Effect of Tagasaste (*Chymancytisus palmensis)* Leaf Meal Supplementation on Feed Intake, Growth Performance and Carcass Characteristics of Rhode Island Red Chicks

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Abstract

Feed intake, growth performance and carcass characteristics of mixed sex Rode Island Red chicks supplemented with varying levels of tagasaste leaf meal were evaluated in this study. One hundred sixty day-old chicks with an average initial weight of 65.5 ± 8.9 g were allocated to 16 pens, with 10 chicks each in a completely randomized design. Four isonitrogenous and isocaloric diets were formulated to contain tagasaste leaf meal at the rate of 0% (T_1), 5% (T_2), 10% (T_3) and 15% (T_4) of the total diet dry matter (DM). The amounts of feed offered and refused were measured daily to determine feed intake. Body weights were taken on weekly basis. At the beginning of the trial, 8 chicks were selected (excluding the 160 chicks) and slaughtered for chemical analyses to determine nutrient retention. At the end of the trial, a male and a female from each replicate were slaughtered for chemical analysis and carcass trait measurement. The average daily DM intake for T4 (48.9 g) was higher ($P<0.05$) than that of T1 (45.9 g). The highest ($P<0.05$) ash, calcium and crude fiber intake was observed in chicks fed T4 diets. The crude protein intake was higher ($P<0.05$) in chicks supplemented with tagasaste leaf meal compared to the non-supplemented one. The metabolizable energy intake was similar ($P>0.05$) among treatment groups. The protein, energy and calcium retention decreased ($P<0.05$) as the level of tagasaste leaf meal increased in the diet. The average daily gain was highest ($P<0.05$) for chicks subjected to T1 while there were no significant difference ($P>0.05$) among the other treatments. The slaughter, drumstick, thigh, back, breast and carcass weights were highest ($P<0.05$) for T1 than the other treatments. The dressing percentage was similar ($P>0.05$) among treatments. Tagasaste leaf meal could be considered as a good source of both protein and energy for smallholder farmers where such supplements are not available. However, further study is recommended aimed at increasing the efficiency of nutrient utilization.

Keywords: *Growth performance, Carcass characteristics, Tagasaste leaf meal, RIR chicks.*

Introduction

The dietary nutrient intake from egg and poultry meat is low in developing countries. According to FAO (2011) the daily intake of animal protein in developing countries was 15 g which is very low compared with 60 g for developed countries. The per capita consumption of meat in Ethiopia was as low as 11-12 kg (Zewdu and Peacock, 2003) which is even lower currently. This indicates that there is considerable potential for increasing the consumption of meat. Chicken play a significant role in human nutrition and as income source and are one of the most suitable resources to improve the livelihood of the poor. However, productivity of indigenous chicken in Ethiopia is low (Fassil et al., 2010) which may be attributed to the poor feeding and management practices coupled with poor genetic potential (Aberra et al., 2011a). In Ethiopia, there are about 56.87 million chicken populations of which 95.86% are indigenous breeds (CSA, 2014/15), which are managed under scavenging systems where conventional concentrate supplement is very little or non-existent.

There are shortages of protein supplements required for the preparation of balanced ration. The feedstuffs used for poultry are often of a quality that could be fed directly to humans which makes it difficult for poultry production especially under smallholder production system. Conventional protein supplements are rarely available under such systems. Where available the price of the conventional protein sources has steadily increased in recent times (Adugna, 2007). As a result their use as poultry feed is limited (Messeret et al., 2011).

Therefore, feeding an alternative protein supplement which is not consumed by human being could reduce competition and is expected to be sustainable. One of such sources of cheap protein sources are the leaf meal of some tropical legumes and browse plants (Iheukwumere et al., 2008; Aberra et al., 2009) which serves not only as a protein source but also supply vitamins, minerals and caretenoids which are essential for chickens (Aberra et al., 2011b).

