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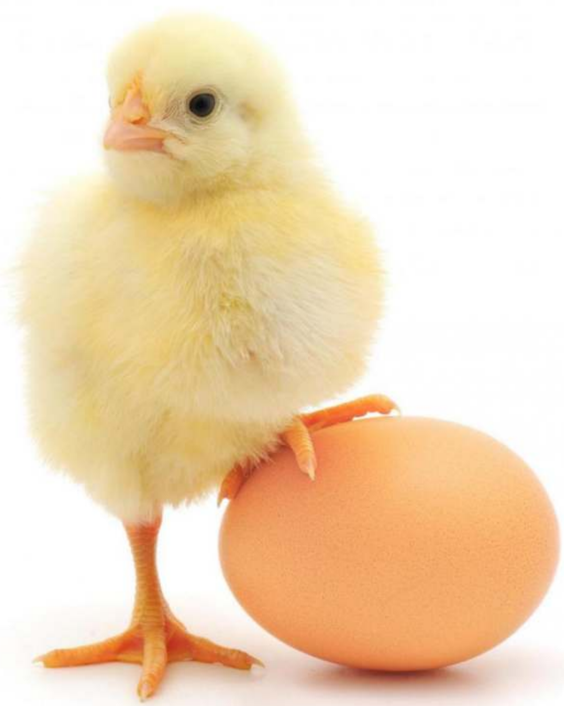

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Influence of Energy Intake on Egg Production and Weight in Indigenous Chickens of Kenya

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Abstract: Indigenous chickens are widespread within the rural areas of Kenya where they contribute more than 50% of the domestic egg requirement. Although they contribute a significant proportion of egg requirements, the productivity is low. Poor nutrition is one of the reasons for the low productivity of indigenous chickens. They depend primarily on the scavenging feed resource base for nutrients. Scavenging is an uncertain method of feeding because the scavenged rations may be inadequate in nutrient supply. Productivity of indigenous chickens can be achieved through improved nutrition by supplementation to supply the deficient nutrients. The energy requirements of growing indigenous chickens have been determined and the energy intakes of the free-ranging chickens have been estimated. However, the energy requirements of indigenous chicken hens in Kenya have not been determined, hence the need to determine the requirements. An on-station feeding trial was conducted to determine the influence of energy intake on egg production, egg and hen weight. Two summit diets were formulated containing 18 and 24% Crude Protein (CP). They were blended in various ratios (diet 2 = 67% of diet 1 and 33% of diet 4; diet 3 = 33% of diet 1 and 67% of diet 4) to obtain two other diets containing 17 and 22% CP. The diets were randomly allocated to 48 indigenous chicken hens 42 weeks of age. Each diet was replicated 4 times and 3 hens were housed per cage. The diets were offered to the hens such that they had similar CP, vitamin and mineral intake but varying energy intake. Egg production, egg and hen weights were measured over an eight-week period. Egg production increased ($p<0.05$) with increasing energy intake from (813-1034 kJ/d). Egg weight was similar ($p>0.05$) for energy intake between 813-1185 kJ. Final hen weight was similar ($p>0.05$) for energy intake between 813-874 kJ and increased from an intake of 1034 kJ. From the results, it is concluded that the daily metabolizable energy requirement for a laying indigenous chicken hen given adequate proteins and other nutrients is 1185 kJ.

Key words: Kenya, local poultry, nutrition, productivity

INTRODUCTION

Indigenous chickens are widespread within the rural areas of the tropical countries where they contribute more than 50% of the domestic egg requirement (Mukherjee, 1992). In 2009, the indigenous chicken population in Kenya was 84% of the total poultry population of 31.8 million (Oparanya, 2009). Although they contribute a significant proportion of egg requirements, the productivity is low. Poor nutrition is one of the reasons for the low productivity of indigenous chickens (Kingori *et al.*, 2007, 2010). They are produced under the scavenging system with little attention to their feed requirements and feeding system. They depend primarily on the scavenging feed resource base for nutrients. Scavenging is an uncertain method of feeding because the scavenged rations may be inadequate in nutrient supply (Birech, 2002; Kingori, 2004). Productivity of indigenous chickens can be achieved through improved nutrition by supplementation to supply the deficient nutrients (Birech, 2002; Kingori, 2004; Kingori *et al.*, 2007).

