Effects of Inclusion Rate of Cassava (Manihot Esculenta Crantz) Leaf and Root Mixture on Feed Intake and Growth Rate of Grower Chicks

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Abstract
The experiment studied the effect of inclusion rate of cassava leaf and root mixture (CLRM) on the performance of grower male white leghorn chicks at Wolaita Sodo ATVET College. The objective of the study was to investigate the effect of inclusion rate of CLRM on performance of grower chicks and to determine the best level of the CLRM. The collected cassava leaves and roots were separately chopped, dried, ground and then mixed in the ratio of 50:50 to get CLRM. Four diets were formulated, T1 contained no CLRM and served as the control, diets T2, T3 and T4 had CLRM at levels of 7.5, 11.25 and 15%, respectively. The grower chicks kept in a deep litter system and the feeding trial lasted for twelve weeks. A total of 180, eight weeks old grower chicks with average initial body weight of 495.68±26.74g (mean±SD) were randomly assigned to 4 experimental groups. Each group was replicated thrice with 15 chicks per replicate. A completely randomized design (CRD) experiment was used. The birds were given known amount of feed and water ad libitum throughout the experimental period. Data were collected on daily dry matter intake (DDMI), total DMI (TDMI), daily body weight gain (DBWG), final BWG (FBWG), DM conversion ratio (DMCR) (g/g), cost-benefit analysis. Data were subjected to analysis of variance for all parameters considered. The chemical analysis showed that, the crude protein (CP) and metabolizable energy (ME) contents of CLRM were 14.5% and 3061.63 kcal/kg DM, respectively. The result of the experiment showed significant difference ($P<0.05$) among treatments in DDMI, TDMI, and CPI. T3 (66.9gm) had higher DDMI than T1 (65.14gm), T2 (65.18gm) and T4 (65.14gm). Similarly, T3 had higher TDMI, than the other dietary experimental feeds. However, there was no significant ($P>0.05$) difference in DBWG, FBWG between treatments. The control diet has lower (5.05±0.29 (±SEM)) DMCR compared to T4 ration (4.70±0.15 (±SEM)). Economic analysis showed that feed cost per bird was lower in the CLRM based diets than the control group. Similarly, the highest net return and marginal rate of return was noted for T3. The results showed that ration formulation using CLRM, like as in T3 of the present study resulted in better biological and economic performance in grower rations. It was concluded that feeding grower chicks with CLRM at 15% of the ration can be used without any adverse effect on the growth and carcass weight of the birds, while 11.25% CLRM in the ration gave the highest economic return and can be considered as best level for growers.
Keywords: Cassava leaf and root mixture, dry matter intake, daily body weight gain

1. Introduction

Ethiopia is believed to have the largest livestock population in Africa. According to CSA, (2012) the population of cattle, sheep, goat, poultry, horses, donkeys, mules, and camels was 52.13, 24.2, 22.6, 44.89, 1.96, 6.4, 0.37, and 0.99 million, respectively. Livestock perform multiple functions in the Ethiopian economy by providing food, input for crop production and soil fertility management, raw material for industry, cash income, fuel, and employment. Rapid income and population growth are driving forces in increasing demand for meat and other animal products in many developing countries (FAO, 2009). Melkamu (2013) illustrated that poultry feed scarcity is the major problem that reduces output. Etalem *et al*. (2012) noted that most of the feed processing plants and poultry farmers in Ethiopia depend on very few feed ingredients that may not be economically feasible in formulating rations for different classes of chicken. In addition to this, production of maize is reduced by rising costs of fertilizer and unfavorable weather conditions.

Consequently, non-ruminants like poultry are greatly affected by this trend. Therefore, poultry producers will indeed have to search beyond cereal grains to keep pace with ever-increasing poultry production (Chauynarong *et al.,* 2009). A possible way of improving poultry production and increasing the supply of poultry products is by reducing the cost of production through the use of locally available feeds (Mammo and Sultan, 2010). One of these kind of feed is cassava, since the plant has peculiar advantage of easy adaptability to extreme stress condition, efficient production of food energy, and year round availability (Fasuyi and Aletor, 2005). Moreover, Tewe (2004) and Chauynarong *et al*. (2009) suggested that cassava is one of the most drought tolerant crops and can be successfully grown on marginal soils by giving reasonable yields where many other crops do not grow well.

