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# Replacement of Wheat Bran for Taro Tuber (*Colocosia esculenta*) on the Fattening Performance of Doyogena Sheep Fed on Rhodes Grass (*Chlorias gayana*) Hay, Southern Ethiopia

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## Abstract

Lengthy fattening of sheep that demands a lot of feed and labour costs is not profitable under smallholder farmer's management conditions in Areka, Southern Ethiopia. An experiment was conducted to evaluate intake, growth performance and carcass characteristics of yearling lambs (10-12 months). Graded levels of Taro (*Colocosia esculenta*) were supplemented to replace Wheat Bran (WB) from a concentrate mix CM at the rate of 25%, 50%, 75% and 100% on DM basis. Twenty four yearling lambs were allocated to four treatments in completely randomized block design:

- T1=Medium quality Rhodes grass hay, MRG (adlibtum) +25% of the WB from the CM replaced by Taro tuber;
- T2=MRG (adlibtum)+50% of the WB from the CM replaced by Taro tuber;
- T3=MRG (adlibtum)+75% of the WB from the CM replaced by Taro tuber and
- T4=MRG (adlibtum)+100% of the WB from the CM replaced by Taro tuber.

The results indicated that lambs that were receiving dietary T1 and T2 (25% and 50% replacement of WB with taro tuber) produced significantly higher ($p<0.05$) live weight changes, Average Daily Gain (ADG) and Feed Conversion Efficiency (FCE) compared to those maintained on dietary T4. However, there was no difference ($p>0.05$) in growth performances of all lambs that were receiving dietary T1, T2 and T3. Similar trend as for growth performance was observed for total fat when the lambs were receiving dietary T1 and T2. The overall mean daily gain was 50.7 g/head/day in 6-8 weeks, which is reasonably acceptable under smallholder management condition. Taro tuber is rich in energy content (13 MJ/kg DM) but when the amount exceeds certain limits (50% replacement with WB) above the daily concentrate allowance for the lambs, it might limit intake which warrants refinements for its anti-biotic contents as a complementary research.

**Keywords:** Carcass; Taro tuber; Doyogena sheep; Fattening; Concentrates

## Introduction

Sheep production is an integral part of crop-livestock mixed farming systems of Southern Ethiopia. High human population pressure along with urbanization and climate changes are the major challenges hindering the benefit gained from sheep production and utilization. Body weight gain and carcass yield of majority of the local sheep breeds types (Menz, Arsi-Bale, and Black head Somali) are often reported to be low. Efforts were done to import exotic breeds with high dressing capacity to improve meat in terms of yield, dressing percentage and quality aspects. However, exotic breeds such as Awassi and Corriedale had hardly been adapted to Ethiopian management (housing, feeding, and healthcare) and climatic conditions.

In spite of the efforts made, meat prices have increased considerably in the last five to ten years, and the demand for meat has also increased considerably. This necessitates improvement of plane of nutrition through supplementation of concentrates and forage legumes which could promote faster daily weight gain and attainment of acceptable market at earlier age. Indigenous sheep have their own merits but their genetic limits need to be addressed by either selection, crossbreeding or improved managements [1]. The government organizations engaged in rural agricultural activities advocated community-based breed selection from indigenous sheep as a sustainable tool to improve local, adapted breeds to poor nutrition, disease and parasites. All male sheep culled from community based ram selection need to be castrated for finishing. However, appropriate feed formation for finishing animals has not been studied previously, particularly taking into account cheaply available local energy-rich non-conventional supplements. Doyogena sheep is currently identified as one of the potential breeds or types that could be improved through community-based participatory selection since 2012. It is one of the sheep flocks with better reproductive and growth capacity reported in the central south region.

