# Effect of Yeast Fermented Feed on Native Sheep of Bangladesh

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## ABSTRACT

Experiment was done with yeast (*S. cerevisiae*) fermented roughage (Rice straw and Sugarcane bagasse) with yeast fermented concentrate (Wheat bran and Rice polish). 12 no. of growing sheep was used for feed trial divided into 3 treatment groups named $T_0$, $T_1$, and $T_2$. Groups were supplied by 4.5, 4.0, and 3.0 kg feed respectively. Nutritional composition of feed were analyzed by the AOAC method (2011) and provided same amount of nutrition for each group. 1125g, 1000g, and 750g feed/animal/day were supplied in $T_0$, $T_1$, and $T_2$ groups respectively. Control $T_0$ was supplied (85% green grass and 15%concentrate mixture). The $T_1$ group was supplied by (60% green grass, 20% fermented roughage, and 20% fermented concentrate mixture) and the $T_2$ group was supplied by (60% fermented roughage and 40% fermented concentrate mixture). The result found that nutrient intake; feed digestibility and body growth was better in fermented feed-supplied groups in $T_1$ and $T_2$ than in the control group $T_0$. DMI was 510.59 (g/d), 405.08 (g/d) respectively in $T_2$ and $T_1$ group whether 356.90 (g/d) in $T_0$ group .CPI was 61.93, 48.61(g/d), and EEI was 18.84, 15.96 (g/d) in $T_2$ and $T_1$ groups respectively whereas CPI was 41.54 and EEI was 15.81 g/d in the T0 group respectively. TAI was 45.34 (g/d), 37.26 (g/d) and NFEI was 278.14 (g/d), 189.66 (g/d) in $T_2$ and $T_1$ groups where TAI was 32.83 and NFEI was 156.64 g/d in $T_0$ group. OMI was 465.25 and 367.81 g/d in $T_2$ and $T_1$ group respectively, whereas, 324.06 g/d in $T_0$ group. Growth performance was best in the $T_2$ group. Total body weight gain (kg) during the trial period was 7.92 and 7.4 kg in $T_2$ and $T_1$ groups respectively and 5.3 kg in the $T_0$ group. Daily weight gain was 66.0 and 62.20 g/d $T_2$ and $T_1$ groups and 44.16 g/d in the $T_0$ group. However, Due to more DM intake in the $T_2$ group, the FCR of feed was best in the $T_1$ group which was 6.81 (kg feed/kg gains) while in $T_0$ and $T_2$ group the FCR was 8.39 and 7.85 (kg feed/kg gains). Result also showed that DMI (g/ $kgW^{0.75}$), and CPI (g/$kgW^{0.75}$) was better in $T_2$ group these were 72.82, and 8.80 (g/ $kgW^{0.75}$) respectively and 57.45, and 6.89 (g/$kgW^{0.75}$) respectively in $T_1$ group whether, 55.07, and 6.41 (g/kgW0.75) respectively in $T_0$ group. Digestibility was better in fermented feed supplied group $T_1$ and $T_2$ than in control group $T_0$. DM, CP, and CF digestibility was 72.48%, 80.72%, and 77.71% in $T_1$ group respectively and 72.38%, 81.50%, and 72.24% in $T_2$ group respectively where 62.25%, 71.04%, and 71.16% in $T_0$ group respectively. EE and OM digestibility was 82.74%, and 73.95% respectively in the $T_1$ group and 79.50%, and 74.15% respectively in the $T_2$ group while 74.74% and 64.70% in the $T_0$ group respectively. Results also showed that the fermentation of feed was cost-effective. In conclusion, Yeast fermented feed improve the growth rate of sheep by increasing the nutrient intake and digestibility.

