The effect of diet and feeding system on the on-farm performance of local chickens during the early growth phase

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Abstract

This study evaluated the performance of local chickens on three diets and two feeding systems under on-farm conditions. The diets used were formulated from local feedstuffs that had been identified in a baseline survey and analyzed for chemical composition in the laboratory. Based on the laboratory results, two diets were formulated containing 20% CP and 2900Kcal ME/kg (D20) and 23% CP; 3200KcalME/kg (D23). A commercial diet (D18) containing 18% CP; 2800 Kcal ME/kg was obtained from a local feed supplier to be used as a control. The three diets were then used in conducting growth trials with chicks under two different systems of feeding. The first system involved feeding the birds intensively. The three diets were feed separately to four replicate groups of ten chicks each .This system used 120 un-sexed day old local chicks that were obtained from a local hatchery and brooded artificially. The second system involved feeding the experimental diets to semi-scavenging chicks brooded by their mother hens in confinement cages from 6.00 am to 12.00 noon, after which they were let out to scavenge. A weighed amount of feed was given to each batch and left over feed was weighed and recorded each week to compute feed consumption.

In both experiments birds were weighed in batches on day one and thereafter weekly for six weeks. The data revealed no difference in the growth rate and final live body weight of chicks under the three dietary treatments. Chickens that were fed intensively exhibited better growth and survival rates than those that were fed from 6.00 am to 12.00 noon then let out to scavenge. Hence it was concluded that that a diet containing 18% CP and 2800Kcal ME/kg is sufficient for rearing local chickens during the early growth phase (0-6 weeks) on-farm. Also intensive feeding of local chickens results into better growth and survival than the semi-scavenging system.

Key words: *chicks, dietary-energy, growth rate, semi-scavenging*

Introduction

Poultry or domestic birds are reared for their meat and eggs which are among the most important sources of edible animal protein (FAO 2010). Over 30% of the global meat production, recently estimated at 275 million metric tones, is sourced from poultry (Chemnitz 2014). Of all poultry, the most common sources of meat are chickens (87%), turkeys (6.7%), and other minor commercially available poultry meats including meat from duck (4%), and that from geese, pigeons, quails, pheasants, ostriches and emus (2.3%) (FAO, 2010). In developing countries, local chickens in particular provide an important food resource to the rural poor and hence a hedge against food insecurity and poverty. This is because they are easier to rear and survive more favorably with minimal resource inputs at household level, high disease resistance and low initial investment costs (Kperegbeyi et al 2009) compared to other types. The six factors, which are believed to have significantly contributed to the rising popularity of chicken meat (in our words, "the chicken revolution") are: lower price in comparison with other foods; better nutritional profile and low in fat; ease of preparation; versatility; its being well suited for fast-service and casual dining menus (FAO 2010), and being ubiquitous.

However, the amount of food (meat and eggs) and income generated from local chickens is still low. Among the factors that have led to the low supply of local chickens in Ugandan markets is poor feeding (Magala et al 2012) and hence low productivity. This has led to a deficit on the demand side in relation to supply of local chickens and their products. Feeds and feeding management affect the productive and reproductive performance of chickens. Feeds defined in terms of protein and energy density exhibit varying effects on the growth parameters such as weight gain, feed conversion rate and growth rate in chickens (Kuietche et al 2014). Chickens are likely to perform differently when subjected to different feeding systems. Indeed, under farmer conditions, neither the growth response of local chickens to differential feeding and holding management, nor their survival has been well understood. This study was therefore conducted to determine the performance of local chicks on diets formulated to contain different level of dietary protein and energy content under two feeding systems on-farm.

Materials and methods

Study sites and experimental design

The experiments were carried out on selected farms in Gulu District in Northern Uganda. They involved conducting growth trials of local chicks on three diets under intensive and semi-scavenging feeding systems. In the first system (Intensive), 120 day-old local chicks were obtained from a commercial hatchery in Gulu district and raised in confinement in open sided deep litter pens in batches of ten chicks per pen. The three diets were then randomly assigned to the pens with each diet being replicated four times.

