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Nutritive Value of Meat of Guinea Fowl Raised on Concrete and Bare Soil Floors from 16-26 Weeks of Age

M.H.D. Mareko, S.J. Nsoso and N. Lebetwa
Department of Animal Science and Production, Botswana College of Agriculture,
Private Bag 0027, Gaborone, Botswana

Abstract: The present study was conducted to determine the effects of floor finish on carcass yield and meat chemical composition of guinea fowls (*Numida meleagris*) at different ages in Botswana. More than 60 keets were raised under an intensive system for four weeks. Keets were fed starter mash and water ad lib. At week 5, keets were allocated to 2 treatments (n=30 each); concrete and bare soil floor partitions within a house. Keets on concrete floor were raised under deep litter. Growers' mash and water were fed ad lib until week 26. From weeks 16-26, three birds were slaughtered from each treatment. Moisture, Dry Matter (DM), Crude Protein (CP) and ash were determined on the breast muscle. Minerals potassium (K), sodium (Na), Phosphorus (P) and Calcium (Ca) were also determined. Data were subjected to ANOVA. Dressing Out Percentage (DOP) ranged between 48.64-74.47% for the soil floor group and 69.32-86.71% for the concrete floor. DM increased significantly with age for both concrete (25.48-45.56%) and soil (27.09-43.07%) floors. Moisture content decreased significantly with age for both concrete (74.53-54.44%) and soil (72.92-56.94%) floors. CP ranged from 68.18-86.65% for concrete floor and 80.34-87.24% for soil floor. The soil floor birds had significantly higher ash content throughout the study period. Generally CP, K, Na, P and Ca contents were comparable for both groups with age. Birds' DOP of over 70% and meat composition compared well with conventional meats, thus their meat can be successfully marketed as a 'white' meat alternative.

Key words: Chemical analysis, concrete and bare soil floors, guinea fowl and meat

INTRODUCTION

The potential for guinea fowl (*Numida meleagris*) production in the world as alternative poultry is a promising enterprise (Nahashon *et al*., 2006 a, b). Poultry has a high socio-economic importance in the rural society where it is mainly kept to supply meat and eggs and also income for the rural poor farmers (Schwanz, 1987; Bonkoungou, 2005). According to Fani *et al*. (2004) guinea fowls originate in Africa where they still retain many of their original traits. These are hardy birds and are opportunistic omnivores inhabiting open savannah and mixed savannah bush (Crowe, 1985). Guinea fowl can be raised under both intensive and extensive management systems (Nsoso *et al*., 2006). The 2 main factors in the successful raising of poultry are proper housing and proper feeding. Of these, perhaps, the most important is the housing. The comfort, health and productiveness of the fowls depend almost entirely upon housing. It has been demonstrated that light intensity, humidity and temperature (heat) play key roles in poultry production (Huges, 1986; Bannor and Ogunsan, 1987). Guinea fowl meat is served extensively in hotels and restaurants because of its peculiar wild gamey flavour (Schwanz, 1987; Feltwell, 1992). According to Schwanz (1987) when raising the birds, one has to ensure that traditional techniques are maintained in order to respect their free ranging instinct, an attribute that helps in maintaining the meat's gamey flavour which leads to its high demand in large markets and its extensive sales in higher priced restaurants (Schwanz, 1987). Further, there are hardly any cultural barriers against consumption of guinea fowl products (Saina, 2005). Nsoso *et al*. (2006) highlighted that information on guinea fowl production is very scanty in Botswana although the birds are in abundance in the wild. The scarcity of such information is even far worse with regard to carcass/meat characteristics. Guinea fowl meat has long been used as relish in Botswana, more especially in rural poor households and has recently found its way into modern retail stores, restaurants and

Corresponding Authors: M.H.D. Mareko, Department of Animal Science and Production, Botswana College of Agriculture, Private Bag 0027, Gaborone, Botswana

hotels. The objective of this study therefore, was to investigate the effects of floor finish on carcass/meat characteristics of guinea fowl from 16-26 weeks of age in Botswana.

