose levels in laying hens found no significant change in egg production, egg mass, feed intake and feed conversion across treatments. Similarly, Orhan and Eren (2011) found that egg production, feed intake and egg weight were unaffected by feeding thyme to laying hens. These reports disagree with the earlier studies of Boluckbasi and Erhan (2007) who found a significant change in reproductive performance after feeding thyme at 0.1 and 0.5% dose levels. However, despite the lack of significant treatment differences, Ghasemi et al. S(2010) realized that egg weight increased in birds fed the 0.1% thyme. The present study found out that feeding ginger at 0.5% and 1.0%, and Euphorbia at 0.75% and 1.5% dose levels had serious inhibitory effects on feed conversion. Several factors (variability in nutrient content, climatic changes, processing methods etc) could be responsible for the discrepancies in results obtained from the different studies. However, the manner and conditions under which the research is conducted should be considered the key determinant for the integrity of the results.

Egg production, egg weight and egg mass results obtained in the present study are similar to those of Radwan et al. (2008). However, slightly higher feed intake, feed conversion ratio and body weight gain values were recorded during the laying period in this study compared to theirs. With moringa as protein supplement in Kabir hens, Raphael et al. (2015) recorded a higher egg production rate (up to 80%), and similar feed intake and weight gains compared to the results in this study. Kagengi et al. (2006), however, reported a decreasing egg weight and egg mass with increasing proportion of moringa in laying hen diets. Radwan et al. (2008) and Boluckbasi and Erhan (2006) recorded lower feed intake values, better feed conversion and higher egg production percentages but similar egg weight at 0.1 and 0.5% thyme inclusion levels compared to the controls. Boluckbasi and Erhan (2006) also found that increasing inclusion levels of thyme (1.0%) in the diet lowered the reproductive performance and decreased yolk percentages. In the present study, however, egg production increased significantly ($P<0.001$) with increasing levels of thyme (up to1.0%) in the basal diet. The beneficial effect of thyme may be due to the presence of thymol and carvacrol which considerably exhibit antimicrobial and antifungal activity (Giannenas et al., 2003; Arcila-Lozano et al., 2004; Bozin *et al.*, 2006) and accordingly could improve the chickens' utilization of dietary nutrients (Hernandez *et al.*, 2004; Jang et al., 2004; Radwan et al 2008). Wide variations in performance were noticed with changing levels of doses. In the moringa treatment, however, dose responses were very similar. This may suggest that the 2.5% inclusion level of moringa might be triggering a similar reproductive physiological response to that of the 5.0% inclusion level and thus could be considered the optimum dose level for Kabir hens.

The quality of a chicken's eggs is judged by many subjective factors (both external and internal). Among many quality characteristics, external factors including cleanliness, freshness, egg weight and shell weight are important in consumer's acceptability of shell eggs (Ali et al., 2007; Radwan et al., 2008; Ghasemi et al., 2010; Nasiroleslami and Torki, 2010; Salman and Tabeekh, 2011). On the other hand, interior characteristics such as yolk index, Haugh unit and chemical composition are also important in egg product industry as the demand for liquid egg, frozen egg, egg powder and yolk oil increases (Silversides and Scott, 2001). It has been shown that both the external and internal characteristics of eggs have significant effects on hatchability, fertility and chick development (Ali et al., 2007; Radwan et al., 2008; Salman and Tabeekh, 2011).

The present study showed that dietary treatments highly significantly affected external egg quality, supporting the reports of Nasiroleslami and Torki (2010) and Raphael et al. (2015), but contradicting those of Boluckbasi and Erhan (2006), Ali et al. (2007), Radwan et al. (2008) and Incharoen and Yamauchi (2009), who found no significant treatment differences. Nasiroleslami and Torki (2010) found that the addition of the essential oil of ginger increased egg shell weight and egg shell thickness in laying hens. Radwan et al. (2008) reported only slight increases in the percentage of egg shape index, egg shell weight and shell thickness compared to the control, while Ali et al. (2007) found no change in these following the addition of thyme to the basal diet of laying hens. Incharoen and Yamauchi (2009), on the other hand, found no significant differences in shell breaking strength, shell thickness and shell ratio of eggs from white leghorn hens fed dried fermented ginger at 1.0 and 5.0% dose levels. Though results from the present study were not in agreement with those of Radwan et al. (2008) statistically, the difference could have been due to the types of additive used and the levels of inclusion in the basal diet. Compared to the findings in this study, Radwan et al. (2008) obtained lower shell weights (10.23 to 11.19%) and thickness (0.347 to 0.358mm), and similar shape index on a 100 to 200 mg vitamin E, and 0.5 and 1.0% thyme, oregano, rosmary and turmeric supplemented diets. Also with the Kabir chicken, Raphael et al. (2015) reported thicker egg shells in the 10% moringa leaves supplement than the 5% and control treatments. In the present study, egg shells were thicker in the non-additive control than the additive groups. It is possible that variations observed could have been due to chance occurrences, or the additives used might have exhibited an inhibiting effect on calcium carbonate deposition on egg shells.