In the second system, the experimental chicks were naturally brooded by their mother hens and feeding them under semi-scavenging system using the experimental diets. Farms having 0-3 day old chicks with their mother hens were identified and were used as experimental units. The hens targeted were those possessing a minimum clutch size of eight chicks being raised from a single hatching. All the treatments were replicated four times in a randomized complete block design (RCBD).

Experimental diets

Locally available feed resources were used to formulate two diets, one containing 20% CP and 2900Kcal ME/kg (D20) and 23% CP and 3200 Kcal ME/kg (D23). Another diet (D18) which acted as the control was obtained from a local commercial feed supplier and was analyzed according to AOAC (1990) for proximate principles. The composition of the experimental diets is shown in Table 1 and of the commercial diet in Table 2.

Table 1. Ingredients and nutrient composition of experimental diets

Ingredients	**D20**	**D23**
Maize bran	54	45.5
Maize	18	20
Fish meal	17	23
Sunflower	10	10
Bone ash	0.4	0.45
Salt	0.4	0.45
Vitamin-mineral premix	0.25	0.25
Vegetable oil		0.35
Total	100	100
Cost/kg (UShs)*	900	1250
Calculated Nutrient Composition		
DM (%)	92	91.5
ME(Kcal/kg)	2912	3224
CP (%)	20.2	23.1
CF (%)	4.6	4.5
Methionine	0.47	0.64
Lysine	1.08	1.05
Calcium	0.9	0.9
Available Phosphorous	0.9	0.8

Vitamin-mineral premix provided the following per kg of complete diet: Vitamin A, 62501IU, Vitamin D_3, 1250IU, Vitamin K_3, 1.5mg Vitamin E, 10mg, Vitamin B_1, 5mg, Vitamin B_2, 2.5mg, Vitamin B_6, 0.5mg, Vitamin B_{12}, 2.5mg, niacin,5.60mg, Pantothenic acid, 0.3mg, ,iodine, 5mg, selenium, 0.0625mg. choline chloride, 50mg, iron, 18.72mg, copper, 3mg, manganese, 37.5mg and Zinc, 31.25mg.
** 1 US $ = 2900 UShs.*

Table 2. Composition of the commercial diet (D18) obtained from a local feed supplier

% Composition	**Level**
%DM	90
Ash (%)	10
Crude fat (%)	5.4
Crude Fibre	6.5
Crude protein	18.3
Calcium	0.98
Available Phosphorus	0.84
ME/kcal/kg	2810

On-farm management of the birds

On arrival, the chicks under the intensive were weighed and placed under a brooder. They were brooded artificially using local pots as a source of heat. A weighed amount of experimental feed was provided *ad libitum* daily during day time. The birds were reared in a deep litter system under natural day light in open-sided pens until they were six weeks old.

In the semi-scavenging system, participating farmers confined their birds during feeding hours before they were let out to scavenge. Experimental diets were fed to both the chicks and the mother since naturally under on-farm conditions the chicks and mother hen feed together. Portable confinement cages made from locally available materials having a 1m radius were used. Feeds were provided from 6:00 A.M. to 12.00 Noon and then they were let out to scavenge with their mother.

In both systems drinking water was provided to the birds *ad libitum*. All chickens at the experimental households were vaccinated against Marek's disease, Newcastle disease, Gumboro, infectious bronchitis, Fowl pox and Fowl typhoid to prevent infections. The chick supplier's vaccination schedule was followed. Batch weight measurements and feed intake per replicate was recorded every week. Before weight taking, birds were fasted overnight and weighed on empty crops the following morning. The collected data was used to compute the mean live body weight, body weight gain, feed consumption and feed conversion ratio. Mortality was recorded as it occurred. The farmers provided the labour and care needed by the chicks.

Data collection

The chicks were weighed on-farm at the beginning of experimentation and thereafter weekly for a period of six weeks. The feed offered to each batch was weighed daily. On a weekly basis, left over feed was weighed so as to compute the amount of feed consumed. Survival rate and chicks mortality was recorded.