Previous studies are mainly centered either on the use of cassava root or leaf in the diets of poultry separately. For instance, Adeyemi *et al*. (2008) indicated that cassava root meal fermented with rumen filtrate served as a potential feed material for monogastric feeding. Similarly, Aderemi *et al*. (2006) studied the utilization of cassava root by layers. Although, cassava leaf and root are cheap sources of nutrients and has better productivity, the extent of practical use in poultry ration is inadequate under Ethiopian condition and limited researches have been conducted on this important crop as a feed ration for grower chicks. Therefore, the aim of this study was to determine the effect of increasing level of mixture of cassava leaf and root on performance of grower chicks with the following objectives.

- To evaluate feed intake, growth rate and feed efficiency in grower ration
- To determine the best inclusion level of cassava leaf and root mixture in grower ration

2. MATERIALS AND METHODS

2.1. Area Description

The experiment was conducted at Wolaita Sodo Agricultural Technical Vocational Education and Training (ATVET) College. The College is found in Wolaita Zone which is located 350 km south west of Addis Ababa with altitude between 700 and 2950 m.a.s.l. and latitude and longitude of 6.49 N and 37.45 E, respectively. Mean monthly temperature (ºC) varies from 11 to 26 (Tsedeke and Endrias, 2011).

2.2. Management of Experimental Birds

A total of 180 male white leghorn (WL) chicks with similar body weight of 495.68±29.95 g (mean ±SD) at the age of seven weeks purchased from Wolaita Sodo Poultry Husbandry Center were selected and distributed randomly into four dietary treatments replicated thrice each with 15 chicks. The already constructed house was separated into 12 pens each measuring 2*2 meter using wooden frames and metal wire mesh. The room was concrete floors and covered with saw dust as a litter material to a depth of 5 cm. The poultry house was cleaned with water and detergent, and then disinfected using formalin (37%) and left for two weeks before the experimental chicks were housed. Standard routine management like draining of remaining water, washing of the watering trough, removal of poultry dropping from the remaining feeds in the feeders on daily basis were practiced as described by Aderemi *et al.* (2006).

2.3. Ingredients and Experimental Rations

Experimental rations are shown in Table 1. The four treatment rations used in this study were formulated on an isocaloric and isonitrogenous basis having 3000 MJ/kg DM of metabolizable energy and 20% crude protein. Ration 1 was made to contain no test feed (control) or 0% cassava leaf and root mixture. Rations 2, 3, and 4 were made to contain 7.5%, 11.25%, and 15% cassava root and leaf mixture for treatments 1, 2, 3 and 4 respectively. Soybean meal, wheat short, methionine, lysine, limestone, vitamin premix and salt were added equally in all treatments rations. Water was provided *ad libitum* on separate troughs for each pen.

Table 1. Proportion of the experimental diet

No	Ingredients (%)	Treatments			
		T1	T2	T3	T4
1	Maize	44.20	36.70	32.63	29.20
2	Cassava leaf and root mixture	0	7.50	11.25	15.00
3	Noug seed cake	34.30	34.30	34.62	34.30
4	Wheat short	10.00	10.00	10.00	10.00
5	Soybean meal	10.00	10.00	10.00	10.00
6	Vitamin premix*	0.10	0.10	0.10	0.10
7	Lysine	0.25	0.25	0.25	0.25
8	Methionine	0.25	0.25	0.25	0.25
9	Salt	0.40	0.40	0.40	0.40
10	Limestone	0.50	0.50	0.50	0.50
Total		100	100	100	100

**premix 1% per kg contains: Vitamins: Vitamin A, 1000000IU; VitaminD3, 200000IU;Vitamin E, 1000mg; Vitamin K, 225mg; vitamin B1, 125mg; vitamin B2, 500mg; vitamin B3, 1375mg; vitamin B6, 125mg; vitamin B12, 1mg; vitamin PP,4000mg; folic acid, 100mg; Choline Chloride, 37500mg; Biotin, 0mg. Trace elements: Iron, 0.45%; Copper,0.05%; Manganese, 0.6%; Cobalt, 0.01%; Zinc,0.7%; Iodium, 0.01%; Selenium, 0.04%; Minerals: Calcium, 29.7%. Other Additives: Anti—oxidant (BHT) 0.05%.*

