Research Article

Effect of Rice Wine Distillers By-Product on Digestibility and Nitrogen Retention in Pre-Pregnant Bach Thao Goats

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Abstract | The present study was conducted to investigate the impacts of dietary supplementation of rice wine distillers' by-product (RDB) on digestibility and nitrogen retention of goats. Four female goats, with an average initial body weight used in this experiment was 27.7±1.63 kg at about 10 months old. The experiment was designed as Latin Square with 4 treatments and 4 replications. The study composed of 4 periods. Each period lasted for 3 weeks with 2 weeks for adaptation, followed by 1 week for data collection of feed intake, faeces, and urine to determine the nutrient digestibility and nitrogen retention. The goats were weighed on 3 consecutive days at the start and end day of each experimental period. Four treatments were supplied rice wine distillers' by-product at 0% (RDB0), 5% (RDB5), 10% (RDB10), and 15% (RDB15). The results showed that the amount of CP consumed was significantly ($p<0.05$) higher in goats fed supplementation of RDB than control treatment. Overall, the RDB supplementation did not affect the DM, DM/ BW, OM and ME intake of the goats ($p>0.05$). However, DM, DM/ BW, OM and ME intakes of supplementation treatments were quantitatively higher than the control group. The dietary addition of RDB had a significant effect on the CP digestibility ($p<0.05$) and digestibility of DM and OM tended to increase quantitatively higher in with the supplementated treatments than control group. However, NDF and ADF digestibility tended to reduce followed by the increasing rate of RDB. The results increased the effect of RDB on the nitrogen retention and DWG of the goats. Overall, the RDB supplementation affected the nitrogen intake, nitrogen retained, and nitrogen retained/ kg body weight of the goats ($p<0.05$). It can be concluded that RDB supplementation at 15% in pre-pregnant goat diets based on maize and elephant grass increased CP digestibility, nitrogen retention and growth performance.

Keywords | Rice wine distillers' By-product, Digestibility, Rumen, Pre-pregnant, Goat

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INTRODUCTION

Currently, the number of goats worldwide has over 1 billion heads, with a significant majority (94%), located in Asia (556 million heads) and Africa (388 million heads) (Mazinani and Rude, 2020). Global goat meat production accounted for about 97% in developing countries (Monteiro *et al*., 2017). In Southeast Asia, the goat population had about 39 million, of which Vietnam accounted for 2.65 million heads in 2019. Goat production in Vietnam based on grass cultivation, crop by-products and browsing shrubs in nature (Don *et al*., 2023).

According to Preston and Leng (1987) the nature of ruminal fermentation in terms of methane production. More produced methane means less propionic acid and therefore less glucose in metabolic sites, thereby reducing animal performance and increasing climate change affects. Previous studies reported that soluble carbohydrate supplementation from maize increased propionic acid concentrations at the period of 3 hours after feeding (Thu, 2020). Moreover, Lana *et al.* (1998), and Hristov *et al.* (2013) demonstrated that diets with high grain content reduced methane emissions. Furthermore, Preston *et al.* (2021) suggested that in response to climate change and biodiversity loss in the tropics, systems of ruminant feeding should be supplemented with carbohydrate-rich by-products of agro-industrial crops into diets based on trees and shrubs.

Rice wine distillers' by-product is a common by-product (Figure 1) from the traditional alcohol process in Vietnam, and is an excellent source of protein (16.6-32.5%), dry mater (5.4-12.9%), NDF (8.4-28.2%), gross energy (18-21 MJ/kg DM) and pH (2.98-3.43) (Manh *et al.*, 2009). Moreover, rice wine distillers' by-product or fermenting polished rice (or cassava root) with yeast (*Saccharomyces cerevisiae*) has the potential to reduce methane emissions from ruminant, these products can provide lactic and acetic contents and yeast walls as prebiotic compounds. As a result, propionic acid was produced more in the rumen and animal performance enhanced indirectly as well as reduction of methane emissions (Preston *et al.*, 2021).

We hypothesize that the relationship between carbohydrates from maize and prebiotic compounds as well as protein content in rice wine distillers' by-product will provide energy and protein sources for bacteria growth that produce more volatile fatty acids to increase digestibility and improve N-retention in goats.

MATERIALS AND METHODS

Location and time

The experiment was conducted at the experimental farm in An Giang University, An Giang province, Vietnam. Four female goats (Figure 2), with an average initial body weight used was 27.7±1.63 kg at about 10 months old.