**Key words: SSF (Solid state fermentation), Yeast (*S. cerevisiae*), Nutrient intake, digestibility, growth of sheep**.

## INTRODUCTION AND BACKGROUND

Fermentation is one of the methods that can be applied to increase animal feed quality. Fermentation can be a promising alternative to increase the nutritional value of agro residues by product into valuable animal feed. Solid-state fermentation (SSF) is an appropriate treatment to improve the nutritional value of poor quality roughage and energy rich concentrate. Rice straw contains low lignin and a high amount of silica (Van Soest, 2006). The microbial treatment to improve the nutritive value of rice straw with extracellular ligninolytic enzymes degrading cellulose or hemicellulose (Sarnklong *et al.,* 2010). Huyen *et al.,* (2019) noticed the rice straw fermented for 28 days with the fungus *Pleurotuseryngii* reduced the content of NDF, ADF, and ADL,

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enhanced the content of crude protein (from 4.2 to 7.1% in DM), and the digestibility of DM from 43 to 53% and of the crude protein from 45.8 to 54.4%. Rice straw fermented by *A. brasilense* and *S. cerevisiae* which gave 27.54% reductions in CF respectively and showed the highest increase in crude protein 13.71% (Zayed, 2018). Sugarcane bagasse is the main sugarcane processing agro-industrial residue, resulting from the crushing of sugarcane during extraction. It is approved as a low-quality roughage presenting 3% crude protein, (40-45) % cellulose, (28-30)% hemicellulose, and (19-21)% lignin (Costa *et al.,* 2015). Sugarcane bagasse can be recycled to produce a value-added product such as protein-enriched animal feed, enzymes, amino acids, organic acids, and compounds of pharmaceutical importance (Pandey *et al.,* 2000). Feed technology should be applied to improve the quality of sugarcane bagasse. Samadi et.al, (2016) stated that chemical pre-treatment such as ammoniation before fermentation is able to optimize microorganism activities. Fermentation of sugarcane bagasse by *L. casei TH14,* in combination with cellulase, and molasses resulted from the best qualities of sugarcane bagasse silage (So *et.al;* 2020). Solid state fermentation is an effective way to improve the properties of wheat brans. Total dietary fiber and soluble dietary fiber increased after solid state fermentation. Over 20% of phytic acid was degraded and protein degradation was also observed in fermented brans (Zhao et. al., 2017). Mahmoud et al, (2022) observed that the levels of protein, fiber, ash, and fat in *S. cerevisiae* fermented wheat bran were higher compared to those in non-fermented bran. Additionally, both the total and free phenolic content, as well as the antioxidant activity, showed an increase trend following solid-state fermentation. Subsequent to the solid-state fermentation of wheat bran using the predominant strain *Enterococcus faecalis M2*, there is a notable enhancement in the overall levels antioxidant capacity and free radical scavenging rate. Furthermore, the concentration of free amino acids rose as the degradation of wheat bran protein occurred, while the amount of the anti-nutrient phytic acid diminished (Mao et al., 2020). Incorporating an appropriate amount of wheat bran into animal diets can enhance intestinal function and growth performance; however, an excessive inclusion may lead to adverse effects due to its elevated lignocellulose content, non-starch polysaccharides, phytic acid, and the risk of mycotoxins (Feng et al; 2020). Numerous research efforts have highlighted that solid-state fermentation (SSF) technology serves as a potent method for enhancing the nutritional quality of by-products, significantly improving the nutritional value, physical characteristics, and flavor attributes of wheat bran (Călinoiu et al; 2019). Furthermore, the incorporation of 5% dry fermented wheat bran (FWB) to broilers (Ross 308) diets improved the growth performance, increased the *Lactobacillus* counts in ileum, and maintained the beneficial intestine environment (Lin et al; 2020). Zhang et al. (2022) found that the solid-state fermentation of wheat bran positively influenced growth performance, nutrient digestibility, and anti-inflammatory responses in broiler chickens. Kraler et al. (2014) reported that wheat bran fermented by *Lactobacillus paracasei* and *Lactobacillus plantarum* significantly increased the apparent digestibilities of dry matter (DM), organic matter (OM), ether extract (EE), and gross energy (GE). Rice bran is a by-product produced during the milling process of rice, representing roughly 8% to 9% of the overall weight of rough rice. This by-product shows significant potential as a component in animal feed. However, the use of rice bran in animal feed remains limited due to the presence of antinutritional factors such as phytic acid, trypsin inhibitors, oxalates, saponins, and tannins (Irakli, Lazaridou, and Biliaderis 2020), which can adversely affect digestibility and the bioavailability of nutrients. The elimination of these anti-nutritional elements can be accomplished through fermentation processes that employ specific microorganisms (Sharath et al., 2014), including fungi (Belewu, 2006). The process of solid-state fermentation utilizing Rhizopusoryzae CCT 7560 on rice bran results in a 26.6% increase in protein content after 120 hours, while the total phenolic compounds also rise during fermentation, peaking at 96 hours (Kupski et al., 2012). This procedure generally utilizes microorganisms like bacteria, yeast, or fungi to decompose complex compounds, which enhances the bioavailability of nutrients. Following fermentation, bran demonstrates an enhanced chemical composition and nutritional worth. The procedure diminishes anti nutritional elements while simultaneously enhancing the bran with advantageous substances such as amino acids and probiotics. Employing fermented bran in animal nutrition presents various benefits, including improved digestive health, increased nutrient uptake, and heightened disease resistance (Ma et al., 2024). The process of fermentation utilizing yeast (*S. cerevisiae*) may represent one of the most effective methods for enhancing its nutritional value. The fermentation of bran enhances its nutritional value while simultaneously promoting sustainable agricultural methods by minimizing waste. Recently, there has been an increasing interest in the fermentation process to improve the nutritional profile of rice bran. Studies have confirmed that the fermentation of rice bran can elevate the levels of crude protein and fat. Furthermore, the use of fermented rice bran (FRB) in animal feed enhances the growth performance of food-producing animals by boosting

