Annals of Tropical Research 45 (2):102-111(2023)
https://doi.org/10.32945/atr4527.2023

Digestibility of fortified sugarcane-top pellets supplemented with concentrates and *Arachis pintoi* leaf meal in goats

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ABSTRACT

Received: 4 December 2019 | Accepted: 6 June 2023

An in vivo digestibility trial was conducted to assess the digestibility of fortified sugarcane top (SCT)-based pellets supplemented with concentrates and *Arachis pintoi (Pinto peanut)* at varying ratios. Six female goats were randomly assigned to six different treatments: T1-concentrate at 1.25% of BW, T2-concentrate at 1.00% of BW and *A. pintoi* at 0.25% of BW, T3- concentrate 0.75% of BW and *A. pintoi* at 0.50% of BW, T4-concentrate at 0.50% of BW and *A. pintoi* at 0.75% of BW, T5- concentrate at 0.25% of BW + *A. pintoi* at 1.00% of BW and T6-*A. pintoi* at 1.25% of BW, all in dry matter (DM) basis. The feeding trial was repeated four times with 7 day intervals as replicates. Feed intake and fecal output were recorded and samples were analysed for dry matter (DM), organic matter (OM), crude protein (CP) and neutral detergent fiber (NDF). Nutrient digestibility were computed and data were subjected to one-way analysis of variance for a randomized complete block design while pairwise comparison of treatment means was done using Tukey's Honestly Significant Difference Test. Results show that the ratio of concentrate and *A. pintoi* at 0.75% and 0.50% of BW, DM basis, significantly increased the digestibility of fortified sugarcane top-based pellets in goats, thus maximizing its utilization.

Keywords: *arachis pintoi*, crop residue, in vivo digestibility, dry matter, nutrient intake

INTRODUCTION

Small ruminant production, particularly goat (*Capra hircus* Linnaeus), is a fast-growing enterprise in the Philippines. Raisers are attracted to goat farming due to its low capital requirements and multi-functional utility as well as its adaptation to

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different climate conditions (Alemu et al 2020). Goats have been considered as the "poor man's cow" because of their immense contribution to landless and marginal farmers, rural economy and national income (Patil 2013). Chevon is known to be a tasty, nutritious and healthy meat. One of the great advantges of goat raising is the steady demand for its meat and the potential high return under traditional management conditions (Upton 1984).

Feeding goats in a feedlot situation, gives producers the opportunity to use economical feeds and crop by-products such as sugarcane tops (Rapetti et al 2008). Goats fed with sugar cane tops in the wet season have the same weight gain and feed conversion as those fed with guinea grass (Nguyen 1997). The inclusion of dried sugarcane tops in sheep diets increases average daily gain and carcass characteristics (Yuangklang et al 2005) and gives better animal performance and economic profitability (Worku 2015). Goats are selective, they taste the feed and choose the palatable one first and they have a preference for concentrates when made available (Rapetti & Bava 2008). The inclusion of sugarcane tops at levels of 20% and 30% as part of a fattening ration for ruminants has been recommended (Mahala et al 2013). Orden et al (2014) reported there is a high potential for a pelletized forage-based diet as an alternative feed ration for productive and sustainable goat farming enterprises.

Sugarcane top has a low nutritive value where this quality is associated with its lignified nature, which limits intake, digestibility and overall utilization (Olafadehan & Adewumi 2009). However, crop residues like sugarcane tops have been used in ruminant diets with supplementation to improve the digestion of its fiber (Sarnklong 2010). Supplementation with concentrates also improves both the prepartum and post-partum body condition of goats raised in an extensive system (Sahu et al 2013). Supplements that improve protein to energy ratio in a low true protein forage diet have potential effects on live weight gains. Protein feed ingredients added to poor-quality diets increase microbial protein synthesis and protein flow from the rumen (Ben-Ghedalia et al 1989). Protein sources for feeding animals could be either from plant or animal sources. *Arachis pintoi (Pinto peanut)* is a potential feed ingredient for ruminants based on its high crude protein(CP) content (18%) and rapid degradation in the rumen (Khamseekhiew et al 2001). *Arachis pintoi* is a leguminous plant which is good of source protein that improves fiber degradation without spending too much for concentrates. *Arachis pintoi* is a leguminous plant which is good of source protein that improves fiber degradation without spending too much for concentrates.When low-quality forages and grains are balanced in the diet, both at the level of the rumen and the animal, significant production responses can be achieved (Minson 2012, Coleman & Moore 2003).