Experimental design and feeds and feeding

The experiment was designed as Latin Square with 4 treatments and 4 replications. The study composed of 4 periods. Each period lasted for 3 weeks with 2 weeks for adaptation time, followed by 1 week for data collection of feed intake, faeces, and urine to determine the nutrient digestibility and nitrogen retention. The goats were weighed on 3 consecutive days at the start and end day of each experimental period. Four treatments were supplied rice wine distillers' by-product at 0% (RDB0), 5% (RDB5), 10% (RDB10), and 15% (RDB15) (Table 1).

Table 1: Ingredient ratio used in experimental diets, % DM.

Ingredients	Treatments			
	RDB0	RDB5	RDB10	RDB15
RDB	0.0	5.00	10.0	15.0
Maize	15.0	15.0	15.0	15.0
Elephant grass	84.7	79.7	74.7	69.7
Premix	0.30	0.30	0.30	0.30
Total	100	100	100	100

RDB: rice wine distillers by-product.

Figure 1: Rice wine distillers by products.

Figure 2: Bach Thao pre-pregnant goats used in this experiment.

Measurements taken

The rice was cooked and then spreaded out on a flat surface to cool. Then yeast (*Saccharomyces cerevisiae*) was sprinkled on the rice and mixed well. The product was put in a tightly closed container to ferment for about three days. Then the barrels were filled with water and kept for about a week.

Finally, the wine was distilled through a covered pot and the steam was directed into a water-cooled condenser. Residues were considered as rice wine distillers' by-product (RDP), using it for goat feeding in this experiment.

Feed offered, refusals and feces were analyzed for dry matter (DM), organic matter (OM) and crude protein (CP), and Ash contents according to the procedures of AOAC (1990). However, neutral detergent fiber (NDF) and acid detergent fiber (ADF) were analyzed by the procedure of Van Soest *et al.* (1991). However, metabolizable energy (ME) was calculated by Bruinenberg *et al.* (2002), in which ME (MJ/animal/day) = 14.2 x DOM + 5.9 x DCP (with DOM/DCP<7.0;) of the diets or ME (MJ/animal/day) = 15.1 x DOM (with DOM/DCP>7.0). DOM is digestible organic matter and DCP is digestible crude protein.

Apparent nutrient digestibility and nitrogen retention: Apparent digestibility of DM, OM, CP, NDF, and ADF were done following the method of McDonald *et al.* (2010). Each experimental period lasted for 21 days including 14 days for adjustment and 7 days for sampling. The nitrogen (N) content of the feeds, refusals, feces, and urine were analyzed using the Kjeldahl methods (AOAC, 1990). Nitrogen retention was employed with the animal feces and urine daily collected: $N_{Retention} = N_{Intake} - (N_{Feces} + N_{urine})$

Daily weight gains (DWG): The pre-pregnant goats were weighed in the morning before feeding, at the beginning and end of each experimental period (two consecutive days).

Statistical analysis

The data were analyzed using the ANOVA Linear Model (GLM) of Minitab Reference Manual Release 20 (Minitab, 2021). Tukey's pairwise comparisons ($p<0.05$) were applied to determine differences between treatments. Data were analyzed using the model $y_{ijk} = \mu + T_i + A_j + P_k + e_{ijk}$; where y_{ijk}: = the dependent variable, μ: the overall mean, T_i = the effect of treatment (i = 1 to 4), A_j: the effect of animal (j = 1 to 4), P_k= the effect of period (j = 1 to 4), e_{ijk} = the random error.

RESULTS AND DISCUSSION

Chemical composition of feeds

Chemical composition of ingredients using in this experiment shown in Table 2. The DM, OM, CP, NDF and ADF values of RDB were similar to Truong and Trung (2023), and in range values which reported by Manh *et al.* (2009). CP content of RDB in this experiment was similar to the CP value (28.18%) reported from Oanh *et al.* (2016), however, this result was lower than the CP value (35.8%) from Oanh *et al.* (2020); and slightly higher than the CP content (24.2%) from Sangkhom *et al.* (2017).

Table 2: Chemical composition of ingredients used in the experiment.

Ingredients	DM %	in% of DM			
		OM	CP	NDF	ADF
RDB	11.7	96.9	27.1	28.0	16.1
Maize	85.2	98.7	8.32	20.8	3.81
Elephant grass	14.6	91.9	7.14	63.9	42.4

RDB: rice wine distillers' by-product.

