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Effect of Dietary Fats on Goat Rumen Condition

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Abstract:- Three (3) rumen-cannulated goats housed in individual elevated metabolism stalls with customized urine collection tools with five treatments on a cross-over trial was conducted over time following the Complete Randomize Design (CRD). Animals were randomly selected on different dietary treatment at different cycle. For each cycle, animals were provided with concentrate on the morning and *ad libitum* feeding of Napier grass thereafter. Clean drinking water were made available all the times in the respective animal watering troughs. The goats were supplemented with two types of dietary fats (VCO and lard) at 3 and 5%.

Data on rumen condition were collected sequentially in every cycle of the study. There were seven (7) days lag period in every cycle for the animals to return to each natural state. On the 8th day of every cycle, animals were given sequential dietary treatment based on randomized assignment. Rumen fluid collection was done on every last day of treatment.

Result showed that the rumen condition showed no changes (P>0.05) on total volatile fatty acid (TVFAs) concentration, NH_3-N, temperature and pH while purine derivatives showed significant difference (P<0.05). This study showed that dietary fats of either virgin coconut oil or lard supplemented did not influence the response of goat rumen ecology except for purine derivatives.

Keywords:- *Dietary fats, Complete Randomize Design, VCO, lard, goat rumen, Los Baños, Laguna, Philippines.*

I. INTRODUCTION

There are several constraints why goat industry could not reach its full potential. One problem is the feed cost that averages 64% of the variable cost of an animal farm operation. It is because of the high cost of supplemented protein feed sources (i.e. soy bean). Any management practices (i.e. fat supplementation – coconut oil and lard) that can reduce feed cost will significantly improve productivity and thus increases profit margin (Solaiman, 2006).

An additional problem is the availability of feeds. Good nutrition is a requirement for good health, good reproduction, high milk yield, fast growth rates and a successful goat production (Hussain, *et al.*, 2010). However, establishment of good nutrition is limited by feed stuff and raw material procurement problems (Chidibelu and Njondjou, 1997; Hussain, *et al.*, 2010). The supply of the imported materials in manufacturing feeds such as soybean is a matter of concern due to high demand.

Abubakr, *et al.* (2013) mentioned the principle that when oil is included in the feed concentrate, it converts unsaturated fats to saturated state by acquiring the Hydrogen in the rumen environment competing with the potential methane produced. Thus, lessening the carbon emissions and has now provided new sources to nourish the animal by the saturated fats, it is aimed to find not only ways to reduce the methane emissions of ruminants but also ways to help improve the animals' nutrition and productivity (Okukpe *et al.*, 2011). Hence, this study was conducted to determine and compare the quantitative changes in the rumen condition [total volatile fatty acid (TVFAs), rumen NH_3-N, pH, temperature and urine volume for estimation of purine derivatives of goats with various dietary fat supplementations.

II. MATERIALS AND METHODS

The study was conducted from August 4, 2014 to February 11, 2015 at the Metabolism Laboratory of the Institute of Animal and Dairy Sciences Cluster (ADSC), University of the Philippines, Los Baños, College, Laguna.

Three (3) female (rumen-cannulated goats) weighting 27.33±1.53 kg were housed in individual elevated metabolism stalls provided with 30% concentrate in the morning based on feed requirements [3% of their body weight (BW) dry matter (DM) basis) of the animals]. *Ad libitum* feeding of napier grass follows thereafter. Clean drinking water were made available all the times in the respective animal watering troughs.

All data were collected sequentially in every cycle of the study. There were seven (7) days lag period in every cycle for the animals to return to each natural state.

On the 8th day of every cycle, animals were given different dietary treatment. Urine volume collections were done on the 11th to 13th day of feeding trial (3 days after treatment) and data on rumen pH and temperature and rumen fluid collection was done on the 14th day (6 days after treatment) with corresponding dietary treatment combinations.

Rumen fluid samples of different treatments were subjected to total volatile fatty acid (TVFAs) production, rumen NH_3-N production, rumen pH and temperature and urine volume for estimation of purine derivatives analysis. These analyses were performed at the Animal Nutrition Analytical Service Laboratory (ANASL) of UPLB on

November 4, 2014 to February 11, 2015. Analysis was based on the standard procedures of Association of Official Analytical Chemists (AOAC, 1995).