2.4. Data collection

Dry matter intake was recorded daily, Body weight Feed conversion ratio

Representative samples of ingredients and treatment rations were taken for chemical analysis. The chemical composition of ingredients and experimental rations were determined for dry matter (DM), crude fiber (CF), total ash and ether extract (EE) contents by using the Weende or proximate analysis method of the AOAC

(2000). Nitrogen (N) content of the feed was determined by Kjeldahl procedure and crude protein (CP) was estimated as N x 6.25. These parameters were analyzed at Haramaya University Animal Nutrition Laboratory. Calcium and phosphorous were determined by atomic absorption spectrometer at Soils Laboratory of Haramaya University. The metabolizable energy values (ME) was calculated indirectly from the values of EE, CF and ash adopting the equation proposed by Wiseman (1987) as follows:

ME (Kcal/kg DM) = 3951 + 54.4 EE - 88.7 CF - 40.8 Ash.

3.6. Data Analysis

The data were analyzed as a completely randomized design (CRD) following the procedures suggested by Gomez and Gomez (1984) by employing ANOVA procedure using Statistical Analysis System (SAS Institute, Inc., 2008 version 9.2) computer software program. Least significant difference (LSD) model was used to identify treatments that were significantly different at 5 % of significance level from each other.

$Y_{ij} = \mu + \alpha_i + e_{ij}$

Where: Y_{ij} = response variable

μ = overall mean effect

α_i = treatment effect

e_{ij} = residual error

4. RESULTS AND DISCUSSION

4.1. Chemical Composition of Ingredients and Experimental Rations

The results of the chemical analysis of the different feed ingredients and the formulated experimental diets are presented in Table 3 and Table 4, respectively. The experimental diets were formulated to meet the minimum nutrient requirement of grower chicks.

Table 3. The chemical composition of feedstuffs (on dry matter basis)

Ingredients	Chemical composition of feedstuffs (%)				
	CLRM	Maize	NSC	Wheat short	Soybean
DM (%)	92.95	91.66	93.20	90.60	93.40
CP (%DM)	14.50	8.20	34.20	15.70	38.90
EE (%DM)	9.99	5.14	8.80	5.21	10.10
Ash (%DM)	5.00	1.80	7.30	6.90	8.10
CF (%DM)	10.70	3.60	19.30	7.60	6.90
Ca (%DM)	1.10	0.04	0.70	0.08	0.30
P (% DM)	1.04	0.25	0.30	0.40	0.60
ME (kcal/kg DM)	3061.63	3602.11	2424.00	3287.50	3570.95

DM=dry matter; CP=crude protein; EE= ether extract; CF=crude fiber; Ca= calcium; P= phosphorus; ME= metabolizable energy; CLRM= cassava leaf and root mixture; NSC= Noug seed cake

The CLRM in the present study was made by mixing one part by weight of leaf meal with one part of root meal. The calculated value indicated that the metabolizable energy (ME) of CLRM was lower than maize, wheat short and soybean meal, but higher than noug seed cake (NSC). However, the crude fiber level of CLRM is higher than the other feed ingredients, except the NSC. Since dietary energy is mainly influenced by CF, CLRM has lower energy feeding value than maize, wheat short and soybean meal. This finding is in agreement with Ochetim (1992) who illustrated that CLRM had relatively low dietary energy than maize. Although the ME of CLRM is low, its crude protein content is comparable with wheat short (15.7%). The CP value of the CLRM of the present study is higher than that reported by Eruvbetine *et al.* (2003; 12.41%). Ochetim (1992) obtained 8.7% CP by mixing one part of dried leaf and three parts of dried root meal. The difference might be due to the proportion of cassava leaf and root mixture that the previous author used in the experiment. Cassava leaf meal is rich in crude protein content (Fasuyi, 2005) while the root is rich in energy (Tewe, 2004). Therefore, reduction of the leaf meal in the mixture will clearly reduce the CP content of the mixture. In addition to this, the age of the leaf during harvest may result difference in CP content. Ravindran and Ravindran (1988) found decrease in CP content from 38.1% in very young leaves to 19.7% in mature leaves, and a similar trend for most amino acids. The EE, CF and ash contents of CLRM in the present study were nearly similar to that reported by Eruvbetine *et al.* (2003, 9.9% EE, 11.09% CF, and 4.56% Ash). The mineral content of CLRM especially calcium and phosphorus were better than the other feed ingredients used in the present study.

