EFFECTIVENESS OF USING FERMENTED TOTAL MIXED RATION FROM DRAGON FRUIT BRANCHES ON THE PERFORMANCE OF GROWING-FINISHING LAMBS

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ABSTRACT

This study was carried out from 8th March to 2nd October 2024 at Ruminant Research and Development Center-Institute of Animal Sciences for Southern Vietnam to evaluate the effect of Dragon fruit branches (DFB) in fermented total mixed ration (FTMR) on growing-finishing lambs. A total of 240 five-month-old Phan Rang lambs were distributed into 03 treatments in a completely randomized design with 4 replicates (20 heads per replicate per treatment). Treatment 1: Control (0.4 kg commercial feed + 0.6 kg cassava residue and grass fed ad libitum); treatment 2: using 60% DFB in FTMR (FTMR1); treatment 3: using 70% DFB in FTMR (FTMR2). The study revealed that incorporating FTMR from DFB had no adverse effects on the growth and development of lambs. Among the diets tested, FTMR1 proved to be more effective than FTMR2. The Phan Rang lambs fed this diet had the same average daily gain and feed conversion ratio as the control. More over, the feed cost per one kg weight gain was significantly reduced over 5% by using FTMR1 diets.

Keywords*: Lambs, DFB, FTMR, growth performance*

INTRODUCTION

Sheep are a valuable agricultural animal, yet remain relatively uncommon in Vietnam. By the end of 2023, Vietnam had a total of 102,474 sheep, with 67,660 sold and a live meat production of 1,837 tons (General Statistics Office, 2024). The majority of these sheep are located in the South Central Coast region, with Ninh Thuan and Binh Thuan provinces alone accounting for 97.21% of the national sheep population. However, in Ninh Thuan the country's primary sheep farming hub, the total number of sheep and goats had decreased by 9.8% by the end of August 2024 compared to the same period the previous year (Ninh Thuan Statistics Office, 2024). This decline is mainly attributed to the harsh climate of the South Central Coast. Severe water shortages during the dry season result in a significant lack of green fodder, the primary feed for sheep.

In challenging conditions, dragon fruit, a member of the cactus family, thrives remarkably well in the climate and soil of the South Central Coast region. During cultivation and harvest, farmers often need to remove a significant amount of branches and pads that are no longer useful. It is estimated that each hectare of dragon fruit generates about 12-15 tons of waste branches annually that require processing (Le Quang Khoi and Nguyen Thi Ngoc Truc, 2017). In recent years, several studies have explored the use of this byproduct in agricultural production to enhance farmers' income. Doan Vinh et al. (2022) found that silage made from fresh dragon fruit branches (DFB) could replace up to 50% of fresh grass in the diet of beef cattle. Since sheep are also herbivores, utilizing DFB to mitigate the feed shortage for sheep presents a highly effective solution.

Fermented Total Mixed Ration (FTMR) is a highly effective method for preserving and enhancing the quality of byproducts, meeting the nutritional needs, and boosting the productivity of livestock (Wang et al., 2024). To fully utilize DFB in the sheep diet, particularly lanbs, it is essential to develop FTMR diets tailored for them. This study aims to evaluate the effectiveness of using FTMR made from DFB on the growth performance of lambs.

MATERIALS AND METHOD

Materials

Experimental animals: Five-month-old Phan Rang lambs, uniform in weight.

Experimental ingredients: DFB, mombasa, rice bran, cassava residue, soybean meal, probiotics, etc.

Location and time

Time: From March 8th, 2024 to October 2nd, 2024.

Location: The experiment was conducted at the Ruminant Research and Development Center-Institute of Animal Sciences for Southern Vietnam.

Experimental Design

Total of 240 five-month-old Phan Rang lambs were used in a completely randomized experiment. The study included 3 treatments (T) with 4 replicates each, and 20 lambs per replicate. The treatments were as follows:

Treatment 1 (Control): Farm diet consisting of 0.4 kg of commercial mixed feed purchased from the company, combined with 0.6 kg of cassava residue and ad libitum mombasa.

