The performance response of scavenging chickens to nutrient intake from scavengeable resources and from supplementation with energy and protein

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Abstract

An experiment conducted under farm conditions and management determined the daily supplemental intake, performance and nutrient specifications of scavenging chickens supplemented with energy and protein either alone separately or in cafeteria.

Supplementing scavenging chickens with protein and energy (soyabean meal together with maize meal) in cafeteria (ScSM) resulted in 64.86 g/bird /day intake of supplemental feed which was 105.6 and 64.24% higher than protein alone (ScS) and energy alone (ScM) supplemented separately respectively. Gain, feed conversion ratio, and mean egg weights, egg mass and percent production was significantly higher for ScSM compared with other treatments. The calculated dry matter, crude protein, lysine, tryptophan, methionine + cystine, crude fibre, crude fat starch, sugar and energy of supplements consumed daily in ScSM were 56.7, 21.2, 0.91, 0.34, 0.57, 2.91, 2.71, 35.78, 1.73% and 196.4 Kcal respectively and for all nutrients were significantly higher compared to corresponding maize meal alone and soyabean meal alone treatments. The proportion of soyabean meal intake to that of maize meal intake from ScSM was 1.33:1.

It is concluded that supplementing scavenging chickens with protein (soyabean meal) and energy (maize meal) in a cafeteria had the highest level of intake, egg production, body weight, rather than offering these supplements separately despite the two supplements offered separately increasing productivity compared to the corresponding scavenging only groups of birds. Scavenging indigenous chickens need to be supplied with 64.6 grams of scavenging balancer with nutrient specification of 21.2% CP, 0.91% Try, 0.34% M+C, and 3044 Kcal/kg or maize meal and soyabean meal to reach a level of 21.2 % protein in the overall diet.

Key word: egg production, indigenous chicken, scavenging, supplementation, weight gain

Introduction

Scavenging indigenous chickens lay, between 49-97 eggs per hen per year, whereas conventionally reared exotic layers lay more than 300 eggs per year. (Okitoi et al 2006). This poor performance can be traced in main to supply of nutrients to scavenging chickens. A major challenge to improving the productivity of scavenging chickens is therefore design of strategies to supply the nutrients required by scavenging chickens for optimum production. Requirement as a statement of the relationship between nutrients intake and performance (egg production or growth) depends on both feed intake and level of production. There is divergence in published estimates of requirements for scavenging chickens. Published information on nutrition and feeding of indigenous scavenging in Kenya and globally is scarce and diet specifications for them are not available.

The situation faced by indigenous chicken farmers in Western Kenya, is that specific compounded feeds to supply nutrients for scavenging chickens are not available and commercial feeds for exotic confined birds often too expensive to purchase. Many farmers who supplement usually do it haphazardly and only do it when surplus kitchen leftovers, energy and protein ingredients are available.

The provision of supplemental feed in scavenging chicken production has direct influence on productivity of scavenging indigenous chickens, but little information is available on the strategies to be used to supplement scavenging chickens. Understanding the effects of supplementing scavenging chickens with energy and a protein sources will, in part, aid in designing supplementation strategies to enhance their growth performance and, ultimately, improve their egg production capacity.

The positive effects of supplementing scavenging chickens has been reported by several authors including Tadele 1996, Rodriguez and Preston 1997, Smith 1990, Kingori et al. 2004, Okitoi et al.2006. Ahmed and Islam 1985 reported a significant improvement in egg production with a provision of supplementary feed. Rashid et al 1995 had similar findings in a case of ducks. Henuk and Dingle 2002 in a review of diet selection by poultry reported strong evidence that indicated that when domestic birds were offered different feedstuffs had the ability to choose a diet that provided them with nutrients necessary for maintenance, growth and production.

This study determined the daily supplemental intake of scavenging pre-lay and early laying chickens supplemented with energy and protein, their performance under such supplementation and determined nutrient specifications for supplementary diets

Materials and methods

Description of the study site

The experiment was conducted in a period of 11 weeks during the rainy and dry seasons including 4 weeks adaptation period in farmers' homesteads in Teso and Kakamega Districts located in Western Kenya.

