

The Effect of Dietary Fats on Goat Digestion

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This study concerns the effect of dietary fats on goat digestion. It was conducted at the Metabolism Laboratory of the Institute of Animal and Dairy Sciences Cluster (ADSC) at the University of the Philippines, Los Baños, Laguna. Three goats weighting 27.33 ± 1.53 kg were housed in individual elevated metabolism stalls with customised faecal collection tools. Treatments were replicated three times over following a Complete Randomised Design (CRD) to evaluate the effect of dietary fats' supplementation on DM, CP, NDF and ADF digestion. Animals were randomly selected for different dietary treatments in different cycles. For each cycle, animals were provided with concentrate in the morning and ad libitum feeding of Napier grass thereafter. Clean drinking water was made available all the time in the respective animal watering troughs. The goats were supplemented with two types of dietary fats (VCO and lard) at 3 and 5%. Data showed that animals supplemented with 3% lard received the uppermost digestion across parameters, while the control received the lowest digestion performance for CP, NDF and ADF despite high DM intake. Analysis of variance showed no significant difference ($P > 0.05$) among treatment means for DM, CP, NDF and ADF digestion. It is concluded that the influence of dietary fats such as VCO and lard showed insignificant differences in treatment means as supplements for goat rumen digestion. This is so even though a trend was observed: giving VCO and lard increases the percentage of CP, ADF and NDF digestion. In this study, virgin coconut oil and lard can be efficiently used as a good source of energy for goats fed with Napier grass without affecting growth performance. This indicates a good approach in exploiting the use of local fat resources for goat production. Supplementing dietary fats in goat concentrate showed decreases in protozoa populations that ingest rumen bacteria. This resulted in increased digestion in the supplemented groups. Satiety's effect on the treated group resulted in lower dry matter intake and dry matter digestion but increases in ruminating time due to negative effects on rumen digestion that tend to increase CP, NDF and ADF digestion.

Key words: *Dietary fats, goat digestion, Complete Randomise Design, VCO, lard, Los Baños, Laguna, Philippines.*

Introduction

In the Philippines, more and more people are interested in raising goats. This is because goats require low maintenance, low initial investment and incur small risks compared to other livestock. Goat meat and milk is also considered Halal food, making it marketable in Mindanao and in the international market, particularly in the Middle East. Carcass recovery and milk production of goats can be increased by understanding the digestion of goats.

Dietary fat supplementation in ruminants' diet has been looked upon as a means of increasing the energy intake of ruminants without proportional increases in the quantity of feed consumed. Limited information is available with regards to the investigation on the influence of dietary fats on the efficiency of nutrient utilisation in growing and lactating ruminants. This is so especially when they are fed roughage-based diets. Although results reported in the literature are highly variable, generally, it is believed that the inclusion of more than 4-8% fat in goats' diet will result in a reduced digestion of fibre in the rumen and sometimes a reduced DMI (Kronfeld, 1982; Moore, *et al.*, 1986). This is unless these lipids are offered in a form that makes them relatively inert in the rumen.

Therefore, the aim of this study is to examine qualitative and quantitative changes in dry matter, crude protein, as well as neutral and acidic detergent fibre digestion in goats supplemented with different dietary fats.

Materials and Methods

The study was conducted at the Metabolism Laboratory of the Institute of Animal and Dairy Sciences Cluster (ADSC) at the University of the Philippines, Los Baños, Laguna, the Philippines.

Samples of different treatments were subjected to analysis (dry matter, crude protein, acid detergent fibre, and neutral detergent fibre). These analyses were performed at the Animal Nutrition Analytical Service Laboratory (ANASL) in UPLB. Analyses were based on the standard procedures of Association of Official Analytical Chemists (AOAC, 1995).

The effect of different dietary fats' supplementation on animal diets were evaluated on digestion performance with corresponding dietary treatment combinations shown in Table 1.

Three female, rumen-cannulated goats weighting 27.33 ± 1.53 kg were housed in individual elevated metabolism stalls and provided with 30% concentrate in the morning based on the feed requirements (3% of their body weight (BW) in dry matter (DM)) of the animals. *Ad libitum* feeding of grass followed thereafter. Clean drinking water was made available all the time in the respective animal watering troughs. There was a seven day lag period in every cycle for the animals to return to their natural states.

On the 8th day of every cycle, animals were given different dietary treatments. A digestion trial was done on the 11th to 13th day of the feeding trial (3 days after treatment).