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efficiency. These findings, coupled with their positive impact on gut microbiota, may contribute to the overall health of food animals (Manlapig& Matsui, 2025). Veerabhadrappa et al., (2014) found the detoxification effect of *S. cerevisiae* diminish the phytate and other anti-nutritional components, thereby enhancing nutrient availability for the animal. As noted by Danesi et al. (2006), the fermentation process requires yeast to have access to specific nutrients such as carbon, nitrogen, trace minerals, and vitamins in order to flourish in the fermentation medium. As microbial fermentation improve the nutritive value of these crop residues, so the objective of these biological trial was to know the response of growing sheep fed *S. cerevisiae* fermented roughage with fermented concentrate. The objectives were as follows:

1. To assess the sheep's response to yeast fermented Roughage and Concentrate.
2. To develop solid state fermentation (bio-technological technique) in small ruminant feeding.

# METHODOLOGY

### Period of study

The study was conducted from January 2025 to June 2025.

### Preparation of Yeast fermented feed

FRM (Fermented roughage mixture), green grass, and FCM (fermented concentrate mixture) were fed to animal. The roughage mixture was prepared with sugarcane bagasse and rice straw at 1:4 ratio and the concentrate mixture was prepared with wheat bran & rice bran at 3:2 ratios. After chopping roughage mixture was prepared with 20% sugarcane bagasse and 80% rice straw and the concentrate mixture was prepared with 60% wheat bran and 40% rice bran. Both mixtures were fermented with five 5% dry yeast (*S. cerevisiae*; 2x 10 ^10) in a plastic bag. The incubation period was five (05) days. After five (05) days, the fermented mixture was dried in sunlight properly. After drying it was ready to feed.