However, similar to other highland areas of the region, problems associated to low productivity and low income earnings of smallholder farmers due to high human population are the typical characteristics of the district, which results in prolonged fattening and reduced profits. Among others, feed shortage is one of the bottlenecks threatening breed improvement in the area. Taro is locally available in mid altitudinal areas, climate resilient with high food or feed value in central south regions of Ethiopia [2]. Strategic supplementation of locally available energy rich unconventional feed sources such as taro tuber (*Colocosia esculenta* ) might be considered for sheep feeding to replace costly energy sources which are either not affordable or accessible to smallholder farmers. However, the utilization methods and level of inclusion of taro tuber in animal diet has not been well investigated and documented. Fattening culled sheep from the flocks during selection, using energy rich local feed sources could help to enhance both productivity and community breed selection practices. Therefore, the study was aimed at evaluating taro tuber for fattening sheep within relatively shorter period of time targeting Ethiopian festive seasons.

## Materials and Methods

### Description of the study site

This experiment was conducted at Doyogena research sub-station, Areka Agricultural research center. The site is located at 254 kms south of Addis Ababa with an altitude of 2530 m.a.s.l, longitude N 07° 06'42.2'' and latitude E 37° 41'6.32''. The long term (10 years) rainfall of the site ranged between 900 and 1600 mm. The rainfall pattern is bimodal with the heavy rainfall observed from July to September. Although the rainfall amount of the site is not very low, due to high atmospheric water demand of the site is reported to have higher evapo-transpiration rate. The mean annual temperature ranged between 6°C-16°C.

### Experimental feeds and feeding management

Rhodes grass (*Chlorias gayana*) which was used as a roughage source was produced for grazing in the experimental farm site. Rhodes hay was chopped and offered adlibtum to experimental animals. The concentrate mix was composed of:

- (%) of Wheat bran,
- (%) of Noug cake and
- (%) of Salt.

The mix was formulated based on TDN for maintenance and growth requirements by considering initial average body weight of 20-25 kg of experimental animals with expected 50 g weight gain per day using modest level of supplementation [3]. The treatments consisted of supplementing three different levels of taro in a graded manner to replace wheat bran from the formulated concentrate mixture on Dry Matter (DM) basis. Experimental dietary treatment is as presented in **Table 1** below.

| Feed ingredient (gram/ head/day) | T1 | T2 | T3 | T4 |
|---|---|---|---|---|
| Rhodes grass | Ad libtum | Ad libtum | Ad libtum | Ad libtum |
| Wheat bran | 493 | 340.5 | 510.75 | 681 |
| Taro tuber | 188 | 340.5 | 170.25 | 0 |
| Noug seed cake | 65 | 65 | 65 | 65 |
| Salt | 7.5 | 7.5 | 7.5 | 7.5 |
| T1=Treatment 1; T2=Treatment 2; T3=Treatment 3; T4=Treatment 4 | | | | |

**Table 1:** Experimental lay out showing dietary ration (g/head/day) formulation.

### Experimental animal selection and feeding management

Twenty four growing male lambs with mean 23.90 ± 1.15 kg were selected from Doyogena community-based sheep breed improvement scheme. The rams were those left after selection of elite rams as breeding males for the next generation's improvement program. Experimental animals were identified using ear tags. The animals were de-wormed against internal parasites and sprayed against external parasites. After 14 days of adaptation period, 6 animals were randomly assigned to each treatment using a completely randomized block design. Weekly weights of the animals were calculated to estimate feed supplement that were offered in the following week. The diets offered and refusals were weighed and recorded daily [4]. Animal weights were recorded at the beginning, fortnightly and at the end of experimental period. Animals are allowed to free grazing for 8:00 hours on Rhodes grass and water was available on ad libtum basis. Half of the taro tuber was offered on DM basis in the morning and half in the afternoon (09:00 am and 4:00 pm). The experiment lasted 90 days targeting Ethiopian festive season, Easter.

### Chemical composition of experimental feeds

Feed samples were analyzed for DM by drying the samples at 105°C for 24 h, ash by ignition in muffle furnace at 600°C for 6 h, and CP by the Kjeldahl procedure. Standard procedures described by were followed to analyze chemical composition and Van Soest and Robertson for *in vitro* dry matter digestibility of the experimental feeds [5-8].

