Growth Performance, Morphometry, And Carcass Characteristics of Goat Fed with Indigofera (Indigofera suffruticosa Mill.) and Super Napier (Pennisetum purpureum Schumach x Pennisetm Glaucoma L.)

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Abstracts: Developing different levels of pasture combinations in goat diets still needs to be well established. Although many farmers have already practiced introducing different kinds of pasture in the goat grazing habits, fewer are into feeding goats with various levels of Indigofera and super Napier grass. The study was conducted to assess the effect of different Indigofera and super Napier combinations on the growth performance, morphometry, and carcass characteristics of goats. The study was carried out using a Completely Randomized Designed (CRD) with six treatments replicated four times, where Treatments 1 and 6 served as a control. Tukey HSD test carried out a multi-comparison of means among different treatments. Feeding goats with 100% Indigofera, 80% Super Napier + 20% Indigofera and 100% super Napier significantly resulted in better growth performance of goats, specifically on the final weight (16.93kg, 16.68 kg, and 16.57 kg, respectively) live weight change (3.16 kg, 2.90 kg and 2.67 kg, respectively). Sixty percent super Napier + 40% Indigofera combination significantly affects the feed intake (1.71 kg), while 70% super Napier + 30% Indigofera and 60% super Napier + 40% Indigofera significantly influence the feed efficiency of goat (0.60 and 0.76, respectively). One hundred percent Indigofera likewise influenced the chest perimeter (57.20cm), loin eye area (11.66 cm2), gastrointestinal contents (2.90 kg), hot carcass weight (6.72 kg), cold carcass weight (6.45%), pluck weight (0.68 kg), the weight of total trimmable fats (0.33 kg), percentage weight of total trimmable fats (2.02%) and 70% super Napier + 30% Indigofera also has a significant effect on the percentage rib cut with a cooler shrink (7.62%) after 60 days of experimentation. These results recommend 80% SN+20% Indigofera, 70% SN + 30% Indigofera, and 60% SN + 40% Indigofera.

Keywords: Goat, Morphometry, Carcass characteristics, Indigofera, Super Napier.

1. INTRODUCTION

Goats are categorized as small ruminants that feed on forage, grass, and leaves of shrubs and trees. In times of need, raisers see them as the best source of income. Many farmers that cannot afford to raise large ruminants like cattle and carabaos have goats since they have traits that make them ideal for low-capital businesses. Goat production requires a low initial capital investment that fits the small-hold farm conditions. Culturally, goats are integral to every occasion, such as birthdays, baptisms, weddings, and fiestas. Hence, they command a higher price than other meats in the market.

Goats require low maintenance because they eat tree leaves, grasses, weeds, and agricultural by-products. Intake studies conducted with goats are limited and are usually of shorter duration (Sahlu et al. (1999). It was one of human's first animals to be domesticated about 9,000 years ago. Today, some 200 different goat breeds produce various products, including milk, meat, and fiber (mohair ancashmere). Worldwide, goat meat production is higher than meat products from cattle or animals (Holcomb, 1994).

Raising goats can be a valuable part of a sustainable farm. Integrating livestock into a farm system can increase its economic and environmental health and diversity, thereby making important contributions to the farm's sustainability. Goats often fit well into a farm's biological and economic niches that otherwise go untapped. They can be incorporated into existing grazing operations with sheep and cattle, and can also be used to control weeds and brush to help make use of a pasture's diversity. Contrary to the popular image of goats thriving on tin cans, goat requires a more nutritious diet than other ruminants. Their shorter digestive system does not retain food for long and thus does not digest nutrients fully. This quicker digestion allows them to eat larger quantities of food to make up for their reduced absorption of nutrients, but it is the goat's unique grazing behavior that really enables them to thrive on pasture. With their small mouths and flexible lips, grazing goats can select the highly nutritious parts of plants and leave less nutritious parts. This gives them an advantage over cattle that grace by taking large

mouthfuls; within that large mouthful, there might be a great quantity of poor-quality forage, including some that are dead or overly mature. Each goat can consume up to 3 to 5% of its body weight in dry matter daily (perhaps more if the forage is highly digestible). To consume that amount, however, goats must be pastured in an area with a large quality of available vegetative forage, as they eat less when they are moved to poor pastures.