Experimental design, treatments and bird management

The experiment included a total of 144 indigenous chicken hens at the age of 14 weeks from eggs collected from Busia, Kisumu, Bungoma, Vihiga and Kakamega Districts of western Kenya, were housed in farmers households. The birds were allocated randomly to four dietary treatments as shown below with 3 replicates and 6 birds per replicate.

1. Scavenging with a supplement maize meal and soyabean meal (ScSM)
2. Scavenging with a supplementation of soyabean meal (ScS)
3. Scavenging without any supplementation (ScO)
4. Scavenging with a supplement of maize meal (ScM).

The experiment had completely randomized (CRD) two factorial designs. Factor 1: Age of chickens (Growers and adult hens), Factor 2: Type of feed supplementation (4 levels viz Free range, maize alone separately, Soya beans meal alone separately and Soya bean meal plus maize meal).

The chemical composition of ingredients is shown in Table 1. Prophylactic measures against some common diseases were taken according to the vaccination programme on Table 1.

Table 1. Vaccination programme

Age of birds, days	Vaccine	Administration
1	Mareks	Subcutaneous
10	Infectious bursitis	Oral
21	New castle	Nose/ eye drop
21	Infectious bronchitis	Eye/ nose drop
112	New castle disease	Eye/ nose drop

One feeder with partition to supply supplements in cafeteria and a drinker were placed strategically within the homestead and feeders and drinkers cleaned and refilled daily in the morning. The grower chickens were allowed to scavenge for feed around the homestead. Over and above this, they were also offered supplements daily adlibitum available from 6.00 am to 6.00pm. Fresh feed was added and residues weighed once a day late afternoon. Individual feed ingredients for cafeteria feeding e.g. maize and soybean meal were procured from the local market. Each maize meal and soyabean meal were prepared and packed into paper bags to last a week.

Data collection and measurements

Collection of data started after one week of adaptation to the diet and to the pens in each household. Bodyweight of each pullet was recorded at beginning, fortnightly and end of the experiment by using a weighing scale with a precision of 2g. Live body weights of individual chickens and supplement refusals for each experimental unit were weighed daily. Body weight gain was calculated by subtracting initial body weight from final body weight. Supplement feed consumption were calculated by subtracting feed leftover from amount of feed supplied.

Supplemented feed efficiency was calculated from average feed consumption per hen per day (g) divided by average egg mass per hen per day (g). Egg mass was calculated by using following formula Egg mass (M) = P **X** W (North and Bell, 1990) Where, P = % of hen day egg production, W= Average egg weight in gram per egg M= Average egg mass per hen per day in grams. Egg production was recorded daily and hen day egg production was calculated by dividing number of eggs produced during the experimental period by number of hendays in the period (North and Bell, 1990). Mortality was recorded as it occurred. Responses in growth were measured over a period of four weeks

Statistical analyses

The data were subjected to ANOVA using SAS with the experimental model below. Pair wise comparisons of treatment means were made using Duncan multiple range test.

$$Yijk= \mu + Ai + Sj + (SL)\ ij + Eijk$$

Where,

Yijk, = the dependent variable of the experiment
Ai =the effect of the ith age of birds
Sj =the effect of the jth type of supplement
ASij = the effect of interaction between age of birds F at ith level and supplementary Level (L) at the jth level
Eijk = residual effect

Parameters of interest were egg production, egg mass, final and initial body weight, body weight gain and feed conversion ratio

Results

Chemical composition of dietary supplements

Table 2 presents the chemical composition of dietary ingredients. The maize used contained 8.46% crude protein, 3141 Kcal/ kg feed ME, 0.3, 0.22 and 0.11% amino acids lysine, tryptophan and methionine + cystine respectively and 3.5% crude fibre.

Table 2. Chemical composition of the dietary supplements

	Soya bean meal	**Maize meal**
Dry matter	87.1	88.1
Metabolizable Energy, Kilo-calories	2944	3141
Crude protein	33.7	8.46
Lysine,	2.23	0.30
Tryptophan	0.75	0.22
Methionine + Cystine	1.45	0.11
Crude fibre	5.22	3.50
Crude fat	3.20	3.53
Starch	53.3	47.6
Sugar	2.22	3.27

The soyabean meal used contained 33.68% crude protein, 2.23, 0.75 and 5.22% amino acids lysine, tryptophan methionine + cystine respectively.