III. RESEARCH DESIGN AND LAY-OUT

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. Complete Randomized 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

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

Table 1:- Treatment assignment of goats for the entire duration of the study.

➢ *Laboratory Analysis*

Evaluation of *in situ* rumen fluid analyses in rumen-cannulated goats fed with different dietary fats on the concentrate were done through different biochemical analysis of different parameters gathered such as.

➢ *Rumen pH*

The pH of the rumen fluid was determined immediately upon collection using a Jenway 3505® portable glass electrode pH meter (Keison Products, United Kingdom).

➢ *Ruminal Temperature, ºC*

Rumen temperature of each animal was obtained and recorded using a digital thermometer.

➢ *Total Volatile Fatty Acids (TVFA's)*

The rumen fluid samples used steam distillation with calculation.

VFA (mmol/100ml) = (titrate (ml) x Na OH factor* x 100)/vol. of rumen fluid.

* 0.05N solution factor should be determined using oxalic acid: Take 1.25ml of saturated NaOH and top up to 500ml with H_2O. Dissolve using phenolphthalein indicator. The colour changes from clear to red.

➢ *Production Estimation by Purine Derivatives Analyses*

To determine the effects of dietary fat on protein nutrition of goats, microbial protein production was estimated by analyzing allantoin in the urine (Chen and Gomez, 1992). On the average, allatoin and uric acid represent 85% and 15% of the total purine derivative excretion in goats respectively. Urine Volume was weighed for the last 3 days of every 11th day of the *in situ* trial for each of the treatment cycle. Freshly collected urine sample were diluted 10:1 with 10% H_2SO_4 to prevent bacterial breakdown of purine derivatives. Urine samples from each animal were further diluted 20X with tap water. Representative sample was kept at 4°C until use.

The method to measure allantoin were based on the colorimetric method describe by Young and Conway (1942). In this procedure, allantoin is initially hydrolyzed under a weak alkaline condition at 100°C to produce allantoin acid which is further degraded to urea and glyoxylic acid in weak acid solution. The glyoxylic acid is then reacted with phynylhydrazine hydrochloride to produce a phenyldrazone of the acid. The product then forms an unstable chromophore with potassium ferricyanide which is read at 522 nm.

Using 15 ml tubes, 1 ml diluted urine sample previously collected and stored at 4°C was thawed at room temperature. The sample was further diluted with 5ml distilled water and 1 ml of 0.5 M NaOH and incubated in boiling water bath for 7 min. After cooling in cold water bath, 1 ml of 0.5 M HCl and 1 ml of 0.023 M phenylhydrazine solution were added to each test tube and re-incubated in boiling water bath for another 7 min. After cooling in icy ethanol, 3 ml of cooled (-20°C) 11.4 N concentrated HCl and 1 ml of 0.05 M potassium ferricyanide were added were added quickly to the samples. After mixing, the solution was allowed to stand for 20 min. Absorbance at 522 nm was determined using Shimadzu model of UV-VIS spectrophotometer (Shimadzu). Concentration of allantoin from urine samples was estimated from a calibration curve using allantoin (Sigma-Aldrich) as standard.

Total urine excretion of allantonic acid was calculated by considering in the calculation the dilution factors and by multiplying the allantoin concentration to the average daily urine excretion of the animal. Computed values were converted as excretion considering that 85% of the total purine derivative excreted in the urine of cattle and water buffaloes in the form of allantoin (Chen and Gomez, 1992). Total purine derivative excretion values were subjected to ANOVA for Crossover Design.

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➢ *Rumen Ammonia-N Analysis*

Ammonia nitrogen (NH_3-N) concentration was measured using ammonia electrode (Model 95-12) in conjunction with an Orion Ion Analyzer (Model 501 pH/mV meter).

➢ *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 ± SD and level of significant at P<0.05).

IV. RESULT AND DISCUSSION

➢ *Rumen Temperature (°C)*

Rumen temperature of goats fed with Napier grass supplemented with different dietary fats (Figure 1) showed that among treatments, goat given with 3% VCO in the concentrate feed got the highest rumen temperature of 28.1°C followed by 5% with 27.9°C, 5% VCO with 27.3°C rumen temperature, without dietary fat supplement with 27.2 °C (T1) and the lowest rumen temperature was with 3% lard having 25.7 °C.