MATERIALS AND METHODS

Over 60 keets were hatched over a period of two days in a commercial incubator in January 2006 and raised as a group under an intensive system in a typical poultry house for four weeks. The keets were fed commercial chick starter mash and water ad lib. At the beginning of week 5 keets were randomly allocated to 2 treatments ensuring balanced weight. The treatments were partitions with a concrete floor finish and a bare soil floor within the same poultry house. Keets in the concrete floor finish were raised under the deep litter system and saw dust was used as litter and replaced every two weeks. The 2 groups were fed growers' mash and water ad lib until 14 weeks of age, after which they were fed finisher mash from week 15 until week 26. At weeks 16, 17, 18, 19, 20, 21, 22, 23, 24, 25 and 26, three birds were randomly picked from each treatment weighed (final weight) and slaughtered according to standard abattoir procedures and thereafter re-weighed after evisceration to obtain hot carcass weight. The final and carcass weights were used to determine the Dressing Out Percentage (DOP) of the birds, expressed as: ((hot carcass weight/final live weight)*100). The carcasses were thereafter packaged in polythene bags and kept frozen at -85°C until at the time of analyses where only the skinless breast muscle from each carcass were removed and used for the evaluation. The lean was chopped by hand into small pieces and then ground to a homogenous mince using a Tres-pas grinder (3.2 mm). The samples were analyzed according to procedures of AOAC (1996) to determine percentage dry matter, moisture, crude protein, ash, potassium, sodium, phosphorus and calcium. Data was analysed using ANOVA in SAS (2000). The weekly means were separated using the Duncan's multiple range t-test.

RESULTS AND DISCUSSION

Dressing out percentage was significantly greater for concrete floor (81.23+2.87, 81+2.87, 77.43+2.87) than the soil floor (48.61+2.87, 61.2+2.87 and 68.6+2.87) at 16, 17 and 21 weeks, respectively (Fig. 1). Despite the fact that there were no significant differences between the groups in some weeks at the same stage of growth, the concrete group in general had heavier carcasses throughout the study period. The concrete birds' dressing out percentage ranged from 69.32+2.87 to 81.71+2.87%, whereas the soil floor group's dressing out percentage ranged from 48.64+2.87 to 74.47+2.87%. These findings are comparable to those reported for poultry. Warriss (2000) has reported dressing out percentages of 50, 53, 72 and 75% for sheep, cattle, broiler chicken and pigs, respectively. The results in the present study also agree with those of Mareko *et al*. (2006), who recorded high dressing out percentage (92.96- 94.40%) for guinea fowls at ages of 10, 12 and 14 weeks of age. Saina (2005) reported dressing out percentages of 75.4 and 71.6% for guinea fowl raised in the intensive and semi-intensive management systems, respectively. Adeyemo and Oyejola (2004) have reported 87.4% dressing out percentage for guinea fowls in a study they carried out in Nigeria. Agwunobi and Ekpenyong (1990) also compared dressing out percentage of broiler chicken and guinea fowl and reported carcass yield of 76 and 74% for guinea fowl and broilers, respectively. Ayorinde and Ayeni (1986) studied the effect of management system on fattening of guinea fowl and obtained a higher dressing out percentage (81.5%) for birds kept in dip litter system compared to those kept in battery cages (79.4%) at 20 weeks of age. It is evident from various studies, the present one included, that guinea fowl have a high carcass yield. The variation in dressing out percentages from these different studies may be associated with the birds' strain, diet, birds' management system and carcass dressing methods. Further, carcass yield may be affected by animals' stage of maturity, degree of finish, breed and the intestinal contents (Warriss, 2000).

