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Full Length Research Paper

Effect of season and farming system on the quantity and nutritional quality of scavengeable feed resources and performance of village poultry in central Tanzania

E. H. Goromela[1,*], R. P. Kwakkel[2], M. W. A. Verstegen[2] and A. M. Katule[3]

[1]Natonal Livestock Research Institute, P. O. Box 202 Mpwapwa, Tanzania.
[2]Animal Nutrition Group, Wageningen University, P.O. Box 338, 6700 AH Wageningen, The Netherlands.
[3]Sokoine University of Agriculture, P. O. Box 3004 Morogoro, Tanzania.

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A 2 x 2 factorial study was conducted to assess the effect of season and farming system on the quantity and nutritional quality of scavengeable feed resources and the performance of village poultry in central Tanzania. A total of 648 scavenging chickens purchased from farmers were slaughtered and the crop contents were subjected to physical and chemical analysis. The mean fresh weights of the crop contents were higher ($P<0.05$) in the dry season (34.5 g) than in the rainy season (28.4 g) and there were no significant differences between the farming systems. Visual observations of the crop contents revealed that kitchen/brew wastes, sand and grit, oil seeds and cakes, cereal bran, cereal grains, and other feed materials were the main physical components and varied ($P<0.05$) with seasons and farming systems. The overall chemical compositions (% dry matter) of the crop contents showed that crude protein (9.24), ash (21.6), magnesium (0.22), nitrogen free extract (58.8) and metabolizable (11.5 MJ/kgDM^{-1}) contents varied ($P<0.05$) with seasons and farming systems. The mean live body weights at slaughter of chickens were higher ($P<0.05$) in the dry season (1238 g) than in the rainy season (890 g). The study showed that quantity and nutritional quality of scavengeable feed resources varied considerably between the seasons and farming systems; and the nutrient contents were below the birds' requirements for high productivity.

Key words: Season, farming system, scavengeable feed resources, village poultry, crop contents, chemical composition, Central Tanzania.

INTRODUCTION

The village poultry production system, commonly known as traditional free-range system, is the most important poultry production system in rural communities of Tanzania and those of other African and Asian countries. This system is entirely practiced by smallholders using indigenous stocks with low input levels that make the best use of locally available resources. In addition, village poultry constitutes an important component of the agricultural and household economy in these countries. This contribution is thus more than direct food production for the fast-growing human population (Guèye, 2003). A major characteristic of the village poultry production system is that part of the diet consumed by poultry is obtained through scavenging on available feed resources. These include those at household level such as food leftovers or kitchen wastes, garden vegetables, crop grains, orchards, harvest residues, and environmental materials such as insects, worms, snails, slugs, forage leaves/flowers, forage seeds, sand and grits (Sonaiya, 2004; Goromela et al., 2007).

Under scavenging conditions, village poultry usually obtain their own diets during the daytime mainly through scratching and foraging activities. Studies have indicated that the amount of scavengeable feed resources consumed by scavenging chickens depend on several factors. The most important are season, grain availability in the household, time of grain sowing and harvesting (Cummings, 1992; Roberts, 1995; Tadelle, 1996; Sonaiya, 2004). Goromela et al. (2007) reported that changes in seasonal conditions, farming activities, land size available for scavenging and the village flock size

*Corresponding author. E-mail: egoromela@yahoo.com.

Table 1. On farm experimental design for data collection in each period, village and sampling time of the day during the rainy and dry seasons in two farming systems

Seasons	Periods[1]	Farming systems		Sampling time of the day	No. of birds slaughtered per village
		Sorghum-pearl millet-groundnut	Maize-bean-sunflower		
Rainy	Jan-Feb	Chitemo+ Kisokwe	Bumila + Chamkoroma	10.0h+14.0h+16.0h	27
	Mar-Apr	Chitemo+ Kisokwe	Bumila + Chamkoroma	10.0h+14.0h+16.0h	27
	May-Jun	Chitemo+ Kisokwe	Bumila + Chamkoroma	10.0h+14.0h+16.0h	27
Dry	Jul-Aug	Chitemo+ Kisokwe	Bumila + Chamkoroma	10.0h+14.0h+16.0h	27
	Sept-Oct	Chitemo+ Kisokwe	Bumila + Chamkoroma	10.0h+14.0h+16.0h	27
	Nov-Dec	Chitemo+ Kisokwe	Bumila + Chamkoroma	10.0h+14.0h+16.0h	27

[1]Jan = January, Feb = February, Mar = March, Apr = April, May = May, Jun = June, Jul = July, Aug = August, Sept = September, Oct = October, Nov = November and Dec = December.