Table 4. The Chemical compositions of treatment diets (dry matter basis)

Treatment	Nutrient (%)							
	DM	CP	EE	Ash	CF	Ca	P	ME (Kcal/Kg DM)
T1	92.21	20.62	4.43	8.08	7.60	0.89	0.27	3188.21
T2	91.52	20.93	4.90	9.89	7.85	0.94	0.30	3117.75
T3	92.39	21.25	5.16	10.4	8.08	1.22	0.32	3090.68
T4	92.19	21.81	5.09	10.6	9.01	1.33	0.32	2996.23

DM= dry matter; CP= crude protein; EE=ether extract; CF= crude fiber; Ca=calcium; P= phosphorus; ME= metabolizable energy; T1=ration with no CLRM; T2=ration containing 7.5% CLRM; T3= ration containing 11.25% CLRM; T4= ration containing 15% CLRM.

4.2. Dry Matter and Nutrient Intake

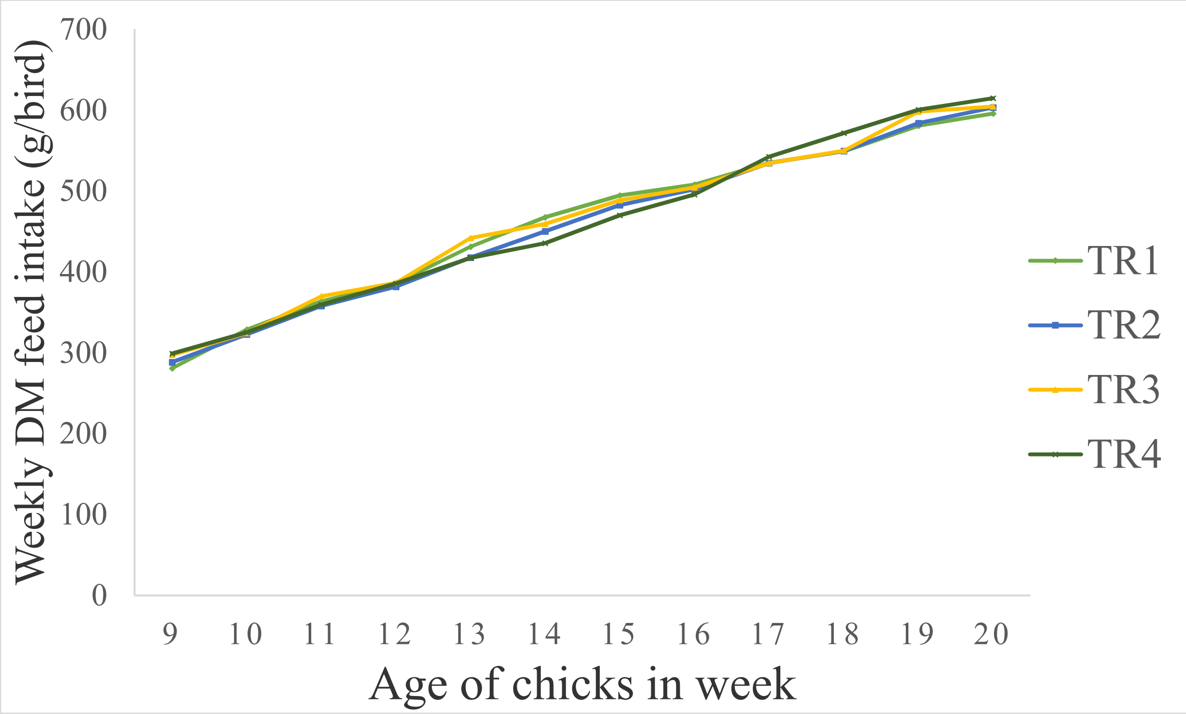
The average daily and total dry matter (DM), metabolizable energy (ME), and crude protein (CP) intakes of the grower chicks fed the different treatment rations for 12 consecutive weeks are presented in Table 5. Dry matter intake of birds steadily increased throughout the experiment weeks in all treatments (Figure 1). There was significant ($P < 0.05$) difference in average daily dry matter intake between the four treatments. The average daily dry matter intake was significantly higher for the groups fed with T3 diet (diet containing 11.25% CLRM) than the rest treatments. The increase in average daily DM intake in T3 may be due to the relatively low energy and high fiber content than T1 and T2. Dry matter intake tended to decrease beyond 11.25% CLRM inclusion indicating that higher level of CLRM inclusion in growers' diet will hamper dry matter intake. This finding is in line with Eruvbetine *et al*. (2003) who reported that inclusion of 10% cassava concentrate gave better feed intake than the control (no cassava), 20% and 30% inclusion level. Borin (2005) illustrated that increasing levels of cassava leaf meal in the diet slightly increased dry matter intake in poultry. Ironkwe and Ukanwoko (2012) also justified that the higher feed intake of birds fed high composite cassava meal could be attributed to the higher fibre content and lower energy levels of the diets. Melkamu (2013) indicated that feed intake improvement in grower chicks might be due to the higher crude fiber or lower metabolizable energy content of dried tomato pomace.