Influences on egg production can be divided into those that are internal and those, which are external i.e., environmental (Chwalibog and Baldwin, 1995). While internal factors are linked to the genotype, environmental factors include feeding strategies, ambient temperature, seasonal effect, stress and housing. Information on the nutrition requirements of indigenous chickens is limited. The estimates of the dietary energy requirements for egg production vary widely (Karunajeewa, 1972). The wide differences reported in the requirements may be due either to differences in environment or differences in genotype of the strains used in the studies. Reid *et al.* (1978) found egg production to increase linearly and loss in body weight to decrease with increasing energy intake. Over-restriction of energy intake during lay led to a decrease in egg output (Pearson *et al.*, 1989). Studies have indicated that increasing dietary energy results in increased egg weight (Brown *et al.*, 1965). Egg weight and body weight of the fowl could be decreased or increased by changing dietary energy concentration (Harms and Waldroup, 1961, 1963; Auckland and

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Foulton, 1973). Dietary factors which decrease egg weight similarly affect egg numbers and body weight (Gleaves *et al.*, 1968; Tonkinson *et al.*, 1968; Nivas and Sunde, 1969). It has been assumed that the nutrient requirements of indigenous chicken are similar to that of exotic chicken. However, studies on the protein requirements of indigenous chicken (Chemjor, 1998; Kingori *et al.*, 2010) indicated that they are different. Therefore, some studies on the nutrient requirements of certain categories of indigenous chicken have been done. The energy requirements of growing indigenous chickens were determined (Chemjor, 1998; Kingori *et al.*, 2003) while Birech (2002) estimated the energy intake of the free-ranging chickens. However, the energy requirements of indigenous chicken hens in Kenya have not been determined, hence the need to determine the requirements. These chickens have a significant contribution to the supply of animal proteins and economic empowerment of the rural households. This information will be useful in formulating diets that have adequate energy supply for maximizing indigenous chicken hens' productivity. Therefore, the objectives of this study were to determine the effect of energy intake on egg production, egg and hen weight of indigenous chicken hens.

MATERIALS AND METHODS

Forty eight indigenous chicken hens, 42 weeks of age were used in a completely randomized designed (CRD) experiment. The hens were housed in battery cages (40x45x40 cm) in a group of three per cage with a wire floor sloping gently to an egg rack in front. Drinking water was supplied through automatic drinking nipples. Two summit diets (diets 1 and 4) were formulated to contain 240 and 180 g/kg crude protein (CP) respectively. They were blended in different ratios (diet 2 = 67% of diet 1 and 33% of diet 4; diet 3 = 33% of diet 1 and 67% of diet 4) to obtain two other diets containing 170 and 220 g/kg CP (Table 2).

The feed was offered *ad-libitum*. Feed offered was weighed daily based on the previous day's intake to ensure that the hens had more than enough and put into the troughs. Feed refusal was also collected every morning and weighed before the next feeding. Daily feed intake was calculated as the difference between feed offered and feed refusal. Each dietary treatment was replicated four times and the experimental unit was the cage of three hens. Egg production was recorded daily while egg and hen weights were measured weekly. Daily egg production per hen was calculated as the total number of eggs collected divided by three and expressed as a percentage. Egg weight was calculated as the weight of eggs collected per cage divided by the number of eggs. Hens in one cage were weighed together and hen weight was calculated as the weight of the hens in the cage divided by the number of hens. The

Table 1: Ingredient composition of diets

	Diets			
Ingredient (g/kg)	1	2	3	4
Maize	497	547	597	647
Soya bean cake	250	214	176	140
Fishmeal	145	126	106	87
Corn oil	0	16.5	33.5	50
Iodized salt	3.5	3.2	2.8	2.5
Premix	0.35	0.32	0.28	0.25
Limestone	92	83	74	65
Di-calcium phosphate	8.5	7.7	6.8	6

Table 2: Proximate composition of the diets (g/kg)