### Experimental design

Sample size (growing native sheep) was twelve (12) in no. and these were divided into three groups named $T_0$, $T_1$, and $T_2$. Here $T_0$ (Control) and $T_1$, and $T_2$ were fermented feed supplied groups. Groups were supplied by 4.5, 4.0, and 3.0 kg feed respectively. Nutritional composition of feed was approximately similar for three groups and was analyzed by the AOAC method (2011). 1125g, 1000g, and 750g feed/animal/day were supplied in $T_0$, $T_1$, and $T_2$ groups respectively. Control $T_0$ was supplied 85% green grass and 15% concentrate mixture. The $T_1$ group was supplied by 60% green grass, 20% FRM, and 20% FRM and the $T_2$ group was supplied by 60% FRM and 40% FCM.

### In vivo digestibility trial

In vivo digestibility trial was done by conventional digestion trial method of measuring feed's nutrient digestibility. The animals were allowed for a digestibility trial in the last week of the experimental period. Accurate daily feed intake, refusals, and fecal output records were kept. Sample of each animal usually 10% of the daily output in the case of feces was retained for analysis. When estimates of nitrogen balance were desired, urine output was also measured. A metabolic crate was used for collecting the excreta of animals for a digestibility trial. A metabolic crate was a stall or box large enough for the animal set on legs from 50 cm to 1 m high. It was so planned as to permit the quantitative collection of feces and urine. The experimental animals were sufficiently comfortable during that period. The space allowed for the animal must be large enough to permit free movement. Digestibility of nutrients was calculated as follows:

Nutrient digestibility%= {(Nutrient intake - Nutrient in feces) / Nutrient intake} x 100

### Statistical analysis

The data was arranged according to ANOVA and were analyzed using Minitab statistical software computer program

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# RESULTS

**Table-1: Nutrient intake of sheep**

| Parameter | | Treatments | | | SEM | p value |
|---|---|---|---|---|---|---|
| | | $T_0$ | $T_1$ | $T_2$ | | |
| Nutrient intake | MEI(MJ/day) | $2.96^{c}$±0.02 | $3.11^{b}$±0.03 | $3.26^{a}$±0.03 | 0.006 | <0.001 |
| | DMI (g/day) | $356.90^{c}$±3.13 | $405.08^{b}$±4.51 | $510.59^{a}$±5.14 | 3.39 | <0.001 |
| | CPI (g/day) | $41.54^{c}$±0.36 | $48.61^{b}$± 0.54 | $61.93^{a}$± 0.62 | 0.44 | <0.001 |
| | CFI (g/day) | $107.64^{c}$±0.94 | $113.74^{a}$±1.26 | $106.67^{b}$±1.07 | 0.17 | <0.001 |
| | EEI (g/day) | $15.81^{c}$± 0.13 | $15.96^{b}$± 0.17 | $18.84^{a}$± 0.18 | 0.07 | <0.001 |
| | TAI (g/day) | $32.83^{c}$±0.28 | $37.26^{c}$±0.41 | $45.34^{a}$±0.45 | 0.27 | <0.001 |
| | NFEI (g/day) | $156.64^{c}$±1.37 | $189.66^{a}$±2.11 | $278.14^{a}$±2.80 | 2.70 | <0.001 |
| | OMI (g/day) | $324.06^{c}$±2.19 | $367.81^{b}$±4.51 | $465.25^{a}$±4.66 | 3.12 | 0.00 |

- $T_0$=( 85% GG +15% CM), $T_1$=(20% FRM+ 60 % GG+20% FCM), $T_2$=(60% FRM+40% FCM)
- GG=green grass, FRM=Fermented roughage mixture, FCM= Fermented concentrate mixture