Treatment 2 (FTMR1): FTMR diet with 60% fresh dragon fruit branches (DFB).

Treatment 3 (FTMR2): FTMR diet with 70% fresh dragon fruit branches (DFB).

The lambs were selected to ensure a uniform initial weight and provided with consistent care and feeding according to the protocols of the Ruminant Research and Development Center. The lambs were housed in 12 experimental pens, with 20 lambs per pen, and each pen representing one replicate. The specific layout of the experimental design is detailed in Table 1

Table 1. Experimental Design

Parameters	Unit	T1 (Control)	T2 (FTMR1)	T3 (FTMR2)
Number of lambs/T/replicate	head	20	20	20
Number of replicates	times	4	4	4
Total number of lambs	head	80	80	80

Experimental Feed: The nutritional composition of the feed ingredients was analyzed at the Nutrition and Animal Husbandry Analysis Laboratory - Institute of Animal Sciences for Southern Vietnam. The analyses were conducted as follows: Dry Matter (DM) according to TCVN 4326:2001; Crude Protein (CP) according to TCVN 4328-1:2007; Ether Extract (EE) according to TCVN 4331:2001; Crude Fiber (CF) according to TCVN 4329:2007; Neutral Detergent Fiber (NDF) according to TCVN 9590:2013; Acid Detergent Fiber (ADF) according to TCVN 9589:2013. Metabolizable Energy (ME) values were calculated using the PT/VCN24:2017 method of the Natinal Institute of Animal science and referenced from the INRAE CIRAD AFZ © 2017-2024 databases (feedtables.com). The nutritional composition of the feed ingredients is detailed in table 2. Treatment 1 consisted of 0.4 kg of complete mixed feed purchased from a company, combined with 0.6 kg of cassava residue and ad libitum mombasa. Treatments 2 and 3 used the respective FTMR1 and FTMR2 diets, fed ad libitum. The FTMR diets were formulated according to NRC (2007). The detailed FTMR

compositions are shown in Table 3. The probiotics used in the study contained *Saccharomyces cerevisiae* (10^7 CFU/g) and *Lactobacillus sp.* (10^7 CFU/g). All lambs had access to mineral licks and free access to water.

Table 2. Nutritional composition of experimental feed ingredients (Based on DM)

Ingredients	**Price** (d/kg)	**DM** (%)	**ME** (kcal/kg)	**CP** (%)	**EE** (%)	**CF** (%)	**ADF** (%)	**NDF** (%)
Complete mixed feed	10,000	87.00	2,876	21.88	3.51	15.32	17.57	28.14
Mombasa	500	15.50	1,716	10.52	2.12	27.29	31.61	55.54
Cassava residue	1,100	23.98	1,810	3.03	0.66	16.35	18.42	35.92
Dragon fruit branches	350	14.69	2,034	8.02	2.57	33.26	32.08	41.33
Rice bran	6,600	89.20	2,320	13.34	11.39	12.97	14.04	33.86
Corn	7,500	87.00	3,350	8.71	3.89	2.73	2.92	12.58
Soybean meal	12,000	87.98	3,330	52.61	1.79	6.79	8.31	14.48
Dry straw	1,500	90.04	1,400	2.99	1.89	31.86	40.82	61.84
Molasses	8,000	72.30	2,160	2.80	-	-	-	-
Probiotics	50,000	90.75	-	-	-	-	-	-