Research Design and Layout

Three mature goats surgically fitted with rumen cannula were used. The experimental animals were in good body condition prior to and throughout the duration of the study. Crossover in a Complete Randomised Design (CRD) was used to evaluate the effect of different dietary treatments. Five dietary treatments were used in the study with dietary treatment combinations as follows:

Treatment Combinations

The rumen-cannulated goats were supplemented with different levels of two dietary fat sources with dietary treatment combinations as follows:

- Treatment 1 - CONTROL
- Treatment 2 - 3% Virgin Coconut Oil (VCO)
- Treatment 3 - 5% Virgin Coconut Oil (VCO)
- Treatment 4 - 3% Lard
- Treatment 5 - 5% Lard

Table 1

Treatment assignment of goats for the entire duration of the study

Treatment	Initial	1 st Cycle	2 nd Cycle	3 rd Cycle	4 th Cycle
Animal 1	T3	T2	T5	T4	T1
Animal 2	T2	T3	T4	T1	T5
Animal 3	T5	T4	T3	T1	T2

Research Procedure

Three mature goats surgically fitted with rumen cannula were used. The experimental animals were in good bodily condition prior to and throughout the duration of the study. Due to a limited number of animals surgically fitted with rumen cannula in the laboratory, a 3 X 5 crossover in a Complete Randomised Design was used to evaluate the effect of different fats'

supplementation on the animals' diet (dry matter, crude protein, acid detergent fibre, and neutral detergent fibre) and digestion with dietary treatment combinations, as shown in Table 1.

Table 1 shows the various dietary treatments' schedules and treatments assignment for the whole duration of the study. For each cycle, animals were provided with Napier grass in the afternoon and concentrate in the morning and were given free access to potable water. The initial data was collected before the start of the study as a control. All data was collected simultaneously in every cycle of the study. Faeces was collected twice every 4th and 5th day of the treatment period of the study. This was to ensure that the rumen environment of the animals was already changing to its expected stable status based on the treatment applied.

Chemical Analysis: For determination of total Dry matter (DM) content, samples of dried feeds, faeces and refuse were dried at 70°C for 48 hours in a forced draft oven. Feed and faecal samples were randomly collected daily, and all samples were combined together and randomly sampled for dry matter (DM) and crude protein (CP) analysis according to AOAC (1990). The contents of neutral-detergent fibre (NDF) and acid-detergent fibre (ADF) were determined according to the procedure of Goering and Van Soest (1970).

Feeding Management: The animals were provided with concentrate in the morning based on the dietary treatments and ad libitum feeding of Napier grass that followed thereafter. Clean drinking water was made available all the time in the respective animal watering troughs.

Preparation of Concentrate: The animals were given 30% concentrate in their total feed requirements of 3% of their total live weight (dry matter basis). Coconut oil and lard was mixed according to the designated treatments.

Digestion Trials

Representative feed and faecal samples were analysed for dry matter content following the Association of Analytical Chemist (1975) method. Crude protein was analysed using the Kjeldahl analysis based on AOAC (1975) procedure. Neutral detergent fibre (NDF) and acid detergent fibre (ADF) analysis was done following the Van Soest and Wine (1967) procedure.

Nutrient analyses of the pooled samples of the faeces and feeds were undertaken and the coefficients of digestion (%) of each were calculated:

a.
$$\frac{(\% \text{ nutrient in feed}) (\text{TFI}) - (\% \text{ nutrient faeces}) (\text{TFP})}{(\% \text{ nutrient in feed}) (\text{total feed intake})} \times 100$$

TFI – total feed intake, TFP – total faeces produced.

Statistical Analysis

The statistical analysis was carried out using Statistical Analysis System (SAS® for windows© v.9.1.3. sp.4) software (SAS Institute, 2003). All results were presented as means (\pm SD and a level of significant of $P < 0.05$).

Results and Discussion

In vivo or digestion is termed as such because it does not take into account the endogenous and metabolic losses in the animal's body. Among the different digestion methods, however, it is the one that gives the closest idea of what is really happening in the animal's body. Barcelo (1989) and Ningal (2008) mentioned that *in vivo* digestion measures the effects of microorganisms and the animals themselves on the chemical composition of the forage and concentrate. This allows it to give the best results in terms of the nutritive value of forages and concentrates.