Tagasaste (*Chamaencytisuse palmensis*) is highly productive and extensively used as wilted, dried and green fodder (Getnet et al., 2012). It is accepted as a cultivated commercial leguminous browse species as a supplement in ruminant feeding in Australia (Lefroye et al., 1992). The latest study by Feleke (2016) showed that tagasaste could grow at an altitude ranging from 750 masl to 1400 masl in Ethiopia. The leaf of tagasaste is highly palatable and it has been fed for sheep, cattle and goats (Getnet et al., 2012). The level of hydrolysable tannin, condensed tannin and alkaloids in tagasaste were below the level that causes toxicity in ruminants (Getnet et al., 2008). Tagasaste leaves contain 16 to 22% crude protein, highly productive (11 t DM/ha) and stays green during dry season (Getnet, 1998). So far there are no reports in literature which evaluates the feeding value of tagasaste leaf meal as feed in poultry diet. Therefore, the objective of this study was to evaluate the effect of feeding different levels of tagasate leaf meal on nutrient utilization, growth rate and carcass characteristics of growing RIR chicks.

Materials and Methods

Experimental diets

The green fresh leaves of tagasaste (*Chymaencytisus palmensis)* were harvested after 6th month of re-growth during dry season from Holleta Agricultural Research Centre (09^{o}N; 38^{o}E). The leaves were manually collected and spread on floor for sun drying for 3 to 4 days until it becomes crispy while still retaining the greenish color. The dried leaves were ground by hand mortar to produce the leaf meal. Maize, soybean, wheat bran, premixes and noug seed (*Guizotia abyssinica*) cake were purchased from local market. Soybean was roasted until it assumes a brown colour to deactivate trypsin inhibitor. The coarse feed ingredients were milled and mixed.

The proportion and calculated chemical composition of the experimental diet is presented in Table 1. Four isocaloric and iso-nitrogenous diets were formulated to contain tagasaste leaf meal at 0, 5, 10 and 15% of total diet DM. The experimental diets were supplemented with vitamin mixtures (premixes 0.5%) along with L-lysine (0.05%) and DL-methionine (0.05%) to meet the recommended requirements of chicken (NRC, 1994).

Table 1. Proportion of ingredients and calculated chemical compositions (%) of the experimental feeds

Ingredients	Treatments			
	T1	T2	T3	T4
Maize	36	39	42	42
Soybean meal	8	9	11	12
Leaf meal	0	5	10	15
Wheat bran	36.9	29.9	19.9	16.4
Noug cake	16	14	14	11.5
[1]Lime stone	2	2	2	2
Salt	0.5	0.5	0.5	0.5
[2]Rear Premixes	0.5	0.5	0.5	0.5
Lysine	0.05	0.05	0.05	0.05
Methionine	0.05	0.05	0.05	0.05
Total	100	100	100	100
Chemical composition:				
Dry matter (%)	93.1	92.8	93.2	93.2
Crude protein (% DM)	16.4	17.3	16.9	16.9
Crude fiber (% DM)	9.3	8.4	7.3	9.4
NFE (% DM)	9.2	6.7	7.0	6.9
Ether extract (% DM)	48.5	52.2	53.7	36.7
ME (MJ/kg DM)	13.4	13.6	13.8	10.6
Calcium (% DM)	1.24	1.8	1.76	2.13
Ash (%DM)	10.5	7.6	9.7	23.5

DM, Dry matter; NFE, nitrogen free Extract; ME metabolizable energy, NFE=DM-(CP + CF+ EE + Ash): Metabolizable energy (Kcal/kg DM) =3951 + 54.40 fat – 88.70 CF - 40.80 ash (Wiseman, 1987), then the value was converted into MJ.

Experimental chicks and design

One hundred and sixty day-old unsexed Rhode Island Red (RIR) chicks with an average body weight of 65.5 ± 8.9 g (mean ± SD) were used in the experiment. They were initially brooded together and fed a standard starter diet for two weeks. After 14 days of adaptation, the chicks were divided into 4 treatment groups of 40 chicks each and randomly assigned to the 4 treatments in a completely randomized design (CRD). Each treatment group was further sub-divided into 4 replicates of 10 chicks per replicates and kept in a 1.25 m × 1.25 m wire mesh partitioned pens. The concrete floor was covered with wood shavings of 4 to 5 cm depth. Before the commencement of the experiment, the pens were properly cleaned and disinfected with 37% formalin solution. Feed was offered ad libitum using horizontal feeders. Chicks had free access to water at all times. The chicks were vaccinated against Newcastle disease at 7^{th} and 21^{st} day through the ocular route. The feeding trial lasted for 84 days.