Growth performance

Growth performance was determined using live weights and growth rate parameters. Weight gains was calculated as follows

$WG=\underline{LW_{ti}-LW_{to}}$

t_i-t_o

Where, WG is weight gain (daily, weekly or overall) per time period in g; LW_{to} is live weight at particular week = t; $t_i LW_{to}$ is live weight for the previous period = t t_o

Feed Conversion was also calculated as follows:

Feed Conversion Ratio (FCR): Weight gain divided by feed intake.

Data analysis

Data on body weight, and feed consumption was subjected to the analysis of variance (ANOVA) using the General linear model procedure (SAS 2006). Microsoft excel spreadsheet was used to make graphical drawings to compare the growth response in each of the experiments.

The data was subjected to analysis of variance using the general linear model.

$Y_{ijk} = \mu + D_i + Sj + DS_{ij} + e_{ijk} \sim N(0, \sigma^2_e)$

Where Y_{ijk} is a given observation for each quantitative statistic; μ is the general mean common to all observations; F_i is the effect of the i^{th} Diet (i=3); Sj is the effect of the j^{th} feeding systems (j=2); DS_{ij} is the effect of interaction between diets and feeding systems; and e_{ij} is the random effects unusual to each observation independently and identically distributed with mean=0 and variance = σ^2. The Tukey's Studentized Range test was used to separate treatment means that were significantly different at 5% level of significance.

Results

There was interaction between the diets and feeding system on any parameters observed on local chicken in this study. Therefore, only main effects of diet and feeding system were considered to have affected the different parameters reported on the local chicken.

Effect of diet and feeding system on the live weight and growth rate of local chicken

The live body weights of the chickens generally increased with age (Fig. 1 and Fig. 2). The final live weights of the birds under the different dietary treatments were statistically similar though the chicken that were fed with the commercial diet (D18) (18% CP 2800 Kcal ME/kg) exhibited numerically lower live body weights at the end of the experimental period (Table 3). The live body weights of the chicken in the first week showed no difference for both intensively fed and semi-scavenging chickens. However in the second to sixth week, chicken that were intensively fed weighed more than those that were reared under the semi-scavenging system.

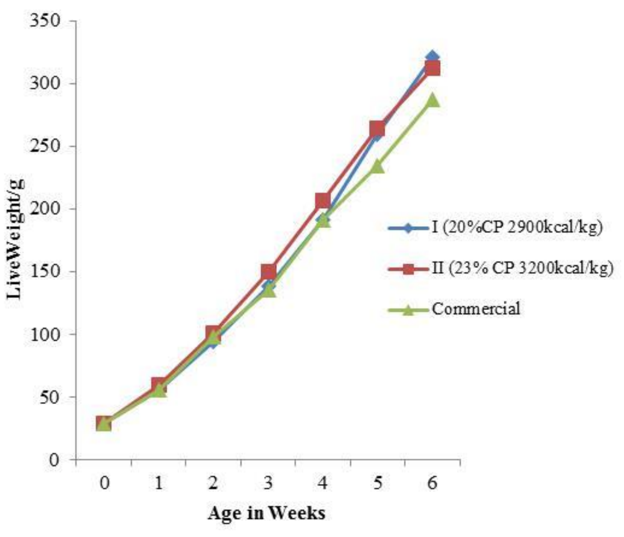

Fig 1: Trend in weekly body weight of local chicks fed on different diets from 0-6 weeks.