have significant influence on availability of scavengeable feed resources for village poultry in central Tanzania. Based on seasonal feed fluctuations, it was concluded that it is uncertain whether the available scavengeable feed resources at the household level and those available on the range-environment are sufficient in quantity and quality to sustain village poultry production throughout the year. A general consensus is that by estimation of the feed intake from scavenging and its relation to nutrient requirements of the birds can improve feeding and management system of village poultry (Huchzermeyer, 1973; Ajuya, 1999). Wood et al. (1963) indicated that analysis of crop contents of free-ranging birds can help determine the food habits and preferences of chickens and provide an indication of the amount of supplementary feed required. The objective of the present study was to determine the quantity and nutritional quality of the feed consumed by scavenging chickens in different seasons and farming systems by assessing physical and chemical composition of the crop contents and the carcass characteristics of village poultry in Central Tanzania.

MATERIALS AND METHODS

Description of the study area

The study was carried out in the two farming systems in Central Tanzania: sorghum-pearl millet and groundnut farming system located in Chitemo and Kisokwe villages (Mpwapwa district) and the maize-bean and sunflower farming system located in Bumila village (Mpwapwa district) and Chamkoroma village (Kongwa district). All the villages are located in the semi-arid zone of central Tanzania which lies between longitude 34°50' E to 35°15'E and latitude 5°32'S to 6°15'S. This zone covers an area of 140,000 km^2 and it lies between 750 and 1750 m above sea level. The zone has a savannah type of climate, characterized by a long dry season from July to December. The area has one growing season due to uni-modal type of rainfall which varies across the zone. The average rainfall ranges between 450 and 700 mm per annum and the day temperature ranges between 19 and 29°C with a diurnal range of 12°C.

Selection of villages and contact farmers

The above four villages were selected during a reconnaissance survey based on the representativeness of the area in terms of physical, biological and socio-economic characteristics and the farming systems practiced. Chitemo and Kisokwe villages have drier climate with sunny days and low soil fertility and the major crops grown are sorghum, pearl millet and groundnuts. Bumila and Chamkoroma villages have relatively cool climate, slope, flood plains and high soil fertility and the major crops grown are maize, beans and sunflower. The villages were also chosen based on accessibility, institutional support and co-operation of local farmers. In each village twenty seven farmers were chosen and selected based on their interest and willingness to participate in the research activities and owning at least 6 to 10 mature chickens. The farmers were randomly picked from three sub-villages, stratified systematically to cover the entire population in the village who owned chickens. In each sub-village, nine contact farmers were selected and were located at least 1000 m from each other in order to ensure that there was no mixing of family flocks when scavenging.

Experimental period and management of birds

The study consisted of two experimental periods (seasons) which were the rainy season from January to June and the dry season from July to December. In each season three sampling periods of each two month intervals were set up. In the rainy season these sampling periods were: January - February; March - April, and May - June while in the dry season were: July - August; September - October, and November - December (Table 1). In each period, sampling of crop contents was done once where a total of 27 scavenging chickens per village were slaughtered. Sampling of the crop contents mostly took one day to cover all the 27 contact farmers in a village. However in rare cases, sampling could take two days in a village especially when some of the contact farmers could not be available or when it was raining. The experimental chickens were purchased from the contact farmers after they had spent 4 hours scavenging, assuming that birds fill their crops in four-hour cycles of eating (Feltwell and Fox, 1978). Thus three sampling times per day were set up as: at 10.0 h in the morning, at 14.0 h in the afternoon and at 18.0 h in the evening. These samplings assisted to assess the amount and types of feeds scavenged by birds at different times of the day. The chickens were allowed to scavenge at 6.00 h early in the morning. In each sampling time, a total of 9 scavenging chickens were slaughtered

Table 2. Effect of season and farming system on the fresh and dry weights of crop contents of scavenging village chickens in central Tanzania

Crop contents of village chickens	Seasons		Farming systems		Pooled standard error of the mean (SE±)	Season x Farming system
	Dry	Rainy	Sorghum-pearl millet-groundnut	Maize-bean-sunflower		
Average fresh weight (g)	34.5[a]	28.4[b]	31.9	31.1	1.21	NS
Average dry weight (g)	18.1[a]	14.9[b]	18.3	15.7	0.67	*
Oven dry matter (%)	50.1	50.5	49.4	51.2	1.19	NS

[ab] Means within a row and factor having different superscripts are different at P<0.05; NS = Not significant, and * = Significant different at P<0.05

according to normal practice on farms.