Measurements of performance parameters

The chicks were weighed at weekly intervals to determine their average daily gain. Feed intake was calculated as the difference between the amount of feed offered and the amount refused. Dry matter conversion was calculated as the ratio between feed consumed and body weight gain during the trial (g feed consumed/g weight gain). Body weight gain was calculated as the difference between the final and initial weight during the trial. Nutrient conversion efficiency ratio was determined from the amount of body weight gain of the chicks per unit of nutrient consumed.

For carcass trait evaluation 32 chicks, a male and a female from each replicate group that represent the mean body weight were randomly selected at the end of the feeding trial. The chicks to be slaughtered were kept off feed and drinking water over night to ensure empty crop. Chicks were killed by cervical dislocation, exsanguinated and de-feathered. Data on slaughter weight, weight of blood, shank, neck, head, breast meat, drumstick, thigh, digestive tract, and wings, gastrointestinal and reproductive organs, the visceral organs including heart, kidney, spleen, lung, and liver weight) were recorded. Gizzard, liver, skin and neck under Ethiopian context are included in total edible offals (TEO). The TEO was calculated by adding gizzard, liver, neck and skin to the commercial carcass (back, drumsticks, thighs, wings and breast). Dressing percentage was calculated from carcass weight as a percentage of slaughter weight.

Determination of nutrient retention

At the beginning of the experiment, 8 chicks were randomly selected and killed by dislocation of neck after starving for 12 hours. In the same manner at the end of the experiment two chicks (a male and a female) from each replicate were selected at random, starved for 12 hours, weighed, leg banded and killed by cervical dislocation. For the determination of nutrient retention, the slaughtered chicks were placed in the plastic bags and kept in a deep freezer (-20^0C). The frozen whole body was then cut into small sections by using machetes and minced thoroughly using mincer (Crypto peerless, IC 32 M) to get a homogenous sample. After uniformly mixing the minced material, samples were taken and dried at 105^{o}C for 12 hours for DM determination. In the same manner, for chemical analysis, samples were taken and dried at 60^{o}C for 100 hours and finely ground to pass through 1mm mesh screen and taken to Debrezeit National Veterinary Laboratory for proximate analysis. After determination of each nutrient in the sample, the amount of each nutrient deposited in the whole body was determined by multiplying the obtained values with their respective slaughter weight. The amount of each nutrient retained during the experimental period was calculated from the difference between the initial and final nutrient composition of the chick. The percent of nutrient retained in the whole body was calculated as the mount of nutrient in the whole body/amount of nutrient consumed × 100.

Chemical analysis of the feeds and minced carcass

The feed offered and refusals were weighed and sampled daily and bulked over the 84 days for each treatment. Sub samples were dried in an oven at 60^{o}C for 48 hours and ground to pass through 1mm mesh screen and were taken to Debrezeit National Veterinary Laboratory for determination of DM, CP, ether extract (EE), crude fiber (CF) and ash following the methods of AOAC (1990). Nitrogen was analyzed using Leco nitrogen analyzer (Leco FP-528, Leco Corporation, USA) according to AOAC (1990). Then CP was obtained by multiplying the N content by 6.25. Calcium was determined by atomic absorption spectrophotometer. Phosphorus was analyzed by continuous flow auto-analyzer (Chemlab, 1978). Metabolizable energy (ME) of the experimental diets was calculated by indirect method according to Wiseman (1987). The ME content of minced carcass was predicted using the energy values of 23.68 MJ/kg for protein and 39.12 MJ/kg for fat as described by Okumara and Mori (1979).

Data analysis

The effect of tagasaste leaf meal inclusion on feed intake, body weight gain, feed conversion ratio and carcass characteristics were analyzed using a single factor ANOVA of SAS software version 9 (SAS, 2004) using the following model: $Yij = \mu + Ti + Eij$, where, Yij = is the response variable, μ = over all mean, Ti = the treatment effect, Eij = random error. Duncan multiple range tests were used to compare the treatment means.