Effects of free choice supplementation of energy and protein

Supplemental feed and nutrient intake table 3 shows supplemental maize intake of 39.49g /day when offered maize alone (ScM), was significantly ($p<0.05$) higher than when offered together with soya bean meal ScSM. Supplemental soya bean meal intake of 31.37 g/day when offered alone (ScS) was however significantly lower than when offered together with maize (ScSM)

Table 3. Daily supplement intake and calculated nutritive values

Data	Treatments[1]		
	ScM	ScS	ScSM
Supplement intake, g/b/d			
Maize meal	39.5[a]	0.00	27.8[b]
Soya bean meal	0.00	31.4[b]	37.1[a]
Total supplement	39.5[c]	31.4[b]	64.9[a]
Calculated nutrient values			
Dry matter, %	34.8[b]	27.3[c]	56.8[a]
Crude protein, %	14.2[b]	9.29[c]	21.2[a]
Lysine, %	0.12[c]	0.70[b]	0.91[a]
Tryptophan, %	0.09[c]	0.23[b]	0.34[a]
Methionine + cystine, %	0.04[c]	0.46[b]	0.57[a]
Crude fibre, %	1.38[b]	1.64[b]	2.91[a]
Crude fat, %	1.40[b]	1.00[c]	2.17[a]
Starch, %	18.8[b]	17.4[b]	35.8[a]
Sugar, %	1.29[b]	0.70[c]	1.73[a]
Metabolizable energy, Kcal/kg	124[b]	92[c]	196[a]

[1]ScM, scavenging and offered maize meal supplement adlibitum; ScS, scavenging and offered soyabean meal supplement adlibitum and
ScSM, scavenging and offered maize meal and Soyabean meal supplements adlibitum. Diets offered from 6.00am to 6.00pm.
[abc] in the same row for each treatment with different superscripts are significantly different ($p<0.05$)

The calculated DM, CP, L, Try, M+C, CF, Cfat, starch, sugar and ME of feed consumed by birds supplemented with protein and energy (soya bean meal together with maize meal) SM were 56.7, 21.2, 0.91, 0.34, 0.57, 2.91, 2.71, 35.8, 1.73% and 196 Kcal respectively. For all nutrients were significantly ($p<0.05$) higher compared to corresponding energy (maize meal alone) and protein (soyabean meal alone) supplemented birds ($P<0.05$).

The total daily supplement intake (64.9 g/bird /day) of birds supplemented with soyabean meal together with maize meal in cafeteria (ScSM) was 105.6% higher than those supplemented with soyabeans alone separately (ScS) and 64.2% higher than those supplemented with maize alone (ScM). The ratio of soyabean meal intake to that of maize meal intake was 1.33:1.

The highest daily supplemental dry matter intake (56.8g) was observed in ScSM, while the lowest intake (27.3 g) was observed in ScS (P<0.05).Similar trends were observed for daily crude protein intake with the highest crude protein intake (21.21g) observed in SM, followed by ScM (14.2g) and then S (9.29g) (P<0.05). The highest daily supplemental amino acids lysine, tryptophan and methionine + cystine intakes (0.91,0.34 and 0.57g respectively) were observed in SM, followed by S (0.70,0.23 and 0.46 respectively) and then ScM (0.12, 0.09 and 0.04g respectively) (P<0.05). A significantly higher supplemental ME intake was observed in ScSM (196.3Kcal) compared to other treatments.

Growth performance

Table 4 presents the mean initial and final weights of chickens, average daily gain (gain) and feed conversion ratio (FCR). There was no significant difference in initial body weights among the treatments (P>0.05). Final body weights were significantly lower for scavenging only birds compared to other treatments (P<0.05).