### Statistical analysis

Dry matter intake, average daily gain, and carcass yield parameters were analysed using General Linear Model (GLM) of Statistical Analysis System for least square analysis of variance. Means separation were done using the Tukey's test at $p<0.05$. The statistical model for the analysis was:

$$Y_{ij}=\mu+a_i+b_j+e_{ij}$$

Where, $Y_{ij}$ is the response variable (Feed intake, weight changes, average daily gain, weekly weight changes); $\mu$ is the overall mean, $a_j$ is replacement effect of wheat bran with taro tuber (T1=25% taro and 75% WB; T2=50% taro and 50% WB; T3=75% taro and 25% WB; T4=100% taro), $b_j$ is the jth block effect and $e_{ij}$ is the random variation or error.

## Results

### Chemical composition and *in vitro* digestibility of experimental feeds

The nutritive value analysis result is presented in **Table 2.** Taro is one of the unconventional feed or food crops in mid altitudes of southern Ethiopia. The protein content is low; however, the energy content is usually high and sufficient for supplementation of feeds with poor values. The energy value of taro was higher than common concentrate feeds like wheat bran by 18.2% while it was higher by 63.77% compared to Rhodes hay. In addition, the *in vitro* digestibility of taro is also higher compared to concentrate mixture and Rhodes hay. When it is supplemented with protein rich sources (Noug cake, sunflower cake, etc) this could improve microbial action on roughage feeds and thereby the overall productivity of animals [9-11].

| Feed types | Chemical composition and *in vitro* digestibility (%) | | | | | | |
|---|---|---|---|---|---|---|---|
| | DM | OM | CP | ADF | NDF | IVOMD | Energy (MJ/Kg DM) |
| Taro (*Colocosia esculenta*) | 89.41 | 96 | 4.16 | 6.84 | 69.31 | 81.41 | 13.02 |
| Concentrate mixture | 91.5 | 93 | 14.8 | 23.9 | 38 | 69.14 | 11.06 |
| Rhodes grass (*Chlorias gayana*) | 91.46 | 88 | 7.13 | 39.5 | 70.24 | 60.61 | 7.95 |

DM=Dry Matter; OM=Organic Matter; CP=Crude Protein; NDF=Neutral Detergent Fiber; IVOMD= *In vitro* Organic Matter Digestibility; MJ=Mega Joule

**Table 2:** Chemical composition and *in vitro* digestibility of taro tubers in Dubo Mante research sub-station, Southern Ethiopia.

### Dry matter and nutrient intake

Dry matter and refusals of experimental animals is presented in **Table 3**. Feed intake is a function of the form of feed offered to animals, nutrient content of the feed and animal health condition. DM intake was not influenced by the proportion of inclusion of Taro tuber in the concentrate mix and total ration of experimental animals. DM intake showed an increasing trend although it was non-significant while refusal declined with an increase in the level of inclusion of taro in the total ration.

### Growth performance and feed conversion efficiency

Initial and final weight, live weight changes, Average Daily Gain (ADG) and Feed Conversion Efficiency (FCR) of the experimental animals is presented in **Table 3.** The average initial live weight of the experimental animals was 23.90 ± 1.15 while the final weight was 28.47 ± 0.97, thus the mean weight change was 4.56 kg. The final weight recorded for lambs on dietary T2 was higher by 14.8% compared to lambs receiving T4 but was found to be statistically non-significant. Except weight changes, ADG and feed conversion efficiency other parameters did not show significant differences. Lambs receiving taro tuber at lower level of replacement (25 and 50%) had higher live weight changes and average daily growth rate than those lambs that were receiving T4 (100%), but was non-significant compared to lambs receiving T4. Feed conversion was however, considerably higher for lambs maintained on T4 than T2 but remained in par with lambs receiving T1 and T3 [12]. In general, sheep did not respond to the higher level of taro tuber replacement when live weight changes and daily weight gains were taken into account. Initial and final weights, average daily gain, total weight changes and feed conversion efficiency as influenced with replacement of wheat bran with taro on fattening performance of Doyogena sheep, Southern Ethiopia.