This study was conducted to determine which ratio of concentrate and *A. pintoi* supplementation would maximize the intake and the Dry Matter(DM), Organic Matter(OM), Crude Protein(CP) and Neutral Detergent Fiber(NDF) digestibility of fortified sugarcane tops-based pellets in goats.

MATERIALS AND METHODS

The study was conducted at the Dairy Goat Research Center of Northern Negros State College of Science and Technology, Escalante City, Negros Occidental, Philippines from August to October, 2018, using 4-month-old native goats. Sugarcane tops(SCT) of the VMC 84-524 variety (9 months old) were

gathered and chopped to about 3-4inches in length. The chopped SCT were then shredded to obtain a finer particle size of about 1-2cm and air-dried to at least 86% DM, as shown in figure 1. The dried-shredded sugarcane tops were then mixed manually with ricebran, pollard and molasses for 10mins. Molasses was included at the rate of 5% which also served as the pellet binder. The mixture was then processed into pellets using a pelleting machine (PL200) and stored in sack for 1 week until used for feeding. The process of producing fortified sugarcane top-based pellets are presented in figure 1 and the nutrient composition is shown in Table 1.

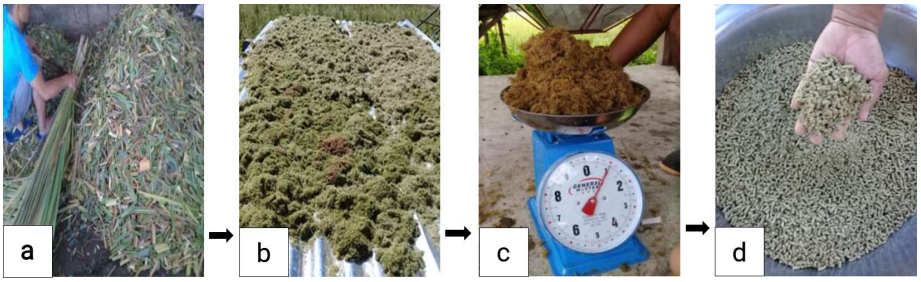

Figure 1. The process of preparing fortified sugarcane tops-based pellet (a) Chopping SCT, (b) Sun-drying SCT, (c) weighing according to the formulation and (c) Pelleting the SCT

Table 1. Nutrient composition of fortified sugarcane tops-based pellets

Nutrient Composition of Sugarcane Top Pellets	
Dry Matter, %	85.72
Crude Protein, %	8.56
Neutral Detergent Fiber, %	34.44
Energy, Kcal/kg	43.56

Treatments and Experimental Design

The experiments were laid out in Randomized Complete Block Design with six treatments and was replicated four times based on periods, with a total of sixteen experimental units.

The dietary treatments were as follows:

T1- Fortified SCT pellets + concentrate at 1.25% of BW (Body Weight), DM basis
T2- Fortified SCT pellets + concentrate at 1.00% of BW, DM basis + *A. pintoi* at 0.25% of BW, DM basis
T3- Fortified SCT pellets + concentrate 0.75% of BW, DM basis + *A. pintoi* at 0.50% of BW, DM basis
T4- Fortified SCT pellets + concentrate at 0.50% of BW, DM basis+ *A. pintoi* at 0.75% of BW, DM basis
T5- Fortified SCT pellets + concentrate at 0.25% of BW, DM basis + *A. pintoi* at 1.00% of BW, DM basis
T6- Fortified SCT pellets + *A. pintoi* at 1.25% of BW, DM basis

Preparation of Supplements

The concentrate comprised of corn, soya meal, copra meal and rice bran, used as supplement was formulated as a source of proteinand analysed at the Animal Nutrition laboratory of the Department of Animal Science, Visayas State University, Philippines. The crude protein composition of the concentrate used as supplement was 12.53% CP; approximately similar with the nutrient composition of the *A. pintoi* leaf meal 12.55% CP.