Diet	1	2	3	4
Dry matter	903.7	872.2	906.2	906.0
Ash	162.9	161.5	153.6	148.8
Crude protein	23.6	22.4	17.8	18.2
Ether extract	54.6	62.8	64.2	88.4
Crude fibre	29.8	28.6	23.2	22.1
Calculated ME* (kJ/g)	12.5	13.1	13.7	14.6

*Metabolizable energy content of the diet

proximate composition of the diets (Table 2) was determined using standard procedures of AOAC (1995). The Metabolizable Energy (ME) of the diets (Table 2) was calculated by summing up the product of the proportion of ingredient in the diet by their ME values of the ingredient (Fishmeal-15.0, Soya bean cake-13.0, Maize-14.3 and Corn oil-37.4 kJ/g). The energy intake per diet was calculated as the product of feed intake and the ME content of the diet. Data was collected over a 56 days period. Egg production, egg and hen weight were calculated per cage and subjected to Analysis of Variance (ANOVA) for a CRD experiment using SPSS (2002) . Significant means were separated using Tukey HSD (Steel and Torrie, 1980).

RESULTS

The ME intake per hen per day was calculated as the product of the ME content of the diet and the feed intake (Table 2 and 3). The Crude Protein and calculated ME of the diets is indicated on Table 2. The effects of energy intake on egg production, egg and hen weight is shown on Table 3.

The maintenance and production energy requirements of the 1.9 kg hen was calculated based on the values derived from indirect calorimetry (maintenance and eating) and the energy content of the egg. Maintenance = 1.2 W x 370 kJ AME/day (Farrell, 2000). The efficiency of utilization of energy for maintenance (k_m) is 0.80. The energy content of the egg is 6.7 kJ/g. The efficiency of utilization of energy for egg production is 0.70.

The hen was in a thermo-neutral environment (25-30°C) so there was no energy cost of thermo-regulation. The hen neither lost nor gained weight. The energy cost of eating was found to be 3% of the hen's daily maintenance heat production (Van Kampen, 1976). The energy costs are summarized in Table 4.

Egg production increased with increased energy intake between 874 and 1034 kJ but was similar ($p>0.05$)

Table 3: Effect of energy intake on egg production, egg and hen weight over 56 day

Feed intake (g/d)	72	76.5	83.3	89.6	Std error
ME (kJ/g) of diet	12.5	13.1	13.7	14.6	-
Energy intake kJ/d	813.33	874.08	1034.16	1185.19	-
CP intake (g/d)	15.36	14.68	13.44	14.77	-
Laying *(%)	21^a	35.5^b	42.6^{bc}	46.2^c	1.049
Egg weight (g)	47.9	53.9	49.3	49.7	1.134
Hen weight (kg)	1.73^a	1.74^a	1.81^{ab}	1.87^b	0.165

$^{a,.b,c}$Means in the same row for each parameter with different superscripts are different at p<0.05

Table 4: Summary of energy requirements (kJ/day) of a 1.9 kg caged indigenous hen laying a 50 g egg at 46% production

Activity	Net energy (kJ/day)	Efficiency (k)	Apparent metabolizable energy (kJ/day)
Maintenance	844	0.8	1055
Eating	-	-	32
Egg Mass	154	0.7	220
Total	998	-	1307

between 1034 and 1185 kJ. Egg weight was similar ($p>0.05$) for all the levels of energy intake. Final hen weight was similar between 813 and 874 kJ but increased between 1034 and 1185 kJ.