One of the main constraints in goat production here in our country is grass production or the unavailability of natural pastures due to the shortage of land. Some agricultural by-products or wastes are now considered alternative feeds for small ruminants just to surpass feed problems.

Feeding is one of the most expensive endeavors in any goat operation. Goats raise high-quality feed and optimum balance of many different nutrients to achieve their finest growth and development. Meat goats do not fatten like cattle or sheep, and rates of weight gain are smaller. Because of their nimble lips, Goats are selective feeders, capable of picking off the most nutritious plant parts. The most possible way of attaining maximum goat gains or reproduction is to ensure complete use of high-quality forage mixed or incorporated with other forages that can boost the goat's performance to a maximum.

Evaluations performed in the carcass are important to observe the performance achieved by the animal during its development. These evaluations are carried out objectively and subjectively. The carcass's quantitative traits are essential in determining yield, regional composition (commercial cuts), tissue composition, and carcass muscularity in the meat production system. According to Gonzaga Neto et al., (2006), carcass characteristics are directly influenced by the nutritional composition of the diet. The proportion of muscle in the carcass can also be assessed using objective (body weight and biometrics) and subjective (body score) parameters in vivo or carcass. Yanez et al., (2004) stated that biometric measurement allows the prediction of some quantitative carcass traits. The study was conducted to identify the level of Indigofera and Super Napier grass combination that can promote better growth, morphometry, and carcass quality in goats.

1.1 Objectives of the study

The study's general objective was to determine the effect of various combinations of Indigofera and Super Napier on the growth of goats. It also aimed to determine goats' morphometry and carcass characteristics after the 60-day experimental period. This study was carried out in two sub-studies with specific objectives indicated as follows:

To determine if there is a significant difference among treatment means on the feed intake, feed conversion efficiency, live weight change, and the final weight of goats fed with varying combinations of Indigofera and Super Napier grass. To evaluate if there is a significant difference among treatment means on the morphometric and quantitative characteristics of the carcass, carcass quality, dressing percentage, meat yield, and the total fat contents of goats fed with different combinations of Indigofera and Super Napier grass.

1.2 Significance of the study

The nutrition of the goat is of paramount importance for successful goat production. Being small-sized animals, they can easily be managed by women and Children. Feeding, milking, and caring for goats only require a little equipment and hard work. Returns on capital of up to 50% and recovery of 70% of retail price are possible in goat farming.

2. METHODOLOGY

2.1. Experimental Design

The experimental design was completely randomized, where goats were allocated to six treatments replicated four times. Treatments were the following:

T1 – 100% super Napier

T2 – 90% super Napier, 10% Indigofera

T3 – 80% super Napier, 20% Indigofera

T4 – 70% super Napier, 30% Indigofera

T5 – 60% super Napier, 40% Indigofera

T6 – 100% Indigofera

Because the study focused only on what levels of super Napier and Indigofera combinations affects the growth performance, morphometry, and carcass characteristics of a goat after 60 days, treatment 1 and 6 served as control.

2.2. Materials

The materials used in this study were as follows: super Napier, Indigofera, mineral lick, concentrates, knife, bolo, feeders, waterers, containers, water, chopping board, weighing scale, measuring stick and steel tape, pencil, labels, ballpen, and record book.

Housing of Animals

The study used the existing monitor-type goat house at the Goat Project of the University of Southern Mindanao. Before the start of the study, the goat house was cleaned thoroughly. It was divided into six compartments representing the 6 treatments, with 4 experimental goats for each. Each compartment was provided with necessary feeders and waterers.