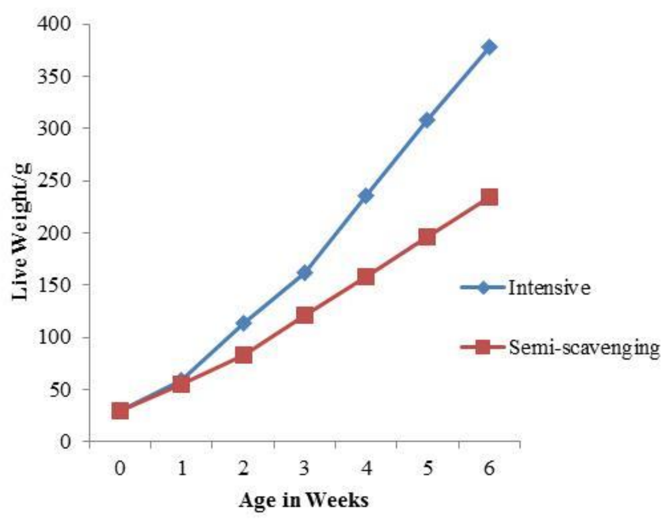

Fig 2: Trend in weekly body weight of local chicks under intensive and semi-scavenging system from 0-6 weeks

Chicks on the different dietary treatments exhibited almost similar growth rates in the first four weeks while in the final weeks chicken fed on the commercial diet (D18) grew at a slightly slower rate. Also chicken that were fed intensively grew faster than those that partly scavenged. The difference was at first small during the first weeks (1-3 weeks), however in as the birds grew older (4-6weeks) the intensively fed birds grew two times faster than their semi-scavenging counter parts.

Table 3. Live body weights (g) of local chicken fed three diets under the intensive and semi-scavenging feeding systems

Age	Diet					System			
(weeks)	D20	D30	D18	*p*	SEM	IFS	SFS	*p*	SEM
0	28.9	29.3	29.2	0.49	0.22	29.2[a]	29.1[a]	0.68	0.18
1	55.9	59.5	56.3	0.38	1.94	59.1[a]	55.4[a]	0.11	1.43
2	94.6	101.3	98.0	0.45	6.75	113.7[a]	82.6[b]	<.0001	2.86
3	138.1	150.1	135.9	0.15	9	161.2[a]	121.5[b]	<.0001	4.63
4	191.6	206.8	191.6	0.34	16.59	236.1[a]	157.5[b]	<.0001	6.43
5	259.9	263.9	234.1	0.15	23.42	308.3[a]	196.7[b]	<.0001	9.33
6	320.0	311.9	286.8	0.18	29.32	377.9[a]	234[b]	<.0001	10.65

[ab] Means in the same row without common superscripts are significantly different at P<0.05
#D20 (20% CP 2900Kcal ME/kg) IFS- Intensive Feeding System
#D23 (23% CP 3200Kcal ME/kg) SFS-Semi-scavenging Feeding System
#D18 (18% CP 2800Kcal ME/kg) SEM-Standard Error of Mean

Effect of diet on feed intake and feed conversion ratio on chickens under intensive feeding system

The FCR of the chickens under intensive system ranged between 2.9-5.7 with a mean of 3.8, 3.6 and 4.0 for D20, D23 and D18 respectively. Overall chickens fed with D2 were more efficient in utilizing feed compared to other diets, though in the first four weeks the FCR for the chickens on the three diets was similar (Table 4). In the fifth week the birds on the commercial diet had a higher FCR (P=0.01). There was a general increase in the FCR as the birds grew though some inconsistencies in this trend were observed at some weeks.

The birds were observed to consume more feed as they grew older (Table 4). In the first week the birds under the three dietary treatments consumed almost similar quantities of feed while in the second week chicks on D20 consumed more feed than those on D23 and the commercial diet (D18). In the third to fifth week this difference was lost. The total feed intake per bird was 200.8g, 182.2g and 172.0g for D20, D23 and D18 respectively.