Results

Chemical composition of the feeds

Chemical compositions of the feed ingredients are presented in Table 2. Tagasaste leaf meal had similar CP content with that of noug seed (*Guizotia abyssinica*) cake but lower than that of soybean. The high CP content of tagasaste leaf indicates its potential as a source of protein supplement. The calcium content was also higher in tagasaste leaf meal than in the other feeds. Similarly, the CF content was higher in tagasaste leaf. There was a slight decrease in ME content with increasing levels of tagasaste leaf meal.

Table 2. Chemical composition (% DM, unless specified) of feed ingredients tagasaste leaf meal used for ration formulation

Nutrient	Ingredients and chemical Composition				
	Leaf meal	Maize	Wheat bran	Soybean	Noug cake
Dry matter (%)	94	94	93	95	96
Crude protein	24	8.1	18	30	25
Crude fiber	20	0.85	8.6	16.2	15
Ether extract	4.3	6.4	4.4	12.1	7.8
[1] Nitrogen free extract	46	59	56	29	28
[2] ME (MJ/kg DM)	9.1	14.6	13.7	12.1	9.6
Calcium	2.2	0.8	0.9	1.7	0.8
Ash	5.3	18	4	6.9	18

ME, meteabolizable energy; Kcal, kilocalories; [1]: NFE= DM- (CP+ CF+ EE + Ash), [2]:Metabolizable energy (Kcal/kg DM) = 3951 + 54.40 crude fat – 88.70 CF - 40.80 ash (Wiseman, 1987), then value converted to MJ.

Feed intake and weight gain

The data on nutrient intake is shown in Table 3. The intake of DM, CP and Ca in T4 were higher (P<0.05) compared with T1. Those chicks fed with T2, T3 and T4 diets had higher (P<0.05) CP intake than those fed on T1. There were no significant differences (P>0.05) in ME intake among treatments. The average daily gain was highest (P<0.05) for chicks subjected to T1 while there were no significant difference (P>0.05) among the other treatments.

Table 3. Daily feed intake and weight gain of chicks (g/chick/day, unless specified) fed different levels of tagasaste leaf meal

Intake	Treatments				
	T1	T2	T3	T4	SEM
DM	45.9^{c}	47.9^{ab}	46.2^{bc}	48.6^{a}	5.6
CF	4.3^{b}	4.04^{b}	3.4^{c}	4.6^{a}	0.26
CP	7.6^{b}	8.3^{a}	7.8^{ab}	8.2^{a}	0.49
EE	4.2^{a}	3.2^{b}	3.3^{b}	3.4^{b}	0.24
NFE	22.3^{b}	24.9^{a}	24.9^{a}	17.8^{c}	1.41
ME (MJ/day)	6.1^{a}	6.4^{a}	6.2^{a}	6.5^{a}	0.39
Ca	0.57^{c}	0.86^{b}	0.81^{b}	1.03^{a}	0.05
Ash	4.8^{b}	3.6^{c}	4.5^{b}	11.4^{a}	0.44
Average daily gain	6.2^{a}	5.5^{b}	5.3^{b}	4.6^{b}	3.3

^{abc} Means in the same row with different subscript letters are significantly different (P<0.05). DM= Dry matter; CF=crude fiber; CP= crude protein; EE= ether extract; NFE= nitrogen free extract; ME= metabolizable energy; MJ= mega joule; Ca = calcium; SEM= standard error of the mean; T_1 = 0% leaf meal; T_2 =5% leaf meal; T_3 =10% leaf meal; T_4=15% leaf meal.

Feed conversion and nutrient efficiency ratio

The DM conversion ratio appeared to increase with increasing levels of tagasaste leaf meal in the diet (Table 4). The highest mean total DM conversion ratio of 7.8 was obtained for T4 diet, but it was not significantly (P<0.05) different from that of T2 and T3 diets. In general, chicks required more feed per unit of weight gain in T4 diets compared with the control diet (T1).

The protein efficiency ratio was highest (P<0.05) for the chicks fed on T1 diet. Chicks fed on T2, T3 and T4 diets required higher (P<0.05) CP per unit of body weight gain than the chicks fed on T1 diet. The protein efficiency ratio was lower in the tagasate supplemented group indicating that CP is less efficiently utilized at higher levels of the leaf meal inclusion. Similarly, calcium efficiency ratio declined (P<0.05) with increasing levels of leaf meal inclusion. Consequently, the amount of Ca required per unit of body weight gain increased as the dietary level of the leaf meal increased.