Table 3. FTMR diets for lambs

Ingredients	**Unit**	**FTMR1**	**FTMR2**
Dragon fruit branches	%	60.0	70.0
Rice bran	%	5.7	4.5
Corn	%	5.2	3.5
Soybean meal	%	7.8	6.3
Dry straw	%	18.1	12.7
Molasses	%	3.0	2.8
Probiotics	%	0.2	0.2
Nutritional Composition (Based on DM)			
DM	%	43.93	36.53
ME	(kcal/kg)	2,167	2,170
CP	%	13.51	13.52
EE	%	3.22	3.16
CF	%	21.33	22.02
ADF	%	24.80	24.86
NDF	%	38.71	37.96

The study employed anaerobic lactic fermentation, enhanced with microorganisms (*Saccharomyces* and *Lactobacillus*). Fresh dragon fruit branches and dry straw were chopped and thoroughly mixed with other ingredients and a microbial preparation blended with rice bran, following the experimental formulas. This mixture was then packed into specialized nylon bags, compressed layer by layer, and sealed. Each bag was labeled with the treatment type and ensiling date for easy identification. After 20 days of fermentation, the feed was

ready for the lambs. Each batch was designed to provide sufficient feed for the lambs for 60 days, with subsequent batches were prepared in a staggered manner to maintain the quality of the ensiled feed.

Measurements taken

Body weight (BW) at different time points: BW was recorded at the start; after 30, 60, and 90 days of the experiment to calculate average daily gain (ADG). Lambs were weighed using a 100 kg electronic scale in the early morning before feeding.

Feed consumption at each experimental stage: This was tracked to calculate the intake of dry matter (DM), metabolizable energy (ME), and crude protein (CP).

Feed conversion ratio (FCR) and feed efficiency: The FCR and the cost of feed per kilogram of weight gain were be determined.

Data analysis

All data were statistically analyzed using one-way ANOVA with Minitab 17 software (Minitab Inc., State College, Pennsylvania, PA, USA). Tukey's test was employed to compare the mean values, with statistical differences considered significant at $P<0.05$.

Analysis of variance model:

$$Y_{ij} = \mu + T_i + E_{ij}$$

Which: Yij: Observed data.

μ: Overall mean of the observed data.

Ti: The contribution of the diet i (where (i = 3))

Eij: Random error or the effect of unidentified factors on the observed data for the lamb j and the diet i.

RESULTS AND DISCUSSION

Body weight and average daily gain

The BW and ADG of the experimental lambs were detailed in table 4. At the start of the experiment (5 months old), the initial weights of the lambs were similar across all treatments, averaging 18.7 kg per head. At 6 and 7 months old, the weights remained consistent ($P>0.05$), ranging from 21.87-22.05 kg and 26.09-26.27 kg per head, respectively. By 8 months old, the weights of head in T1 and T2 were approximately 29.6 kg per head, showing an improvement over the 29.21 kg per head in T3. The weights observed in this study were higher than those reported by Dau Van Hai et al. (2021), where Phan Rang lambs fed with ensiled cashew apple had weights at 5, 6, and 7 months old ranging from 16.20-17.00 kg, 18.00-19.50 kg and 20.20-22.10 kg per head, respectively. In the study by Nguyen Duc Thinh et al. (2021), Phan Rang lambs fed with ensiled cashew apple or corn stalks had weights of 16.6-16.9 kg at 5 months, 18.2-18.4 kg at 6 months, and 19.0-19.9 kg at 7 months old. The current study's results were also significantly higher than the most recent survey by Nguyen Huu Van et al. (2023) on Phan Rang lambs raised in households in Ninh Thuận province, where the weights of male and female at 6 months old were 21.67 kg and 18.75 kg, respectively, and at 9 months old were 27.26 kg and 22.81 kg, respectively.