Table 5. Response of grower chicks to different cassava leaf and root mixture

Parameters	Treatments						
	1	2	3	4	SEM	CV%	SL
Mean daily DM intake (g/bird)	65.15^{b}±0.28	65.18^{b} ±1.47	67.00^{a} ±0.21	65.15^{b}±0.36	0.31	1.19	*
Mean total DM intake (g/bird)	5472.3^{b}±23	5475.4^{b}±1.24	5627.9^{a} ±18.0	5472.4^{b} ±30	25.8	1.19	*
Daily CP intake (g/bird/day)	13.55^{b}±0.13	13.64^{b} ±0.31	14.07^{a} ±0.59	14.33^{a}±0.05	0.10	1.24	*
Daily ME intake (Kcal/bird/day)	212.85±1.95	211.25±4.78	212.38±0.88	209.55±.79	0.76	1.25	NS
Mean initial body weight (g/bird)	482.69±35.8	501.60±13.13	498.56±45.87	499.87±5.26	7.72	6.04	NS
Mean daily weight gain (g/bird)	12.97±1.19	13.10±1.05	14.01±0.17	13.89±0.77	0.32	8.69	NS
Total body weight gain (g/bird)	1089.04±1.0	1100.40±1.54	1177.6±2.45	1166.4±6.4	2.69	8.69	NS
Final body weight (g/bird)	1572.7±69.4	1602.0±99.9	1676.4±33.9	1666.3±21.5	27.3	5.97	NS
FCR (feed: gain)	5.05±0.5	5.04±0.73	4.78±0.09	4.70±0.25	0.08	9.38	NS
Cost per kilogram feed (birr)	6.82	6.66	6.59	6.51			
Feed cost/kg of gain	34.44±3.28	33.57±0.82	31.5±0.11	30.60±1.68	0.88	9.44	NS

*Feed cost/kg of gain=FCR × kg feed cost; cost/total feed consumed=FCR × kg feed cost × total weight gained; FCR= feed conversion ratio; [ab]Means within the same row bearing different superscripts are significantly different; * = P<0.05; NS = Non-significant; SL= significance level; SEM= standard error of mean; CV= coefficient of variation; T1=ration with no CLRM; T2=ration containing 7.5% CLRM; T3= ration containing 11.25% CLRM; T4= ration containing 15% CLRM.*

Moreover, Oyebimpe and Biobaku (2006) indicated that the lower feed intake on the control maize based diet without cassava could be due to its low fiber content than the other diet contained cassava meal.



T1=ration with no CLRM; T2=ration containing 7.5% CLRM; T3= ration containing 11.25% CLRM; T4= ration containing 15% CLRM.