Table 4. Dry matter conversion ratio (g feed/g weight gain) and nutrient efficiency ratio (g gain/g feed) of chicks fed different dietary levels of tagasaste leaf meal

Efficiency	Treatments				
	T1	T2	T3	T4	SEM
DM	0.045^{a}	0.035^{b}	0.036^{b}	0.032^{b}	0.007
CP	0.144^{a}	0.110^{b}	0.119^{b}	0.101^{b}	0.022
EE	0126^{a}	0.094^{b}	0.088^{b}	0.099^{b}	0.023
NFE	0.006^{c}	0.009^{cb}	0.011^{ab}	0.014^{a}	0.003
ME (MJ/day)	0.007^{a}	0.005^{b}	0.005^{b}	0.005^{b}	0.001
Ca	0.085^{a}	0.062^{a}	0.038^{b}	0.023^{c}	0.019
Ash	0.066^{a}	0.065^{a}	0.039^{b}	0.012^{c}	0.012
DM conversion ratio	5.6^{b}	6.5^{ab}	6.4^{ab}	7.8^{a}	

[abc]: Means in the same row with different subscript letters are significantly different (P<0.05). DM= dry matter; CP= crude protein; EE = ether extract; NFE= nitrogen free extract; ME= metabolizable energy, MJ= Mega joule; Ca = calcium; SEM = standard error of the mean; T_1 = 0% leaf meal; T_2 =5% leaf meal; T_3 =10% leaf meal; T_4=15% leaf meal.

Nutrient retention of chicks fed on different dietary levels of tagasaste leaf meal

The CP retention tended to decrease with increasing dietary level of tagasaste leaf meal (Table 5). The chicks fed on T1, T2 and T3 diets retained similar (P>0.05) CP, while those chicks fed on T4 diets had lower (P<0.05) CP retention compared with that of T1.

Ether extract and ME retained in the carcass was found to be the highest (P<0.05) for T1 compared with other treatments. There was no significant (P>0.05) difference in CP, EE, NFE and ME retention among the chicks fed on different levels of the leaf meal. Ca and ash retention also tended to decrease at higher level of tagasaste leaf meal in the diets. Chicks fed on T1 diet had the highest ash deposition. When compared to the chicks fed on T1 and T2 diets, chicks fed on T3 and T4 diets had significantly (P<0.05) lower body Ca and ash deposits.

Table 5. Daily nutrient retention (g/chick/day, unless specified) of chicks fed different levels of tagasaste leaf meal

Retention	Treatments				
	T1	T2	T3	T4	SEM
DM	2.08^{a}	1.70^{b}	1.67^{b}	1.56^{b}	0.33
CP	1.09^{a}	0.92^{ab}	0.92^{ab}	0.82^{b}	0.18
EE	0.53^{a}	0.30^{b}	0.28^{b}	0.33^{b}	0.08
NFE	0.14^{b}	0.23^{a}	0.28^{a}	0.25^{a}	0.08
ME (MJ/day)	0.04^{a}	0.03^{b}	0.03^{b}	0.03^{b}	0.01
Ca	0.04^{a}	0.04^{a}	0.03^{c}	0.02^{c}	0.01
Ash	0.32^{a}	0.23^{b}	0.17^{c}	0.14^{c}	0.05

^{abc}: Means in the same row with different subscript are significantly different (P<0.05).
DM = dry matter; CP = crude protein; EE= ether extract; NFE= nitrogen free extract; ME = metabolizable energy; SEM = standard error of the mean; T_1 = 0% leaf meal; T_2 =5% leaf meal; T_3 =10% leaf meal; T_4=15% leaf meal.

Carcass characteristics of chicks fed on different levels of tagasaste leaf meal

Chicks fed on T1 diet had the highest (P<0.05) slaughter, drumstick, thigh, back and breast weights (Table 6). However, the weights of these carcasses among the chicks fed on different levels of tagasaste leaf meal were comparable (P>0.05). Chicks fed on T1 diet had the highest (P<0.05) total NEO and carcass weights compared with those chicks fed on other treatment diets. The inclusion of the leaf meal at different level had no significant (P>0.05) effect on the dressing percentage.