Although more than 2 °C was observed between the lowest to highest rumen temperature, no significant difference (P > 0.05) among treatment means was observed., This implies that supplementing 3 to 5% dietary fats from two different sources (VCO and Lard) in ruminant diet do not influence the rumen temperature of mature female goats.

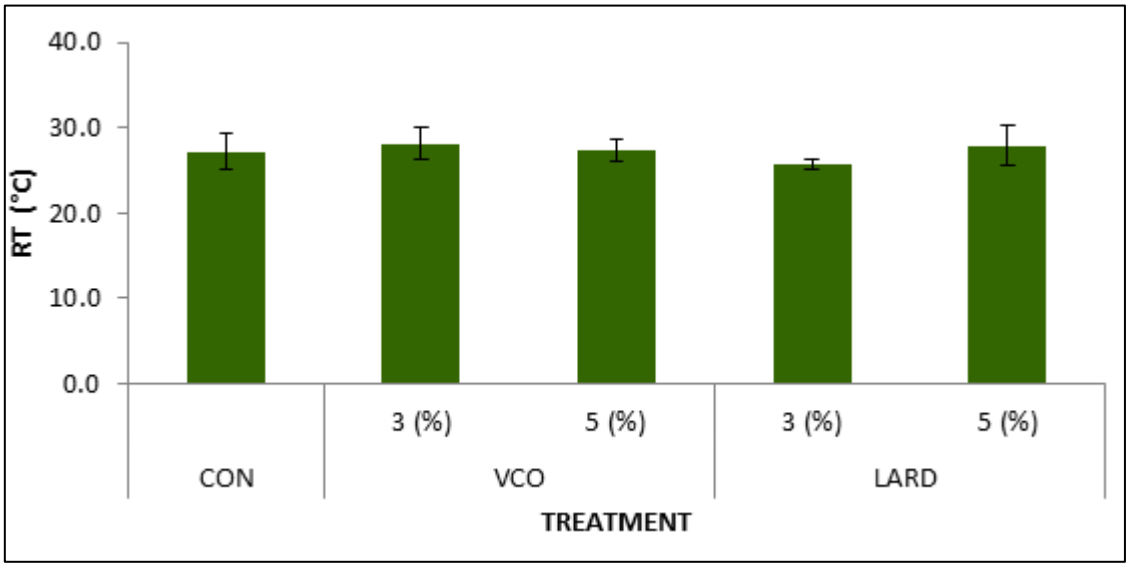

Fig 1:- Mean (± SD) rumen temperature (°C) of female matured goats.

➢ *Rumen pH*

Rumen pH was gathered simultaneously with rumen fluid using digital pH meter in the laboratory. The highest rumen pH was observed in animal supplemented with 5% VCO in the concentrate feed with 6.6 followed by 5% lard with 6.38, 3% VCO with 6.37, 3% lard with 6.24 and the lowest rumen pH was coming from control group with 5.93.

No significant differences (P> 0.05) in the rumen pH were observed on different sources of fats and levels of fats (3 and 5%) in concentrate feeds of mature female goats. This only showed that dietary fats supplementation at a maximum of 5% did not influenced rumen pH.

The result confirms the study conducted by Drackey, J.K., et al. (1993) showing that no significant difference (P > 0.05) among treatments on rumen pH among Holstein cows fed with partially hydrogenated tallow at the maximum of 6% of total DM as replacement for shelled corn in the diet. However, the pH values in all dietary treatments were within the range of 5.8–7.0 below which the rumen function might be negatively affected (de Veth and Kolver, 2001).