There was a significant increase of dry matter content in both groups from week 16-week 26 (Fig. 2). Dry matter content of the earth group ranged from 29.09+1.15 to 43.07+1.15 and that of the concrete group ranged from 25.48+1.15 to 45.56+1.15%. Generally, there were no significant differences ($p>0.05$) between the two groups at the same stage of growth, except at the week 18, where the concrete group had a higher dry matter content (33.17+1.15) ($p<0.05$) compared to the soil floor group (29.19+1.15). Further, the concrete group in several stages of growth had higher dry matter content compared to the soil floor group. Saina (2005) has reported dry matter content of guinea fowl under intensive and semi-intensive management at 22.9 and 26.1%, respectively. These values are closer to the present study's values, more especially when the birds were at week 16-18. Fisher *et al*. (2000) reported dry matter of 23.07% for value added ostrich meat, whereas Viljoen *et al*. (2005) reported a range of 97.04-97.11% dry matter on freeze dried ostrich meat through use of near infrared reflectance spectroscopy. When animals are young, their tissue material possesses a high amount of moisture, compared to when they are

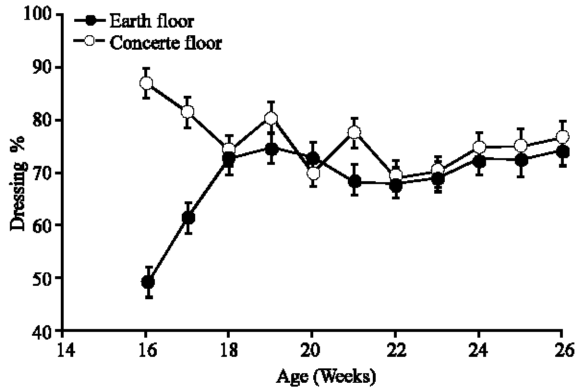

Fig. 1: Dressing Percentage content of guinea fowl raised from 16-26 weeks of age in Botswana

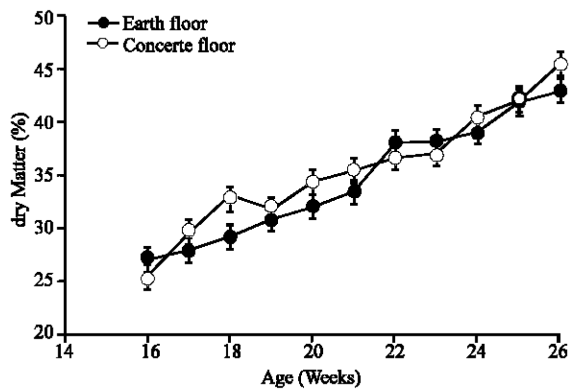

Fig. 2: Dry Matter of guinea fowl raised from 16-26 weeks of age in Botswana

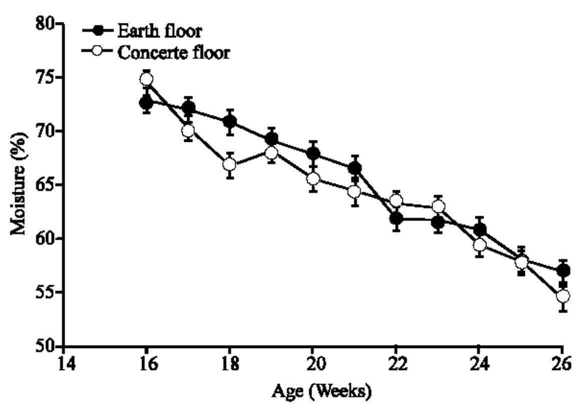

Fig. 3: Moisture content of guinea fowl raised from 16-26 weeks of age in Botswana