Determination of physical composition of crop contents

A total of 648 scavenging chickens of both sexes with an average liveweight of 1.1 ± 0.3 kg and with an age of seven to eight months, were randomly purchased from contact farmers in the above four villages to assess both physical and chemical com-position of crop contents and carcass characteristics (weights and body parts). The crop contents were used to determine the amount or intake and types of feeds consumed by scavenging chickens in different seasons and farming systems. Chickens were weighed before slaughtering using an electronic balance (Salter max 5000 g with dimension of 2 g). The chickens were slaughtered in different seasons and farming systems at different times of the day according to the 2 x 2 factorial design (Table 1) . Feathers were removed in 2 - 3 min after dipping the body into hot water. The carcasses were dissected and the chicken crops were removed and packed in 2 coolmate boxes each with 6 ice-blocks. Samples of the crop contents were taken to the laboratory where they were frozen in a deep freezer at -30^{o} C. Later the crop contents were thawed for 2 - 3 h in the laboratory. The crop contents of each bird slaughtered at 10.0, 14.0 and 18.0 h were physically separated differently into different individual feed components using forceps. These individual feed components were weighed using laboratory electronic balance and were then dried at 60^{o}C until constant weight in the oven for determination of air dry matter.

Determination of carcass yields

The carcass of each bird was taken after feathers, intestinal tracts, shanks, liver, heart, lungs, ovary, testis or oviduct, spleen, kidneys, gizzard, crop, proventriculus, pancreas, and head had been removed. The weight of each of the body parts or organs was recorded. A measuring tape was used to measure the length of gastro-intestinal tracts (GIT) and caeca and the circumference of thigh. The carcass dressing percentage was calculated by dividing carcass weight over live bodyweight at slaughter multiplied by 100%.

Chemical analysis of crop contents

Samples of the crop contents collected during the experimental period were sub-sampled according to the seasons and farming systems they had been collected. All the samples were ground using laboratory mills with a 2 mm screen and were analysed for dry matter (DM), crude protein (CP), ether extract (EE), crude fibre (CF) and ash, calcium (Ca), phosphorus (P), potassium (K) and magnesium (Mg) according to the procedures of AOAC (1990). Nitrogen free extract (NFE) was calculated by difference. The Metabolizable energy (ME) of the crop contents was calculated using a regression equation: TME (MJ kg DM^{-1}) = (3951 + 54.4 EE% - 88.7 CF% - 40.8 ash %) multiplied by 0.004184, where TME refers to the True Metabolizable energy content (Wiseman, 1987).

Statistical analysis

The 2 x 2 factorial design was analysed using the General Linear Model (GLM) of the SPSS software version 11.0 for windows (2001). The statistical model used was:

$$Y_{ijklm} = \mu + S_i + F_j + V_{jk} + P_{il} + (SF)_{ij} + E_{ijklm},$$

Where Y_{ijklm} is an observation from the mth time of the day in the lth period of recording and kth village within the jth farming system and ith season; μ is the general mean common to all observations in the study; S_i is the effect of the ith season of the year (i = 1, 2); F_j is the effect of the jth farming system (j = 1, 2); V_{jk} is the effect of the kth village within the jth farming system; P_{il} is the effect of the lth period of recording within the i th season; $(SF)_{ij}$ stands for interaction effect between the ith season of the year and jth farming system; E_{ijklm} represents the random effects peculiar to each observation.

The villages within farming system (V_{jk}) were used to test the differences between farming systems while the periods within season (P_{il}) were used to test the differences between seasons. Further analysis of data was performed to break down an interaction effect of independent variables using "simple effects analysis technique" (Andy, 2005).

RESULTS

Weights of the crop contents

Results on effect of season and farming system on the weights of crop contents and their physical compositions are presented in Tables 2 and 3 respectively. The mean fresh weights of the crop contents were higher (P<0.05) in the dry season (34.5 g) than in the rainy season (28.4 g). The mean fresh weight of the crop contents in the dry season ranged from 33.7 g for the chickens from the maize-bean-sunflower farming system to 35.3 g for the chickens from sorghum-pearl millet-groundnut farming

Table 3. Effect of season and farming system on the physical components of crop contents of scavenging village chickens in Central Tanzania

Physical components (%) of total, dry basis)	Seasons		Farming systems		Pooled standard error of the mean (SE±)	Season x Farming system
	Dry	Rainy	Sorghum-pearl millet-groundnut	Maize-bean-sunflower		
Kitchen/brew wastes (%)	6.99[b]	18.9[a]	11.9	12.9	0.27	NS
Tree leaves/flowers (%)	0.64	0.80	0.66	0.76	0.03	NS
Sand and grit (%)	0.28[b]	1.54[a]	1.49[a]	0.14[b]	0.05	*
Insects and worms (%)	1.22	1.85	1.45	1.57	0.07	NS
Inert materials[1] (%)	0.40	0.54	0.43	0.51	0.02	NS
Oil seeds and cakes[2] (%)	6.25	7.11	4.36[b]	9.14[a]	0.18	NS
Tree and fruit seeds[3] (%)	0.75	1.07	1.01	0.76	0.05	NS
Cereal bran[4] (%)	12.2[a]	7.70[b]	5.78[b]	15.0[a]	0.27	NS
Cereal grains[4] (%)	67.1[a]	52.4[b]	67.5[a]	52.8[b]	0.63	**
Other materials[5] (%)	4.13[b]	8.09[a]	5.47	6.40	0.12	NS