Ideally, the internal quality of an egg is determined by the composition of egg white and yolk and possible enclosures (flesh, blood), as well as the freshness since egg starts to age directly after laying (Van Niekerk, 2014). However, the consumer might consider a good internal egg quality as those eggs that have a dark yellow yolk (Koekebeck, 1999) while the thick albumen serves as an important measure of freshness (Toussant and Latshaw, 1999). The internal egg quality (albumen weight %, yolk weight % and yolk index) values showed high treatment variations. This is consistent with the findings of Radwan et al. (2008), though numerical values differed in magnitude. Boluckbasi and Erhan (2007) in an earlier study using 3 dose levels (0.1, 0.5 and 1.0%) of thyme found no significant treatment differences on albumin percentage and haugh units, but yolk percentage was significant. Incharoen and Yamauchi (2009) in another study with 1.0 and 5.0% fermented ginger found no significant differences in albumin ratio, yolk ratio, yolk colour and Haugh unit among the dietary treatments. Compared to the results in the present study, Radwan et al. (2008) recorded higher values of yolk weights (37.67 to 40.32%) and yolk index (42.35 to 52.19) and lower values of albumen weights (47.00 to 52.03%). In either study, the yolk colour score was not significantly affected by treatment differences.

From the controls, it was observed that generally, the Kabir chicken's egg yolk colour naturally appear to be bright yellow (a colour very desirable by consumers). One other important finding in this regard involved egg shell colouring. It was realized that moringa, thyme and euphorbia supplementation resulted in a deep brown, light brown and cream white egg shell colour respectively. The deep brown colour portrayed by moringa is very desirable by consumers. This further indicated that apart from the health and nutritional benefits derived from moringa, using the plant for the purpose of improving on the aesthetic value of eggs can be greatly achieved at the rate of 2.5% inclusion level or more.

Fertility and hatchability are major parameters of reproductive performance which are most sensitive to environmental and genetic influences (King'ori, 2011). Heritability estimates for fertility and hatchability in chickens range from 0.06-0.13 (Sapp *et al*., 2004), indicating that the non-genetic factors have a higher influence on these traits (King'ori, 2011).With regards to fertility, this study showed highly significant ($P<0.001$) treatment variations, as also reported by other investigators. Ali *et al*. (2007) reported that the addition of 0.25% thyme in the diet of laying hens improved fertility and hatchability. Radwan *et al*. (2008) reported significant treatment variations on fertility and with higher values (74 to 88%) than those obtained in the present study (46 to 75%). With indigenous Bangladesh chicken, Desha et al. (2015) recorded a fertility rate of up to 70.81%. Raphael *et al*. (2015) working with the Kabir chicken recorded higher fertility values as well (75 to 81%) but differences were not significant. The observed variation in fertility could be due to breed, body weight at breeding, treatment and dose differences. At dose levels of either 0.5% or 1.0%, Radwan *et al*. (2008) reported improved semen characteristics and decreases melondialdehyde formation in egg yolk as a result of the antioxidant property of the products used. On the other hand, Raphael et al. (2015) used higher dose levels of moringa (5 and 10%) as replacers of soy bean meal in the diet and established that body weight in poultry negatively affected fertility. In the present study, Kabir roosters gained up to 4.5Kg at maturity while the hens went up to 2.5Kg which is heavier than the commercial layer breeders (2kg). These weight differences seriously affected mating in the Kabir chickens during the study period, and this was probably the main reason for differences in the results obtained. Though conditions under which Radwan et al. (2008) and Raphael et al. (2015) carried out their studies were not clearly spelled out in their report, it is possible that environmental conditions that prevailed during their experimental periods could have also influenced fertility. It has been reported that heat stress affects all phases of semen production in breeder cocks (King'ori, 2011).