mature. Moisture and dry matter content in animal tissues are inversely related as further illustrated by Fig. 2 and 3 2 and fig. 3 (Warriss, 2000). Moisture level in the birds' meat throughout the study declined with time (Fig. 3). The soil floor group had a declining moisture range of 72.92+1.15 to 56.94+1.15% and the concrete group had a declining range of 74.53+1.15 to 54.44+1.15%. Interestingly, the significant difference observed for dry matter (Fig. 2) at week 18, where the concrete group had a higher dry matter level (33.17+1.15%) is reversed in the moisture content with the concrete floor birds having significantly lower moisture (66.83+1.15%) compared to the earth floor group with a significantly higher moisture level (70.82+1.15%). The moisture level (70%) in the present study, more especially at weeks 16 and 17 compares well with figures reported by other works on animal lean tissue composition. Gracey *et al.* (1999) reported an average of 75% across meat sources and FAO (1992) and Seman and McKenzie-Parnell (1989) reported 74 and 74.4%, respectively. Hoffman *et al.* (2000) also reported a comparable moisture range of 69.91-71.76% for breast muscle for four broiler strains used in the South African poultry industry. In another study by Mareko *et al.* (2007) in which different meat sources from different retail stores were evaluated for nutritional parameters, chicken had a lower moisture value (66.37%) comparable to the present study's moisture contents around week 19 to 22. The decrease in moisture content was consistent with the norm that the percentage moisture is inversely related to fat and dry matter, as fat and dry matter forming tissues mature, moisture level in tissues declines (Seman and McKenzie-Parnell, 1989; Warriss, 2000).

The ash content was significantly higher for the soil floor group compared to the concrete group throughout the study period (Fig. 4) and it was increasing at every point of growth. The ash amount for the earth floor group ranged from 8.8+0.7 to 20.20+0.7%, whereas for the concrete floor ranged from 6.60+0.7 to 18.15+0.7%. The ash values in this study are far higher compared to those reported by Hoffman *et al.* (2000) for the breast muscle obtained from four South African chicken strains. They reported a range of 1.07-1.46%. Mareko *et al.* (2007) also reported a lower ash amount for the chicken thigh cut (0.63%), when they evaluated different meat sources found in four major retail stores in Gaborone. Saina (2005) also reported relatively higher ash levels for guineas reared under the intensive (9.3%) and semi-intensive (7.8%) management. According to Saina (2005), pecking of feed on the ground results in high ash content and this could be true for this study since the soil floor group had a significantly higher ash content at all points of growth compared to the concrete floor group. Fisher *et al.* (2000) also reported 0.33% of ash in fresh ostrich meat, whereas Gracey *et al.* (1999) reported value of 0.65% as an average for animal lean tissue material. Srinivasan *et al.* (1998)

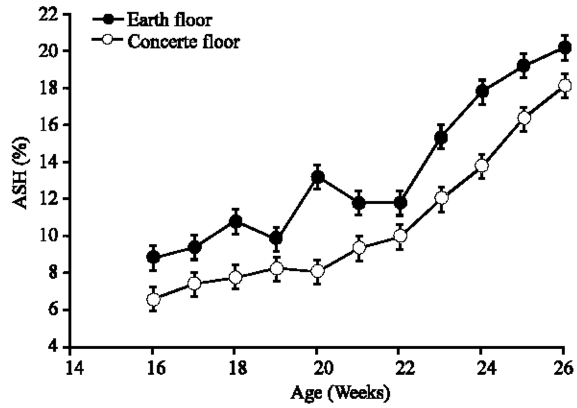

Fig. 4: Ash content of guinea fowl raised from 16-26 weeks of age in Botswana

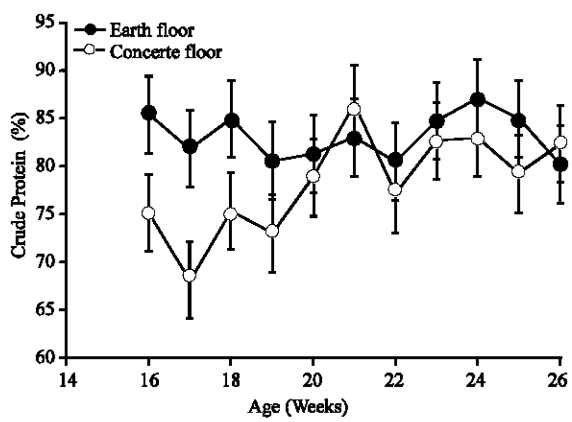

Fig. 5: Crude Protein content of guinea fowl raised from 16-26 weeks of age in Botswana