Discussion

Chemical composition of the experimental feeds and ingredients

The CP content of tagasaste leaf meal recorded in this study (24.1 %) was higher than the value (18.5%) reported by Ventura et al. (2000) and Getnet (1998) but similar to the value (24%) reported by Debele et al. (2005). The CP value of the leaf meal was superior to that of wheat bran (18%), and comparable with that of noug cake (25%). The high CP content in tagasaste leaf makes it ideal for supplementation in animal feeds (Getnet et al. 2012). The CP content of the diets (16.4 to 17.3%) could fulfill the minimum CP requirements (16%) suggested for chicken by NRC (1994).

The calculated ME value of the leaf meal was comparable with that of the noug cake (2300 kcal/kg DM) which indicates that tagasaste leaf meal could be considered as a good source of both protein and energy. The ME content of T1, T2 and T3 diets were more than the minimum recommended requirements (2800 kcal/kg DM) for growing chicks by NRC (1994). The CF content in all treatments was above the recommended maximum limit (5-6%) for broilers (Mirnawati et al., 2011). According to the same author such high CF content could reduce the digestibility of protein and energy in addition to reduction in feed intake. However, the crude fiber content of T1 and T4 diets in the current experiment is similar.

Table 6. Carcass characteristics of chicks feed on different level of tagasaste leaf meal

Parameters	T1	T2	T3	T4	SEM
Slaughter weight (g)	563.4^{a}	448.3^{b}	446.6^{b}	461.9^{b}	28.7
Carcass parts					
Drum sticks (g)	47.8^{a}	35.3^{b}	37.7^{b}	37.5^{b}	3.06
Thighs (g)	42.3^{a}	30.8^{b}	32.3^{b}	33.0^{b}	2.65
Wings (g)	39.2^{a}	31.5^{b}	33.2^{ab}	31.5^{b}	2.29
Back (g)	42.3^{a}	31.7^{b}	32.4^{b}	31.5^{b}	2.63
Breast (g)	74.0^{a}	56.0^{b}	56.1^{b}	59.0^{b}	4.98
Total carcass weight	245.3^{a}	185.1^{b}	191.6^{b}	192.4^{b}	15.2
Edible offal					
Liver (g)	14.9	12.2	12.0	12.1	1.00
Gizzard (g)	22.3	19.5	20.2	20.3	1.28
Skin (g)	36.4^{a}	27.5^{b}	29.2^{b}	29.1^{b}	2.26
Neck (g)	20.7^{a}	16.2^{b}	17.2^{ab}	17.6^{ab}	1.21
Total	94.1^{a}	75.4^{b}	78.6^{ab}	79.2^{ab}	5.12
Total edible (g)*	339.6^{a}	260.8^{b}	270.4^{b}	271.8^{b}	20.1
Dressing percentage **	59.9	58.0	60.5	58.8	1.05
Total non-edible offal NEO) ***	183.0^{a}	145.8^{b}	143.3^{b}	144.5^{b}	8.47

^{abc} Means with different superscripts across the row are significantly (P<0.05) different; SEM standard mean error; T_1, 0% leaf meal; T_2, 5% leaf meal; T_3, 10% leaf meal; T_4, 15% leaf meal supplementations.

* Total edible = carcass weight + edible offal; ** Dressing % = total edible/ slaughter weight x 100; *** Total non-edible offal = blood + feather + head + shank and claw + esophagus + crop + proventriculus + spleen + pancreas + kidney + heart + lung + small intestine + large intestine