Experimental Animal

Twenty-four experimental goats with an age range of 3-4 months were used in this study. The initial weights were taken and randomly distributed to their respective treatments.

Preparation of Experimental Diets

Indigofera legume and super Napier grass were harvested early in the morning from different plots in the goat project. The harvested grass was chopped into 2-4 inches lengths, and the legume leaves were removed from the stems and branches and fed to the experimental goats on a fresh basis. Before giving of the specific amount of super Napier and Indigofera combination per treatment, 50 grams of concentrate per goat was offered daily.

Feeding Management

Goats were fed with their corresponding levels of super Napier and Indigofera combination. They were fed four (4) times a day. Feeds were given at 8:00 am, 11:00 am, 2:00 pm, and 5:00 pm. Potable and clean drinking water was made available throughout the duration of the study. Feeders and waterers were washed and cleaned daily before giving feeds. Pens and their surroundings were cleaned regularly to avoid foul odor and possible occurrence of flies in the area.

Care and Management of Goats

All goats were dewormed with Albendazole against internal parasites. Waterers were washed and cleaned every morning before giving clean drinking water. The surroundings were kept clean to avoid flying that predisposes to disease. Fecal materials were removed every day to avoid building up.

Statistical Analysis

The data gathered were analyzed using the analysis of variance technique for Complete Randomized Design. One-way analysis of variance was used to determine the mean significant differences among the different treatments. Multiple mean comparisons were calculated using the Tukey HSD test in the significant results.

2.3. Morphometric Evaluation and Measurement

Before goats were slaughtered, animal body condition scores (BCS) were determined by spine palpation after the 13th pair of thoracic ribs. The classification was performed using a scale from zero to five (Plate 1.), where zero rates the cachectic animal and five rates the very fat animals. Found in Plate 2 are examples of spinous processes in the BCS of goats. (Meat Goat Production Handbook, Langston University, 2007). Objectively, external morphometric measurements were determined in vivo, using methods described by Yanez et al. (2004): body length (BL), the distance between cervical-thoracic articulation and tail base in the first inter-coccygeal articulation; wither height (WH), the distance between withers and distal forelimb region, height (RH), the distance between sacral tuberosity and distal hind limb, hindleg length (HL), the distance between the largest femur trochanter and the edge of tarsal-metatarsal articulation, thoracic perimeter (TP), perimeter taking the sternum and withers as a base, passing the tape after the palette; rump width (RW), the distance between the largest trochanters of the femur. Body compactness (COMPAC; kg/cm), the objective index of in vivo conformation, was determined by the formula cited by Ynez et al. (2004): COMPAC = WS/BL

2.4. Slaughtering Procedure and Carcass Measurements

The following slaughter procedures are followed:

1. Before slaughtering two goats per treatment, they were subjected to 8-hour fasting, were recorded for their empty live weight, and were humanely slaughtered by the severance of carotid arteries and jugular veins.

2. All the blood of the severed goats was allowed to be dripped.

3. The heads were removed at the atlantooccipital joint, while the fore and hind legs were removed at the carpal and tarsal joints. The heads and legs were weighed and recorded as non-carcass weight.

4. The slaughtered goats had undergone a scalding process where they passed through boiling water to remove hair fleece.

5. Evisceration or removing the visceral organs from the carcass immediately followed. The esophagus was tied to prevent contamination of the carcasses by the gut contents.

6. The carcass was weighed immediately after evisceration and designated as the hot carcass weight.

7. The heart, liver, spleen, kidney, and lungs were weighed together and designated as pluck.

8. The gastrointestinal tract was weighed full and empty to determine the empty body weight (EBW), aiming to determine the true yield: TY (%) = HCW/EBW X 100 (Cezar and Souza, 2007).

9. The weight of the digestive or gastrointestinal tract contents was computed as the difference between the full and empty digestive tract.

10. Visceral fats, subcutaneous fats, inter-muscular fats, and fats coming from the pluck were taken and weighed, and designated as the total trimmable fats weight.