[ab] Means within a row and factor having different superscripts are different at P<0.05; NS = Not significant; *Significant at P<0.05; **significant at P<0.01; [1]Bones, buttons, piece of shoes, plastics, pieces of glass, wood particles and fibrous materials; [2]Groundnuts, sesame, sunflower seeds and sunflower cakes; [3]Acacia tortilis, water melon, pumpkin and pawpaw; [4]Maize, pearl millet and sorghum; [5]Fish meal, cassava peelings and chips, vegetable trimmings, feathers, egg shells and other feed materials.

system; and in the rainy season the mean fresh weight of the crop contents from each farming system was 28.4 g. The mean weights of the crop contents on dry basis also were higher (P<0.05) in the dry season (18.1 g) than in the rainy season (14.9 g). The mean dry weights of the crop contents in the dry season ranged from 16.3 g for the chickens from the maize-bean-sunflower farming system to 19.9 g for the chickens from the sorghum- pearl millet-groundnut system. The mean dry weights of the crop contents in the rainy season ranged from 14.8 g for chickens from the sorghum-pearl millet-groundnut system to 15.2 g for the chickens from the maize-bean-sunflower farming system. There were no significant differences (P>0.05) between the types of farming sys-tem practiced. However, there was a significant inte-raction between season and types of farming system practised where in the sorghum-pearl millet-groundnut system the mean dry weight of crop contents was lower (P<0.05) in the rainy season (14.7 g) compared to the dry season (19.9 g). The overall mean air dry matter contents of the crop contents was 50.3% and ranged from 43.9 to 56.3% in the dry season and 40.1 to 53.1% in the rainy season and were not different (P>0.05).

Physical composition of the crop contents

The crop contents of the chickens were visually catego-rized into nine main components: kitchen and brew wastes; tree and forage leaves and flowers; insects and worms; sand and grit, inert materials; oil seeds and cakes; tree and fruit seeds, cereal grains and their by-products and other feed materials (Table 3). Results show that the overall physical crop contents varied with seasons and farming systems. The proportion of cereal grains and bran was higher (P<0.05) in the dry season than in the rainy season. The occurrence of kitchen and local brew wastes, sand and grit and other feed materials was higher (P<0.05) in the rainy season compared to the dry season. Also, the proportions of tree leaves and flowers, insects and worms, inert materials, oil seeds and cakes, and tree and fruit seeds were fairly high during the rainy season although they were not different from those in the dry season. Occurrence of cereal grains and sand/grit was higher (P<0.05) for the crop contents of chickens from the sorghum-pearl millet-groundnuts based farming system, whereas proportions of cereal bran, and oil seeds and their by-products were higher (P<0.05) in the crop contents of the chickens from the maize-bean-sunflower based farming system. The proportions of kitchen and brew wastes, tree leaves and flowers, insects and worms, inert materials and other feed materials though relatively high in the crop contents of chickens from the maize-bean-sunflower based farming system were not different in both systems. There was no significant interaction effect between season and farming system on most of the physical components of the crop contents except for the cereal grains and sand/grit. The proportions of cereal grains were higher (P<0.05) in the sorghum-pearl millet- groundnut farming system during the dry season (15.1 g) than the rainy season (8.25 g) while sand and grit were higher (P<0.05) in both farming systems during the rainy season than in the dry season.

Chemical composition of crop contents

Results on the effect of season and farming system on the chemical composition of crop contents are presented in Table 4. Results show that DM, CF, EE, Ca, P and K contents of the crop contents did not vary between the seasons and farming systems. However, EE and K con-

Table 4. Effect of season and farming system on the chemical composition (% of DM) of the crop contents of village chickens in Central Tanzania.