Table-1 represents the nutrient intake of sheep during the experimental period of animal. $T_0$, $T_1$, and $T_2$ group was supplied by 4.5, 4.0, and 3.0 kg feed according to average body weight. Each group was consisting of 4 no. of the animal. 1125g, 1000g, and 750g feed/animal/day were supplied in $T_0$, $T_1$, and $T_2$ groups respectively. $T_0$ was supplied by 85% GG and 15% CM. $T_1$ was supplied by 20% FRM, 60% GG, and 20% FCM. 60% FRM and 40 % FCM was supplied to the $T_2$ group. The table showed that DM intake per animal in the $T_0$ group was 31.72% of total feed. Similarly, DM intake of the $T_1$ and $T_2$ group was 40.50% and 68.07% of total feed respectively. Results revealed that DM intake significantly differ (<0.001) between the non-fermented and fermented feed-supplied group. CP intake was 8.25% of feed in group $T_2$ that was supplied by 100% fermented feed, whether 4.86% and 3.69% of feed in the $T_1$ and $T_0$ group. Similarly, CF and EE intake (g/day/Animal) was higher in only fermented feed supplied group $T_2$ which was 14.22% and 2.51% of feed respectively. Ash intake (g/day/Animal) of $T_0$, $T_1$ and $T_2$ groups was 2.91%, 3.72%, and 6.04% of feed respectively. NFE intake (g/day/Animal) was 13.92%, 18.96%, and 37.08 % of feed in the $T_0$, $T_1$, and $T_2$ groups. Similarly, ME intake (MJ /day/animal) was 3.26 in the $T_2$ group and 3.11 and 2.96 in the $T_1$ and $T_0$ groups respectively.

**Table-2: Nutrient digestibility of sheep**

| Parameter | | $T_0$ | $T_1$ | $T_2$ | SEM | pvalue |
|---|---|---|---|---|---|---|
| Nutrient digestibility (%) | DMD | $62.25^{b}$±1.93 | $72.48^{a}$±3.39 | $72.38^{b}$±1.63 | 0.60 | <0.001 |
| | CPD | $71.04^{c}$±1.14 | $80.72^{b}$±3.34 | $81.50^{a}$±1.95 | 0.58 | <0.001 |
| | CFD | $71.16^{c}$±1.76 | $77.71^{a}$±3.06 | $72.24^{b}$±1.92 | 0.41 | <0.001 |
| | EED | $74.74^{c}$±4.12 | $82.74^{a}$±3.69 | $79.50^{b}$±2.77 | 0.40 | <0.001 |
| | OMD | $64.70^{c}$±$2.65^{b}$ | $73.95^{b}$±4.08 | $74.15^{a}$±1.87 | 0.59 | <0.001 |

- $T_0$=( 85% GG +15% CM), $T_1$=(20% FRM+ 60 % GG+20% FCM), $T_2$=(60% FRM+40% FCM)
- GG=green grass, FRM=Fermented roughage mixture, FCM= Fermented concentrate mixture

Table-2 showed the nutrient digestibility of sheep. $T_0$, $T_1$, and $T_2$ group was supplied by 4.5, 4.0, and 3.0 kg feed according to average body weight. Each group was consisting of 4 no. of the animal. 1125g, 1000g, and 750g feed/animal/day were supplied in $T_0$, $T_1$, and $T_2$ groups respectively. It is observed that fermented

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roughage mixture (Rice straw and sugarcane bagasse) with green grass showed the increased digestibility of feed. Results represent the nutrient digestibility of yeast fermented roughage mixture and concentrate mixture. Results revealed that nutrient digestibility showed an increasing trend in fermented treatments $T_1$ and $T_2$. DM, CF, and EE digestibility were higher in the $T_1$ group and that was 72.48%, 77.71%, and 82.74% respectively. DM, CF, and EE digestibility was 72.38%, 72.24%, and 79.50% respectively in the $T_2$ group whereas DM, CF, and EE digestibility was 62.25%, 71.16%, and 74.74% respectively in the $T_0$ group. CP digestibility was 81.50% in the $T_2$ group and 80.72% and 71.04% in the $T_1$ and $T_0$ groups respectively. $T_1$ group was supplied with 20% FRM, 20% FCM, and 60% GG and 60% FRM and 40% FCM were supplied to the $T_2$ group. Unfermented feed-supplied group $T_0$ showed the lowest nutrient digestibility among the treatments.

