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Feed Intake, Weight Gain and Profitability of Sasso Chickens Fed Locally Formulated Rations at Wollega University, Nekemte, Ethiopia

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Abstract: This experiment was conducted in Wollega University for 150 days to evaluate the effect of feeding locally formulated ration on feed intake, weight gain, feed conversion ratio and profitability of Sasso chicken farming. One hundred chicks of forty two day old male Sasso chickens were purchased and randomly distributed in to four dietary treatments with three replications each. The treatments were: T1 (feed composed of mixes of sorghum grain, soya bean grain, noug seed cake, limestone, salt and *Sesbaniasesban* green leaf), T2 (Commercial ration), T3 (feed composed of mixtures of quality protein maize grain, limestone and salt) and T4 (feed composed of mixtures of wheat grain, soya bean grain, noug seed cake, limestone, salt and *Sesbaniasesban* green leaf). The birds were randomly distributed to the different feeding treatments. A completely randomized design (CRD) was used to manage the experiment. The experimental chickens were offered their respective experimental diets (*i.e.* grower and finisher) *ad-libitum.* Feed offered and feed refused were recorded every 24hours to calculate amounts of feed consumed. Body weight was taken every week early in the morning starting from 06:00 am before offering feed. At the end of the experiment, at 150th days, chickens were sold. Feed samples from both ingredients and rations were taken and sent to the National Veterinary Institute (NVI) laboratory at Bishoftu to evaluate their chemical composition after drying in an oven. Finally, significant differences ($p < 0.05$) were observed in their feed intake, daily gain and feed conversion ratio and profit ability analysis. Feed intake was highest for those chickens fed on T2 and the least feed intake was recorded from those chickens fed T1. Feed conversion ratio was lowest for those chickens fed on T2 (8.68) and highest for those chickens fed on T3 (9.97). Those chickens fed on T4 fetched the highest profitability with 6.40, 540.51 and 83.73% for CBR, RoI and GPMP respectively, indicating that T4 ration with some fine-tuning works in the future to use the full potential of this diet can replace T2 without adversely affecting Sasso Chickens' growth performance.

Key words: Daily Gain · Feed Intake · Profitability · Ration · Sasso Chickens

INTRODUCTION

Agriculture remains the pillar of the developing countries economy for growth and development [1]. Likewise Ethiopian economy is mainly dependent on agriculture [2]. The livestock sector has been contributing to the economy of the country and has the potential to contribute more [3]. Poultry (chicken) production is animportant sub sector in the livestock industry and unique in that it offers the highest turnover rate and the quickest returns to investment outlay, the means of solving the problem of protein deficiency, the highest feed conversion rates and produces the least expensive and best sources of quality animal protein [4]. According to the authors, chicken is one of the most appropriate farm animal for rural women and for landless and marginalized farmers for whom it provides employment opportunities and generate income for household immediate expenses.

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Coffey, *et al.* [5] pointed out that demand for cereal and meat products will increase due to growth in human population coupled with higher purchasing cost. Food security is, therefore, endangered due to increased demand by a growing population. The fact that cereal grains are used as both human food and animal feed ingredients leads to increase in their prices will obviously impact the price of animal protein. Despite the increase in number of chickens in Ethiopia (65.87 million) with expected increase in the future [6], the annual per capita consumption during the year 2013 for chicken meat was 1.8Kg per year. According to GAIN [7], Ethiopia's annual chicken meat production is about 50, 000 metric tons, with yearly imports of about 1, 000 metric tons, which do not meet the total demand in the country. The country's average per capita poultry meat consumption of 1.8 kg is among the lowest in the world while per capita consumption in Sub-Saharan Africa is 2.3 kg. Of this amount, only 3000 metric tons or 6 percent is considered commercial broiler production.

The major challenges and constraints of poultry production in Ethiopia are lack of quality and availability of feed, poor genetic resources poor institutional linkage and disease and predators, of which feed constraint takes lion's share [8]. The availability and cost of feed ingredients stand at the forefront [9]. The gap between local supply and demand for these traditional ingredients is expected to widen over the coming decades, providing a compelling reason for exploring the usefulness of locally available, alternative feedstuffs in feed formulations. The viability of village broiler farms has been continually threatened by the rising costs of imported ingredients used in commercial feeds. Thus, there is a need for alternative sources of feed that are cheap and affordable [4]. On the other hand, it will be essential to transform the traditional backyard family poultry that relies onindigenous scavenging chickens into a market-oriented improved family poultry system with semi-scavenging crossbred chickeneco-types (broilers) using alternative sources of feed that are locally available, cheap and affordable. Broilers are chickens kept for meat production due to their genetic potential for high growth rate and high feed conversion ratio. According to Jiya, *et al.* [4], broiler chickens are the fastest source of animal protein because of their rapid growth, feed efficiency and quick turn-over rate. When combined with proper rationing and adequate health services, broiler chickens would greatly express their genetic potential for both eggs and meat [10]. This experiment, therefore, was conducted to determine feed intake, live weight gain, feed conversion ratio and profitability of Sasso chickens fed on different locally formulated rations as compared to commercial ration.

MATERIALS AND METHODS

Description of the Study Area: The study was conducted for a period of five months (150 days, January to May 2019) in Wollega University, main Campus, Nekemte. Wollega University is situated in Nekemte town, East Wollega Zone of Oromia Regional State. The study area is located at 10° 0' North latitude and 37° 30' East longitudes. Wollega University, Nekemte campus has an elevation of 2, 088 meters above sea level (m.a.s.l.) and found at a distance of about 328 km from Addis Ababa, capital city of Ethiopia to the west directionon the main highway to Benishangul-Gumuz regional state. The mean annual rainfall of the study area is about 1998 mm, relative humidity ranges from 31 to 110 and the meanminimum and mean maximum temperatures are 8°C and 30°C, respectively [11].