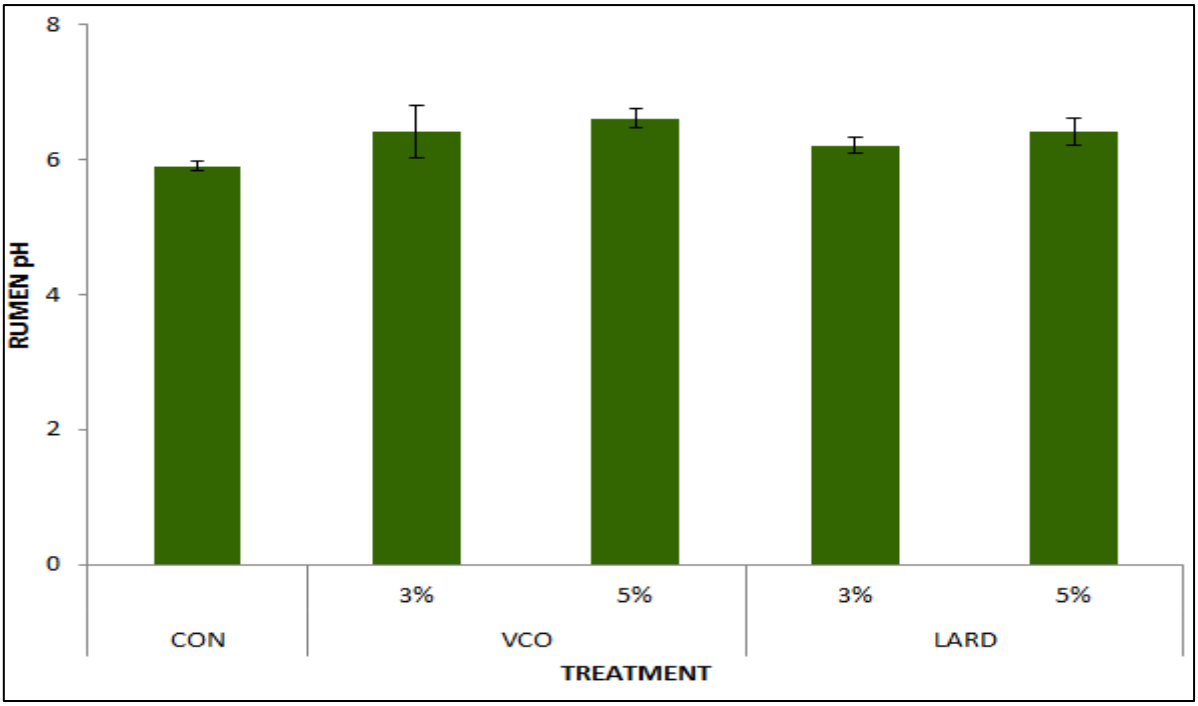

Fig 2:- Mean (± SD) rumen pH of female matured goats.

➢ *Total Volatile Fatty Acids*

On the 14th day of feeding trial, rumen fluid was preserved by adding 50% H_2SO_4 solution for the total volatile fatty acids (VFAs) production on the goat rumen.

The result showed (Figure 3) that the highest total volatile fatty acids was coming from treatment supplemented with 3% coco oil of 6.91 mg/l followed with the control with 6.84 mg/l. Treatment supplemented with 3% lard, 5% coco oil and 5% lard got 6.73 mg/l, 6.07 mg/l and 4.07 mg/l respectively.