Table 4. Feed intake (g/bird/day)and Feed conversion ratio (FCR) of local chickens under intensive feeding system during a 1-6 week growing period

Age (Weeks)	Feed Intake (FI) Diet					Feed Conversion Ratio (FCR) Diet				
	D20	D23	D18	*p*	SEM	D20	D23	D18	*p*	SEM
1	13.8[a]	12.5[a]	14.4[a]	0.13	0.32	3.3	2.9	3.4	0.22	0.09
2	23.0[a]	20.5[b]	20.2[b]	0.03	0.73	3.1	2.7	2.61	0.26	0.15
3	31.1[b]	32.3[b]	27.3[b]	0.08	1.03	4.3	4.9	4.8	0.78	0.18
4	37.8[a]	35.1[a]	34.4[a]	0.60	1.45	4.3	3.3	3.0	0.23	0.32
5	43.3[a]	38.4[a]	36.9[a]	0.26	1.64	3.4[b]	3.5[b]	5.7[a]	0.01	0.39
6	50.4[a]	43.3[b]	39.9[b]	0.001	1.71	4.3	4.8	4.5	0.68	1.67

[ab] Means in the same column without common superscripts are significantly different at P<0.05

The effect of diets and feeding system on mortality levels of local chickens

Diets had no effect on mortality, however the system of feeding was observed to greatly determine mortality levels. Higher mortalities were observed in the semi-scavenging birds compared to those that were confined and fed intensively.

Table 5. Mortality levels (%) of local chickens fed three diets reared under the intensive feeding systems in a six weeks growing period of age

	Mortality Levels, % System	
	Intensive	**Semi-scavenging**
D20	12.5	25.6
D23	13.5	25
D18	12.5	30

Discussion

Effect of diet and feeding system on the live weight and growth rate of local chicken

The growth rate of chickens is influenced by a number of factors including genotype, system of production, diet, age, sex stocking density and activity (Magala et al 2012). In terms of diets the protein and energy density of the feeds greatly determines their growth performance. The chickens fed on the commercial diet, D18 (18% CP and 2800Kcal ME/kg) exhibited numerically low but statistically indifferent live weights. These results are in agreement with findings by Nguyen, and Bunchasak (2005) when evaluating the growth performance of Betong chickens. Also Ndegwa et al (2001) had similar findings on local chickens in Kenya when fed diets containing CP content of 17-24%. Engku et al (2011) reported no difference in the growth response of Malaysian Kampung chicks when fed diets with varying energy levels during a three week growing period. However these results disagree with those of Miah et al (2014) who reported an improvement in body weight and body weight gain of Desi chicks when fed high energy diets compared to those fed with low energy diets. The inconsistencies in comparison to similar researches could be due to breed differences which exert effects on gene encoding factors including hormones, enzymes and metabolic pathways (Richards and Proszkowiec-Weglarz 2007). The fact that diets varying between 18-23% CP and 2800-3200Kcal ME/kg gave no difference implies that diets that contain a minimum of 18% CP and 2800Kcal ME/kg can be used in rearing local chickens when provided intensively or as supplement to semi-scavenging birds. The use of high energy and high protein rations in local chickens is therefore not rational since they come with higher costs yet the performance does not justify their use.

The higher live weights and growth rates of intensively fed chicks compared to those that were partly scavenging is not surprising. First the birds under the semi-scavenging system did not get access to the experimental diets once they are set out to scavenge. However this was not ideal but since these studies were on-farm farmers had to restrict other chicken (non-study birds) from eating the diets in order to get reliable data. This therefore restricted the hours that the semi-scavenging birds had access to the feed un-like in semi-intensive system such as the run where the birds scavenge but still have access to supplementary feed all the time. Secondly the slow growth rate and low live weights of semi-scavenging birds could be due to the inadequacy of the scavengeable feed resource base in both quality and quantity. The superiority in live weight and growth rate of intensively fed chickens compared to those that were semi-scavenging could be due to the fact that semi-intensive birds had a higher feed intake and a low energy expenditure due to reduced locomotory activity as a result of total confinement. This could probably have led to a better feed conversion efficiency of the birds (Sanka and Mbaga 2014). This results are consistent with those of Mutayoba et al (2012); Duo et al (2009) and Gondwe and Wollny (2005) whose results on growth rate and feed efficiency for intensively managed chickens was higher than for those that were either free-ranging or under semi-intensive systems.