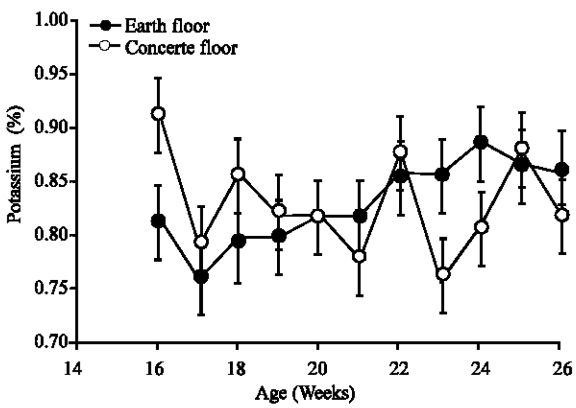

Fig. 6: Potassium content of guinea fowl raised from 16-26 weeks of age in Botswana

reported a range of 1.04-111% for beef steers and Aganga *et al.* (2003) reported a range of 5.10-8.11% for different cuts of donkey carcass.

Crude Protein (CP) differed ($p<0.05$) between the earth and concrete floor groups at weeks 16-18 and thereafter there were no significant differences ($p>0.05$) although the earth floor group generally recorded high contents compared to the concrete floor group except at week 21 (Fig. 5). At weeks 16, 17 and 18, the soil floor group had significantly higher CP at 85.49+4.05, 81.91+4.05 and 85.04+4.05%, whereas the concrete floor recorded 75.23+4.05, 68.18+4.05 and 75.40+4.05%, respectively. The soil floor group had a CP range of 80.34+4.05 to 87.24+4.05%, whereas the concrete floor group recorded a CP range of 68.18+4.05 to 86.68+4.05%. Saina (2005), reported closer values of CP for intensive and semi-intensive managed guineas at 75.4 and 72.7% in Zimbabwe and also Viljoen *et al.* (2005) reported CP values of 90.40% for freeze dried ostrich meat. Fisher *et al.* (2000) reported 17.48% for fresh ostrich meat. A range of 20.52-21.35% CP from four South African chicken strains was reported by Hoffman *et al.* (2000) for the breast muscle. Holland *et al.* (1997) reported 16.6, 17.6, 17.9 and 18.9% for the thigh cut of pork, chicken, lamb and beef, respectively. Mareko *et al.* (2007), reported lower CP values for lamb, chevon, pork, beef and chicken at 57.19, 67.81, 50.13, 54.44 and 51.56%, respectively. Gracey *et al.* (1999), has reported an average CP of 19% across different meat sources, whereas FAO (1992) and Seman and McKnzie (1989) reported 21% for raw chicken meat. The varying nutritive figures obtained in different studies its further prove that physiochemical properties of meat do vary affected by intrinsic factors (Carragher and Mathews, 1996; Pearson and Gillet, 1999) and also by sample preparation and analytical methods (Holland *et al.*, 1997). According to Aganga *et al.* (2003) and Pearson and Gillet (1999), the nitrogenous components of meat are the most important nutritionally. Proteins are polypeptides or combinations of amino acids, linked together into chains by the reaction of amino and carboxyl groups of adjoining amino acids, by means of peptide linkages. Nutritionally, guinea fowl meat is proving to be a potential competitor in meat industry, rich in crude protein and more so that it is classified as 'white' meat.