| Parameters | Treatments | | | | Mean | SEM | SL |
|---|---|---|---|---|---|---|---|
| | T1 | T2 | T3 | T4 | | | |
| DM intake (g DM/ head/day) | 724.4 | 720.6 | 739.1 | 735.6 | 729.9 | 7.16 | NS |
| Refusal (gDM/ head/day) | 25.6 | 29.4 | 14.35 | 10.93 | 20.07 | 7.16 | NS |
| Initial weight (g/ head) | 23.5 | 24.5 | 24.5 | 23.3 | 23.9 | 1.15 | $0.8307^{ns}$ |
| Final weight (kg/ head) | 28.5 | 30.13 | 29 | 26.25 | 28.47 | 1.34 | $0.2718^{ns}$ |
| Weight changes (kg, 90 days) | $5.05^{a}$ | $5.63^{a}$ | $4.63^{ab}$ | $2.95^{b}$ | 4.56 | 0.65 | * |
| Average daily gain (g/ head/ day) | $56.11^{a}$ | $62.50^{a}$ | $51.39^{ab}$ | $32.78^{b}$ | 50.7 | 7.23 | * |
| Feed conversion efficiency | $7.53^{ab}$ | $8.38^{a}$ | $6.89^{ab}$ | $4.40^{b}$ | 6.8 | 0.97 | * |

SEM=Standard Error Mean; SL=Significance Level; *=p<0.05; NS/ns=Non-Significant; a,b=means within rows without common superscript are different at p<0.05

**Table 3:** Parameters of the experimental animals.

## Carcass characteristics

Carcass characteristics of sheep that fed a basal diet of Rhodes grass hay through grazing and supplemented with different levels of taro tuber to replace wheat bran is presented in **Table 4**. All parameters considered under carcass evaluation did not differed (p>0.05) with level of Taro replacement for wheat bran. Numerically, however, supplementation of lambs with Taro tuber at higher level of wheat bran replacements such as that was seen for lambs receiving dietary T4 displayed lower performance almost for all measured carcass parameters.

| Para meters | Treatments | | | | SEM | SE | Significance level |
|---|---|---|---|---|---|---|---|
| | T1 | T2 | T3 | T4 | | | |
| SW (kg) | 27 | 28.17 | 27.17 | 25 | 26.83 | 0.34 | NS |
| EBW (kg) | 22.5 | 23.5 | 22.5 | 20.83 | 22.33 | 1.24 | NS |
| HCW (kg) | 11.9 | 12 | 11.83 | 10.5 | 11.56 | 0.82 | NS |
| Dressing (%) | 44.07 | 42.67 | 43.52 | 41.71 | 42.99 | 1.15 | NS |
| Hind quarter weight (kg) | 5.5 | 5.17 | 5.17 | 4.67 | 5.13 | 0.35 | NS |
| Fore quarter weight (kg) | 6.33 | 5.75 | 5.92 | 5.5 | 5.88 | 0.37 | NS |
| NS=Non-significant; SEM=Standard error of mean; SW=Slaughter weight; EBW=Empty Body Weight; HCW=Hot Carcass Weight; $cm^2$ = Square of Centimeter | | | | | | | |

**Table 4**: Least-square (Mean ± SE) of edible carcass components as influenced by replacement effects of wheat bran with taro tuber on Doyogena fattening sheep in Areka, Southern Ethiopia.

## Edible non-carcass component

The edible non carcass components of Doyogena sheep fed a basal diet of Rhodes grass hay supplemented with taro tuber to replace wheat bran from commercial concentrate mix is presented in **Table 5.** Except testicle weight, total fat and intestinal weight the remaining parameters considered under edible non-carcass parameters didn't show variations (p>0.05) with levels of Taro tuber replacement for wheat bran from the concentrate mix. In general, while there were no significance difference (p>0.05) among sheep receiving the Taro tuber at rates between 25 to 75% levels of replacements for wheat bran for testicle weight, total fat and intestinal weight, supplementation with Taro tuber at lower level of wheat bran replacements (25 and 50%) generated considerably higher edible non-carcass weight for these same three parameters compared to lambs that were receiving the Taro tuber at higher levels of wheat bran replacements (T4).