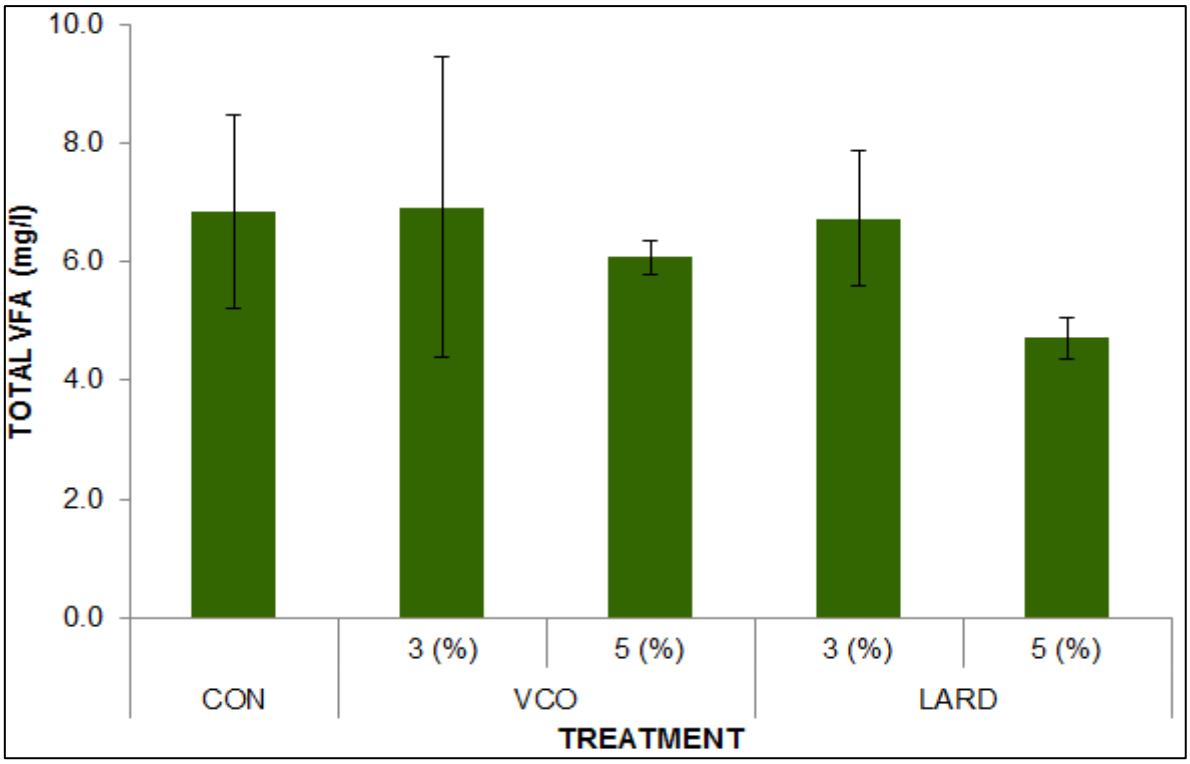

Fig 3:- Mean (± SD) total volatile fatty acids (VFAs) production of female matured goats.

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Analysis of variance show no significant mean differences (P>0.05) but numeral means show that upon the increase of the amount of fats in the concentrate, there were drastic decrease on the amount of TVFA's produced in the rumen. The results confirmed the claim of Drackey, J.K. et al. (1993) that concentration of total VFAs did not differ among Holstein cows fed with partially hydrogenated tallow at the maximum of 6% of total DM as replacement for shelled corn in the diet. However, result showed that treatment with 5% dietary fat supplementation got the lower total VFAs produced. This was brought by the present of oleic, linoleic and palmitoleic fatty acids in both lard and VCO. An unsaturated fatty acid those are toxic to many of the species of the rumen bacteria, particularly those that are involved in fiber digestion. Devendra and Lewis (1974) reported that fat could depress cell wall degradation by four mechanisms: physical coating of fiber by lipids, shortage of cations (e.g. Ca) due to the formation of insoluble soaps, inhibition of the rumen microbial activity, and the modification of microbial population. The results of the experiment conducted clearly showed that dietary fat decreases the rumen bacteria population resulting to lower rumen fermentation consequential to lower VFAs production.

➢ *Rumen Ammonia Nitrogen Production*

The rumen ammonia nitrogen was analyzed using rumen fluid. The rumen fluid samples were preserved by adding 2 ml of 10% (w/v) NaOH solution. This was collected on the 14th day of every cycle of the feeding trial. Treatment in control group got the highest NH_3-N of 0.0467 mg/l followed by 3% coco oil with 0.0333 mg/l and treatment supplemented with 5% coco oil, 3% and 5% lard got the same concentration of NH_3-N having 0.0300 mg/l.

Results of the analysis of variance for the percentage production of ruminal ammonia nitrogen with the influence of lard and virgin coconut oil supplementation in the concentrate was presented in Figure 4. Analysis shows that supplementation of fat regardless of level or proportion on the basal diet did not significantly (P>0.05) affect ruminal ammonia nitrogen production. Although there seems to be a trend in numerical decreased in the NH_3-N production in the rumen with dietary fat inclusion in feed. This apparent decline may imply that continuous increased in fat supplementation in the basal diet may be considered further in reducing methane emission to the environment as associated to N-NH_3.