Composition (%)	Seasons		Farming systems		Pooled standard error of the mean (SE±)	Season x Farming system
	Dry	Rainy	Sorghum-pearl millet-groundnut	Maize-bean-sunflower		
Dry matter	90.1	90.8	90.9	90.1	0.73	NS
Crude fibre	4.02	4.88	5.03	3.87	0.52	NS
Ether extract	6.83	5.45	6.80	5.48	0.54	NS
Crude protein	8.40[b]	10.1[a]	9.58	8.90	0.36	NS
Crude ash	18.2[b]	24.9[a]	25.0[a]	18.2[b]	3.08	NS
Nitrogen free extract	62.5	54.6	53.5[b]	63.6[a]	3.33	NS
Calcium	0.45	0.60	0.57	0.47	0.06	NS
Phosphorus	0.58	0.66	0.67	0.57	0.05	NS
Magnesium	0.22	0.22	0.27[a]	0.17[b]	0.03	NS
Potassium)	1.08	0.96	1.08	0.96	0.11	NS
ME ($MJ/kgDM^{-1}$)	12.2[a]	10.8[b]	10.8[b]	12.1[a]	0.54	NS

[ab] Means within a row and factor having different superscripts are different at P<0.05 and NS = Not significant at P<0.05.

tents were relatively higher in the dry season compared to the rainy season while CF, Ca, and P were fairly high in the rainy season. The CP and ash contents were higher (P<0.05) for crop contents of chickens in the rainy season than in the dry season. Also the metabolizable energy (ME) contents were higher (P<0.05) in the crop contents of chickens in the dry season than in the rainy season. The NFE and Mg contents of the crop contents did not show any significant differences (P>0.05) between seasons but NFE had higher values in the dry season than in the rainy season. Ash contents were higher (P<0.05) in the crop contents of the chickens from the sorghum-pearl millet-groundnut farming system while the metabolizable energy (ME) contents were higher (P<0.05) in the crop contents of the chickens from the maize-bean-sunflower farming system. The CP contents did not vary between the farming systems, but relative high CP values were found in the cop contents of the chickens from the sorghum- pearl millet-groundnut farming system. The NFE values were higher (P<0.05) in the maize-bean-sunflower; whereas Mg values were higher (P<0.05) in the sorghum -pearl millet-groundnut farming system. Moreover, there were no significant interaction effect of season and the farming systems for all chemical parameters studied.

Live bodyweights and carcass characteristics of the village chickens

The overall mean live body weight of chickens at slaughter was 1063 g. The mean live body weights were higher (P<0.05) in the dry season (1238 g) than in the rainy season (890 g). Likewise, the mean carcass weights of the chickens were higher (P<0.05) in the dry season compared to the rainy season. There were no significant differences in the carcass dressing percentages, liver and proventriculus weights between the seasons (P>0.05). The mean weights for the heart, lung, spleen, gizzard, gastro-intestinal tract (GIT), and caeca length and thigh circumference were higher (P<0.05) in the dry season than in the rainy season. Chickens from the maize-bean-sunflower farming had significant higher (P<0.05) mean body weights (1144 g) than those from sorghum-pearl millet-groundnut system (984 g). Similarly mean carcass weights followed the same trend for the two farming systems. There were no significant (P>0.05) differences for the mean carcass dressing percentage and the mean weights of the lung, heart, spleen and proventriculus, GIT and caeca lengths between the farming systems. However, chickens from the maize-bean-sunflower farming system had lower gizzard weights and higher (P<0.05) thigh circumferences than those from the sorghum-pearl millet-groundnut farming system. There were significant (P<0.05) interaction effects for the mean live body and carcass weights and thigh circumferences while other carcass parameters studied did not vary very much between the seasons and farming systems. In both farming systems, village chickens had significant (P<0.05) live body and carcass weights and thigh circumferences during the dry season compared to the rainy season.

DISCUSSION

Weights of the crop contents of scavenging chickens

The higher mean crop content weights in the dry season than in the rainy season could be attributed to the large consumption of cereal grains and their by-products, oil seeds and their by-products, which were more abundantly available during this period. Cereal grains such as sorghum and pearl millet and oil seeds such as groundnuts and sesame are the most important crops grown in the sorghum-pearl millet-groundnut farming system, while cereal grains such as maize and oil seeds such as sunflower are the most important crops grown in the maize-bean sunflower farming system. The grains and seeds of these crops and their by-products are the most important scavengeable feed resources for the village poultry and their availability is high during the dry season when they are harvested (Goromela et al., 2007) . The lower mean fresh weights of crop contents in the rainy season (Table 2) could be explained by the fact that in the rainy season the availability of cereal grain, bran, oil seeds and oil seed cakes in the households is usually very low. Lower availability of cereal grains, oil seeds and their by-products were also confirmed by Goromela et al. (2007) who reported that supplementation of these feedstuffs decreases and sometimes disappears during the wet season in most of the households due to their scarcity. However, in the present study lower weights of the crop contents could be found in the chickens slaughtered in the morning compared to those slaughtered at later periods of the day during the rainy season which indicates that in both farming systems farmers do not supplement their chickens in the morning because they spend most of their time in ploughing, sowing and weeding their crops. As a result supplementation of village poultry is normally done in the afternoon or evening when farmers are back at home. Also the lower weights of the crop contents in the morning could be due to the chickens behaviour because when released for scavenging they tend to restrict their scavenging area close to the household compounds due to wet and chilly conditions in the morning. However, the higher mean weights of the crop contents in the dry season found in chickens slaughtered in the morning and in the evening might be due to supplementation of locally available feed resources. In a previous study, Goromela et al. (2007) reported that supplementation of local chickens with cereal grains and their by- products and household wastes is generally done in the morning or evening depending on their availability in the households. Also the higher mean weights of the crop contents in the morning and evening could be due to the fact that in these periods of the day it is not very hot, as a result the chickens tend to consume more diet. Thus the lower feed intake in the afternoon was most likely due to hot conditions prevalent in the study area during this period of the year. Heat stress may cause reduction in food intake in farm animals (Smith, 1990). However, tropical breeds have developed heat tolerance attributed to heat dissipation mechanisms such as sweating, thermal panting and reflection of incoming solar radiation by the coat (Webster, 1983).