Feed and nutrient intakes

The amount of CP consumed was significantly ($p<0.05$) higher in supplementation treatments of RDB than in control group (Table 3 and Figure 3). Overall, the RDB supplementation did not affect the DM, DM/ BW, OM and ME intake of the goats ($p>0.05$), although DM, DM/ BW, OM and ME intakes of goats supplemented with RDB were quantitatively higher than control group (Figure 4). RDB0 showed the lowest value on DM, OM, CP and ME intake than other treatments. These results were in an agreement with Truong and Trung (2023) that nutrient intakes increasing followed by the rise of the RDB rate in the diet. Previous publication indicated that RDB was palatable (Manh *et al.*, 2009). Because RDB contains acetic and lactic acids to stimulate the appetite, therefore animals tend to consume more feed.

Table 3: Effect of RDB levels on feed and nutrient intake in pre-pregnant goats.

Criteria	Treatments				SEM	P
	RDB0	RDB5	RDB10	RDB15		
Feed intakes, g DM/ goat/ day						
RDB	0.00[d]	34.3[c]	66.2[b]	99.2[a]	4.24	0.001
Maize	92.5	106	102	102	3.93	0.210
Elephant grass	472	502	437	404	24.3	0.115
Premix	1.83	2.09	2.02	2.02	0.08	0.212
Nutrient intakes, g DM/ goat/ day						
DM	566	644	607	607	27.0	0.341
DM/BW, %	1.92	2.18	2.06	2.05	0.09	0.350
OM	531	605	572	574	25.1	0.306
CP	43.7[b]	56.8[a]	60.3[a]	66.7[a]	2.05	0.001
NDF	298	322	292	282	16.0	0.410
ADF	194	210	189	181	10.3	0.325
ME, MJ	5.54	6.47	6.07	6.12	0.28	0.239
Water intake, g	132	82	238	177	33.7	0.07
Output, goat/ day						
faeces, g DM	186	201	195	189	12.8	0.844
Urine, g	1874	1702	1882	1821	87.4	0.494

RDB: rice wine distillers' by-product. [a, b, c, d] Mean values within rows with different superscripts are different at P<0.05

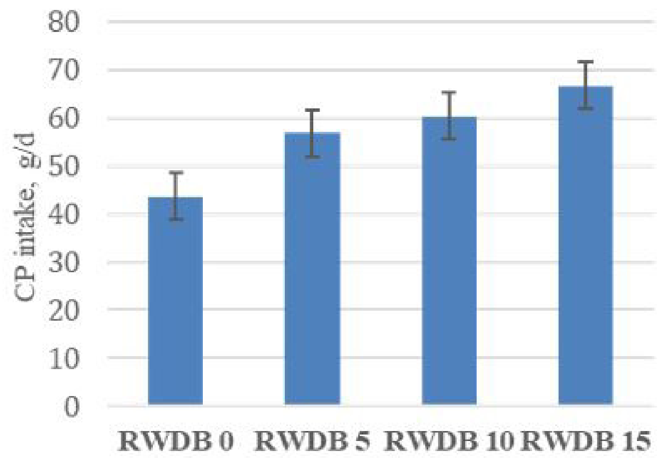

Figure 3: Effect of RDB on CP intake.

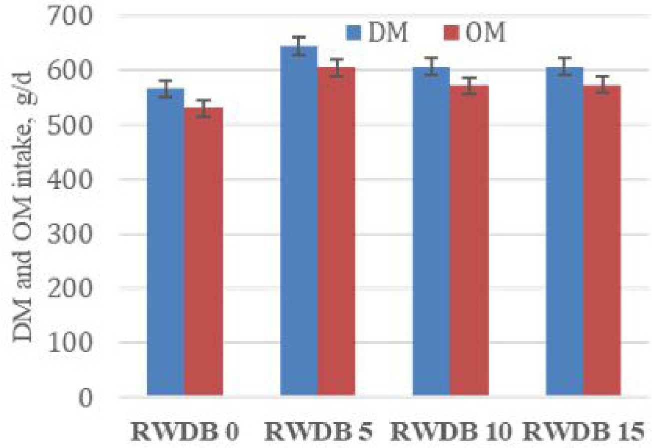

Figure 4: Effect of RDB on DM and OM intake.