Table 4. Effects of supplementation of scavenging chickens with maize and soyabean meals free choice on gain and FCR

Treatment	Initial body weight, g	Final body weight, g	Gain, g	FCR, g feed/g gain
ScO	1053	1122^{d}	1.40^{c}	0
ScM	1063	1253^{c}	2.84^{b}	10.3^{a}
ScS	1057	1330^{b}	3.83^{a}	5.70^{b}
ScSM	1043	1371^{a}	4.48^{a}	10.1^{a}

[1]M, scavenging and offered maize meal supplement adlibitum; S, scavenging and offered soyabean meal supplement ad libitum
and SM, scavenging and offered maize meal and Soyabean meal supplements adlibitum.O, scavenging only
[abc] in the same column for each treatment with different superscripts are significantly different (p<0.05)

Gain was significantly higher (4.48 and 3.83 g) for ScSM and ScS respectively, followed by ScM (2.84g) and then ScO (1.40g) (P<0.05). The FCR was significantly lower (5.7) for S compared to other treatments (P<0.05).

Egg production performance

Table 5 presents average egg weight, egg mass, % production. The highest egg weight was 51.22g, observed in ScSM which did not differ significantly with 49.75g observed in S (p>0.05). The lowest egg weights (45.84g) were observed in ScO (P<0.05).

Table 5. The effects of supplementation on egg wt, egg mass, egg production and FCE early laying period 24-28 weeks of age

Treatment	Average egg weight	Average egg mass	Hen housed, %	Hen day, %	FCR
ScO	45.8^{c}	109^{d}	1.19^{d}	2.98^{d}	0
ScM	48.9^{b}	182^{c}	1.49^{c}	3.77^{c}	12.28^{b}
ScS	49.8^{a}	224^{b}	2.68^{b}	6.17^{b}	10.03^{c}

ScSM	51.2[a]	262[a]	4.41[a]	9.37[a]	16.46[a]

[1]M, scavenging and offered maize meal supplement adlibitum; S, scavenging and offered soyabean meal supplement adlibitum
and SM, scavenging and offered maize meal and Soyabean meal supplements adlibitum.O, scavenging only
[abc] in the same column for each treatment with different superscripts are significantly different ($p<0.05$)

For the period between 24-28 weeks, egg mass was highest (262g) for ScSM ($p<0.05$), followed by ScS (224g). The lowest egg mass (109g) was observed in ScO ($P<0.05$). The highest hen housed production (4.41%) for the period between 24-28 weeks was observed in ScSM. The lowest hen day production during the period (2.98%) was observed in ScO ($P<0.05$). A similar trend was observed for hen day production in which the highest hen day production during the period (9.37%) was observed in ScSM. The FCR was significantly lower (10.03) for S compared to other treatments ($P<0.05$).

Discussion

The crude protein content in the maize used (8.6% of DM) and metabolizable energy 3141 Kcal/kg DM is similar to that of maize found in Ethiopia (Dana and Ogle 2002), Burkina Faso (Pougsa et al 2005), and Vietnam (Minh et al 2005).

The crude protein in the soyabean meal used (33.5% of DM) was lower than that of soyabean meal found in Vietnam. The soyabean meal used was purchased locally from poultry feeds manufacturers and was mechanically extracted.

The amino acid lysine in the soyabean meal used (2.23% of DM) was similar to that used in Vietnam (2.64% of DM) Minh et al 2004. The lower levels of crude protein in the soyabean meal used compared to that used in Vietnam was because the Vietnam soyabean meal was of whole soyabeans roasted and ground while the one used was mechanically extracted.

Maize meal had lower levels of lysine compared to soyabean meal, which is in agreement with studies, by Fernandez et al (1994) who reported lysine and tryptophan limiting in maize. Conversely soyabean meal had lower levels of sulphur amino acids (methionine and cystine) as compared to maize protein. This suggests that soyabean meal protein and maize meal protein complement each other with maize meal protein having higher levels of sulphur amino acids (Methionine + Cystine) and deficient in lysine whereas soyabean meal is relatively rich in lysine.

The daily supplement intake (64.9 g/bird /day) of birds supplemented with soyabean meal together with maize meal in cafeteria (ScSM) is similar to that reported by Tuitoek et al 2000, Minh et al, 2004, Minh and Ogle 2005, and Pougsa et al 2005. The ratio of soyabean meal intake to that of maize meal intake was 1.33:1.