Physical composition of the crop contents

Visual observations indicated that scavenged feed consisted of two major components: household materials and environmental materials (Table 3). The amount of household materials formed a major proportion of the total diet consumed per day ranging from 69% in the rainy season to 90% in the dry season. On the other hand a smaller proportion of 10 and 31% of the diet in dry season and in the rainy season respectively, came from scavenging in the surrounding environment. This probably means that over two- third of the scavengeable feed resources consumed per day by a scavenging chicken is obtained from household materials. These observations are in agreement with those reported by other authors (Gunaratne et al., 1993; Tadelle, 1996; Mwalusanya et al., 2002; Rashid et al., 2005; Sonaiya, 2004; Pousga et al., 2005) who found that a greater part of the diet consumed by scavenging birds came from household materials and the remaining part came from environmental materials.

The physical composition of the diet consumed per day varied considerably between individual birds within the households in the farming systems, and also between seasons and farming systems. The higher proportion of cereal grains and oil seeds and oil seed by- products in the crop contents during the dry season could be explained by the fact that in this season farmers in the study area were harvesting their cereal and oil seed crops. As a result, both grains and seeds and oil seed by-products were readily available in the household backyards. Nevertheless a higher proportion of cereal grains were generally found in the crops of chickens from the sorghum - pearl millet - groundnut farming system practised in Kisokwe and Chitemo. In these villages, sorghum and pearl millet are the most grown cereal crops. More importantly higher proportions of cereal grains, oil seeds and their by- products in the crop contents were found in the chickens slaughtered at 10.0 and 14.0h during the dry season probably due to the fact that in these periods of the day, most of the farmers were threshing and winnowing cereal and oil seed crops. The high occurrence of kitchen and local brew wastes in the rainy season could be attributed by the fact that in this period, usually there is a scarcity of cereal grains and oil seeds and seed cakes and as a result most farmers have a tendency to supplement their chickens mainly with kitchen wastes or kitchen leftovers and some local brew wastes. However a higher proportion of kitchen/local brew wastes was noticed in the maize-bean-sunflower farming system practised in Bumila and Chamkoroma villages, probably due to assured household food security in these villages. Irrespective of their locations and seasons, higher proportions of kitchen and local brew wastes were found in the crop contents of chickens slaughtered at 14.0h and 18.0 h than at 10.0 h. This could be explained by the fact that, at this time of the day, farmers were taking lunch and others drinking their local brew. The higher proportion of sand/grit and inert materials in the crop contents during the rainy season was most likely be due to low availability of scavengeable feed resources such as cereal grains and their by-products as noted above. As a result the

Table 5. Effect of season and farming system on live body and carcass weights and organ characteristics of scavenging village chickens in central Tanzania

Carcass characteristics	Season		Farming system		Pooled standard error of the mean (SE±)	Season x Farming system
	Dry	Rainy	Sorghum-pearl millet-groundnut	Maize-bean-sunflower		
Live weight (g)	1238[a]	890[b]	984[b]	1144[a]	32.37	*
Carcass weight (g)	799[a]	563[b]	623[b]	739[a]	23.85	*
Carcass dressing (%)	64.3	63.2	63.3	64.1	0.66	NS
Liver weight (g)	38.4	29.9	36.9	31.4	3.89	NS
Heart weight (g)	8.12[a]	5.90[b]	6.78	7.24	0.40	NS
Lung weight (g)	9.08[a]	7.14[b]	7.62	8.60	0.42	NS
Spleen weight (g)	2.95[a]	2.08[b]	2.51	2.52	0.24	NS
Gizzard weight (g)	61.9[a]	55.9[b]	61.5[a]	56.3[b]	1.76	NS
Proventriculus weight	8.39	7.66	8.31	7.74	0.32	NS
GIT length (cm)	187[a]	167[b]	176	178	2.41	NS
Caeca length (cm)	17.6[a]	16.0[b]	17.0	16.6	0.34	NS
Thigh circumference (cm)	12.3[a]	10.7[b]	11.2[b]	11.8[a]	0.17	**