Effect of feeding tagasaste leaf meal on feed intake and growth of RIR chicks

The high intake of CP, NFE and ash in the supplemented chicks and the high DM intake in T4 diets compared with T1 is consistent with previous report of higher DM and CP intake (Aberra et al., 2011) and DM intake (Egbewande et al., 2011) in chicks supplemented with *Moringa stenopetala* and *Tapinanthus bangwensis* (neem tree) leaf meal, respectively. No significant effect on feed intake was observed in chicks supplemented with different levels of chaya leaf meal (Donkoh et al., 1999). Moreover, Ng'ambi et al. (2009) observed no effect on feed intake, digestibility and live weight in broilers fed *Acacia Karroo* leaf meal despite its high tannin content. On the contrary, reduction in nutrient intake was observed in broilers, pullets and layers fed different levels of neem tree *(Azadirachta indica*) (Onyimonyi et al., 2009), sweet potato (Berhan and Wude , 2010), *Centrosema pubescens* (Nworgu and Fasogbon, 2007) and *Gliricidia sepium* (Odunsi et al., 2002), respectively, compared to the control diet.

The reduced weight gain for chicks fed on T2, T3 and T4 diets despite higher DM intake suggest poor utilization of nutrients. Similar to the current experiment, reduction in growth without affecting intake was also reported in chicks fed on other leaf meals. Onyimonyi et al. (2009), Ekenyem and Madubuike (2006) reported reduction in weight gain in chicks fed on neem tree, *Ipomoea asarifolia* and *S. grandiflora* leaf meal, respectively, compared with the control. Moreover, Odunsi et al. (2002) fed Gliricida leaf in the diet of layers and observed weight loss at 10 and 15% of supplementation. Whereas Berhan and Wude (2010) observed improved body weight gain at 5 and 10% sweet potato leaf meal supplementation where as there was reduction in body weight gain at 15 and 20% supplementation. Ekenyem and Madubuike (2006) implicated high crude fiber content with increasing levels of leaf meal for the reduction in weight gain. In the current experiment, though there was weight loss at high level, the weight change was positive for all treatments. To the contrary, Aberra et al. (2011) and Nworgu and Fasogbon (2007) observed higher average daily gain in chicks supplemented with *Moringa stenopetla* and *Centrosema pubescens* leaf meal compared to the control. Abou-Elezz et al. (2011) observed no significant effect on body weight change in RIR hens' fed on 0, 5, 10 and 15% of *Leucaena leucocephala* and *Moringa oleifera* leaf meal.

In general, the average weight gain of chicks on the T1 diet was higher than chicks fed on T2, T3 and T4 diets. Despite higher intake in chicks supplemented with tagasaste leaf meal, they could not be able to utilize the feed efficiently for growth. The low performance experienced by chicks fed tagasaste leaf meal may be due to the bulkiness and anti-nutritional factors (Togun et al., 2006) which makes it difficult for the chicken to satisfy the protein and energy requirements. According to Nworgu et al. (2000) fiber was reported to absorb amino acids and peptide as well as preventing their absorption from the intestine. Another possible drawback is the anti-nutritional factors noticeably tannins and alkaloids. High concentration of tannin can bind with protein and form strong complexes which lead to reduction in intake and digestibility (Makkar, 2003). According to the same author the formation of complexes inhibits a number of digestive enzymes in the GIT such as pepsin, trypsin and chymotrypsin there by reducing the digestibility of proteins and amino acids. Medugu et al. (2012) from their review work indicated several options such as physical and chemical methods (eg. use of wood ash, addition of tallow, use of tannin binding agents, and use of enzymes) which reduce the impact of anti-nutritional substances in poultry feeds. However, the best method to be adopted will depend on their effectiveness and cost of processing.

Nutrient retention and nutrient conversion efficiency

Protein deposition in the carcass showed a decreasing trend with increased level of tagasaste leaf meal in the diet. This might be due to the effect of anti-nutritional factors which results in the loss of endogenous protein rich sulphur-containing amino acids. It is this depletion of critical amino acids which might results in depression in growth and protein accretion (Liener, 1989). The decreasing trend in CP retention with the increase of leaf meal inclusion observed in this study might be associated with the effect of anti-nutritional factors and fiber loading of the diets. Adverse effects of tannin on feed efficiency were reported by Makkar (2003). However, Adugna et al. (1997) reported low level of condensed tannin (4.66%) in tagasaste. An improved carcass protein accretion was observed in chicks fed on T1 diets. D`Mello and Acamovic (1989) reported that chicks fed on 15% *L. leucocephela* leaf meal diets showed low energy and protein retention.