**Table-3: Growth rate of sheep during experimental period**

| **Parameter** | | **$T_0$** | **$T_1$** | **$T_2$** | **SEM** | **pvalue** |
|---|---|---|---|---|---|---|
| Body weight gain | IBW (kg) | $6.8^{a}$ ± 0.64 | $6.08^{b}$±0.59 | $5.55^{c}$± 1.02 | 0.15 | 0.002 |
| | 1st MG(kg) | 1.00 ± 0.48 | 1.1 ± 0.08 | 0.84 ± 0.43 | 0.06 | 0.21 |
| | 2nd MG(kg) | $1.20^{c}$ ± 0.35 | $1.77^{b}$ ± 0.11 | $1.82^{a}$ ± 0.31 | 0.06 | <0.001 |
| | 3rd MG(kg) | $1.21^{c}$ ± 0.34 | $1.85^{b}$ ±0.52 | $2.14^{a}$ ±0.40 | 0.09 | <0.001 |
| | 4th MG(kg) | 1.50 ± 0.76 | 2.26 ± $0.92^{a}$ | 2.37 ±0.76 | 0.14 | 0.027 |
| | TWG(kg) | $5.3^{c}$ ± 0.69 | $7.4^{b}$ ±1.35 | $7.92^{a}$ ± 0.63 | 0.24 | <0.001 |
| | WG(g/ day) | $44.16^{c}$ ± 5.81 | $62.20^{b}$ ±11.33 | $66.0^{a}$ ±5.28 | 2.06 | <0.001 |
| | FCR(kg feed/kg gain) | 8.39 ±0.79 | 6.81 ±1.78 | 7.85 ±0.97 | 0.45 | 0.24 |
| | Cost (taka) | $1249.58^{c}$±24.04 | $1702.42^{b}$±71.98 | $2308.05^{a}$±160.4 | 133.45 | <0.001 |
| | wg*600tk/ sheep | $1915.42^{c}$±422.22 | $2767.57^{b}$±821.2 | $2446.95^{a}$±270.6 | 179.64 | 0.14 |
| | profit tk/sheep | $665.84^{c}$±400.0 | $1065.15^{c}$±753.9 | $138.9^{c}$±147.99 | 173.59 | 0.07 |

- $T_0$=( 85% GG +15% CM), $T_1$=(20% FRM+ 60 % GG+20% FCM), $T_2$=(60% FRM+40% FCM)
- GG=green grass, FRM=Fermented roughage mixture, FCM= Fermented concentrate mixture

Table-3 showed the growth rate of sheep during experimental period. There is a significant difference (<0.001) in growth rate in the 2nd and 3rd months among treatment groups. In the 2nd and 3rd months, the growth rate was highest in the $T_2$ group and that was 1.82 kg and 2.14 kg respectively. In the $T_0$ group, the growth rate was 1.20 kg and 1.21 kg in the 2nd and 3rd months respectively. Total weight gain (kg) and daily weight gain (g/day) of growing sheep were significantly different (<0.001) among treatments. Total weight gain was 7.92 kg in the $T_2$ group, and 7.4, 5.3 kg in $T_1$ and $T_0$ groups respectively. Weight gain (g/day) was high in fermented feed groups $T_1$ and $T_2$. Improved FCR (kg feed/kg gain) was shown in $T_1$ compared to $T_0$ and $T_2$ groups. FCR of $T_0$, $T_1$ and $T_2$ groups was 8.39, 6.81, and 7.85 (kg feed/kg gain) respectively. The current research proved that fermented feed significantly (<0.001) improved the growth of animals than non-fermented feed trial group $T_0$. Results also showed that the experiment is cost-effective.