[ab] Means within a row and factor having different superscripts are different at P<0.05; NS = Not significant; *Significant at P<0.05; **significant at P<0.01.

chickens were strained to ingest such large amount of sand/grit and inert materials to fill their crops which would alternatively prevent the chickens from ingesting adequate amounts of feedstuffs to meet their requirements. The higher proportion of forage leaves and flowers, tree and fruit seeds, insects and worms and vegetable trimmings in the crop contents of scavenging chickens in the rainy season may be explained by the high availability of these feedstuffs during the rainy season compared with the dry season (Goromela et al., 2007).

Nevertheless, higher proportions of forage leaves-/flowers and insects/worm in the crop contents were found in chickens slaughtered at 10.0 and 18.0h probably because of the favourable conditions. In the study area, it is usually sunny and hot at 14.0 h and as a result insects and worms tend to hibernate and forage leaves and flowers become shrunken. Moreover, the proportions of other feed materials such as vegetable trimmings were relatively high in the crop contents of chickens from the maize-bean-sunflower farming system practised in Chamkoroma village and Bumila villages. In these villages particularly Chamkoroma village, horticulture is their mainstay. The occurrence of high proportion of cereal bran in the crop contents of the chickens from the maize-bean-sunflower farming system was likely due to the fact that chickens had access to bran fed to other animals. Most of the contact farmers in Bumila village kept pigs and to some extent improved goats; whereas in Chamkoroma they kept pigs and dairy cattle in open pens and maize bran was the most commonly used supplemental feed. These findings are in agreement with Mwalusanya et al. (2002) in Tanzania who found chickens from the cool zone and wet zone had higher content of bran in their crops which was scavenged from pigs kept in the open pens.

Chemical composition of crop contents

The proximate and mineral composition observed in the present study were within the range reported by Tadelle (1996), Mwalusanya et al. (2002), Rashid et al. (2005) and Pousga et al. (2005) . The higher proportion of forage leaves and flowers, tree and fruit seeds and insects and worms could explain the higher CP content in the crop contents during the rainy season compared to the dry season. In the rainy season protein-rich feedstuffs accounted for 19% of the total diet consumed by chickens compared to 13% of the protein- rich feedstuffs in the dry season (Table 2). These results are supported by Tadelle (1996) who reported higher CP contents in the crops of scavenging hens in the Central Highlands of Ethiopia during the rainy season (10.2% of DM) com-pared to the dry season (7.6% of DM) due to higher intakes of worms and green plants. However, they are in contrast with Pousga et al. (2005) who found higher levels of CP contents in the crop contents of scavenging pullets in Burkina Faso during the dry season (11.5% of DM) compared to the rainy season (10.5% of DM) due to increased availability of insects and worms at the end of dry season, as a result of occasional showers. Using the results in Table 2, where the daily DM intake was 18.1 g in the dry season and 14.9 g in the rainy season, and assuming that the birds fill their crops in four-hour cycles of eating (Feltwell and Fox, 1978), it appears that the actual intake from scavenging would have been around 54 g/day in dry season and 45 g/day in the rainy season, with an average intake of 4.6 g CP per bird per day. These results are lower than the estimated daily requirement of 6.0 g CP for a scavenging indigenous hen laying at a rate of 20% (Farrell, 2000) and 6.8 g CP per day per laying hen obtained from the scavengeable feed resources in Bangladesh (Rashid et al., 2005). The results are below the protein requirements (11.3 g/day) for a local laying hen with an average weight of 1.14 kg producing an egg weighing 35 - 38 g assuming daily DM intake of around 100 g (Tadelle, 1996).

The higher EE contents in crop contents of chickens during the dry season compared to the rainy season was likely due to higher consumption of oil seeds and seed cakes in the dry season than in the rainy season. Oil seed crops such as groundnuts and sesame were commonly grown in the sorghum-pearl millet-groundnut farming system, whereas sunflower was commonly grown in the maize - bean - sunflower based farming system. The ME concentrations of the crop contents were higher in the dry season compared to the rainy season which might be explained by the high consumptions of energy-rich feedstuffs such as cereal grains and their by-products and oil seeds and oil seed cakes.