Table 4. Body weight and average daily gain across different stages

Items	Stages	T1	T 2	T 3	SEM	P
BW *(kg/head)*	5 months old	18.71	18.75	18.68	0.188	0.863
	6 months old	22.05	21.93	21.87	0.202	0.486
	7 months old	26.27	26.27	26.09	0.183	0.302
	5 months old	29.56	29.57	29.21	0.189	0.056
ADG *(g/head/day)*	5-6 months old	111.08^{a}	106.13^{b}	106.42^{b}	1.472	0.002
	6-7 months old	140.94^{b}	144.51^{a}	140.54^{b}	1.694	0.017
	7-8 months old	109.78^{a}	109.53^{a}	104.16^{b}	1.181	<0.001
	5-8 months old	121.87^{a}	121.49^{a}	118.35^{b}	0.347	<0.001

Note: Means with different letters in the same row are significantly different (P<0.05).

In the 7-8 month stage, the growth of lambs in T3 decreased compared to the control group, while the growth rate of lambs in T2 remained stable. Overall, the ADG of lambs in T2 was comparable to the control group (approximately 122 g per head per day), significantly higher than the 118.35 g per head per day in T3 (P<0.001). Compared to previous studies on Phan Rang lambs by Dau Van Hai et al. (2021); Nguyen Duc Thinh et al. (2021) and Nguyen Huu Van et al. (2023), the results of this study were higher. The differences in BW and ADG between these studies may be due to variations in rearing conditions, feed sources, and farming methods.

In general, the FTMR diet with 70% DFB tended to negatively affect the growth of lambs, whereas the FTMR diet with 60% DFB had a positive impact. This suggests that an appropriate level of DFB in the complete fermented FTMR diet is effective for lambs.

Nutrient intake

The nutrient intake of the experimental lambs at various stages, including ME, CP, and DM intake, was detailed in table 5. Throughout the initial 30 days and 7-8 month stage, DM intake in treatments remained consistent. However, in the 6-7 month stage, the DM intake in T3 was significantly affected by the FTMR diet with 70% DFB (P<0.05). Over the 90-day experiment, compared to the control group in T1, the lambs in T2 and T3, which received 60 and 70% DFB in their FTMR diet, showed a corresponding decrease in DM intake of 11 and 10 g per head per day, respectively. Although the DM intake of the lambs in this study was clearly better than previous reports. Bui Van Loi (2014) noted that the DM intake of 6-7 month-old lambs, primarily fed natural grass and elephant grass, was 0.53-0.54 kg per head per day. More recently, Dau Van Hai et al. (2021) reported that Phan Rang lambs fed with ensiled cashew apple had a maximum DM intake of only 0.73 kg per head per day for the 3-7 month-old stage.

Table 5. Dry matter (DM), metabolizable energy (ME), and crude protein (CP) intake

Items	Stages	T1	T 2	T 3	SEM	P
DM *(kg/head/day)*	5-6 months old	0.922	0.921	0.925	0.006	0.078
	6-7 months old	1.028[a]	1.017[ab]	1.010[b]	0.007	0.019
	7-8 months old	0.986	0.975	0.973	0.007	0.067
	5-8 months old	0.979[a]	0.968[b]	0.969[b]	0.004	0.004
ME *(kcal/head/day)*	5-6 months old	1,998[ab]	1,976[b]	2,006[a]	13.47	0.029
	6-7 months old	2,181	2,206	2,191	15.65	0.133
	7-8 months old	2,109	2,114	2,111	15.34	0.900
	5-8 months old	2,096	2,099	2,103	7.45	0.422
CP *(g/head/day)*	5-6 months old	126.37[a]	123.29[b]	125.04[a]	0.839	0.002
	6-7 months old	137.58	137.58	136.59	0.975	0.298
	7-8 months old	133.18	131.87	131.59	0.953	0.088
	5-8 months old	132.38	130.91	131.08	0.463	0.093

Note: Means with different letters in the same row are significantly different (P<0.05)

For ME intake, the results in table 5 showed that, except for the first stage which lambs could be attributed to the lambs adjusting to the new feed, the average kcalME intake in the groups of lambs fed FTMR diets was the same as those fed the farm's diet. Throughout the entire experiment, the ME intakes which was about 2,100 kcal/head/day met the energy requirements for lambs growth as recommended by the NRC (2007). These results were also higher than those previously reported by Bui Van Loi (2014), where the total gross energy intake from natural grass and elephant grass diets for 3-7 month-old lambs was only 2,000 and 1,951 kcal per head per day.