Experimental Design and Dietary Treatments

Experimental Design: Completely randomized design (CRD) was used to manage the experiment since the initial weight, age and sexof the chickens were similar.

Experimental Treatments: The study was conducted with four experimental treatments as shown in Table 1.

Experimental Feed

Feed Ingredients: For the locally formulated rations, quality protein maize (QPM) grain, sorghum grain, wheat grain, soya bean grain and noug seed cake were used as the main ingredients. Soya bean grain and noug seed cake were used as the primary protein sources while sorghum and wheat were served as energy sources. In the current study, salt and limestone were used to meet the mineral requirement, leaf of *Sesbania sesban* (*S. sesban)* was used as green forage requirement as well as source of protein and QPM grain was used both as source of energy and proteins (as sources of essential amino acids). In the current study, chickens were randomly assigned in to four treatments having different feed ingredients using a lotto system.

Experimental Ration: Test diets were formulated according to NRC` [12] with the Standards specifications for broiler grower and finisher mash feed requirements.

Table 1: Experimental treatments and their codes

Treatments	Codes	Components (specifications)
1	T1	Ration formulated from mixes of sorghum grain, soya bean grain, noug seed cake, lime stone, Salt and *Sesbania sesban* leaf.
2	T2	Commercial ration bought from Ethiochicken PLC.
3	T3	Ration formulated from mixes of quality protein maize grain, limestone and salt.
4	T4	Ration formulated from mixes of wheat grain, soya bean grain, noug seed cake, lime stone, salt and *Sesbania sesban* leaf.

The diets as shown in Table (1) were formulated to contain a minimum 3000Kcal/kg ME, 220g CP/kg for grower and 3200Kcal ME, 180g CP/kg in finisher ration to satisfy their requirements. These diets were formulated with the ratio of 70%:19%:10%:0.65%:0.35% carbohydrate: protein: fat: limestone (Ca) and salt (Na) sources, respectively for the 1st and 4th treatments, while 98% QPM: 1%LS: 1% salt in 3rd treatment in grower phase. These diets were again formulated with the ratio of 75%:10%:13%:0.65%:0.35% carbohydrate: protein: fat: limestone (Ca) and salt (Na) sources respectively for the 1st and 4th treatments, while 98% T3: 1%LS: 1% salt in 3rd treatment in finisher phase. But the 2nd treatment (T2) for both grower and finisher phases were bought directly from Ethiochicken PLC farm and used as positive control treatment. Noug seed cake and soya bean grain were used as protein sources for T1 and T4.

Ration Formulation and Management: The three locally formulated rations (T1, T3 and T4 treatments and their respective ingredients) were milled by local grinder (miller) to improve their palatability and digestibility at ≤ 3.2mm particle size depending on the age of the chickens (growing and finishing phases) and formulated to contain the required nutrients (Energy 3200Kcal/ Kg; Protein 19%, Mineral 2%). T2 (Commercial rations for grower and finisher rations) was bought from Ethiochicken PLC. Chickens were adapted to the diets for seven days prior to the commencement of the actual experiment. During the study, the animals were offered with measured quantity of the daily ration. The feed samples accumulated over the experimental period were thoroughly mixed manually, sub-sampled and packed in dry paper bags and taken to the National Veterinary Institute of Ethiopia (Bishoftu) for analysis of their chemical composition.

Housing and Equipment: Properly constructed house of different classes with concrete floor covered with fine wood shaving collected from wood works and roofed with corrugated iron sheet was used for the experiment depending on their individual floor space requirement (0.96cm^2/chickens) [13]. In every room a bulb with11watts was suspended 45cm over the floor to offer night light. The house was checked for proper entrance of air through upper wall mesh wire for proper ventilation. Before chickens were introduced the rooms were properly cleaned with detergents and disinfected with HI-7 disinfectant as necessary based on veterinary professionals guide. Different equipment and materials including feeder, waterer, sensitive (digital) weighing balance, record book, chicken identification materials, etc. were bought and used to measure and record data. Each room sufficiently accommodated 25 chickens. Twelve holes on the side of the feeder facilitated the chickens to access feed by only inserting their beaks. There was one separate isolation room for follow up of sick animals in case it happens.

Experimental Chickens and Their Management: One hundred (n=100) 42 day old male dual purpose broiler chickens (Sasso T44) with an average initial weight of 623.05g ±6.4g were purchased from a Ethiochicken PLC and grown for 150 days in Wollega University, Nekemte campus. This was because Sasso T44 commercial broilers require relatively longer time to retain weight next to Cobb 500 [14].

The experimental chickens were checked for their source and prior to 42 days vaccination. Upon arrival all chickens were vaccinated against fowl cholera. Before the actual experiment had started, the chickens were identified with permanent marker on their shank, weighed and recorded during the entrance and actual experiment date, sorted based on their weight, randomly assigned to the room and weighed weekly throughout the experimental period using digital weighing balance, record book and coop to manage them. The health and welfare of the animals was well maintained until the end of the experiment. The experiment lasted 150 days. Foot bath was used on the entrance of every room for prevention of disease outbreak.