There was a significant difference of potassium between the two groups at weeks 16, 23 and 24 (Fig. 6). At week 16, the concrete floor group had significantly higher potassium amount (0.92+0.03%) compared to the soil floor group at 0.82+0.03%. From weeks 16-20, potassium content was higher on the concrete floor group, but the situation got reversed after week 22, where the soil floor group had a higher ($p<0.05$) potassium amount at week 23 and 24. In the mid range, ie. from week 17 to 22, the two groups had non significant differences ($p>0.05$) so far as potassium amount is concerned. Potassium and sodium are important elements in osmotic regulation of the body fluids and in acid base-balance in the animal. They play an important part on nerve and muscle excitability and in carbohydrate metabolism (Seman and McKenzie-Parnell, 1989; Pearson and Gillet, 1999). Seman and McKenzie-Parnell (1989) and FAO (1992) reported 330 mg potassium and 72 mg sodium on 100 g meat serving. According to Higdon (2003), human diet studies indicate that groups with relatively high dietary potassium intakes have lower blood pressure compared to groups with relatively low potassium intakes. Potassium is an essential dietary mineral and therefore, guinea fowl meat can meet the requirements of this mineral in the diet and reduce its deficiency. The concrete floor birds had a higher ($p<0.05$) sodium level at week 16-21 and again at week 23 (Fig. 7) than the soil floor group. A high significant difference was observed in week 19 than in all other weeks. The difference narrowed down from week 20 to 23. The sodium levels were equal for both treatments at week 24 to 26 (Fig. 7). Sodium is contributed to the meat by eating salt in the diet which contains sodium and chloride. A diet high in sodium is one of several risk factors associated with high blood pressure (Seman and McKenzie-Parnell, 1989) and controlling high sodium intake may reduce this risk. Most fresh meats, poultry like guinea fowls and fish are low in sodium. According to Seman and McKenzie-Parnell (1989), sodium and potassium are the principal cations of the intra- and extracellular fluid balance, respectively in the body. Both elements also play important roles in maintenance of normal blood pressure, acid/base regulation, cardiac function, nerve and muscle excitation and body metabolism (Seman and McKenzie-Parnell, 1989).

Significant differences in phosphorus level between the two groups were observed at weeks 17, 18, 19, 20, 21 and 22 (Fig. 8). At week 17, soil floor birds had significantly high phosphorus level (2.27+0.14%) compared to the concrete floor group (1.96+0.14%). There were no significant differences at the beginning of the study (week 16) and at the end, weeks 23 to 26. Mostly higher levels of phosphorus were observed on concrete floor birds which might be due to the fact that concrete floor birds were mostly feeding on modern broiler feed balanced for nutrients, compared to soil floor birds which sometimes abandoned provided feeds to eat insects and plant matter. Pearson and Gillett (1999) reported that meat is a good source of phosphorus compared to calcium, something evident in the present study. Phosphorus values ranged from 1.96–2.55 and 1.81–2.48% for the concrete and earth floors, respectively and calcium values ranged from 0.14-0.16 and 0.14-0.15% for concrete and soil floors, respectively (Fig. 9). Seman and McKenzie (1989),