Similar to ME intake, CP intake did not significantly differ between lamb groups in all most stages. Over the 90-day experiment, the grams of CP intake in this experiment ranged from 130.91 to 132.38 g/head/day. Although the CP intake in all the experimental lamb groups was notably higher than reported in the studies by Bui Van Loi (2014) and Dau Van Hai et al. (2021) and falls within the recommended range of 109-145 g per head per day for lamb weighing 20-30 kg, with a daily weight gain of 10-150 g per head per day, as suggested by Jayanegara et al. (2017) for local sheep breeds in Indonesia. This level of intake also meets the NRC (2007) guidelines for optimal growth and development in lamb. This could explain why the lambs in those studies had lower AGD and did not reach 100 g per head per day.

Feed conversion ratio and feed efficiency

Table 6. Feed conversion ratio and feed efficiency of experimental lambs

Items	Stages	T1	T2	T3	SEM	P
FCR *(kgDM intake/kg weight gain)*	5-6 months old	8.29[b]	8.59[a]	8.69[a]	0.128	0.005
	6-7 months old	7.30[a]	7.04[b]	7.19[ab]	0.109	0.028
	7-8 months old	9,01[a]	8.88[b]	9.34[a]	0.103	<0.001
	5-8 months old	8.12[b]	8.06[b]	8.28[a]	0.041	<0.001
Feed efficiency *(d/kg weight gain)*	5-8 months old	50,522	47,862	48,705	-	-

Note: Means with different letters in the same row are significantly different (P<0.05)

The DM intake per kg of weight gain significantly differed among the experimental lambs groups (P<0.05). During the 5-6 month stage, the FCR was best (8.29 kg DM/kg weight gain) in the control group, lower by 0.30 and 0.40 kg DM per kg weight gain in T2 and T3, respectively. Over the next 30 and 60 days and overall for the 90-day experiment, as the lambs's digestive physiology adapted to the new feed, the FTMR diets did not negatively affect this ratio. Moreover, in the group fed 60% DFB in the FTMR diet, the FCR tended to improve compared to the control group. However, increasing DFB in the FTMR diet to 70% reduced growth, adversely affecting the FCR in the experimental lambs. The lambs fed the FTMR diet with 70% DFB throughout the experiment consumed an additional 0.16 and 0.22 kg DM per kg weight gain compared to the control group and the group fed the FTMR diet with 60% DFB. The FCR of Phan Rang lambs in this study was consistent with the results of 6.75-8.38 kg DM intake per kg weight gain reported by Ahmed et al. (2018) for local lambs breeds in Bangladesh. Liu et al. (2021) also reported similar FCR results for Tan lambs in China, with FCR ranging from 8.1-10.3 kg DM intake per kg weight gain during the 7-9 month stage.

In term of feed efficiency, this indicator varied significantly among the experimental lambs groups, being lowest in those fed the FTMR diet containing 60% DFB. Compared to the lambs in T1 and T3, the feed cost per kg of weight gain in T2 was saved by 2,660 and 1,817 Vnd, or 5,26% and 3.60%, respectively. It can be said that using 60% DFB in the FTMR diet brought significant economic benefits in lambs farming. Optimizing the nutritional regime and utilizing by-products not only helped maintain lambsgrowth but also reduced costs, increasing profitability for farmers.

CONCLUSIONS

Conclusion

Using FTMR diet made from DFB did not hinder the growth and development of lambs. The diet consisting of FTMR with 60% DFB supported well growth and development. Moreover, this diet reduced feed costs by over 5%.

Recommendation

Fresh DFB can be effectively used to create complete fermented feed for lambs in regions where dragon fruit is cultivated.

