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Growth Performance and Carcass Characteristics of Dual-Purpose "Potchefstroom Koekoek"Chickens Fed Varying Levels of Raw (Sun-Dried) Boloso-1 Taro (Colocasia esculenta) Corm Meal

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Abstract

A 91 day feeding trial was conducted to investigate the effects of different inclusion levels of processed Boloso-1 taro corm (*Colocasiaesculenta*) meal on growth performance and carcass characteristics of dual-purpose Koekoeck chickens. Three hundred koekoek of one day old were randomly assigned to five treatment diets. Diets 1, 2, 3, 4, and 5 contain 0%, 3%, 6%, 9% and 12% levels of processed taro corm meal. Each treatment was replicated three times with 20 birds per replicate in a completely randomized design. The result of the experiment shows significant differences ($p<0.05$) in final body weight, average daily feed intake, feed conversion ratio and average daily weight gain. However, T2 had the highest (925.27 g) final body weight while T5 had the lowest (775.21 g). The higher and better ($P<0.05$) final body weight of T2 could be attributed to the difference in feed composition or the acceptability of the diets or other factors. Mortality was the same across all dietary treatments. Inclusion of sun dried processed Boloso-I Taro corm meal up to 9% level was acceptable since inclusion at this level did not adversely affect the production performance of dual purpose Koekoek chicken in terms of growth rate, mortality rate, and feeding efficiency. The use of taro meal as nonconventional and alternative carbohydrate source in poultry diet presents positive economic implications, especially to small hold farmers from the developing countries.

Keywords: Dual purpose,Taro corm, growth performance, feed intake, *Koekoek,*Corm Meal*, Colocasiaesculenta*.
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INTRODUCTION

The tremendous increase in population, high demand of foodstuff and high cost of conventional energy feed ingredients like maize, sorghum, guinea corn, wheat and many others has necessitated the need for alternatives cheap energy sources(Olajide and Akinsoyinu, 2015)**.** Unfortunately, the rapid growth of human population has also intensified the competition between man and livestock for these cereal grains resulting in high cost of feeds and consequently high prices of poultry products leading to very low levels of protein intake in most developing countries(Abdulrashid and Agwunobi, 2009).(Abdulrashid and Agwunobi, 2009)

Energy feed sources (maize and sorghum) are expensive feedstuff, constituting about 50-55% of the formulated poultry diets. Maize as a major component of feed is expensive; the productivity is low which means it does not meet its demand(Agbede et al., 2002, Hamzat et al. 2003, and Okereke et al., 2006). With the present trend of rising prices of animal feed stuff all over the world, greater attention is being paid to the search for safe and cheap local feed stuff (including unexplored feed-stuff, by –products of agriculture and industry). Especially in the developing countries that cannot afford the expensive diets for livestock. Ethiopia like most other developing countries suffer greatly from a constant shortage of livestock feeds, especially those supplying protein and energy (Esonu et al., 1999).

The results of the previous studies revealed that Taro is a cheap source of carbohydrates in animal nutrition(Aderolu et al., 2009; Onu and Madubuike, 2006). Adejumo and Bamidele (2012)also concluded that there was economic decrease in price of feed with the inclusion of cocoyam meal. Abdulrashid and Agwunobi (2009)revealed that cocoyam meal with proper processing will effectively replace maize at 50% level of inclusion as a major source of energy in finishing diet of broiler birds for maximum profit. Though there is limited reference work on the utilization and inclusion of Taro cocoyam as an alternative energy source in poultry production, Abdulrashid and Agwunobi (2009) reported that Taro meal should not exceed 25% replacement of maize in broiler diets. Esonu et al. (2001)reported that starter broilers could tolerate up to 20% inclusion levels of wild variegated cocoyam (*Canadiumhortulanum*). On the other hand, Uchegbu*et al*. (2010) showed that raw sun dried cocoyam meal can be used in the diet of finisher broilers up to 15% inclusion level without being detrimental to their performance. However, 10% cocoyam inclusion level is the best in terms of daily weight gain, feed conversion ratio, and cost effectiveness(Uchegbuet al, 2010).

There is still limited reference work in Ethiopia on the utilization of Taro corm as an alternative energy source in poultry production. As a result, this study aimed to evaluate the potential of Boloso-1Taro corm as feed ingredient in dual purpose chicken rations.

MATERIALS AND METHODS

The experiment was carried out at Bodit Agricultural Office, SNPR, Ethiopia. The Town is located at about One hundred seventy five kilometers (175 km) away from Hawassa main town of the region.