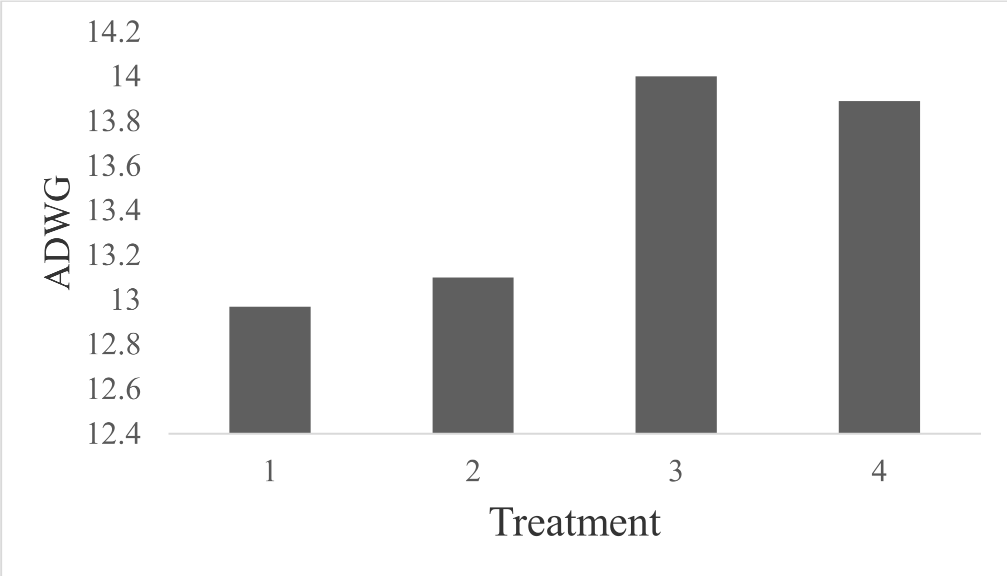
Figure 1. The dry matter feed intake of chicks during the experimental period

The mean daily crude protein intake during the grower phase (Table 5) was significantly ($P<0.05$) different between group of birds that received the different experimental rations. Birds kept on T3 and T4 diet consumed higher amount of crude protein than others. This might be due to the higher crude protein content of the ration, which might be attributed to the higher CLRM content of T4 ration. The better efficiency of CP utilization might be attributed to the amino acid profile of the cassava leaf. Similarly, (Borin, 2005) noted that cassava leaf was reported to have higher concentrations of most essential amino acids compared with soybean meal. The mean daily ME intakes during the entire experimental period did not differ ($P>0.05$) significantly among the four dietary treatment rations. This is attributed to the similar energy densities of the ration fed to the birds. It is concluded that inclusion of CLRM did not affect the ME energy intake. The absence of significant differences in energy intake between treatments might be due to similarities in energy contents of the ration.

4.3. Body Weight Gain

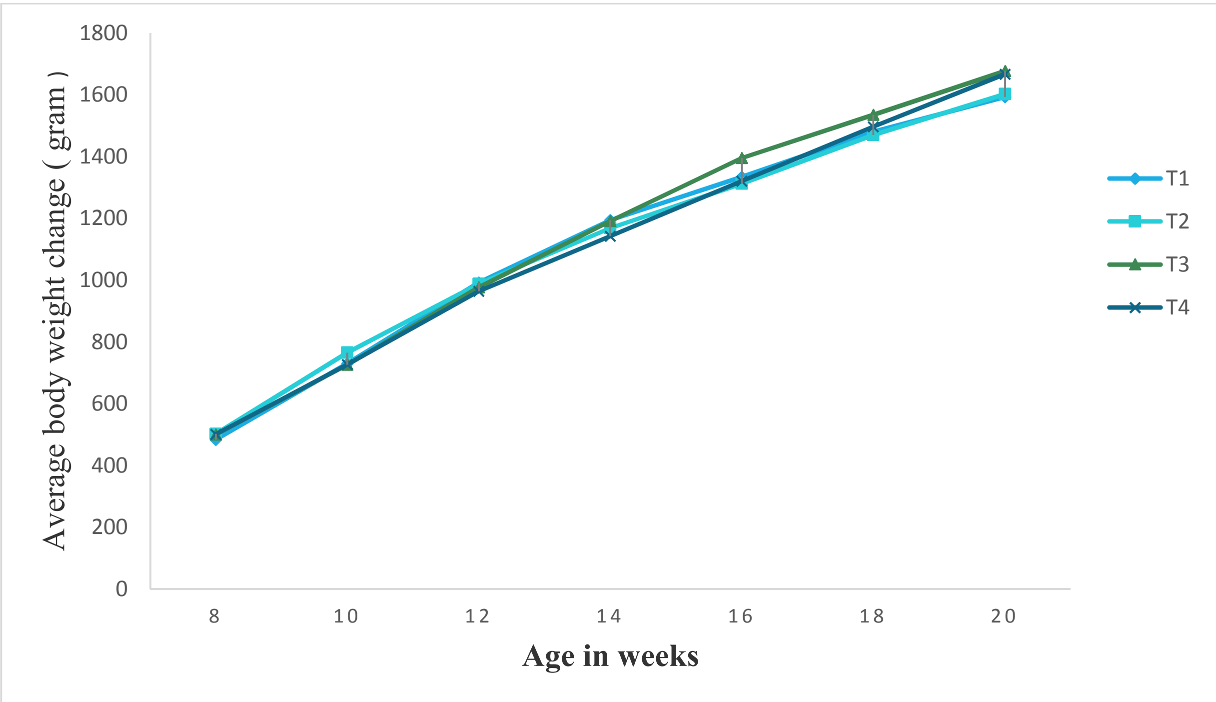
As shown in Table 5, there was no significant ($P> 0.05$) difference in average daily, final and total body weight gain of grower chicks fed ration containing increasing levels of CLRM. However, birds fed T3 ration had numerically the higher average daily gain than the other treatments. The trend in body weight gain (Figure 2) showed that as levels of CLRM increased, body weight gain also increased up to T3 (11.25% CLRM). The high fiber content in CLRM might have an influence on feed intake and body weight gain of growers at high level of inclusion. The similarity in the final body weight (Figure 3 and Table 5) between birds fed the control and CLRM containing diets is an indication of good quality nutrient content and utilization of CLRM by grower chicks up to the level used as in the present study. This finding is in accordance with Okorie *et al*. (2011) who found no significant difference in the average final body weight gain between the treatments when the diet contained cassava leaf meal at 0, 5, 10 and 15%.