Data Collection: All measurements on feed offered, left over, body weight were recorded using a digital balance (Electronic Kitchen scale) with 7kg capacity. Data on chemical analysis of feeds was recorded based on the reports from the National Veterinary institute. Variable cost of inputs and selling prices were also recorded to describe profitability.

Feed Intake: Feed intake was monitored daily by adding a known amount (measured in grams) of feed in feeder and the leftover feed was weighed every morning at 12:00 hours local time. The feed offered and left over were weighed using Electronic Kitchen Scale in grams and the daily weight of feed consumed per group were calculated by difference. The average daily feed intake (ADFI) were calculated by dividing the total amount of feed consumed by the group for the total number of experimental days (150 days) and for the total amount of chickens in the room (25 Sasso chickens).

Growth and Weight Gain: After one week of adaptation to the diets and the rooms, their initial body weight was taken individually and body weight of the four groups were recorded using digital balance. The chickens' growth performance measurement was started after day 7 of acclimatization period. Data on weight of the chickens was taken on a weekly (every Wednesday morning at 12:00 hrs local time) basis after overnight fasting and before providing the morning diets. Body weight gain (BWG) was calculated by difference in weight between the final weight and initial live weight of chickens. The average daily gain (ADG) was calculated by subtracting initial weight from final weight and then dividing by the total days chickens stayed under actual experiment (150 days).

Feed Conversion Ratio: The feed conversion ratio was calculated by dividing the total amount of feed consumed (g) per chicken by its corresponding average daily gain (g).

Chemical Analysis of Feed Ingredients and Ration: Chemical composition of individual ingredients (sorghum, wheat, QPM, soybean grain and Noug seed cake) and the four experimental rations (T1, T2, T3 and T4) were determined using the procedures described by AOAC [15] and analyzed at the Ethiopian National Veterinary Institute situated at Bishoftu. Accordingly, dry matter (DM) was estimated by oven drying the samples at 105°C for 24 hours, Ash content was determined by burning the samples at 500°C for 72 hours in a muffle furnace.Ether extract was determined by exposing the sample in diethyl ether using a solvent extractor and weighing the dried extract. Crude protein (CP) was estimated using the Kjeldahl method [16, 17, 18] which was used to measure the Nitrogen (N) content of the sample. The CP was calculated by multiplying the N content by the factor 6.25. Metabolizable energy (ME) of the experimental diets was estimated using predictive equations from the proximate analysis data of the treatments as indicated below:

$$ME = -0.45 + (1.01 \times \text{DE} \quad (1)$$

$$\text{DE (Digestible Energy)} = \text{TDN} \times \frac{4.409}{100} \quad (2)$$

$$\text{TDN (Total Digestible Nutrients)} = 54.6 + (36.6 \times \text{CP}) - (0.26 \times \text{CF}) + (6.85 \times \text{EE}) \quad (3)$$

Profitability Analysis: The Cost benefit ratio (CBR), return on investment (RoI) and gross profit margin percentages (GPMP) were the three indices used for evaluating the profitability feeding Sasso chicken with the experimental rations.

The determination of profitability considered only total variable cost of production. Feed costs were calculated from the ingredient prices based on quantities of each incorporated in the dietary feed treatments. Costs of variable inputs at the time of the study and revenue collected from sale of the chickens at the end offeeding phase were assumed to represent all the costs and benefits accrued from the experiment respectively.

Cost Benefit Ratio (CBR) was calculated as the ratio of sales revenue to feed cost and interpreted as: cost benefit ratio above one (>1) means that the benefits of the project (treatment) exceeded the costs and vice versa. Return on Investment (RoI) was calculated as the ratio of profit (sales revenue minus feed cost) to the total feed cost and interpreted as the higher the RoI value, the better the return on investment (treatment).

Profit is the difference between the project revenue and the project cost. Gross profit and gross margin were the two measurements used to measure the profitability of the treatments. Gross profit was calculated as the difference between the sale of chickens (SR) on a live weight basis and total cost of feeds (CFC), while Gross profit margins were calculated as the ratio of gross profit to total revenue and the Gross profit margins percentage (GPMP) were finally calculated as the ratio of gross profit to total revenue multiplied by 100 percent.

Statistical Analysis: Data on feed intake, weight gain, FCR and profitability of the experiment was analyzed using the General Linear Model Procedure of the Statistical Analysis System SAS [19]. Whenanalyses of variance declared existence of significant differences, mean separation was performed using Tukey Honestly significant difference (HSD) at α: 0.05.

The model used was:

$$X_{ie} = \mu + A_i + e_{ei} \quad (4)$$

where:

X_{ie} = an observational data,
μ = Overall mean,
A_i = Effect of the i^{th} treatments.
e_i = Residual error

RESULTS AND DISCUSSION

Chemical Composition of Feed Ingredients: Chemical composition of feed ingredients used in the study was shown in Table 2. The resultant chemical compositions of ingredients sorghum grain, QPM grain, wheat grain, soya bean grain and noug seed cake attained a CP level of 10.02%, 12.49%, 10.23%, 37.6% and 22%, respectively. In different literatures [20, 21] the CP content for sorghum was 14.89%, for QPM 12.49%, for soya bean 30.2% and for noug seed cake 37.69%. About 3.30%, 6.75% and 28.20% EE values were identified for sorghum, QPM and soya bean in the current study. This disparity in chemical composition can be attributed to the fact that the feed ingredients were obtained from different sources and could also be different in varieties used in this study. The nutrient compositions of the feed ingredients obtained in the current study were within values reported in literatures [19-22].