Experimental feed preparation

Taro (*Colocasiaesculenta*) corm: boloso-1 was harvested at 9 months of age from the Areka Agricultural Research Center used for this experiment. The Taro corm was then processed by peeling the tuber and cleaned of soils. The tubers were then cut in to small pieces and dried in the sun for 3 days. The dried tubers were then milled with hand by using locally available grinding materials and used in the formulation of starter and grower dual purpose chicken diets.

Chemical analysis of cassava leaves

The nutrient compositions **(**proximate analysis**)** of Boloso-1corm mere used from previously analyzed results (literature) for treatment formulation (Temesgen M, Retta N, Tesfaye E, 2017).

Table 1: Proximate, β-carotene and Phenols contents in Boloso-1 corm

Parameters	PGF1	PGF2
Moisture (%)	4.3 ± 2.16	6.22 ±1.83
Protein (%)	12.1± 2.32	10.49±2.38
Crude fat (%)	3.01 ±1.35	2.67±1.21
Crude fiber (%)	2.11 ±0.26	2.66±1.08
Total Ash (%)	3.29± 0.49	3.57±0.97
Carbohydrate (%)	75.49± 4.43	74.26±5.10
Energy value (Kcal)	376.78± 9.87	363.16±14.13
Amylose (%)	13.21± 1.07	13.13±0.99
B-carotene (μg/100g)	2.01 ±0.42	2.31±0.16
Phenols (mg/100g)	6.95 ±2.33	8.18±2.40

PGF1: pre-gelatinized without peel, PGF2: pre-gelatinized with peel.

Experimental birds and Design of the Experiment

Three-hundred a day-old dual purpose *Potchefstroom Koekoek*chickens breed were used in this experiment. The birds were divided in to five groups consisting of 60 birds per group. Each treatment group was further replicate 3 times with 20 birds per replicate in a completely randomized design experiment. Based on the result of the chemical compositions of ingredients five starter and grower diets were formulated to contain Taro Corm Meal at 0% (T_1), 3% (T_2), 6% (T_3), 9% (T_4) and 12% (T_5) (Table 2& 3). Feed and water were provided *ad libitum*. The necessary routine vaccination and veterinary attention was provided.

Table 2: Gross composition of the starter experimental diets (% on DM basis).

Ingredients (%)	Varying Dietary Levels of Taro Corm Meal (CLM)				
	T_1 (0%)	T_2 (3%)	T_3 (6%)	T_4 (9%)	T_5 (12%)
Maize grain	60	58	54	55	53
Wheat bran	8	7	8	4.04	4.02
Soybean meal	24.75	24.75	24.75	26	25
Nougseed cake	5	5	5	4	4
Taro Corm meal	0	3	6	9	12
Limestone	1.5	1.5	1.5	1.25	1.25
Salt	0.3	0.3	0.3	0.2	0.2
DL-Methionine	0.1	0.1	0.1	0.16	0.18
DL-lysine	0.1	0.1	0.1	0.1	0.1
*Premix	0.25	0.25	0.25	0.25	0.25
Calculated ME (Kcal/Kg DM)	2806.44	2811.29	2783.54	2842.64	2842.92
Required ME (Kcal/Kg DM)	2800				
CP (%)	18.99	18.83	18.83	18.73	18.31
Required CP (%)	20				
ME:CP	147.8	149.3	147.8	151.8	155.3

* **Company**: Top Mix, Medion, Bandung-Indonesia; **providing the following per kg diet basis**: Oxytetracycline (60 g), Vitamin A (5,000,000 IU), Vitamin D3 (500,000 IU), Vitamin E (2,500 IU), Vitamin K_3 (1 g),Vitamin B_1 (2 g), Vitamin B_2 (4 g), Vitamin B_6 (1 g), Vitamin B_{12} (1 mg), Vitamin C (20 g), Nicotinic acid (15 g) Calcium-D-pantothenate (5 g).

Table 3: Gross composition of the grower experimental diets (% on DM basis).