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REFERENCES

Ahmed S, Rakib M.R.H., Yesmin M., Queen N.S., Jahan N. and Ershaduzamman Md. 2018. Evaluation of lamb production potentiality of the Barind, Jamuna river basin and coastal region sheep of Bangladesh under intensive management. Journal of Advanced Veterinary and Animal Research 2018, Vol 5(1): 37-43.

Bui Xuan Loi. 2014. Evaluating the adaptability of Phan Rang sheep raised in Thua Thien Hue. (Doctoral thesis). Hue university, 2014, 171 pages

Dau Van Hai, Phan Van Sy, Le Ba Chung, Vu Minh, Doan Vinh and Nguyen Van Phu. 2021. Effects of fermented cashew fruit supplement in diets on growth performance in sheep. Journal of Animal Science and Technology 2021, Vol 125:31-39.

Doan Vinh, Nguyen Duy Khanh, Phan Thi Tuong Vi, Dinh Thi Quynh Lien, Pham Van Quyen and Hoang Thi Ngan. 2022. A study of using the fermented dragon fruit branches as a feed source for cattle. Journal of Animal Science and Technology 2022, Vol.134:53-59.

General Statistics Office. 2024. Vietnam Livestock Statistics 2023 (preliminary).

https://www.feedtables.com

Jayanegara A., Ridla M., Astuti D.A., Wiryawan K.G., Laconi E.B. and Nahrowi. 2017. Determination of Energy and Protein Requirements of Sheep in Indonesia using a Meta-analytical Approach . Media Peternakan journal of Animal Science and Technology. 40(2):118-127 Available on: https://journal.ipb.ac.id/index.php/ mediapeternakan/article/view/16203

Le Quang Khoi and Nguyen Thi Ngoc Truc. 2017. Transforming discarded dragon fruit branches into bio-organic fertilizer using beneficial microorganisms and manure. 2017 Project report, 63 pages.

Liu H., Yang G., Degen A., Ji K., Jiao D., Liang Y., Xiaoe L., Longa R. and Zhoua, J. 2021. Effect of feed level and supplementary rumen protected lysine and methionine on growth performance, rumen fermentation, blood metabolites and nitrogen balance in growing Tan lambs fed low protein diets, Animal Feed Science and Technology 279 (2021) 115024 <https://doi.org/10.1016/j.anifeedsci. 2021.115024 >

Ninh Thuan province's Statistical Office. 2024. The socio economic situation in August and the first eight months of 2024

Nguyen Duc Thinh, Ngo Huynh Bao Trinh, Le My Thanh and Nguyen Thi Thu Hien. 2021. Survey growth indicators of Phan Rang sheep when using silage feed. Thu Dau Mot University Journal of Science 2021, Vol 2[51]:40-47

Nguyen Huu Van, Nguyen Thi Mui, Le Tran Hoan, Van Ngoc Phong, Tran Ngoc Long, Dinh Van Dung, Vo Thi Minh Tam, Ho Le Quynh Chau, Ngo Mau Dung, Bui Van Loi, Tran Quang Vui, Pham Van Tiem and Nguyen Xuan Ba. 2023. The status of sheep husbandry and the growth and reproductive performance of Phan Rang sheep raised in Ninh Thuan province. Journal of Animal Husbandry Sciences and Technics, 2023, Vol 295:25-31

NRC. 2007. Nutrient Requirements of Small Ruminants: Sheep, Goats, Cervids, and New World Camelids 2007

Wang L., Jin S., Wang P., Li X., Liu C., Sun S., Zhang G., Chang J., Yin Q., Zhang H. and Zhu Q. 2024. Fermented total mixed ration enhances nutrient digestibility and modulates the milk components and fecal microbial community in lactating Holstein dairy cows. Front Vet Sci. Available on: https://doi.org/10.3389/fvets.2024.1408348

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