According to Edeheudimet, *et al.* [20], sorghum grain contains about 88.94% DM, 14.89% CP, 3.30 EE, 3.01CF, 2.59% Ash and 4120Kcal/kg gross energy. QPM grain contains about 89.56% DM, 12.49% CP, 6.75% EE, 2.52% CF, 1.55% Ash and 3858.2Kcal/kg gross energy [21]. Soya bean grain contains about 95.61% DM, 37.69% CP, 28.20% EE, 5.44% CF, 4.29% Ash and 3858.2Kcal/kg gross energy Ruth [23]. Noug seed cake contains about 92% DM and 30.2% CP [22]. These all literatures confirm that the nutrient composition of the feed ingredients in the current study werein the acceptable range, though the CP content of noug seed cake shown lower values.

Chemical Composition of Experimental Rations: Chemical composition of the experimental diets used in the study was shown in Table 3. The difference in CP content between those locally formulated and commercial diets could be due to variability in CP content of ingredients. The commercial diet or T2 had the highest ether extract concentration in grower (8.33%) and finisher (4.68%) diets and highest dry matter concentration in the grower (91.59%) and finisher (91.33%) diets. Relatively higher ash concentrations were obtained in T3 (6.57%) from grower and in T1 (6.35%) from finisher ration. Relatively least Ca content of about 2.198% and 1.825% were observed in T4 grower and T2 finisher rations. In the current study, the crude fiber values of 7.76% and 6.87%wereobserved in T4 and T1 of the grower ration and 5.68% in T1 finisher ration, respectively. ME was highest in T2 of both grower and finisher rations (3812.45 Kcal/Kg) and 3595.7Kcal/Kg feed respectively), followed by T3 of both grower and finisher rations (3487.6Kcal/Kg) feed, respectively. This indicates that the highest EE in T2 and soluble carbohydrate in T3 must have contributed to the highest ME values observed in both diets. But the rations of T3 did not fulfill the above mentioned requirements. The CP content of T3 was only 12.49%. In addition to T3 others also did not fulfill the nutrient requirement of chickens.

Feed Intake of Sasso Chickens: The mean daily feed intake of Sasso chickens during growing, finishing and entire feeding periods of the four treatments are shown in Table 4. Highly significant differences (P<0.001) were observed among the mean daily feed intake (GPADFI) of the chickens in all treatments during the growing phase. In addition, during finishing phase and during whole experimental period ADFI were also significantly differed in all treatments (P<0.05).

During growing phase, T3 had been highly consumed by the chickens (178.74g/day/bird) while the T1 was the least consumed (82.37g/day/bird) ration. This may be due to anti nutritional factor, tannin, content of sorghum grain in the T1 diet [25]. In contrast, the highest level of intake for T3 may be due to its least CP concentration. In the current study, cannibalism was observed in those chickens kept on T3, indicating they are deficient in one of the nutrients (CP). This was confirmed during finishing phase in that T3 was lightly consumed by chickens (139.12g/day/bird) than all other dietary treatments.

During the entire feeding phase T2 was highly consumed by chickens (170.37g/day/bird), but not significantly different with T3 (158.93g/day vs. 158.30g/day). Feed consumption was not significantly varied among T2, T3 and T4. The highest superiority of feed intake of T2 ration during finishing phase was due to increased body weight of the chickens that enhanced their intake. It was observed from the current result that feeding of locally formulated ration did not bring variation in intake of chickens when they were compared to that of T2. But the cumulative feed intake during the whole period indicated that there were no variations in feed intake among T2, T3 and T4. So we should not only expect locally formulated ration to increase feed intake than commercial ration but if they achieve non-significant difference with regard to performances compared to T2 that result should be considered promising.

Table 2: Chemical composition (%) of feed ingredients used in the study

	Chemical composition (%)						
Ingredients	DM	CP	CF	EE	Ash	ME*	Ca
Sorghum grain	89.48	10.02	1.308	3.031	1.84	3924.8	1.118
QPM grain	89.793	12.49	2.127	0.996	1.47	3756.54	2.042
Wheat grain	89.45	10.23	1.934	0.483	1.975	3725.15	0.932
Soya bean grain	92.963	37.6	13.392	5.34	5.472	2830.37	1.614
Nouge seed Cake	93.96	22	23.776	3.84	9.057	1681.44	1.951

DM=Dry Matter, CP=Crude Protein, CF= Crude fiber, EE=Ether Extract, ME=Metabolizable Energy, *= Kcal/Kg, Ca=Calcium, QPM =Quality Protein maize.

Table 3: Chemical composition of experimental diets (% DM basis)

	Experimental diets							
	Broiler Grower Mash				Broiler Finisher Mash			
Chemical composition (%)	T1	T2	T3	T4	T1	T2	T3	T4
DM	90.767	91.59	90.62	91.007	90.823	91.33	90.62	90.22
CP	16.34	19	12.24	16.34	14.13	18	12.24	14.13
CF	6.868	3.832	2.659	7.758	5.681	4.04	2.659	5.376
EE	3.252	8.328	0.742	0.27	0.288	4.682	0.742	1.015
Ash	6.067	6.169	6.566	6.45	6.349	6.168	6.566	6.144
ME*	3271.2	3812.45	3487.6	3014.39	3203.72	3595.7	3487.6	3278.69
Ca	2.203	2.73	3.311	2.198	2.596	1.825	3.311	2.032

DM=Dry Matter, CP=Crude Protein, CF= Crude fiber, EE=Ether Extract, ME=Metabolizable Energy, *= Kcal/Kg, Ca=Calcium, T1=Ration formulated from sorghum grain, soya bean grain, nouge seed cake, limestone, salt and Sesbania sesban leaf, T2=commercial ration bought from Ethiochicken PLC, T3= Ration formulated from Quality protein maize grain, limestone and salt, T4= Ration formulated from Wheat grain, soya bean grain, noug seed cake, limestone, salt and Sesbaniasesban leaf, CP= crude protein, NSC=Noug seed cake.