11. Carcass inner length, carcass external length, rump width, rump perimeter, chest width, chest depth, and chest perimeter were measured.

12. Each carcass was split longitudinally into left and right halves and was sectioned into six parts: the leg, loin,

rib, neck, breast, and foreshank. The cut is made based on the standard cutting schemes of chevon (Plates 3, 4, and 5. They were subjected to 24-hour refrigeration at 5℃., after which, they were weighed to obtain their cold weight and were recorded in relation to their cooler shrink (Cezar and Souza, 2007).

13. The loin eye area (LEA) was measured. A cross-section was performed between the 12th and the 13th thoracic vertebrae on the left half-carcass. After exposure of the longissimus dorsi, the muscle, the length, and the height were taken and were multiplied for the loin eye area (cm2) (Cezar and Souza, 2007).

14. Carcass was cooled for 24 hours in a refrigerator at approximately 5oC. afterward, they were weighed to obtain the cold carcass weight (CCW). The index of loss by cooling (ILC) and cold carcass yield and/or commercial yield using the formula as described by Mattos et al., (2006).

Statistical Analysis

The data gathered were analyzed using the analysis of variance technique for Complete Randomized Design. One-way analysis of variance was used to determine the mean significant differences among the different treatments. Multiple mean comparisons were calculated using the Tukey HSD test in the significant results.

3. RESULTS AND DISCUSSIONS

The study was composed of two sub-studies in which study 1assesed the growth performance of goats as affected by different combinations of Super Napier grass and Indigofera legume. Study 2 followed immediately after study 1 terminated to determine the morphometry and the carcass characteristics of goats after 60 days of feeding.

One-way analysis for the variance of completely randomized design (CRD) with six treatments replicated four times where treatments 1 and 6 served as control. Multiple comparisons of means among different treatments were carried out by the Tukey HSD test.

The findings of the study are summarized as follows:

1. No significant difference was observed in goats' initial weight, ranging from 13.76 to 13.90 kg.

2. A diet of 80% Super Napier combined with 20% Indigofera given to goats for 60 days revealed significant effects on the final weight of goats.

3. Live weight change (kg) and live weight change (%) of goats fed with a combination of 80% Super Napier and 20% Indigofera were significantly higher than the other treatments.

4. Feed intake was statistically higher in goats fed with 60% Super Napier combined with 40% Indigofera than those given with other different Super Napier combined and Indigofera combinations.

5. Feed efficiency in goats fed 80% Super Napier and 20% Indigofera diets was 0.03 kg of weight in every kg of feed.

6. The external measurements (cm) of goats include the body length, heart girth, wither's height, hindleg length, foreleg length, and thoracic perimeter, as well as the COMPAC and the body condition scores of goats, posted no significant effects after 60 days of feeding trial.

7. Carcass inner length, carcass external length, rump width, rump perimeter, chest depth, and the carcass compactness index showed no significant results.

8. Goats fed with 90% Super Napier + 10% Indigofera and 80% Super Napier + 20% Indigofera revealed a significantly higher value in terms of chest perimeter with a mean of 52.05 cm and 55.05 cm, respectively.

9. Goats fed with 90% Super Napier + 10% Indigofera, 80% Super Napier + 20% Indigofera and 60% Super Napier + 40% Indigofera exhibited a significantly higher loin eye area of 7.31 cm2 and 7.11 cm2 and 7.55 cm2

respectively.

10. No significant influences were revealed regarding weight at slaughter, empty body weight, true yield, loss index by cooling, hot carcass yield, and cold carcass/commercial yield after 60 days.

11. Goats under experimental diets of 90% Super Napier + 10% Indigofera, 70% Super Napier + 30% Indigofera and 60% Super Napier + 40% Indigofera exhibited a significant weight of total gastrointestinal contents after 60 days of the experiment.

12. For the gastrointestinal contents, goats fed with 90% Super Napier + 10% Indigofera, 70% Super Napier + 30% Indigofera and 60% Super Napier + 40% Indigofera combinations all did significant changes on the said parameter after 60 days.