The energy rich feedstuffs accounted for 86% of the total diet consumed by chickens during the dry season compared to 79% of energy- rich feedstuffs consumed during the rainy season (Table 2). However, the ME concentrations obtained were comparable to the ME content of 11.6 MJ/kgDM^{-1} found in the dry season and lower than an ME content of 13.5 MJ/kgDM^{-1} during the rainy season (Pousga et al., 2005). According to Scott et al. (1982) the ME values obtained could therefore meet the requirement of a non-laying hen. However for laying hens the limitations in scavengeable feed resources in terms of nutrient supply may not be sufficient to support reasonably high levels of poultry productivity.

The higher ash content in the present study could be due to higher proportion of sand/grit, inert materials and green forage materials in the crop contents of the chickens during the rainy season. Plant materials have higher contents of ash, Ca and CP than seeds (Martin et al., 1976) as cited by Tadelle (1996). Calcium and phosphorus contents, though not different, were higher in the rainy season than in the dry season probably due to high consumption of forage leaves and flowers (Table 2). Forage leaves and flowers contain high contents of calcium and phosphorus than cereals (Ali, 1995). The levels of Ca in the crop contents were very low in all the seasons and farming systems which are below the requirement of 3.5% for high producing birds kept under semi intensive or free-range system for egg production (Feltwell and Fox, 1978).

Live weights and carcass performance

The higher mean live body and carcass dressing weights (1238 g) in the dry season could be explained by the higher intakes of cereal grains and oil seeds and cakes. A previous study indicated that in the dry season there are substantial amounts of cereal grains and oil seeds and their by-products spilled on the ground during harvesting, threshing and winnowing activities (Goromela et al., 2007). This finding could further be confirmed in the present study where the diet consumed had higher ME content (12.2 MJ/kg) in the dry season than in the rainy season (10.8 MJ/kg), an indication that supplemen-tation of energy sources is needed more in the rainy sea-son. Also higher live bodyweights of the chickens (1144 g) in the maize-bean-sunflower farming system is an indication that differences in farming systems and climatic conditions had significant effect on the type and availability of scavengeable feed resources consumed by chickens. However, the mean live body weights observed in the dry season (Table 5) was higher than the mean live body weights of 924 g reported by Kondombo et al. (2005) and 1121 g reported by Tadelle (1996) for mature village chickens during the dry season.

The same authors reported higher mean live body weights of 1279 g in Burkina Faso and 1168 g in Ethiopia respectively in the rainy season, resulting from high consumption of insects, worms and green plants. The mean carcass dressing percentage observed in the present study (63-64%) was lower than the mean dressing percentage of 83% reported by Kondombo et al. (2005) and 65.6% reported by Tadelle (1996) for village chickens, probably due to the heavier weights of gastrointestinal tract (GIT) and their contents (Table 5). Also it may be attributed by higher percentage of giblets in females than males (Sing and Essary, 1974) as cited by Tadelle (1996) and higher proportion of late maturing organs mainly used for egg production (Havez, 1955) as cited by Teketel (1986).

However, the dressing percentage in the present study was comparatively higher than the mean dressing percentage of 60.6% for scavenging pullets in Burkina Faso (Pousga et al., 2005). The lower gizzard weights and higher thigh circumferences in chickens from the maize-bean-sunflower farming system could be due to lower consumption of sand and grit indicating that chickens were very selective as a result of sufficient amount of scavengeable feed resources especially in the dry season. Based on the estimated DM intake, it is apparent that scavenging chickens in the present study were probably getting between 45 and 54% of their total DM intake from scavenging during the rainy season and dry season respectively, resulting in differences in body weights between seasons. Thus additional supplementation of around 46 and 55% of their requirement in the dry season and rainy season respectively, may be necessary to improve the nutritional status of the village poultry which in turn may possibly improve their productivity. Supplementation of energy and protein sources for scavenging local birds have been reported to improve egg production, egg weight, feed efficiency, survival rates, growth rate, carcass quality and economic efficiency (Tadelle, 1996; Minh, 2005).

Conclusion

The present study indicated that quantity of scavengeable feed resources scavenged by chickens and their chemical composition varied considerably with seasons and farming systems. In the dry season availability of cereal grains, oil seeds and their by-products and kitchen wastes were high resulting into higher dry matter intake and subsequent higher body weights. The lower weights of the crop contents in the rainy season with the conesquent lower body weights of the village chickens, demonstrate that scavengeable feed resources were not enough to meet the chickens' requirements. Thus additional supplementation with locally available energy feeds in the rainy season may consequently have more impact on the performance of village chickens. However, further investigations on the effect of supplementation of protein and energy using locally available feed resources on the performance of village chickens in different sea-sons and farming systems in central Tanzania are needed.

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