Ingredients (%)	Varying Dietary Levels of Taro Flour Meal (CLM)				
	T_1 (0%)	T_2 (3%)	T_3 (6%)	T_4 (9%)	T_5 (12%)
Maize grain	60	60	60	58	57.4
Wheat bran	14.5	11.5	8.4	6	5
Soybean meal	18.08	18.08	18	20.4	18
Nougseed cake	5	5	5	4	5
Taro Corm Meal	0	3	6	9	12
Limestone	1.2	1.2	1.2	1.2	1.2
salt	0.2	0.2	0.2	0.2	0.2
DL-Methionine	0.01	0.01	0.1	0.1	0.1
DL-lysine	0.01	0.01	0.1	0.1	0.1
Premix	1	1	1	1	1
Total	100	100	100	100	100
Calculated ME (Kcal/Kg DM)	2766.70	2804.15	2843.63	2852.86	2876.15
Required ME (Kcal/Kg DM)	2800				
CP (%)	17.03	16.76	16.57	16.91	16.19
Required CP (%)	16				
ME:CP	162.5	167.3	171.6	168.7	177.6

* **Company**: Top Mix, Medion, Bandung-Indonesia; **providing the following per kg diet basis**: Oxytetracycline (60 g), Vitamin A (5,000,000 IU), Vitamin D3 (500,000 IU), Vitamin E (2,500 IU), Vitamin K_3 (1 g),Vitamin B_1 (2 g), Vitamin B_2 (4 g), Vitamin B_6 (1 g), Vitamin B_{12} (1 mg), Vitamin C (20 g), Nicotinic acid (15 g) Calcium-D-pantothenate (5 g).

Data Collection

The initial body weights of the birds, in grams, were determined before the application of the different dietary treatment. The body weights were monitored every 7 days early in the morning prior to feeding using a digital balance. Final live weights were determined at experimental termination. Feed was offered daily on group basis in two halves; first half in the morning after the refusal is collected and weighed while the second half was offered in the afternoon. Samples of the feed offered and refused was taken daily for chemical analysis. From the collected data, feed intake and body weight gain and feed conversion ratio were calculated. The amount of dried Taro Corm Meal required for the feeding trial was determined based on the total number of chicks and duration of the trial. Mortality was recorded throughout experimental period as it occurred.

Measurement of carcass characteristics
At the end of the feeding trial, two chickens (one cockerel and one pullet) from each of the 3 replicates of the 5 dietary treatments, whose final body weights are closest to the average body weight of their respective groups, were selected. They were starved overnight, weighed and killed by severing the jugular vein to allow complete bleeding. Immediately after killing, the birds were defeathered by hand plucking, eviscerated and carcass cuts were determined. The uneviserated carcass was weighed. Weights of feather, shank + claws, head, lungs, heart, spleen, pancreas, digestive and urogenital organs and abdominal fat were included in total non-edible offal. Carcass weight was apportioned into back (thorax + lumbar), two thighs, two drumsticks, two wings, a breast and neck. Edible offal included skin, liver and gizzard. Dressing percentage was calculated as percent of dressed carcass to slaughter weight. Slaughter weight is described here as a live weight taken after overnight starvation of the selected chickens for slaughter.

Statistical Analysis
The data were subjected to ANOVA and the general linear model procedure of SPSS (IBM® SPSS® version 20) was employed to perform all ANOVAs.Final body weight and carcass parameters were analyzed by two-way ANOVA and feed intake by one-way ANOVA techniques. Effect of sex was taken into account in all parameters studied except nutrient intakes and FCR since these results are presented as replication (experimental pens) means containing chickens of mixed sex.

One between subject factor (treatment) and one within subject factor (age in weeks) repeated measure ANOVA design was used to analyze DBWG, DMI and FCR. The differences in mean values of the treatments were separated by Duncan Multiple Range Test. The following statistical models summarize the statistics employed to analyze the data.

Model .1
$Yijk = \mu + Ai + eik$;
Where, Yik=individual values of the dependent variables;
μ = overall mean of the response variable;
Ai= the effect of the i^{th} TCM level (*i*= 3, 6, 9, 12,) on the dependent variable
eik= error associated with the experimental study.

Model 2
$Y_{ij} = \mu + \alpha_i + b_j + ab_{ij} + e_{ij}$
μ= overall mean
i= effect of sex,
j= effect of Taro Corm Meal levels on dietary treatments, 1, 2, 3, 4 and 5
αb_{ij}= effect of i^{th} sex on j^{th} level of Taro Com Meal meal substitution
e_{ij} = error associated with the experimental study.

RESULTS
Effect of feed on performance of chickens
The growth performance of the dual purpose*Potchefstroom Koekoek* chickens fed dietary levels of sun dried processed Boloso-1 taro corm meal is presented in Table 4. Final weight, average daily feed intake, feed conversion ratio and average daily weight gain were significantly ($P<0.05$) influenced by the test diets. T2 had the highest (925.27 g) final body weight while T5 had the lowest (775.21 g).