The average final body weight of the present study was also increased up to T3 (11.25% CLRM). This finding is in agreement with Onyimonyi and Ugwu (2007) who reported that final body weight of experimental bird increased with increasing level of whole cassava meal up to 10% in the ration of broilers. This finding is also similar with Chhum (2004) who argued that using 10% cassava leaves meal for replacing maize and fish meal has improved the performance of chicken. The trend of total body weight gain of the present study was similar to that of average daily and final body weight gain. It is also in tandem with the work of Eruvbetine *et al*. (2003) that got a progressive decline in the average body weight gain of birds with increasing concentration of cassava root meal when the proportion of cassava leaf and root mixture was beyond 20% and 30%. The decline in body weight was due to the presence of the high fibre of cassava leaves (13.50%).



T1=ration with no CLRM; T2=ration containing 7.5% CLRM; T3= ration containing 11.25% CLRM; T4= ration containing 15% CLRM; ADWG= average daily weight gain.

Figure 2. The average daily weight gain of the different treatments used in the experiment

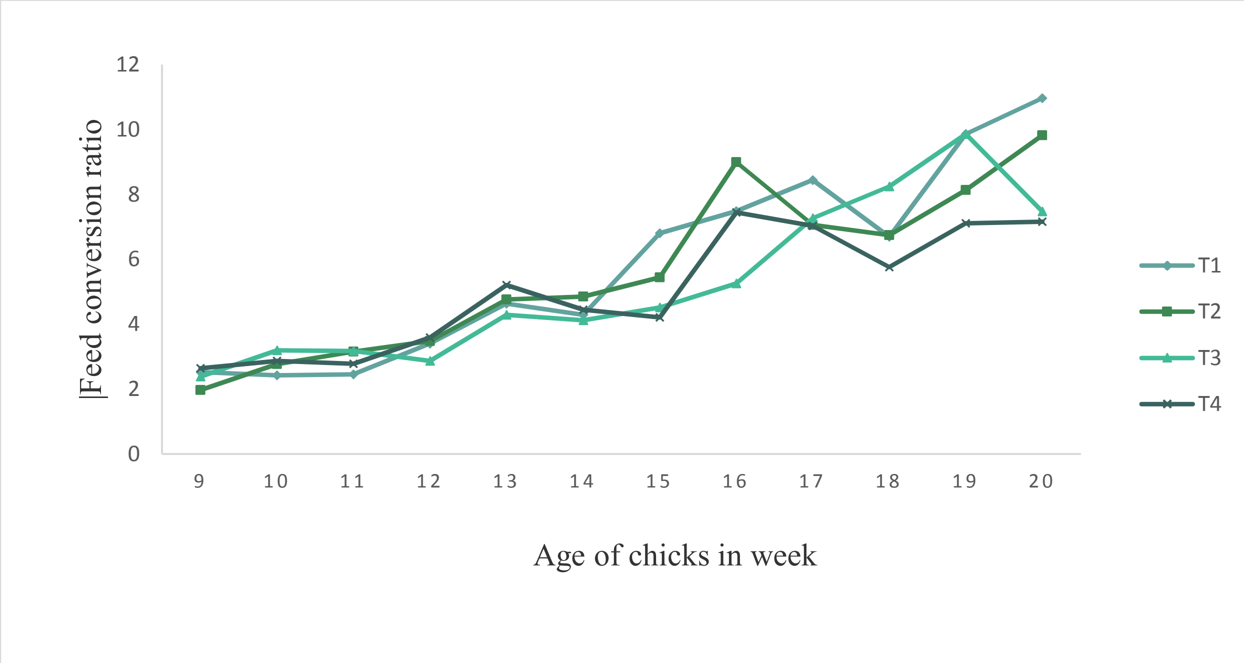


T1=ration with no CLRM; T2=ration containing 7.5% CLRM; T3= ration containing 11.25% CLRM; T4= ration containing 15% CLRM.

Figure 3. The growth rate of chicks during the experimental period

4.4. Dry Matter Conversion Ratio

Statistically, there was no marked variation in feed conversion ratio among the birds in the different dietary treatments. The mean feed conversion ratio was better with the inclusion of CRLM diets. The best DM conversion ratio was obtained in T4 (15% CLRM) group and the lowest in T1 (control) group. Thus, more feed was required for T1 (control) to attain a unit weight gain compared with T3 and T4. Therefore, based on the present study, T3 and T4 were nearly similar in terms of DM conversion ratio and required low feed for a unit of body weight gain than the other treatments. This is in agreement with the result Sultana *et al*. (2012) that revealed improved FCR with the inclusion of cassava tuber meal diets. The trends in the weekly feed conversion ratio in the different experimental groups are presented in Figure 4.



T1=ration with no CLRM; T2=ration containing 7.5% CLRM; T3= ration containing 11.25% CLRM; T4= ration containing 15% CLRM.

Figure 4. Feed conversion ratios in the different experimental groups