Therefore local chickens though considered to be slow growing, they positively respond to improved feeding systems in terms of growth and production.

Effect of diet on the feed conversion ratio and feed intake on chickens under intensive feeding system

Feed conversion ratio (FCR) is a measure of how efficient the birds on a particular feed utilize it to gain weight. It also varies with diet, environmental conditions genotype among others. Kuietche et al (2014) reported that the feed conversion ratio of local barred chickens in Cameroon increased with increase in dietary energy of the feeds while Hosseini et al (2010) also reported a similar trend on broiler chicks. However this was only observed in the fifth week in this study when birds on the commercial diet (D18) had a higher FCR compared to the other diets. This could be as a result of inconsistence caused by feed wastage at farm level since wasted feed can be assumed to have been consumed. In the other weeks the FCR was statistically similar for the different diets. The CP contents of the diets in this study ranged between 18-23% and as mentioned earlier there was no significant difference in the FCR in the first four weeks. These results also agree with findings by Darsi et al (2012) on male broiler chicks though Banerjee et al (2013) reported an improvement in the FCR between chicken on 16%, 18% and 20% and no further improvement beyond 20% CP for Koekoech chicken breeds when using iso-caloric diets. The inconstancies observed in the general FCR trend could be due other factors such variation in environmental temperatures that were not studied.

Feed intake in chickens greatly impacts production since its key in determining the nutrient intake levels (Mbajiorgu et al 2011). According to NRC (1994) birds principally eat to satisfy their energy needs and will adjust their feed intake according to their metabolizable energy requirement. However local chickens in the present study behaved differently in this respect since birds on the high energy D23 (3200Kcal ME/kg) and a lower energy D20 (2900Kcal ME/kg) didn’t show statistically different results in terms of total feed intake. In addition birds on the least energy diet consumed the least feed quantity in total yet according to the NRC (1994) theory; these would have consumed the highest amounts of feed. The growth response of indigenous chickens is influenced by genetic limitation which in turn affects their nutritional requirement (Tadelle et al 2000). Tadelle et al (2000) explained that the implication of this limitation is loss of sensitivity to regulate feed intake according to dietary energy level for local

Venda chickens. Miah et al (2014) in a recent study on Desi chickens also reported similar results when birds in the starter phase fed on very low energy (2400Kcal ME/kg) diets exhibited low feed intake compared to those on moderate (2800Kcal ME/kg) or high energy (3000Kcal ME/kg) diets. Also Dairo et al (2010) reported low feed intakes for broiler chickens fed with a low energy-low protein diets. The relatively higher fibre content in the commercial diet could be partly responsible to the reduced feed intake since fibre potentially reduces feeding value and depresses feed intake in poultry (Siriwan et al 2012).

Mortality

The difference in mortality rates observed was due to the fact that the birds under intensive system were in a controlled environment and were protected against external factors such as harsh weather, predators and risk of infection from other birds. The semi-scavenging birds were however exposed to hash weather predators and possible risk of disease spread from other free-ranging birds. The morality levels for this semi-scavenging system were however lower than those reported by Abalaka et al (2013) in the rural areas of Nigeria. This was as a result of vaccination and prophylactic treatments given to birds during the experimental period. In fact majority of the deaths reported by farmers were due to predators and occurred mainly in the first three weeks when the birds were very susceptible to predators. Also partly confining birds helped to keep birds near homesteads and not to wonder very far from home where it could be unsafe. This observation was made by farmers engaged in the study.

Conclusion

Based on findings from the present study, the following conclusions can be drawn

- Local chickens reared under intensive feeding system have better growth performance and survival rate compared to those under semi-scavenging when reared on-farm.

- Local chickens fed 18% CP: 2800 Kcal ME/kg, 20% CP: 2900 Kcal ME/kg and 23% CP: 3200 Kcal ME/kg diets gave similar response in terms of growth during 0-6 week growing period. Therefore, a diet containing 18%CP: 2800kcal ME/kg is sufficient for rearing local chickens in the early growth phase.

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