The result supports the study of Cieslak (2010) that dietary fat supplementation reduced the loss of protein, thus reducing the amount of ammonia emitted to the environment. The study also confirmed the report of Lapierre, *et.al.,* (2005) that the most important source of nitrogen for the growth of ruminal bacteria is ruminal ammonia, which makes them independent from the sources of protein, peptides or amino acids (AA). However, excessive nitrogen-ammonia production in the rumen results to high protein but low efficiency of its utilization that results in the excretion of the surplus amount of ammonia in the urine (Styler, et. al, 1975).

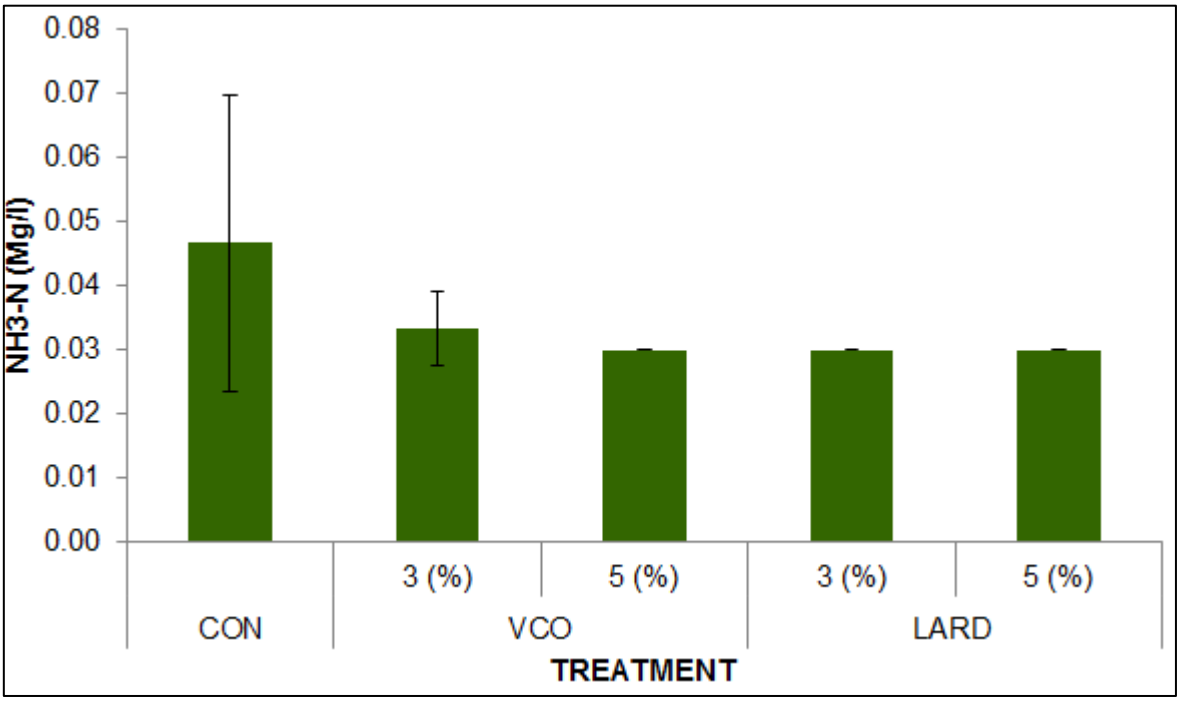

Fig 4:- Mean (± SD) NH_3-N production of female matured goats.

➢ *Purine Derivatives Estimation*

The analysis of microbial N supply in ruminant is based on estimated purine derivative (PD) excretion and calculates the PD absorbed subsequently estimating the microbial supply to the small intestine.

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The result showed that goat supplemented with 5% lard got the highest urinary allantoin of 1.5850 mg/l of urine followed by goat supplemented with 3% lard, 3% coco oil, 5% coco oil and control groups of 1.1433 mg/l, 1.0100 mg/l, 0.8633 mg/l and 0.6750 mg/l respectively.