13. Goats fed with 90% Super Napier + 10% Indigofera, 80% Super Napier + 20% Indigofera and 60% Super Napier + 40% Indigofera significantly revealed a higher hot and cold carcass weight than those with other treatments applied.

14. No significant difference was observed in the dressing percentage or the hot carcass yield, non-carcass weight, percentage non-carcass, total GIT weight, percentage total GIT weight, and percentage pluck weight of goats after 60 days of the feeding period.

15. With regards to pluck weight, four treatments were used, specifically the 90% Super Napier + 10% Indigofera, 80% Super Napier + 20% Indigofera, 70% Super Napier + 30% Indigofera and 60% Super Napier + 40% Indigofera all significantly gave an increase on the said parameter measured.

16. Those goats fed with 90% Super Napier combined with 10% Indigofera and 60% Super Napier + 40% Indigofera significantly revealed a high weight and percentage of total trimmable fats.

17. For cut yield, goats fed with 70% Super Napier combined with 30% Indigofera showed a significantly cooler shrink of 7.620 in rib cut parts.

Growth performance of goats

Goats fed 80% Super Napier in combination with 20%. Indigofera had the highest final weight after 60 days, revealing a significant result ($P < 0.01$). This can be attributed to the nutrient contents of both nutrients and crude protein and essential amino acids (Pugh, 2016). Animals were expected to gain once their diet contains 22% crude protein, according to Fernandez (2014), and crude fiber is exceptionally well digested by goats. Feed efficiency was calculated as the difference in weight between the final and initial weights divided by the amount of feed consumed between the dates the initial and final weights were taken (SAS, 1999). In this study, statistically significant differences were observed in the feed efficiency of goats fed with different amounts of Super Napier and Indigofera combination ($P=0.01$). Among the grass-legume combination, 80% + 20% combined with Super Napier was more efficient than other treatments used. This implies that goats fed this combination efficiently converted feed into the meat (Linn et al., 2009).

Morphometrics of goats

Morphometric analyses are commonly performed on animals and help analyze their fossil record. Morphometrics can be used to quantify a trait of evolutionary significance. By detecting changes in the shape, deduce something of their ontogeny, function, or evolutionary relationships. A major objective of morphometrics is to statistically test hypotheses about the factors that affect shape (Yanez et al., 2004).

Carcass Characteristics of Goats

The weight at slaughter and empty body weight did not significantly influence goats after 60 days. The actual yield is the most accurate since it eliminates the changes in the contents of the gastrointestinal tract from the calculation (Hashimoto et al., 2007). In this study, the dressing percentage of goats had not been significantly

affected by the feeding of different levels of Super Napier and Indigofera combinations. The interactions among the individual factors affecting dressing percentage are significant, making it somewhat challenging to accurately predict carcass yield or quality (Shelton et al., 1984). No significant difference was observed in goats' total gastrointestinal tract weight after 60 days (Osorio et al., 2002). However, the gastrointestinal tract contents showed a significant result ($P<0.05$) where three treatments had influenced the weight of the GIT. This showed that nutrients derived from the feeds were solely directed to increasing carcass components rather than the non-carcass parts. Goats' pluck components (heart, liver, kidney, and lungs) also showed significant differences between treatments.

3. CONCLUSIONS AND RECOMMENDATIONS

It can be conducted that goats fed with 80% Super Napier combined with 20% Indigofera resulted in better growth performance in terms of final weight (kg), live weight change (kg), weight change (%), and feed efficiency. Grater chest perimeter (cm) and higher weights in GIT contents, hot carcass, cold carcass, pluck, and total trimmable fats were also observed. The study recommends the use of an 80% Super Napier + 20% Indigofera combination is highly recommended as feed for goats. The same study can be conducted for a longer period of time since the study was conducted only for 60 days. And digestibility studies can be conducted to determine which of the combinations are easily digested.

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