Digestibility

The supplementation of RDB had a significant effect on the CP digestibility ($p<0.05$) and digestibility of DM and OM tended to increase quantitatively higher in supplemented treatments compared to the control group. However, NDF and ADF digestibility tended to reduce followed by the increasing RDB rate in the diet (Table 4 and Figures 5, 6). This implied that fermentation in the rumen was decreased, resulting in more feed components would escape rumen fermentation and available present in the intestine for digestion. According to Sangkhom *et al.* (2017), brewers grains or RDB were the presence of yeast containing β-glucan components derived from the cell walls of yeast, which regulate the rumen biofilm and facilitate the production of propionic acid in the rumen VFA. Moreover, Sangkhom *et al.* (2017) reported that the RDB supplementation increased the concentration of propionic acid in the composition of VFAs in the rumen and reduced the ratio of methane to carbon dioxide in the rumen gas by 26%. According to Whitelaw *et al.* (1984) reported that there was the relationship between menthanogenesis and the proportion of propionic acid in the rumen, due to changes in protozoa populations in the rumen when the rumen produced more propionic acids, then methane levels were reduced.

Table 4: Apparent digestibility of nutrients.

Criteria	Treatments				SEM	P
	RDB0	RDB5	RDB10	RDB15		
Nutrient digestibility, %						
DM	65.8	68.6	67.4	68.0	1.78	0.73
OM	67.9	70.6	69.7	69.8	1.68	0.719
CP	71.4	72.1	74.2	75.9	2.14	0.495
NDF	64.8	65.6	64.1	61.4	1.86	0.478
ADF	58.3	60.7	58.9	55.2	1.86	0.303
Nutrient digestibility, g/ animal/ day						
DM	381	443	412	418	19.1	0.251
OM	367	429	402	405	18.8	0.239
CP	31.6^{c}	41.0^{bc}	44.9^{ab}	50.8^{a}	1.94	0.002
NDF	197	213	189	179	10.4	0.225
ADF	117	129	112	104	5.69	0.095

^{a,b,c,d} Mean values within rows with different superscripts are different at $P<0.05$

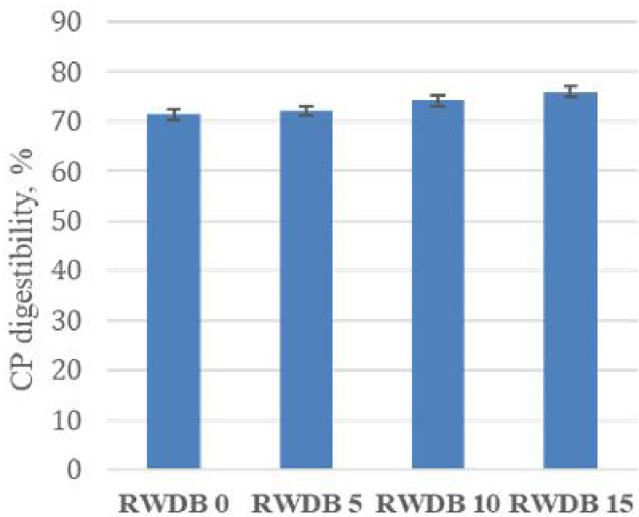

Figure 5: Effect of RDB on CP digestibility.

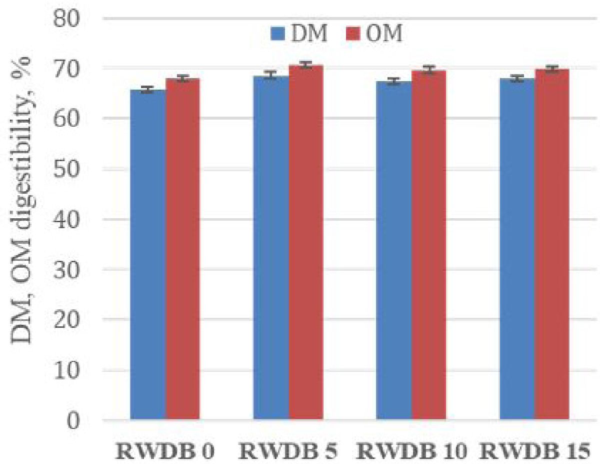

Figure 6: Effect of RDB on DM and OM digestibility.

Table 5: Effect of RDB supplementation on nitrogen retention.