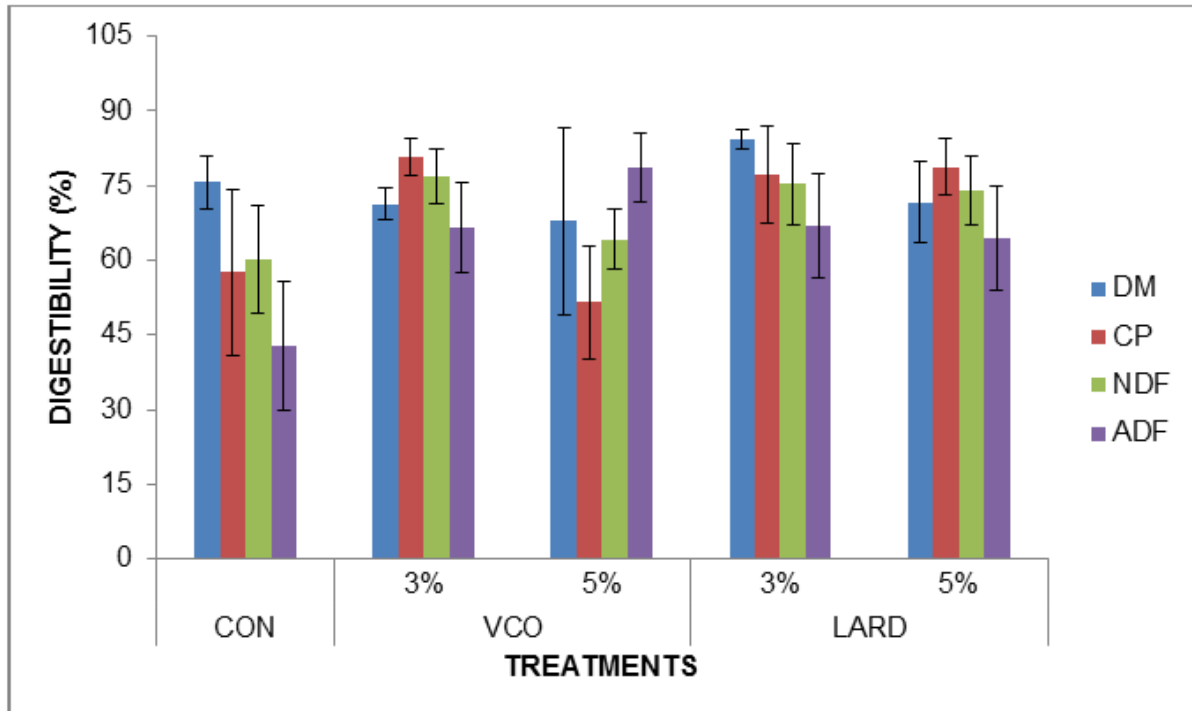
Dry Matter Digestion

The summary of the *in vivo* digestion of some nutrients utilised by goats fed with Napier grass with different dietary fats in their concentrate was shown in Figure 1.

The highest dry matter digestion was observed in goats with 3% lard with 84.3% digestion. This was followed by the control, with 75.8% digestion, followed by the goat supplemented with 5% lard with 71.7% digestion. This was followed by the goat supplemented with 3% VCO with 71.3% digestion. The lowest dry matter digestion came from the goat supplemented with 5% virgin coconut oil.

Figure 1

Mean (\pm SD) apparent nutrient digestion of mature female goats



Analysis of variance showed no significant difference ($P>0.05$) among treatment means. However, based on the data presented, the control is the second highest in terms of dry matter digestion. The reduction of dry matter digestion in the dietary fat supplemented group show an increase in ruminating time due to negative effects on rumen digestion and a slowdown of rumen emptying due to metabolic effect of fatty acids (Chilliard, *et al.*, 1993). In both situations, a satiety effect due to rumen replenishment could occur (Martinez Marin, *et al.*, 2012).

The results of the experiment confirm those of a study conducted by Jordan *et al.* (2006a, 2006b) on the effect of increasing levels of coconut oil (0; 125; 250; 375 g/day) on the digestion of sixteen Charolais/Limosin heifers. The results showed that as the level of coconut oil increased, dry matter digestion (DMD) decreased. However, no significant differences ($P>0.05$) were observed in supplementing coconut oil at a maximum of 250g/day. The inhibitory effect of high-fat intake on fibre digestion is explained by disturbance of ruminal fermentation through depression of cellulolytic bacteria (Coppock and Wilks, 1991). Thus, the effect on dry matter digestion is higher on 5% coco oil and 3% lard in the concentrate. The results show that there was alteration occurring in the rumen ecology of the upgraded goats used

in the research. It is therefore concluded that the inclusion of coconut oil as part of 50/50 silage and concentrate rations has no adverse effects on the DMD up to the 250 g/day level.