| Edible offal | Treatments | | | | SE | SL |
|---|---|---|---|---|---|---|
| | T1 | T2 | T3 | T4 | | |
| Head and Tongue (kg) | 1.79 | 1.84 | 1.81 | 1.65 | 0.11 | NS |
| Heart (g) | 205.3 | 146 | 142.3 | 148.3 | 28 | NS |
| Kidney (g) | 80.67 | 82.33 | 76 | 71.67 | 6.35 | NS |
| Testicles weight (g) | 388.3$^{ab}$ | 408.3$^{a}$ | 352.3$^{b}$ | 295.0$^{c}$ | 30.4 | * |
| Liver and bile (g) | 525 | 398.3 | 417.7 | 451 | 52.81 | NS |
| Total fat (g) | 705.7$^{a}$ | 712.7$^{a}$ | 675.3$^{ab}$ | 422.3$^{b}$ | 46.7 | ** |
| Intestinal weight (kg) | 2.76$^{a}$ | 2.50$^{a}$ | 2.60$^{ab}$ | 1.67$^{b}$ | 0.23 | * |
| Tail weight (g) | 638.3 | 665.7 | 618 | 563.7 | 118.9 | NS |
| Mean values in a row having different superscripts differ significantly each other; **p<0.01, *p<0.05; NS=Non-Significant; SEM=Standard Error Mean; a,b,c=means within rows without common superscript are different at p<0.05 | | | | | | |

**Table 5:** Least-square (Mean ± SE) of edible non carcass components as influenced by wheat bran replaced with taro tuber on fattening performance of Doyogena sheep at Areka.

## Non edible non-carcass components

| Non edible offal non-carcass components | Treatments | | | | | |
|---|---|---|---|---|---|---|
| | T1 | T2 | T3 | T4 | SE | SL |
| Skin weight (kg) | 2.83 | 2.92 | 3.08 | 2.4 | 0.34 | NS |
| Lung and pancreas (g) | 350.7 | 372.3 | 334.7 | 351.3 | 37.27 | NS |
| Spleen (g) | 38.67 | 37.67 | 37 | 33.67 | 3.65 | NS |
| Gut content (kg) | 4.5 | 4.67 | 4.67 | 4.17 | 0.38 | NS |
| NS=Non-Significant; SEM=Standard Error Mean | | | | | | |

**Table 6:** Least-square (Mean ± SE) of non-edible non-carcass components as influenced by replacement effects of wheat bran with taro tuber on the Fattening Performance of Doyogena Southern Ethiopia.

The non-edible non-carcass component of Doyogena sheep fed a basal diet of Rhodes grass hay supplemented with taro tuber was presented in **Table 6.** The weights of total non-edible offal, gut content and lung and trachea were similar among the treatments.

# Discussion

## Feed intake, weight gain and feed conversion efficiency

Feed intake is a function of feed type, texture, form of feed and environmental condition (temperature) of a given environment. The presence of anti-nutritional feed ingredients such as oxalate might limit intake of taro as its level increased. Similar to the present findings, has also noted the decreased intake of taro tuber as the level increased for fattening oxen in south central zones of Ethiopia. A similar finding has noted that local feeds and fodders with better protein value are affordable to smallholder farmers and are easily accessible. Major energy rich local feed sources had also been identified for finishing in crop-livestock mixed farming system of southern Ethiopia. On the contrary, some feed categories are mentioned as poor to promote growth and or finishing animals [13-15].

Proportion of energy and protein feed is also important among others vitamins and minerals to a certain extent. The inclusion of taro to certain amount might have resulted in higher FCE, however further studies need to be conducted to refine the findings. Similar to our findings, noted the importance of taro for growing oxen in south central zones of Ethiopia. It is noted that, local feeds and fodders with better protein value are affordable to smallholder farmers and are easily accessible. Major energy rich local feed sources had also been identified for finishing in crop-livestock mixed farming system of Southern Ethiopia. On contrary, other scholar described some feed categories that are poor support for growing and/or finishing.

The non-edible non-carcass component of Doyogena sheep grower animals reach at better growth further fattening is a deposition of fat and is not cost effective.