Table 4: Effect of locally formulated diets on feed intake of Sasso chicken

	Experimental diets						
Phases of feed intake	T1	T2	T3	T4	SEM	P value	SL
GPADFI (g/bird/day)	82.37^{c}	127.81^{b}	178.74^{a}	104.06^{cb}	6.99	0.0003	***
FPADFI (g/bird/day)	200.45^{a}	212.94^{a}	139.12^{b}	212.55^{a}	12.01	0.0136	*
CADFI (g/bird/day)	141.41^{b}	170.37^{a}	158.93^{ba}	158.30^{ba}	4.11	0.0143	*

^{abcd}Means with different letters and superscript in a row shows significantly difference ($p \leq 0.05$), GPADFI =Growing phase Average Daily Feed Intake, FPADFI= Finishing phase Average Daily Feed Intake, CADFI =Cumulative Average Daily Feed Intake, T1=Ration formulated from sorghum grain, soya bean grain, noug seed cake, limestone, salt and Sesbania sesban leaf, T2=commercial ration bought from Ethiochicken PLC, T3= Ration formulated from Quality protein maize grain, limestone and salt, T4= Ration formulated from Wheat grain, soya bean grain, noug seed cake, limestone, salt and Sesbania sesban leaf, SEM=Standard Error of the Mean, Sl=significance level, *=significant ***=highly significant.

Both T1 and T4 have soya bean grain ingredient that has anti nutritional factor that reduces feed intake unlike that of T3. According to Leeson and Summers [25], protease trypsin inhibitors, iso-flavones, lectins and oligosaccharides are among the anti-nutritive factors in soybean. The 141.41g/day average intake of T1 observed in the present study was in agreement with Osei-Amponsah, *et al.* [26] who reported average intake of 145kg/bird/day for Sasso T44. However, intake reported for T2 (170.37), T3 (158.93) and T4 (158.30) g/day in current study were in disagreement with the above authors, which could be due to the difference in nutrient composition of the experimental rations (Table 4).

Table 5: Effect of feeding Sasso chickens with experimental diets on their growth performance

	Experimental diets						
Phases and performance parameters	T1	T2	T3	T4	SEM	P value	SL
Grower phase (W1-W5)							
Initial weight (IBW) (g)	625.86	626.98	627.69	626.83	6.04	0.9975	ns
Final weight (GPFBW) (g)	1414.28^{c}	2238.04^{a}	1394.87^{c}	1900.54^{b}	62.85	0.0002	***
Total weight gain (GPTWG) (g)	788.43^{c}	1611.05^{a}	767.18^{c}	1273.70^{b}	64.53	0.0002	***
Daily gain (GPADG) (g/day)	22.52^{c}	46.02^{a}	21.92^{c}	36.39^{b}	1.84	0.0002	***
Finisher phase (W6-W20)							
Initial weight (g)	1414.28^{c}	2238.04^{a}	1394.87^{c}	1900.54^{b}	62.85	0.0002	***
Final weight (FPFBW) (g)	3054.86^{c}	3907.42^{a}	2755.98^{d}	3556.86^{b}	39.49	<0.0001	***
Total weight gain (FPTWG) (g)	1640.57	1669.38	1361.11	1656.32	91.95	0.1493	ns
Daily gain (FPADG) (g/day)	13.93	14.51	11.83	14.40	0.80	0.1600	ns
Entire Feeding phase (W1-W20)							
Initial weight (IBW)(g)	625.86	626.98	627.69	626.83	6.04	0.9975	ns
Final weight (FPFBW) (g)	3054.86^{c}	3907.42^{a}	2755.98^{d}	3556.86^{b}	39.49	<0.0001	***
Daily gain (CADG (g/day)	18.29^{c}	30.15^{a}	16.89^{c}	25.39^{b}	0.60	<0.0001	***

^{abcd}Means with different letters and superscript in a row shows significantly difference ($p \leq 0.05$), T1=Ration formulated from sorghum grain, soya bean grain, noug seed cake, limestone, salt and Sesbania sesban leaf, T2=commercial ration bought from Ethiochicken PLC, T3= Ration formulated from Quality protein maize grain, limestone and salt, T4= Ration formulated from Wheat grain, soya bean grain, noug seed cake, limestone, salt and Sesbania sesban leaf, SEM=Standard Error of the Mean, Sl=significance level, ns-non significant, ***=highly significant, W=week, IBW=Initial Body weight, GPFBW Growing phase Final Body weight, GPTWG= Growing phase Total weight gain, GPADG= Growing phase Average Daily Gain, FPFBW=Finishing phase Final Body weight, FPTWG= Finishing phase Total weight gain, FPADG= Finishing phase Average Daily Gain, CADG= Cumulative Average Daily Gain.