Preparation and Feeding of Experimental Animals

There were six weanling female goats used in the study which were randomly assigned to six different treatments. The initial weights of goats were between 4kg tand 5kg at the start of the study and used as the basis in the determination of the *ad libitum* intake requirement of the basal diet. Goats were placed in open-top, 2x4ft. metabolism cages as used by Bestil and Espina (1992) to allow measurement of feed intake and refusal, while at the same time allowing for the separation of the feces from the urine for digestibility determination. Pre-feeding with the basal diet and experimental ration were introduced gradually over a three day interval to prevent digestive up-set as the microbial population adjusted to the new diet and also to ensure enzyme production by the animals on the experimental ration. Deworming with albendazole at .5mL per 5kg BW was done prior to the conduct of the study to ensure the goats were free from parasites.

The fortified SCT-based pellets were offered twice a day at 8am and 4pm. The supplements comprisied of concentrates and *A. pintoi* at varying percentages were mixed together and were given to the experimental animals at 12 noon. Drinking water was made available at all times.

Intake and Digestibility Trial

The in vivo digestibility trial was adopted according to the procedures of Bestil (2008).

Day	Activities
1-7	Adjustment Period. The experimental goats were given the treatment diets based on the previous day's voluntary intake with 20% allowance added Initial weights of animals were also measured and daily feed intake was recorded throughout the adjustment period.
8-14	Collection Period. Daily feed given and refusals were recorded to calculate the voluntary feed intake. Samples of feed offered and refused were collected daily for laboratory analysis. Daily fecal outputs were recorded and representative samples were obtained, pooled together, and sub-sampled for laboratory analysis of dry matter, crude protein, organic matter, and neutral detergent fiber content.
15-19	Elimination of carry-over effects. The experimental animals were released into the grazing area for 7 days with native grasses until the next feeding period.

Laboratory Analysis

Fortified SCT- based pellets were prepared weekly and samples were taken from each batch. Feces were collected daily, pooled together and samples were taken for analysis. Samples were then dried at 60°C for 48h, ground using a Wiley mill with 3mm screen and analysed for DM, CP and ash using the methods of AOAC (1990). Neutral Detergent Fiber (NDF) was measured according to the method of Goering and Van Soest (1970). Digestibility of nutrients were calculated according to Schneider and Flatt (1977).

The data were computed according to the following formula:

1. Dry Matter Intake (DMI)

$$DMI = \text{VFI x \%DM of feed, DM basis}$$

where VFI = Voluntary Feed Intake of SCT-based pellets

DMI was measured for fortified SCT-based pellets and total diet, as the amount of supplement (concentrate and *A. pintoi* leaf meal) was given fixed.

2. Dry Matter Digestibility (DMD, %)

$$DMD, \% = \frac{\text{DMintake} - \text{DMexcreted}}{\text{DMintake}} x100$$

where: DM excreted = Fecal output, kg x % DM of feces, DM basis

3. Organic Matter Digestibility (OMD,%)

$$OMD, \% = \frac{\text{OMintake} - \text{OMexcreted}}{\text{OMintake}} x100$$

where: OM excreted = DM excreted x % OM of feces, DM basis

4. Crude Protein Digestibility (CPD,%)

$$CPD, \% = \frac{\text{CPintake} - \text{CPexcreted}}{\text{CPintake}} x100$$

where: CP excreted = DM excreted x % CP of feces, DM basis

5. Neutral detergent Fiber Digestibility (NDFD, %)

$$NDFD, \% = \frac{\text{NDFintake} - \text{NDFexcreted}}{\text{NDFintake}} x100$$

where: NDF excreted = DM excreted x % NDF of feces, DM basis

RESULTS AND DISCUSSION

DM Intake and Digestibility

Goats fed with fortified SCT-based pellets supplemented with concentrates and *A. pintoi* leaf meal at different ratios shows no significant differences on the DM intake and % BW. No significant difference was also found on the nutrient intake of goats fed with fortified SCT-based pellets supplemented with concentrates and *A. pintoi* at varying levels. DM digestibility revealed a significant difference on goats fed with fortified SCT-based pellets supplemented with concentrate at 0.75% of BW + *A. pintoi* at 0.50% of BW compared to treatments with concentrate at 0.50% of BW + *A. pintoi* at 0.75% of BW; concentrate at 0.25% of BW + *A. pintoi* at 1.00% of BW and treatments with *A. pintoi* at 1.25% of BW as shown in Table 2.