Criteria	Treatments				SEM	P
	RDB 0	RDB 5	RDB 10	RDB 15		
Nitrogen balance, g/animal/ d						
N intake	6.98[b]	9.09[a]	9.65[a]	10.7[a]	0.327	0.001
N faeces	1.93	2.53	2.46	2.54	0.156	0.089
N urine	2.13	2.16	2.67	2.49	0.146	0.103
N retained	2.92[b]	4.41[a]	4.51[a]	5.64[a]	0.251	0.002
N retained/ kg BW	0.232[b]	0.349[a]	0.355[a]	0.445[a]	0.022	0.003
Live weight, kg						
Initial	29.48	29.23	29.31	29.01	0.162	0.310
Final	29.9	29.8	30.2	30.1	0.199	0.492
DWG, g/d	20.3	27.6	43.0	53.7	8.620	0.114

[a, b, c, d] Mean values within rows with different superscripts are different at P<0.05

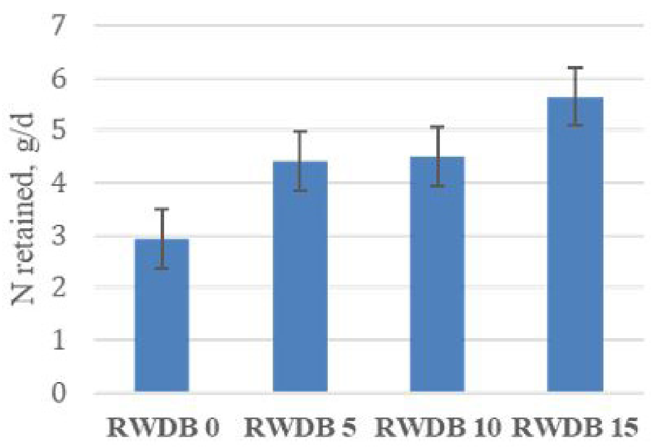

Figure 7: Effect of RDB on N retained.

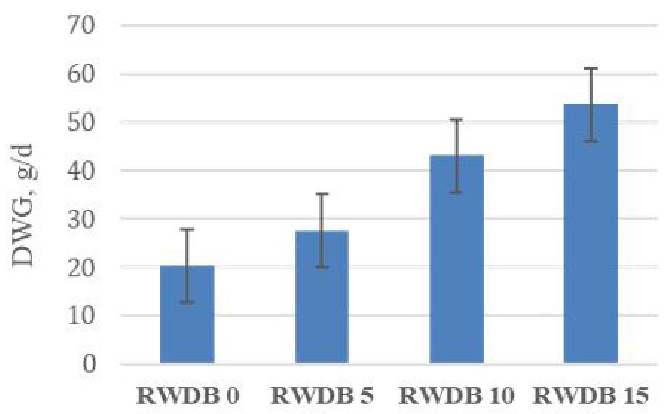

Figure 8: Effect of RDB on DWG

Nitrogen retention and daily weight gain

The results on Table 5 revealed the effect of RDB on the nitrogen retention and DWG of the goats. Overall, the RDB supplementation affected the nitrogen intake, nitrogen retained, and nitrogen retained/ kg body weight of the goats (p<0.05) (Figure 7). Although the ADG of the goats fed with supplemented RDB were quantitatively higher than the control group (Figure 8). These results showed that RDB contained good protein source (27.1 % CP) and amino acids well-balance (Manh *et al*., 2009). Additionally, Sengsouly and Preston (2016) claimed that the addition of RDB into a basal diet included cassava root silage and fresh cassava leaves of local yellow cattle improved growth rate by 37%.

CONCLUSIONS AND RECOMMENDATIONS

It can be concluded that rice wine distillers' byproduct supplementation at 15% in pre-pregnant goat diets based on maize and elephant grass increased CP digestibility, nitrogen retention and growth performance.

A level of 15% RDB in the diet of pre-pregnancy goats would be recommended for local by-product source utilization for farmers.

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NOVELTY STATEMENT

Determining the level of use of Rice wine distillers' by-product on Bach Thao goats in the pre-pregnancy period is new.

AUTHOR'S CONTRIBUTION

NBT and TTT conceived and designed the experiments. NBT performed the experiments. NBT and TTT analyzed the data. NBT and TTT wrote the paper; all authors reviewed and approved the final manuscript.

Conflict of interest

The authors have declared no conflict of interest.

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Links Researchers

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