The daily nutrient intake of DM, CP, L, Try, M+C, CF, Cfat, starch, sugar and ME of selected diet were 56.7, 21.2, 0.91, 0.34, 0.57, 2.91, 2.71, 35.8, 1.73% and 196.4 Kcal respectively. The daily nutrient intake was similar to specifications of 16- 17% cp, 0.15 – 1.15 % lysine, 0.17 – 0.2

% tryptophan, 0.6 -0.83 % metionine + cystine and 11.5 – 12 MJ/kg ME for free range chickens (Portsmouth 2000).

Selective preference tests have shown that bird had specific appetites for such nutrients as energy and protein Henuk and Dingle 2002. The precision of this mechanism was demonstrated when birds consumed an almost perfectly balanced diet when offered a free choice of ingredients. Other authors (Hughes 1984, Leeson and Summers 1997) have shown the ability of hens to select from ingredients on offer such that the composition of their diet meets their actual needs and production capacity. This suggests, soyabean meal and maize meal in the ratio 1.33: 1 at an intake of 64.86 / bird / day provided nutrients required by free-range chickens. It also suggests that nutrient intake supplemental diet with DM, CP, L, Try, M+C, CF, Cfat, starch, sugar and ME of with values 56.7, 21.2, 0.91, 0.34, 0.57, 2.91, 2.71, 35.78, 1.73% and 13044 Kcal/kg provided the supplemental feed specifications. Small differences can be explained by the fact that specifications by Portsmouth 2000 were for free-range hybrid brown egg layers on free-range.

The highest supplemental maize meal intake was observed when maize meal was offered separately rather than in combination with soyabean meal. This is similar to findings by Pougsa et al 2005 in Boukina Faso and Dana and Ogle 2002 in Ethiopia who showed high intake of maize when given separately. The intake of maize was however reduced when offered together with soyabean meal in a cafeteria in favour of soyabean meal. This indicates the soyabean meal seemed to have a negative effect on palatability of maize meal. The negative effects could be explained by possible traces of anti-trypsin effects that may have been in the soyabean meal.

Dry matter intake was about 63.2% higher for protein and energy (maize meal and soyabean meal) supplemented in a cafeteria (ScSM) to corresponding energy (maize meal alone) (ScM). Similarly the dry matter intake by scavenging chickens was 107% higher for maize meal and soyabean meal supplemented birds (ScSM) to corresponding Soya bean offered separately (ScS).This indicates that supplementing scavenging chickens with maize meal in combination with soyabean meal superior to supplementing with those sources separately. Similar trends were observed for other nutrients. The explanation for this is that scavenging chickens have specific appetites for various nutrients and increase their feed intake to make up for slight deficits (Mc Donald 2002).

The non-significant initial weights was the reason the birds were selected more or less similar weights and randomly given to farmers at 14 weeks. However, at the end of the trial, the final weights were significantly different ($p<0.05$). This result is in agreement with Olver and Malan 2000. This suggests that scavenging chickens improved their weight gain when supplemented with soyabean meal and maize meal.

Increase in growth and egg production performance of scavenging chickens when supplemented is in agreement with studies in Ethiopia (Tadelle and Ogle 2001 and Dana and Ogle 2002).

The results have shown that supplementing scavenging chickens with energy and protein sources singly is not as good as supplementing them together in cafeteria for the simple reason of complementary supply of nutrients from the available ingredients.

Increased egg weight was obtained with supplementing soyabean meal in combination with maize meal rather than offering them separately

The highest rate of lay/hd was obtained from the group that was given a combination of soya bean meal and maize meal rather than offering them separately. The result indicates that the hens were biologically influenced with the level of supplementation.

Conclusions

- Nutrient specification of most favourable supplementation treatment 21.2% CP, 0.91% Try, 0.34% M+C, and 3044 Kcal/kg may be followed for formulating supplemental diets for scavenging chickens.

- Supplementing scavenging chickens with protein and energy (soya bean meal and maize meal together) had the highest level of intake, egg production, egg weight body weight.

- Supplementing scavenging chickens with complementary feeds to allow birds to select a diet to meet their requirement is an effective method of feeding scavenging chickens than offering those foods separately.

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Go to top