Selecting and selling lambs better growth is a common practice among the rural communities, as prolonged feeding can increase production costs. Improving animal weight by reducing labour and feed costs is one of the animal management strategies to improve productivity. Weight change (weight gain) is affected by the mode of feed (physical or chemical treatment, feed quality (energy and protein content), environmental temperature and health status of the experimental animals. There were no weight losses during experimental period. In our study, the initial weight had contributed to fast gaining over experimental period. Feeding with better grower ration might help the attainment of export market weight (28-30 kg) within few weeks (8-9 weeks), which is advantageous because of mainly feed cost inflations from time to time. It is also suggested that, to shorten the period, the amount of supplement would be increased for finishing animals. Except local market, over-fattening is not required for export market because once a grower animals reach at better growth further fattening is a deposition of fat and is not cost effective.

Fattening is one of the common animal husbandry practices among rural communities of Southern Ethiopia. However, prolonged feeding exercise results in extra expenses due to higher labour and feed requirements. Improving animal weight by reducing labour and feed costs is one of the animal husbandry strategies to improve production and productivity of animals under smallholder management. Weight change (weight gain) is affected by the mode of feed (physical or chemical treatment, feed quality (energy and protein content), environmental temperature and health status of the experimental animals. There were no weight losses during experimental period. For producers who targets export market, Doyogena rams started attaining the required export body weight (28.47 kg) within few weeks. In our study, the initial weight might have contributed to earlier weight gains over the experimental period.

It could happen that animal weight changes over time, fluctuating sometimes up and sometimes down, depending on feed texture or health condition of animals. Trends in weight changes of fattening sheep with 25% and 50% replacement of wheat bran taro tuber resulted in consistently higher weight over the experimental period. In line with our findings, noted consistently increasing weight change for oxen fed on one of the local energy rich feeds, taro tuber (*Colocasia esculenta*). This trend might not always show direct relationship due to various factors: health condition of animals, the form of feed offered, environmental temperature.

## Carcass characteristics

The experimental sheep supplemented with T1 and T2 diets attained heaviest total fat content than those sheep supplemented with T4 diets due to fact that higher intake of total DM, ME intake and *in vitro* organic matter digestibility, IVOMD of nutrients. According to dressing percentage of animals increased as total DM and nutrient intake increased, which is in line with the current findings. Moreover, ingested energy above the requirement deposits at different organs of the carcass showed that the sheep have a greater tendency of deposit fat at abdomen and less in muscle. The similarity in DP, SBW, fat thickness and EBW among the sheep supplemented with T1 and T3 from the current study might be due to partitioning of the body weight gain obtained as a result of supplementation into carcass and non-carcass components that might have minimized the differences among the groups. Other scholars have also observed that planes of nutrition demonstrated that the plane of nutrition did not significantly affect DP which is in line with the present findings. Generally, the DP values on EBW basis obtained from the current study is higher than the values of 41.34% and 41.79%, respectively, as reported by for Somali and Mid-Rift Valley sheep raised on concentrate-based diets. However, the DP value from this study is lower than the range of values of 55.2–62.9% reported by for local Somali sheep under high planed nutrition. The higher total edible fat of T1 than T2 and T3 is might be due to higher in gut content which has been expected to lower rate of digestion, which induced proportionally bigger gut content. The sheep that were supplemented with T2 weighed lower gut contents than the sheep supplemented with T1 and T3. This could be related to the diet sheep were fed, which was highly digestible compared with T1 and T2 and took low retention time in the rumen. However, sheep supplemented with T1 diet had considerably heavier gut content than sheep fed on T2 and T3. This could be due to slower digestion of the feed consumed by the former group, which allowed the digesta to stay in the rumen for longer time than in the latter group of sheep. The similarity in total non-edible offal components among the experimental sheep might be due to similarity in gut contents.

## Conclusion

The overall mean daily gain of 50.70 g/day in 6-8 weeks is generally better with minimum supplementation. Therefore, up to 50% replacement of wheat bran by taro tuber could not affect weight and carcass composition of Doyogena sheep. Sheep could reach export market weight (25-30 kg) within 7-8 weeks for Doyogena sheep with strategic supplementation of taro i.e. feeding energy-rich local feeds targeting festive markets of the year.

## Conflict of Interest

The authors declare that there was no conflict of interests.

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