Crude Protein Digestion

The *in vivo* crude protein digestion performance of goats fed with Napier grass supplemented with different dietary fats in their concentrate, as presented in Figure 1, showed that the highest crude protein digestion was observed in goats supplemented with 3% VCO of 80.80%, followed by 5% lard of 78.75%. Goats supplemented with 3% lard, 5% VCO and the control got 77.06%, 73.24% and 57.55% respectively.

Analysis of variance showed no significant differences ($P > 0.05$) among treatment means regarding CP digestion. However, there was a trend observed showing that treatment supplemented with dietary fats has higher CP digestion compared to non-supplemented treatment. Several studies showed that dietary lipids reduce protozoan concentrations in the rumen (Firkins, *et al.*, 2007). Rumen ciliate protozoa ingest rumen bacteria. This results in increased recycling of microbial N in the rumen (Jouany, 1996) and decreased amino acid supply to the intestine by 20–28% (Ivan *et al.*, 1991). Therefore, adding dietary fats that reduce protozoa concentrations allows the proliferation of rumen bacteria that help facilitate the production of microbial proteins. Dietary fats inhibit microbial activity in the rumen (Devendra and Lewis, 1974, A.R. Abubakr, *et al.*, 2013). Concentrate feed reaches the reticulum intact and is efficiently digested and absorbed in the small intestine.

Neutral Detergent Fibre Digestion

Apparent neutral detergent fibre digestion performance of goats fed with Napier grass was supplemented with different dietary fats in the concentrate (Figure 1). The highest neutral detergent fibre digestion was observed in goats supplemented with 3% VCO of 77.00%, followed by 3% lard of 75.31%. Goats supplemented with 5% lard, 5% VCO and the control got 73.95%, 68.85% and 60.10%, respectively.

Supplementation of dietary fats showed no significant difference ($P < 0.05$) in neutral detergent fibre digestion among treatments. However, there was a trend observed that showed treatment supplemented with dietary fats has higher NDF digestion compared to the non-supplemented treatment. Several studies showed that dietary lipids reduce protozoa concentrations in the rumen (Firkins, *et al.*, 2007). Rumen ciliate protozoa ingest rumen bacteria. This results in the increase of the population of rumen bacteria that facilitate fibre digestion. Other reasons for the reduction of neutral detergent fibre digestion within the dietary fats supplemented group are an increase of ruminating time due to negative effects on rumen digestion and a slowdown of rumen emptying due to the metabolic effect of fatty acids (Chilliard, *et al.*, 1993). Thus, the increase of exposure time of fibre to the rumen for the treated group could lead to the increase of digestion of the fibre materials while fibre-rich concentrate feed passes through the rumen

with lesser microbial fermentation due to manipulated rumen ecology. This results in increased NDF digestion.

Acid Detergent Fibre Digestion

The apparent acid detergent fibre digestion performance of goats fed with Napier grass supplemented with different dietary fats in the concentrate showed that goats supplemented with 3% lard perform best with 66.96% digestion, followed by 3% coco oil supplementation of 66.57% digestion, followed by 5% lard supplementation with 64.44% digestion, followed 5% coco oil supplementation of 58.61% digestion. The lowest acid detergent digestion came from the control with 42.92%.

Analysis of variance showed no significant difference ($P>0.05$) among treatment means in ADF digestion. However, there was a trend observed showing that treatment supplemented with dietary fats caused higher ADF digestion compared to non-supplemented treatment. The results showed an increase of exposure time of fibre in the rumen for the treated group could lead to the increase of digestion of the fibre materials, while concentrate passes through the rumen with less microbes due to manipulated rumen ecology. Dietary lipids reduce protozoa concentrations in the rumen (Firkins, *et al.*, 2007). Rumen ciliate protozoa ingest rumen bacteria, resulting in an increase in the population of rumen bacteria that facilitate fibre digestion.

Conclusion

It is concluded that with the influence of the dietary fats such as VCO and lard as supplements for goats, no significant difference among treatment means were found. This is so even though there was a trend observed that giving VCO and lard increases the percentage of CP, ADF and NDF digestion. According to this study, virgin coconut oil and lard can be efficiently used as a good source of energy for goats fed with Napier grass without affecting growth performance. This indicates they are a good approach in exploiting the use of local fat resources for goat production.

Supplementing dietary fats in the concentrate of goats showed decreases in protozoa populations that ingest rumen bacteria. This resulted in increased digestion in the supplemented groups. Satiety's effect on treated groups resulted in lower dry matter intake and dry matter digestion. It increased ruminating time due to negative effects on rumen digestion that tend to increase CP, NDF and ADF digestion.

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