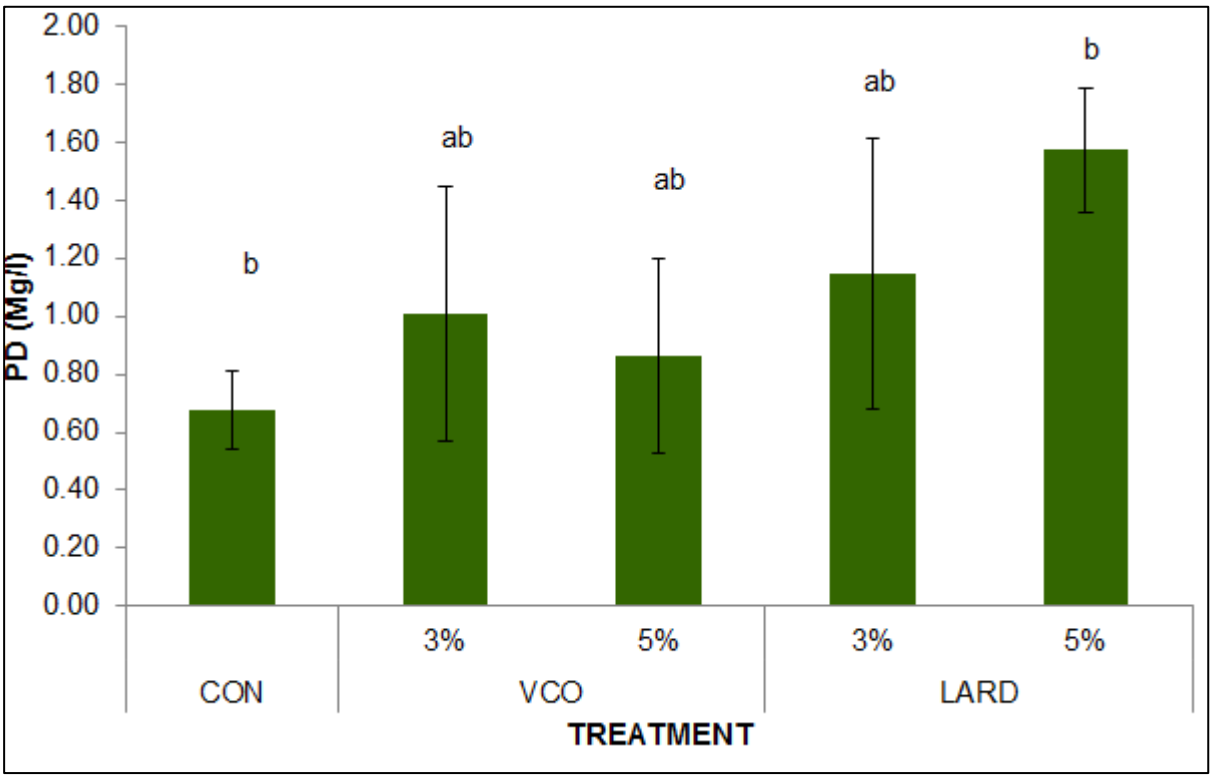

Fig 5:- Mean (± SD) purine derivatives estimation of female matured goats. Different letters indicate significant mean differences (P<0.05).

Results of the analysis of variance for the purine derivatives estimation of goat supplemented with different dietary fats was presented in Figure 5.

Analysis revealed that supplementation of 5% lard on the concentrate results to significant (P<0.05) production (1.5850 mg/l per day) of purine derivatives. This may explain that animal supplemented with animal fat such as lard give higher effect of production of microbial protein compare to plant-based oil such as the virgin coconut oil. The reason is due to high amount of unsaturated fatty acids (Oleic and linoleic) present in lard compare with virgin coconut oil. Results were in line with the study of Or-Rashid, *et al.*, (2001) that supplementation of oils can increase microbial protein synthesis due to defaunating action of the rumen microorganism and the process of biohydrogenation that takes place on the dietary fats that have high amount of unsaturated fats.

However, it was also noted on treatment supplemented with VCO (3 & 5%) as well as lard (3%) on the concentrate was statistically similar from treatment with 5% lard and from the control.

V. CONCLUSION

This study showed that dietary fats of either virgin coconut oil or lard supplemented influence the response of goat rumen ecology. At 5% level of lard, there were significant the response of microbes in terms of production estimation of purine derivatives and rumen NH_3-N, however total VFAs production, pH and temperature showed no significant differences with different dietary fats.

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