Effect of Locally Formulated Rations on Sasso Chickens' Growth Performance: Both the mean Initial body weight and body weight change of the chickens are shown in Table 5. There were non-significant (P>0.05) differencesamong the treatments in the mean initial body weight of the chickens for all treatments due to weight randomization done inthe initial date of the experiment. During the entire feeding phase, highly significant (P<0.0001) differences were observed in FPFBW (P<0.0001) and cumulative daily gain (CADG) for all the dietary treatments despite the non-significant differences in initial body weights (IBW) of the experimental animals. From this it can be said that differences observed were due to differences in experimental diets.

During the growing phase, chickens provided with the T2 achieved the highest total weight gain (GPTWG) of 1611.05g and highest average daily gain (ADG) of 46.02g followed by those kept on T4 (GPTWG 1273.70g and ADG 36.39g). The likely reason for the highest growth performance of the chickens fed onT2 ration may be due to its highest macro nutrients (CP and Energy (ME) as indicated in Table 4.However, there was non-significant (P>0.05) difference on mean final body weight, mean total weight gain and mean daily gain among the chickens kept on T1 and T3 diets. Both energy diets and protein supplements can influence growth of animals [12, 22].

Despite the similar protein content of T_1 and T_4 diets and the relatively higher energy content of the T_1, chickens fed on T_4 had attained higher ADG (46.02g). This was because, in addition to the essential amino acids (lysine), in soy bean grain, the wheat ingredient in T4 contained other additional essential amino acids (methionine) and these amino acids, together, might had supported for the better growth performance of chickens than thosechickens fed on T_1 diet (36.39g). This is because protein is nutrients which mostly affect growth of animals [12]. The least ADG for chickens fed on T3 could be mainly due to the low protein (CP) content unlike its high energy (3487.6kcal/kg) value. While the QPM (F_1) was believed to have quality protein that could support proper growth of chickens, the one used in the current study was the F_2 generation and thus it could have lost its protein value due to segregation. Hence chickens fed on F_2 generation QPM showed stunted growth and farmers using this maize variety must include additional quality protein feed ingredient in the diets of their chickens. Similar trend was followed during finishing phase for all treatments.

The ADGs observed in current study were higher than the values reported by Tesfaye *et al.* [28], who reported ADGs of 16.6g, 15.7g and 16.8g for Sasso T44 chickens when substituting maize with cassava root chips at 25 %, 50 % and 75 %, respectively. Melkamu Bezabih [29] also reported lesser ADG when intensively reared growing male Sasso chickens were fed on graded levels of soya bean meal, dried blood and rumen content mixture.

Table 6: Effect of locally formulated rations on Sasso chicken feed conversion ratio

	Experimental diets						
FCR Parameters	T1	T2	T3	T4	SEM	P-value	SL
Grower phase (W1-W5)							
Daily gain (GPADG) (g/day)	22.73[c]	45.67[a]	21.99[c]	36.46[b]	1.87	0.0003	***
Feed intake (GPADFI) (g/day/bird)	82.37[c]	127.81[b]	178.74[a]	104.06[cb]	6.99	0.0003	***
Feed conversion Ratio (GPFCR)	3.62[b]	2.80[d]	8.13[a]	2.85[c]	0.00	<0.0001	***
Finisher phase (W6-W20)							
Daily gain (FPADG) (g/day)	13.85	14.63	11.79	14.33	0.82	0.1640	Ns
Feed intake (FPADFI) (g/day/bird)	200.45[a]	212.94[a]	139.12[b]	212.55[a]	12.01	0.0136	*
Feed conversion Ratio (FPFCR)	14.48[b]	14.56[ba]	11.80[c]	14.86[a]	0.07	<0.0001	***
Entire Feeding phase (W1-W20)							
Daily gain (CADG) (g/day)	18.29[c]	30.15[a]	16.88[c]	25.39[b]	0.59	<0.0001	***
Feed intake (CADFI) (g/day/bird)	141.41[b]	170.37[a]	158.93[ba]	158.30[ba]	4.11	0.0143	*
Feed conversion Ratio (CFCR)	9.05[b]	8.68[d]	9.97[a]	8.85[c]	0.03	<0.0001	***

[abcd]Means with different letters and superscript in a row shows significantly difference ($p \leq 0.05$), T1=Ration formulated from sorghum grain, soya bean grain, noug seed cake, limestone, salt and Sesbania sesban leaf, T2=commercial ration bought from Ethiochicken PLC, T3= Ration formulated from Quality protein maize grain, limestone and salt, T4= Ration formulated from Wheat grain, soya bean grain, noug seed cake, limestone, salt and S. sesban leaf, SEM=Standard Error of the Mean, Sl=significance level, *=significant, ***-highly significant, W=week, GPADG= Growing phase Average Daily Gain, GPADFI = Growing phase Average Daily Feed Intake, GPFCR=Growing phase Feed conversion ratio, FPADG= Finishing phase Average Daily Gain, FPADFI = Finishing phase Average Daily Feed Intake, FPFCR=Finishing phase Feed conversion ratio, CADG= Cumulative Average Daily Gain, CADFI =Cumulative Average Daily Feed Intake, CFCR= Cumulative Feed conversion ratio

The value reported by the author was lowerthan the values of the current finding in slaughter/market weight (1731.5g). The difference could be attributed to the duration of study (56 days vs. 150 days) and differences in agro-ecologies. Similar experiment was conducted by Franco *et al.* [30] to compare growth performance, carcass components and meat quality between Mos rooster and Sasso T-44 line slaughtered at 10 months unlike in current study which was conducted for 5 months. The authors reported 17g/head/day while in current study g/head/day reported for T1, T2, T3 and T4were 20.37, 26.06, 18.37 and 23.71, respectively.