Table 4: Growth performance of *Potchefstroom Koekoek* chickens fed diets with different levels of Boloso-1 Taro CormMeal

Parameters	Dietary treatments					SEM	Sig
	T1	T2	T3	T4	T5		
Initial body weight (g/chick)	96.26	97.27	96.47	100.27	98.31	0.71	0.397
Final body weight (g/chick)	843^{b}	925.27^{c}	864.38^{b}	888.82^{bc}	775.21^{a}	7.33	<0.001
Feed intake (g/h/day)	46.64^{a}	47.86^{a}	53.81^{b}	54.27^{b}	53.13^{b}	0.44	<0.001
DBWG (g/chick/day)	9.7^{b}	10.75^{c}	9.97^{b}	10.24^{bc}	8.79^{a}	0.09	<0.001
FCR (g feed/g gain)	5.68^{b}	5.19^{a}	5.99^{b}	5.61^{ab}	6.46^{c}	0.07	<0.001
Mortality (%)	8.3	8.3	21.7	23.3	20	2.56	0.131
Cost of Production							
Avg. cost of feed ETB/kg	6.34	6.30	6.24	6.16	6.11		
Avg. cost of daily feed intake/b	0.34^{b}	0.33^{b}	0.32^{b}	0.296^{a}	0.292^{a}	0.003	<0.001

Mean values within the same row bearing different superscript letters are significantly different (p<0.05); T1 = 0% TCM; T2 = 3% TCM; T3 = 6% TCM; T4 = 9% TCM; T5 = 12% TCM; DBWG= daily body weight gain; FCR = feed conversion ratio; TCM = Taro Corm Meal; SEM = standard error mean; p=probability value

Carcass characteristics of chickens

The effect of feeding various levels of sun dried Boloo-1 taro corm meal on slaughter weight, dressed carcass, dressing percentage and weights of different body parts and organs of the experimental birds is shown in Table 5. Except liver weights inclusion of taro corm meal produced significant effects on carcass traits of the chickens. The slaughter weight of birds fed T1, T2, and T4 were comparable and higher than those fed T3 and T5.

Table 5: Effect of diet and sex on carcass characteristics of *Potchefstroom Koekoek* chickens fed various levels of Boloso-1 Taro CormMeal

Parameters	**Sex**			**Dietary Treatment**						**p**	
	M	F	SEM	T1	T2	T3	T4	T5	SEM	Diet	Sex
Slaughter Weight	803.35^{a}	684.55^{b}	12.488	787.75^{b}	796^{b}	692^{a}	790.5^{b}	683.5^{a}	19.746	0.003	0.000
Breast	66.55	62.35	1.183	65.75^{bc}	66^{bc}	61.5^{a}	71.5^{c}	57.5^{a}	1.871	0.001	0.025
Drumstick	92.35^{a}	77.15^{b}	1.935	89.75^{b}	87^{ab}	81.5^{ab}	86.5^{ab}	79^{a}	3.059	0.142	0.000
Thigh	98.15^{a}	83.55^{b}	1.425	98.75^{c}	87.5^{ab}	88.5^{b}	98.5^{c}	81^{a}	2.254	0.000	0.000
Back	50^{a}	36.2^{b}	1.451	44.5^{bc}	49^{c}	45.5^{bc}	39.5^{ab}	37^{a}	2.294	0.016	0.000
Wing	134.37a	119.75^{b}	1.554	134.8^{c}	126.25^{ab}	132.25^{bc}	121.75^{a}	120.25^{a}	2.457	0.003	0.000
Skin	59.7	53.6	2.362	61.75^{bc}	57^{abc}	48.5^{a}	64.75^{c}	51.25^{ab}	3.735	0.040	0.089
Gizzard	34.4	29	0.854	29.5^{a}	30.25^{a}	26.75^{a}	37.25^{b}	34.75^{b}	1.351	0.001	0.001
Liver	23.9	20.9	1.033	24	21.25	21	24.5	21.25	1.634	0.402	0.059
Abdominal Fat	9.45	8.5	0.73	25.5^{c}	15.75^{b}	1.75^{a}	0.375^{a}	1.5^{a}	1.155	0.000	0.373
Dressing %	70.74	69.71	0.70	69.7	68.7	72.9	68.8	71.1	0.66	0.28	0.47

Row means within the same category with different superscript letters are significantly different (p<0.05); *Total carcass = sum of commercial carcass components (breast, drumsticks, thighs, back and wings); **Edible offal = sum of skin, gizzard and liver; ***Total edible = total carcass plus edible offal; T1 = 0% TCM; T2 = 3% TCM; T3 = 6% TCM; T4 = 9% TCM; T5 = 12% TCM; TCM = Taro Corm Meal; p = probability value

DISCUSSION

The higher and better (P<0.05) final body weight of T2 could be attributed to the difference in feed composition or the acceptability of the diets or other factors. The lowest final body weight and average daily weight gain recorded in birds fed T5 (15% Taro Corm meal) could be attributed to the presence of anti nutritional factors present in taro Corm, which may have limited the consumption of nutrients by the birds. However, the levels of anti nutritional factors present in the diets and the dusty nature of the feed with increasing levels of the taro corm meal could decrease feed intake. Agwunobi et al. (2002)reported the presence of saponin, tannin, phytates and oxalates in taro cocoyam.