High dietary energy levels are often claimed for excessive fat accumulation (Saleh et al., 2004). However, in the current study even though chicks fed on T2 and T3 diets had higher ME intakes which was more than the recommended level (2800 kcal/kg DM) by NRC (1994), they accumulated the lowest fat as compared with the chicks fed on T1 diet. From this experiment, it was observed that the chicks fed on the leaf meal diets grew slower, which indicates inferior CP retention and decreased whole body fat deposition as compared with the chicks fed on T1 diets. Ng'ambi et al. (2009) reported that broiler chickens fed on tanniferous *Acacia karroo* leaf meal had lower fat content compared with the unsupplemented ones.

Chicks required more feed per unit of weight gain in T4 diets than the control diet which is consistent with the report of Donkoh et al. (1999) in chicks fed chaya leaf meal in which the efficiency with which feed is converted to gain decreased with increasing levels of leaf meal. The results (Table 4) indicated that the DM efficiency ratio, protein efficiency ratio and energy efficiency ratio were low in chicks fed on tagasaste leaf meal supplemented diets. This indicated that the feed was utilized less efficiently when tagasaste leaf meal is used which lead to reduction in live weight gain. Chicks at higher level of tagasaste leaf meal required higher CP and ME per unit of body weight gain compared with the control. Increased feed conversion ratio was reported in broilers when the level of *Leucaena leucocephala* (Okonkwo et al., 1995) and sweet potato (Berhan and Wude, 2010) exceeded 10% in the diet. This shows that the feed was less efficiently utilized with increased level of leaf meal.

The effects of feeding tagasaste leaf meal on the carcass characteristics of RIR chicks

According to Bamgbose and Niba (1998) carcass yield is an indication of the quality and utilization of the ration. Therefore, it appeared that chicks fed on the T4 diets poorly utilized their feed as evidenced by lower dressed carcass, breast muscle, thigh, back, and breast and drumstick weights. Similarly, Togun et al. (2006) observed significant reduction in live and carcass weight with increased level of leaf meal inclusion. Low nutrient utilization which results in poor tissue growth and fat deposition were suggested to be the cause for low carcass yield in broilers (Berhan and Wude , 2010). Meseret et al. (2011) reported similar response in carcass yield characteristics except drumstick weight in chicks fed on graded levels of *Prosopis juliflora* leaf meal.

The lack of an increase in the weight and length of GIT is consistent with the result of Berhan and Wude (2010) who indicated that the inclusion of sweat potato leaf meal at different dietary level did not increase the weight and length of GIT as the level of the leaf meal increased. The weight of the liver was similar among treatments which were not consistent with other studies in chicks fed on leaf meal supplemented diets. Ekenyem and Madubuike (2006) observed low weight of liver and heart at high level of leaf meal inclusion which was probably due to the stress effect on the organs caused by high intake of fiber. To the contrary, Togun et al. (2006) observed increased liver weight in broiler cocks fed on wild sunflower leaf meal compared with the control.

The low growth rate, body weight gain, drumsticks thigh and breast meat weight in tagasaste supplemented group might be due to the poor nutrient utilization of chicks possibly due to inadequacy in certain essential amino acids required for optimum growth (Berhan and Wude , 2010). In agreement to the present study, Ekenyem and Madubuike (2006) observed a significant decrease in carcass, gizzard, and kidney weights, when broilers were fed above 5% *Ipomoea asarifolia* leaf meal. However, Berhan and Wude (2010) fed different levels of *Ipomoea batatas* and observed no effect on drumstick, thigh and breast meat up to 15% of inclusion level compared with the control. In agreement with the current study Togun et al. (2006) reported no effect of increased level of leaf meal on dressing percentage in broiler chickens.

Conclusion

There were no toxic effects observed throughout the feeding period of tagasaste leaf meal as mortality was very minimal. The result also showed that there was no problem of acceptability/palatability by chickens as evidenced from high DM intake. Therefore, it is possible to use tagassaste leaf meal as an alternative source of supplementation in diets deficient in protein to formulate a feed for chickens in areas where it grows. However, there is a need for further research which evaluates the mechanism of reducing anti-nutritional substances through the use of chemical and physical methods for efficient utilization of nutrients.

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