Effect of the Rations on Feed Conversion Ratio of Sasso Chickens: During the current study, mean feed conversion ratio of Sasso chickens fed on experimental diets during growing, finishing and entire feeding phases are shown in Table 6. During the growing phase, there were highly significant ($p<0.01$) differences between chickens fed on the different dietary treatments on daily gain (GPADG), mean daily feed intake (GPADFI) and feed conversion ratio (GPFCR). Significant ($p<0.0001$) difference in feed conversion ratios (FPFCR) were also observed between chickens fed on the different dietary treatments.

During the whole experimental period chickens which were fed on T2 had the highest ($P<0.01$) FCR followed by those fed on T4. Chickens fed on T2 hadsignificantly higher FCR (2.80) followed byT4 (2.85) during the growing phase, indicating that they had nearby values of feed utilization ratio. On the other hand, those chickens fed on T3 had the highest ($P<0.01$) FCR during finishing phase. The trend for ADG among the treatments during the growing and finishing phases wassimilar. From this one could observe that feeding of locally formulated ration (T4) had only slightly lesser efficiency than the commercial ration.

Profitability Analysis of Feeding Sasso Chickens with Locally Formulated Rations: Economic implication of feeding Sasso chickens with experimental diets is shown in Table 7. In conducting this analysis, it was assumed that the cost of ingredients as well as other related inputs and the sale of live chickens at the end of the feeding trial were the only source of costs and profits, respectively considered. During the growing phase (7th to 35th day), finishing phase (36th to 150th day) and the entire feeding phase (7th to 150th day) there were significant differences ($p < 0.05$) among the four dietary treatments in feed cost and sales revenue, cost benefit ratio, return on investment, gross profit, gross profit margin and gross profit margin percentage. During the grower and finisher phases, as well as the cumulative phase, the costs of consumed feed across the diets were highly different ($p < 0.05$).

Chickens fed on T2 had incurred the highest mean feed cost (153.88ETB/bird), while those fed on T1 had incurred the least feed cost (30.56ETB/bird) and

Table 7: Economic (profitability) analysis of feeding Sasso chickens with experimental diets

	Experimental diets						
Economic parameters	T1	T2	T3	T4	SE	P value	SL
Cost of feed (ETB/kg)							
Grower feed	9.65	34.45	9.99	12.92			
Finisher feed	10.39	15.86	28.87	12.09			
Feed intake (g/bird)							
Grower phase (GPADFI)	82.37^{c}	127.81^{b}	178.74^{a}	104.06^{cb}	6.99	0.0003	***
Finisher phase (FPADFI)	200.45^{a}	212.94^{a}	139.12^{b}	212.55^{a}	12.01	0.0136	*
Cumulative feed intake (CADFI)	141.41^{b}	170.37^{a}	158.93^{ba}	158.30^{ba}	4.11	0.0143	*
Cost of feed (ETB/bird)							
Grower phase (GPFC)	30.56^{c}	153.88^{a}	58.81^{b}	46.98^{cb}	5.23	<0.0001	***
Finisher phase (FPFC)	239.74^{ba}	281.37^{a}	195.44^{b}	68.08^{c}	10.67	<0.0001	***
Total Feed Cost (TFC)	270.30^{b}	435.26^{a}	254.25^{b}	115.06^{c}	14.73	<0.0001	***
Cumulative Feed Cost (CFC)	135.15^{b}	217.63^{a}	127.53^{b}	57.53^{c}	7.37	<0.0001	***
Live weight at slaughter (g)	3054.86^{c}	3907.42^{a}	2755.98^{d}	3556.86^{b}	39.49	<0.0001	***
Economic analysis parameters							
Live (market) weight (FPFBW) (g)	3054.86^{c}	3907.42^{a}	2755.98^{d}	3556.86^{b}	39.49	<0.0001	***
Sale of chickens (SR)	272.24^{c}	430.15^{a}	234.41^{d}	354.01^{b}	4.72	<0.0001	***
Cost Benefit Ratio (CBR)	2.02^{b}		2.03^{b}	1.89^{b}	6.40^{a}	0.21	<0.0001 ***
Return on Investment (RoI)	102.08^{b}	102.71^{b}	89.62^{b}	540.51^{a}	20.55	<0.0001	***
Gross profit (GP) (ETB)	137.09^{c}	212.52^{b}	107.27^{c}	296.48^{a}	9.60	<0.0001	***
Gross profit margin(GPM) (ETB)	50.33^{b}	49.53^{b}	46.06^{b}	83.73^{a}	2.35	<0.0001	***
Gross profit margin (GPMP) (%)	50.33^{b}	49.53^{b}	46.06^{b}	83.73^{a}	2.35	<0.0001	***

[abcd]Means with different letters and superscript in a row shows significantly difference ($p \leq 0.05$), T1=Ration formulated from sorghum grain, soya bean grain, noug seed cake, limestone, salt and Sesbaniasesban leaf, T2=commercial ration bought from Ethiochicken PLC, T3= Ration formulated from Quality protein maize grain, limestone and salt, T4= Ration formulated from Wheat grain, soya bean grain, noug seed cake, limestone, salt and Sesbaniasesban leaf, SEM=Standard Error of the Mean, Sl=significance level, ***-highly significant, ETB=Ethiopian birr, FPFBW=Finishing phase final body weight.

non-significant difference was observed between those fed on T3 and T4 during the growing phase. During the finishing phase, the mean feed cost incurred per head was ETB 281.37for chickens fed on T2 and it was the highest, while the least ETB 68.08 per bird was incurred on birds fed on T4. Generally, during the entire feeding periodsboth the total feed cost (TFC) and the cumulative feed cost (CFC) of those Sasso chickens fed on T2 were the highest (435.26 and 217.63 ETB/bird, respectively) and those fed on T4diet were the least (115.06 and 57.53ETB/bird, respectively).