The highest value of feed conversion ratio in T_5 (15% Taro corm meal) indicating that the higher the level of taro corm meal, which could be due to inability of the birds to extract required nutrients from the feed because of the effect of anti-nutritional factors which reduced feed digestibility and utilization. This observation agrees with report of Abdulrashidet al. (2006) who indicated that feed conversion ratio of the birds increased with the increase level of cocoyam meal. Adama and Ayanwale (1999) also observed poorest feed/gain value with uncooked cocoyam which could have been due to oxalate content of the ration. The increase in feed intake as level of inclusion of taro corm meal increased did not bring along with it corresponding weight gain. However, it is expected that increase in feed intake will normally result in increased body weight gain (1995). The feed conversion ratio also increased with contents of taro corm meal in the diets. This may be attributed to the contents of residual anti-nutritional factors in taro corm meal. Contents of residual anti-nutritional factors detected in taro corm meal could be responsible for the depression in the weight gain and elevated feed conversion ratio. These anti-nutritional factors have been found to impair digestion, absorption and utilization of nutrients (King et al., 2000 and Olajide et al., 2009). This limiting factors leads to severe reduction in feed intake, nutrient utilization and weight gain (Esonu et al., 1999).

Statistically there was no significant difference ($P \geq 0.05$) distinguished among treatment groups for mortality rates. Suggesting that the inclusion of taro corm meal in a dual purpose chicken ration did not affect the general health and survival of the birds. Even though no statistical difference ($p \geq 0.05$) was observed, mortality rate of birds fed a diet containing taro corm meal at 0 % of T_1(8.3%) and at 3% of T_2(8.3%) was noticeably lower than the other groups. In agreement to the current observation, none of any adverse effects on chickens' health and mortality due to replacement value of fermented wild cocoyam [*colocasiaesculenta*(l.) schott] for maize up to 15% and cocoyam-corm meal as partial energy replacement for maize up to 50% in the diets of broiler finisher diets were observed by Olajide (2017)and De la Cruz (2016)respectively. Mortalities occurred during first week of their ages could be attributed to thestresses induced from transfer of birds from brooding house to their experimental pens and the coccidiosis disease.

Average cost of feed per kilogram decrease with increase in the level of sun dried Bloso-1 taro corm level across the treatments. This was due to reduced cost of taro corm as compared to other energy feed ingredients used in the test diets which have a lot of economic implications in the use of these diets. The average cost of daily feed intake was also showed slight decreases with increase in the level of sun dried Bloso-1 taro corm level inclusion in the test diets. This was owing to reduced cost of the feed consumed, which indicates economic implications in the use of sundried Boloso-1.

This attributed to better conversion of feed to edible meat by the birds fed these diets. The lower values of several carcass parameters (Breast, drumstick, Thigh, Back) and slaughter weights at 12% sun dried taro corm meal levels could be as a result of lower crude protein and contents of ANFs. Similar lower weight and carcass yield have been attributed to reduce CP[21] and fiber concentration in diets[22]. Relatively higher gizzard weight was recorded for birds fed taro corm meal at level of 9% (T4) and 12% (T5). This could be attributed to the physical activity of handling nature of gizzard for different types of feeds.

Sex effect on slaughter weight was pronounced with higher value for males (Table 5). The current result is in line with the results of Tegene and Asrat (2010) for RIR dual-purpose chickens. This difference related to sex of chickens is attributed to the presence of sex hormones (Androgen) in males that enhanced muscle development than the sex hormone (Estrogen) in females which is mostly responsible for fat deposition rather than muscle tissue development (Workinesh, 2009). This is a physiological fact that the weight of adipose tissue is lighter than that of muscle tissue (Scanes, 2003).

CONCLUSION AND RECOMMENDATION

These results showed that inclusion of sun dried Boloso-I Taro corm meal at up to 9% was no determinant effect on weight gain, feed intake and carcass parameters of the dual purpose chicken. Further research is needed with different processing methods and different poultry breeds (layers, broilers) with different levels to make use of cheap available energy value in poultry ration ingredients.

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