**Table-4: nutrient intake of /w $^{0.75}$ sheep**

| **Parameter** | | **$T_0$** | **$T_1$** | **$T_2$** | **SEM** | **pvalue** |
|---|---|---|---|---|---|---|
| Nutrient intake /kg W $^{0.75}$ | Initial $W^{0.75}$ (kg) | 4.20 ± 0.31 | 3.87 ± 0.29 | 3.61 ± 0.52 | 0.07 | 0.04 |
| | Final $W^{0.75}$ (kg) | 6.48 ± 0.55 | 7.05 ± 0.54 | 7.03 ± 0.27 | 0.08 | 0.008 |

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| | | | | | | |
|---|---|---|---|---|---|---|
| | DMI g/kgW$^{0.75}$ | 55.07$^{c}$ ± 0.49 | 57.45$^{b}$ ±0.64 | 72.82$^{a}$ ± 0.72 | 0.41 | <0.001 |
| | CPI g/kgW$^{0.75}$ | 6.41$^{c}$ ± 0.05 | 6.89$^{b}$ ± 0.07 | 8.80$^{a}$ ± 0.08 | 0.05 | <0.001 |
| | MEI MJ/kgW$^{0.75}$ | 0.45$^{b}$ ±0.004 | 0.44$^{c}$ ±0.004 | 0.46$^{a}$ ± 0.004 | 0.0005 | <0.001 |

- $T_0$=( 85% GG +15% CM), $T_1$=(20% FRM+ 60 % GG+20% FCM), $T_2$=(60% FRM+40% FCM)
- GG=green grass, FRM=Fermented roughage mixture, FCM= Fermented concentrate mixture

The Table-4 showed the mean value of initial W $^{0.75}$ (metabolic body weight) & final W $^{0.75}$ (metabolic body weight) DM, CP, and ME intake per kg W $^{0.75}$. Final W $^{0.75}$ (metabolic weight) was 6.48 kg in the $T_0$ group, 7.05 kg in $T_1$, and 7.03 kg in the $T_2$ group. DMI, CPI (g/kg W 0.75) were significantly (<0.001) higher in fermented feed supplied group $T_2$ that was 72.82 and 8.80 respectively where, 55.07 and 6.41 respectively in $T_0$ group and 57.45 and 6.89 respectively in $T_1$ group. The table showed significant differences among treatment groups in MEI. MEI (MJ/kg W $^{0.75}$) was 0.45 in $T_0$ group, 0.44 in $T_1$ and 0.46 in $T_2$ group. The fermented feed supplied group gets less ME than the Control group because fermentation reduces the ME content of the feed.

## DISCUSSIONS

### Effect of fermented feed on nutrient intake, growth performance, and digestibility of feed

Incorporating 9% yeast into pelleted diets at elevated levels facilitates the growth of rumen epithelium and modulates the fermentation dynamics within the rumen, thus supporting the overall health of the rumen in sheep (Xu et al., 2025).The inclusion of yeast in the diet may enhance the growth and slaughter performance of fattening Hu sheep by improving nutrient digestion, particularly nitrogen utilization, the rumen microbial environment, and the development of the rumen epithelium. This underscores the advantages of paraprobiotics in animal production (Wang et al., 2022).Yeast products into pelleted total mixed ration can enhance lamb growth performance. The observed improvement in performance may be linked to enhanced fiber digestibility (Song et al., 2021).

The rumen microbiota is essential for breaking down plant fibers and affects ruminant production and health diversity (Wang et al; 2022).The digestibility of nutrients is enhanced by a rise in the population of microbial biomass that degrades cellulose within the rumen. The enhanced digestibility may result from a stable rumen pH and the elimination of oxygen. The stable pH level in the rumen creates a more favorable environment for the proliferation of rumen microbes, particularly those bacteria and fungi that degrade cellulose. Simultaneously, the anaerobic environment within the rumen contributed to the enhanced development of fibrinolytic microbial biomass. As a result, these microbial organisms facilitated improved fiber digestion (Ghazanfer et al., 2015).