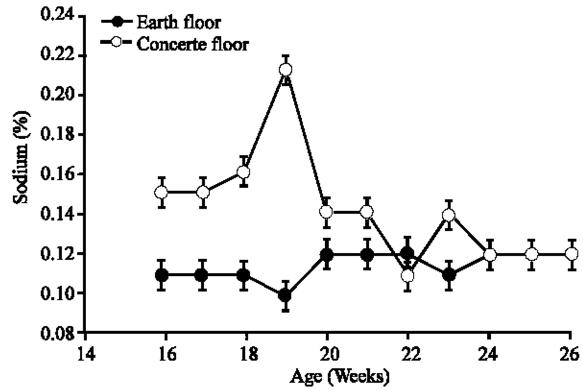

Fig. 7: Sodium content of guinea fowl raised from 16-26 weeks of age in Botswana

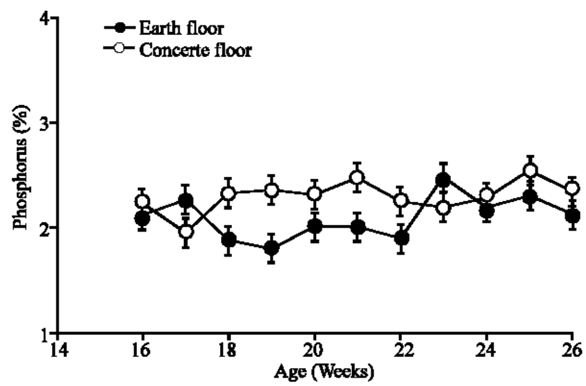

Fig. 8: Phosphorus content of guinea fowl raised from 16-26 weeks of age in Botswana

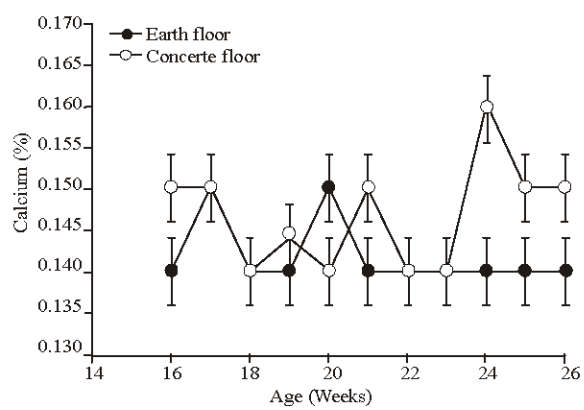

Fig. 9: Calcium content of guinea fowl raised from 16-26 weeks of age in Botswana

further reported 210 mg phosphorus and 10 mg calcium from a 100 g meat serving, whereas (FAO, 1992) reported 180 mg phosphorus and 10 mg calcium. Phosphorus is an essential mineral that is required by every cell in the body for normal function. According to Higdon (2003) most of the phosphorus in the body is found as Phosphate (PO_4). Approximately 85% of the body's phosphorus is found in bone. Phosphorus is found in most foods because it is a critical component of all living organisms (Higdon, 2003). Pearson and Gillett (1999) stated that calcium is the most abundant mineral element in the animal body and described it as an important constituent of the skeleton, in which about 99% of the total body calcium is found. Calcium plays a role in mediating the constriction and relaxation of blood vessels (vasoconstriction and vasodilation).This clearly explains why the calcium level was low in the carcass of guinea fowls because it is a major structural element in bones and teeth not flesh. Higdon (2003) confirmed that the physiological functions of calcium are so vital to survival that the body will demineralize bone to maintain normal blood calcium levels when calcium intake is inadequate, hence guinea fowl meat with its optimum levels of calcium can be a good calcium supplement in rural areas to prevent this devastating effects of bone demineralization in humans and thus, adequate dietary calcium is a critical factor in maintaining a healthy skeleton (Higdon, 2003). Calcium and phosphorus are the major constituents of bone and are important in neuromuscular transmission, blood coagulation, enzyme activity and energy storage (Seman and McKenzie, 1989; Pearson and Gillet, 1999).

CONCLUSION

This study showed that guinea fowl meat composition is very comparable with other conventional meat sources nutritionally, with a high carcass yield. Dry matter and ash levels increased significantly with age from weeks 16-26 for the two groups. Ash amount for the soil floor group was significantly higher than that of the concrete floor at all points of growth. Moisture dropped significantly from week 16-26 for both treatments. Crude protein, potassium, sodium, phosphorus and calcium were not significantly affected by the floor finish. This shows that the birds' performance in the 2 management systems was not very different, therefore farmers can be advised to use a cheaper option being the soil floor finish type. It would also be advisable for such farmers to sell their birds at or before week 16, since keeping them for long does not bring any additional nutritive value. Further research on the birds' carcass/meat characteristics should be carried out to help in their selection and breeding programs. Such works can address issues on costs in different management systems, feeding, meat processing and profiling further nutritive parameters such as amino and fatty acids, which are the major components in good diet and health.

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