From the results indicated above, it was observed that the feed with the highest cost resulted in the least cost benefit ratio and thereby attained the least profit. On the other hand it has shown that the highest ADG of chickens fed on T2 did not achieve the highest economic values indicating that the chickens fed on T4 diet also obtained promising ADG that could fetch promising total return that influenced the profitability of these chickens. This finding had confirmed the hypothesis that locally available feeds were more economical than purchasing costly industrial by products located at urban and cities of Ethiopia that forces users to incur additional transport cost.

Sasso chickens fed on T2 and T4 were significantly different in live weights ($p < 0.05$) than those fed on T1 and T3. They attained 3907.42g and 3556.86g at slaughtering age, respectively. Never the less, those chickens fed on T3 were the lightest (2755.98g) of all at slaughtering age. Chickens were sold on a live weight basis and fetched 271.88ETB/bird, 429.82ETB/bird, 234.26ETB/bird and 352.13ETB/bird from treatment T1, T2, T3 and T4, respectively indicating that heavier chickens fetched higher prices. Chickens fed on T2 and T4 fetched the highest selling prices of430.15ETB/bird and 354.01ETB/bird, respectively and those fed on T3 and T1 were the least (234.41ETB/bird and 272.24ETB/bird, respectively). Chickens fed on T4had fetched the highest (83.73%) gross profit, gross profit margin (83.70) and gross profit margin percentage (83.73%) and also recorded statistically highest profits which fetched 34.2% more profit than those fed on T2, while those fed on the other dietary treatments (T1, T2 and T3) had fetched almost similar (non-significant) GPMP of 50.33%, 49.53% and 46.06%, respectively. They had also fetched the highest (6.40) CBR, while those fed on T1, T2 and T3 had fetched similar and non-significant CBR of 2.02, 2.03 and 1.89, respectively. From this it can be revealed that use of dietary treatment T4 had 4.37 higher CBR, than using the conventional T2 diet.

With regard to RoI, chickens fed on T4 had fetched 540.51 which wasthe highest in the current study, while those fed on T3 had fetched the lowest (89.62). On the other hand, T1and T2 fetched similar and non-significant RoI of 102.08and 102.71, respectively. From this it can be revealed that use of T4 had fetched about 437 higher CBR than the T1 and T2 diet.

The total cost of consumed feed during the grower phase (grower ration) was lower by 123.32ETB/bird than the conventional (commercial) feed. Although the grower phase feed intake was not similar in all the experimental diets, feeding Sasso chickens with T1 was the cheapest because of the lowest cost of grower feed (9.65ETB/bird). The price of the commercial diet used during grower phase was the highest. Price per kg in ETB for the commercial diet was 34.45 and 153.88ETB/bird. Both during grower and finisher phases, the costs of consumed feed across the diets were highly different ($p<0.0001$). Feeding chickens on T4 during finishing phase resulted in the lowest feed costs (68.08ETB/bird), about 24.45% lower cost than the commercial diet. The highest feed cost of 239.74ETB/birdwas reported fromT1 and it was not comparable to the commercial diet. Cumulatively, in terms of all feed consumed during the grower and finisher phases, the commercial feed (CR) was the most expensive (217.634ETB/bird) followed by T1 (135.15ETB/bird) and T3 (127.53ETB/bird). In the current study, T4 was the cheapest (57.53ETB/bird) ration made from locally available crops. The cost of ingested feed gradually decreased starting from positive control diet (T2) to T4, with increased replacement of commercial ration with locally formulated ration (T4).

In general, according to the economic analysis, T4 recorded the highest (6.40) cost benefit ratio (CBR), best (540.51) returns on investment (RoI) and best (83.73%) gross profit margin percentage (GPMP), while T3 recorded the least CBR, RoI and GPMP, meaning 1.89 and 46.06%. Based on the economic analysis, it can be concludedthat commercial ration can be replaced with T4 with no any adverse effects in the study area and areas similar with the current study site.

CONCLUSIONS AND RECOMMENDATIONS

From the findings of the current study it is concluded that from different locally formulated rationsusing locally available feed ingredients, T4 can replace the commonly used commercial ration (T2) for both grower and finisher Sasso chicken without affecting average daily feed intake, total weight gain and feed conversion ratio. Besides, T4 is economically profitable for use in Sasso chicken as grower and finisher diets instead of the T2.

Based on the results of the current study, utilization of T4 by farmers and small and micro enterprises for growing Sasso chicken is recommended. However, fine-tuning of the diet by adding other locally available ingredients, vitamins and additives in its formulation may further improve the importance of the ration. Although the results of the present study were promising, further work is required to promote their formulation (use of different available feed ingredients and various processing methods) due to the fact that formulation and use of locally available ration (non-conventional) is not commonly practiced by chicken producers and not available in the marketeither. Hence the research works and training of the farmers on how to formulate the recommended concentrate mixtures has to be done by concerned organizations such as Wollega University, Ministry of Agriculture and livestock and Non-governmental organizations, so that farmers and small and micro enterprises can get higher income by selling Sasso chickens.

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