5. SUMMARY, CONCLUSIONS AND RECOMENDATIONS

Poultry is one of the most widely reared livestock that assure food security and socio economic development. Even if Ethiopia has a huge potential of poultry production, its productivity remained low due to different factors. Among these factors, shortage of feed ingredients play a significant role since feed is the highest production cost in poultry production. Therefore, unconventional feed ingredients like cassava, which are reasonably cheaper and available, may be very potential ones to solve the existing problem. The use of cassava would improve the poultry industry since its root is rich in energy where as its leaf is rich in protein and its production per hectare is high. Therefore, this study was conducted to evaluate the effect of inclusion rate of cassava leaf and root meal mixture (CLRM) on grower performance to determine the best level of cassava leaf and root. The experiment lasted for 12 consecutive weeks, during which mean dry matter intake, growth rate, feed conversion ratio (feed consumed/weight gain) were undertaken. Statistical analysis showed significant difference ($P < 0.05$) among means of daily dry matter intake of the chicks. T3 had better feed dry matter intake (67.00g/bird/day ±0.21) than the other treatments. Daily body weight gain was not significantly different ($P>0.05$) among treatments means. Grower chicks in T3 (14.01±0.17), showed higher gain than those on diets containing T1 (12.97±1.19), T2 (13.10±1.05) and T4 (13.89±0.77). The dry matter conversion ratio (dry matter intake/gain) was non-significant with T3 (4.78±0.09) and T4 (4.70±0.25) having numerically better FCR.

- Incorporation of CLRM in the diets of grower chicken at grower phase plays considerable role in reducing feed cost. Moreover, in order to strengthen the results of the present study subsequent work should be addressed on other classes of chicken.
- CLRM as a feed ingredient for grower chicks at 11.25% inclusion level reduces the production cost and maximizes profit without deleterious effect on the overall performance of grower chicks. Therefore, the utilization of this feed stuff by poultry producers should be encouraged to be profitable by reducing production cost.
- Further research on mixing of the cassava leaf and root with same or different proportions should be tested on actual broiler chickens and pullet growers.

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