Table 2. Nutrient digestibility of fortified SCT-based pellets in goats supplemented with concentrates and *A. pintoi* at varying ratios

Treatments	DMI (g)	DMI (%BW)	DMD (%)	OMD (%)	CPD (%)	NDFD (%)
T1 - Fortified SCT pellets + concentrate 1.25% of BW	562	4.09	63.06^{ab}	71.57^{abc}	82.68^{b}	59.00
T2 - Fortified SCT pellets + concentrate at 1.00% of BW + *A. pintoi* at 0.25% of BW	530	4.08	67.95^{ab}	77.56^{ab}	88.71^{a}	63.86
T3 - Fortified SCT pellets + Concentrate at 0.75% of BW + *A. pintoi* at 0.50% of BW	426	3.36	73.74^{a}	80.16^{a}	89.52^{a}	72.90
T4 - Fortified SCT pellets + Concentrate at 0.50% of BW + *A. pintoi*at 0.75% of BW	519	3.97	56.36^{b}	67.63^{bc}	82.75^{b}	50.42
T5 - Fortified SCT pellets + Concentrate at 0.25% of BW + *A. pintoi*at 1.00% of BW	615	4.96	56.89^{b}	68.94^{bc}	85.05^{ab}	38.72
T6 - Fortified SCT pellets + *A. pintoi* at 1.25% of BW	659	5.05	57.25^{b}	66.08^{c}	80.68^{b}	52.80
p-value	0749^{ns}	0.0757^{ns}	0.0111*	0.0020*	0.0007*	0.0578^{ns}
CV,% =	19.41	19.11	10.79	6.16	2.92	25.21

Treatment means within column with different superscript letters are statistically different
** - Highly significant at $p<0.01$
* - Significant at $p<0.05$

Pelleted SCT improves the overall intake of goats as pelleting of feedstuff increases feed intake, improves the palatability and decreases the bulkiness of feeds (Preston & Leng 1987). Feeding of sugarcane tops to ruminant animals supplemented with wheat bran and *Lentil chuni* improves nutrient intake and digestibility as shown by Gendley et al (2002).

Nutrient Digestibility

Table 2 shows a significant difference on the OM digestibility between treatments with concentrate at 0.75% of BW + *A. pintoi* at 0.50% of BW and treatments supplemented with *A. pintoi* at 1.25% of BW. Also CP digestibility showed significant difference between treatments supplemented with concentrates at 1.00% of BW + *A. pintoi* at 0.25% of BW and concentrate at 0.75% of BW + *A. pintoi* at 0.50% of BW to treatment supplemented with concentrate at 1.25% of BW; treatment with concentrate at 0.50% of BW + *A. pintoi* at 0.75% of BW and treatment with *A. pintoi* at 1.25% of BW, respectively.

Feeding sugarcane stalks to ruminants as a roughage source is possible when supplemented with protein and energy sources (Kawashima et al 2002). While pelleting improves the quality of sugarcane top as feed for ruminants (Yuangklang et al 2005)and increases the rate of Volatile Fatty Acid absorption (Dijkstra et al 1993). Significant production responses can be achieved, both at the level of the rumen and the animal, by feeding ruminants with balanced low-quality forages and grains (McDowell 1996, Sampaio et al 2010). The utilization of sugarcane tops as feed for goats can be maximized through supplementation with concentrate or a plant-based protein source. Feeding protein or non-protein nitrogen (NPN) in concentrate could increase feed intake, digestibility, microbial protein production, and rumen fermentation efficiency; thereby, improving the performance of ruminant-fed low-quality roughages (McGuire et al 2013, Khattab et al 2013).

CONCLUSION

The ratio of concentrate at 0.75%-1:00% of BW and *A. pintoi* leaf meal at 0.50%-0.25% of BW level of supplementation significantly increased the DM, OM, CP and NDF digestibility of the fortified SCT-based pellets in goats. The digestibility of fortified sugarcane-top-based pellets is highest with concentrates at 0.75% of BW and *A. pintoi* leaf meal at 0.50% of BW levels of supplementation.

RECOMMENDATION

To maximize intake and digestibility of fortified SCT-based pellets in goats, it is recommended to supplement with a combination of concentrates at 0.75% of BW and *A. pintoi* leaf meal at 0.50% of BW level.

ACKNOWLEDGMENT

The financial support of the Department of Science and Technology – National Science Consortium (DOST-NSC), to Dr. Victor B. Asio (VSU-NSC Coordinator), and to Dr. Lolito C. Bestil (Chairman of the Graduate Advisory Committee), are gratefully acknowledged.

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