DISCUSSION

The energy requirement for animals is partitioned into maintenance and production. Data from indirect calorimetry indicate maintenance requirement for layers to be close to 400 kJ/$w^{0.75}$ (Balnane *et al.*, 1978; Macleod and Jewitt, 1988; Pest *et al.*, 1990). Review papers on the partitions of ME in mature hens by De Groote (1974) found that maintenance requirement to vary between 414 and 556 kJ/$w^{0.75}$. The maintenance energy requirements of a hen in this study was calculated based on values derived from indirect calorimetry as = 1.2 W x 370 kJ AME = 522 kJ/$w^{0.75}$ per day (Farrell, 2000). This is within the range reported by De Groote (1974). This study (feeding trial) estimated the energy requirement to be 1185 kJ/d. If the efficiency of utilization of meatabolzable energy for maintenance and production is 0.75, then the energy requirement for maintenance and production is 888.9 kJ. Prediction of metabolizable energy (ME) intake in white leghorns (Chwalibog, 1985) gave maintenance requirements to be 561-568 kJ/d. Reid *et al.* (1978) studied the energy requirements of white leghorn hens and reported their maintenance to be 464.4 kJ/d. The values are different though hens of the same breed were used in the studies. Kingori (2004) reported maintenance requirement of Kenyan indigenous hens to be 480 kJ/d. The values reported by Reid *et al.* (1978) and Kingori (2004) are close although the hens were of different breeds but similar weight.

Energy requirement is influenced by body weight, rate of weight gain, size and output of eggs (Balnane *et al.*, 1976; Pearson, 1989; Kingori, 2004, Farrell, 2000). This is in agreement with the findings of this study that reported increases in egg production and hen weight when energy intake increased from 874 and 1034 kJ respectively. Decreased egg size and rate of egg production has been observed as a result of restricted energy intake (Belnane *et al.*, 1976; Pearson, 1989; Kingori, 2004). In this study, increasing energy intake from 874 to 1034 kJ/d increased ($p<0.05$) egg production but not egg and hen weight. When the energy intake was 1034 kJ/d, egg production and hen weight increased ($p<0.05$). This implies that the hens utilized some of the energy for building body reserves reflected in the weight gain.

Oluyemi *et al.* (1978) reported increases in body weight and egg production for energy intake of 552 kJ/d and an increase in egg weight at 644 kJ/d. Kingori (2004) in a study with indigenous chicken hens in Kenya found increases in egg numbers and body weight at an energy intake of 695 kJ. In this study, egg production and hen weight increased when the energy intake was 1034 and 1185 kJ respectively. The hens in this study were heavier (1.7 kg) compared to the earlier report (Kingori, 2004) that weighed 1.5 kg. The chickens in this study were of similar ecotype but have been undergoing selection for size at the research station. The heavier chickens are preferred because the indigenous chickens are mainly kept for meat production. The difference in energy requirements for these Kenyan indigenous chicken hens can be attributed to their difference in body and egg weights. The lighter hens (1.5 kg) had higher egg production (laying percentage) but lower egg weights at lower energy intakes compared to the heavier ones (Kingori, 2004). This can be attributed to their lower body maintenance and egg energy requirements.

Conclusions: Energy intake influenced egg production and hen weight but not egg weight. The energy requirement for a laying indigenous chicken hen in confinement given adequate protein and other nutrients is 1185 kJ/d. This information is useful in the formulation of commercial feeds for laying indigenous chicken hens. The demand for commercial indigenous chicken feeds is on the increase because of the shift from scavenging to semi-intensive and intensive systems of production. The shift towards more intensive indigenous chicken production is mainly due to an increased demand and prices of indigenous chicken products (eggs and meat). The two methods (factorial and feeding trial) of determination of the energy requirements gave different values. The factorial method gave a higher ME value. The feeding trial method would be more preferable because of the limited availability and the complexity of use of the animal calorimetry method and equipments. An on-farm study should be carried out to evaluate the response of free-ranging hens to energy supplementation based on the deficit between intake from scavenging (Birech, 2002) and the requirement reported in this study.

Implications: The commercial feeds formulated based on this energy requirement and other nutrients will be used as supplements in the:

1: Free range when chickens are confined during the crop growing season
2: Backyard (semi-intensive) system to maximize meat, fertile and table egg production. Fertile eggs are incubated for chick/grower production for sale during the festive season when the demand is high and best prices
3: Intensive system as complete diets to maximize egg (fertilized/table) production for sale. Fertilized eggs for hatching are in high demand. They are incubated for production of day-old chicks that can be sold at this stage or after brooding (4 weeks old). Most farmers starting indigenous chicken production prefer to buy chicks at 4 weeks of age because they are past the very delicate stage when high mortality occurs

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