Hatchability, together with egg production percentage and fertility, determines the population size of local chicken in every community, keeping other factors (diseases, predation, nutrition etc.) constant. Hatchability is a function of egg size (Abiola et al., 2008; King'ori, 2011), weight, shell thickness and porosity, shape index and the consistency of the contents (King'ori, 2011) and others. The absence of significant treatment differences in hatchability is consistent with the reports of Raphael et al. (2015), but does not agree with Ali et al. (2007) and Radwan et al. (2008) who found significant differences. More so, the hatchability percentages obtained in this study (36.16 to 56.67 %) were closer to those reported by Raphael et al. (2015) (53.78 to 66.16 %), but this was low compared to those reported by Radwan et al. (2008) (61.11 to 82.33), IHP (2011) (up to 88%) and Desha et al. (2015) (up to 77.52%). Radwan et al. (2008) reported that the addition of 1% thyme, 0.5 or 1.0% curcuma longa to hens' diets significantly increased the percentages of hatchability of fertile fresh eggs in comparison to hens fed control diets by 18.60, 14.87 and 13.48%, respectively. Even the addition of thyme to laying hens diet as low as 0.25% was reported to significantly increase the percentages of fertility and hatchability of eggs by 1.77 and 4.96% respectively compared to laying hens fed control diets (Ali et al., 2007). This is probably due to the fact that thyme decreases the total lipid and low density lipids, and increases antioxidant capacity in plasma and, consequently, decreases the sources of free radicals passing to the egg. In support, Galobart et al. (2001) stated that antioxidant compounds of herbs such as thymol present in thyme and carnosic acid present in rosemary are transferred to eggs and deposited into yolk and increase the adaptation mechanism to deal with overproduction of free radicals, consequently increasing hatchability. Results of this study, showed that shell characteristics were not a problem to hinder hatchability. Such differences obtained could have therefore been due to several unknown factors related to internal egg quality and difference in incubation conditions. In this study and that of Raphael et al. (2015), eggs were incubated at 400 m above sea level, where temperature varies between 23 to 24.4^{o}C while relative humidity goes up to 87%. High altitudes are detrimental to hatchability of chicken eggs. Research has shown that hatchability of chicken eggs is reduced by 10% at altitude of 305 meters, and by 30% at 2,130 meters above sea level (World

Poultry, 2012). At high altitudes, three hatching-related factors come into play: reduced O_2 availability, excessive loss of CO_2 and excessive water/weight loss by the incubating embryos (World Poultry, 2012).

Another difference in hatchability could be resulting from the type and efficiency of incubator used as well as the quality of electricity supply. In the present study, eggs were incubated in a 500 capacity (microcomputer full autohatcher) automatic egg turner incubator which turned eggs twice a day. During the incubation process, the temperature varied within narrow limits (37.5 to 38.5ºC) but the relative humidity showed great fluctuations, sometimes going down to 60% and up to 85%.

Embryonic mortality was not significantly affected by treatment differences but was thought to be affected by the increasing levels of additives in the diet. This had been reported by Raphael et al. (2015) on Kabir chicken eggs resulting from hens fed diet supplemented with 5% and 10% thyme as soy bean replacers. Radwan et al. (2008) recorded significant improvements in hatchability with 1.0% thyme diet over the control treatments, but variations due to different dose levels was not evident.

Chick body weight at hatching was very similar in the various treatments but was significantly increased in the 1.0% thyme treatment. Radwan et al. (2008) found no significant treatment differences but the numerical chick weight values reported in their study (34.99 to 35.40g) was similar to those obtained in this study (32.39 to 37.55g). Day-old chicks are the end-products of the hatchery and important starting material for the poultry farms. A good-quality day-old chick is hence a crucial hinge between the hatchery and farm (Petek et al., 2010). The quality of the day-old chick has an important effect on the growth performance. Among other factors, Visual and Tona scores (Tona et al., 2005) and day-old chick weights are commonly used for measuring chick quality. Correlating physical broiler chick parameters on growth performance, Petek et al. (2010) found that longer, hence heavier chicks, exhibited better growth potentials throughout the experiment. Also, they realized that the feeding efficiency and survival rate of longer chicks were numerically greater compared to smaller chicks.

5.0 CONCLUSION

Variability in the phytochemistry of feed additives, processing methods and other environmental conditions has serious impact on productive response in the chicken generally. However, the use of feed additives significantly promoted reproductive performance which included egg production percentage, external and internal egg quality, fertility and hatchability in the Kabir Chicken. Fertility was moderate and appeared to have been promoted by the ginger additive while hatchability was generally poor and not treatment related.

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