The supplementation of *S. cerevisiae* resulted in a significant increase in dry matter (DM), organic matter (OM), crude protein (CP), and fiber digestibility. This enhancement in nutrient digestibility may be attributed to a rise in the population of cellulose-degrading microbial biomass within the rumen (Lascano et al., 2012). The differences in nutrient digestibility could be attributed to the type and quality of the diet provided to animals. Moreover, Yeast has the ability to use some of the free sugars found in the rumen, which helps to prevent a shift in fermentation that could occur due to the rapid breakdown of these sugars.Using ruminal fermentation modifiers boosts dry matter intake (DMI) and nutrient use, resulting in higher milk production. They also lower the risk of infections, metabolic disorders, and reproductive issues (Eastridge, 2006). This fermented product derived from *S. cerevisiae* is rich in antioxidants, B vitamins, nucleotides, amino acids, soluble fiber, and various other bioactive compounds, which can act as nutrient sources and growth enhancers for rumen microflora (Callaway and Martin, 1997) that promote the proliferation of cellulolytic, proteolytic, and lactate-utilizing bacteria within the rumen can subsequently enhance the digestibility of dry matter and

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protein in the rumen (Miller-Webster et al., 2002) and concentrations of propionate or ammonia, or both (Erasmus et al., 2005).Fermented feed enhanced the digestibility of fiber, probably because of a rise in cellulose-degrading bacteria or metabolites that stimulate the activity of ruminal cellulolytic bacteria (Zhang et.al,2022).

Another possible explanation is that the culture of *S. cerevisiae* could enhance the presence of anaerobic fungi within the fiber. This enhancement may lead to improved accessibility of the fiber for bacteria that are responsible for its degradation, rather than having a direct effect on the growth of the bacteria themselves (Garcia-Mazcorro et.al, 2019). Hristov et al., (2010) showed that the diet containing *S. cerevisiae* fermentation can enhance the production of microbial protein in the rumen, increase the availability of amino acids in the small intestine, and facilitate protein deposition. Fermented feed elevates the NH3-N concentration in the rumen, suggesting that microbes have improved their protein utilization, potentially leading to enhanced growth performance in animals. Malekkhahi et al., (2015) also found that Yeast-fermented feed reduces microbial nitrogen flow in the rumen, speeds nutrient passage to the intestines, improves nitrogen circulation in the duodenum, enhances nitrogen absorption, and lowers nutrient excretion in feces and urine and promotes the absorption and deposition of nitrogen. β-glucan, a key component of yeast culture, acts as a substrate for the immune response, stimulating the humoral immune system to produce antibodies that protect intestinal villi from degradation and promote their development. The rumen microbiota is essential for breaking down plant fibers and affects ruminant production and health diversity (Ma et.al., 2021). In a concentrate ration, yeast-fermented products can be employed as an unconventional source of protein without having any negative effects on ruminants' nutrient intake, digestibility, nitrogen balance, or in situ digestive kinetics (Awais et al., 2021).

The direct action of yeast that degrade fiber in the rumen through its action at the level of oxygen consumption and promote the fibrinolytic action to accelerate intestinal transit, resulting in an increase in the amount of dry matter intake (Chaucheyras-Durand, 2010). Contrary to recent studies, Desnoyers et al., (2006) discovered that feed consumption didn't alter much with yeast supply. Similar outcomes were found by Moncoulon and Auclair, (2001). They noticed that beef cattle consumed (2–6) % less dry matter. According to Beauchemin et al., (2003), *S. cerevisiae* makes the rumen flora lactate effective, which prevents lactic acid from building up in nutritional circumstances and causing the development of acidosis. Starch (a concentrated carbohydrate) ferments significantly more quickly and produces more volatile fatty acids (VFAs), but lactic acid produced as an intermediary product is digested less quickly. Consequently, yeast can enhance the flow of microbial protein in the rumen and stimulate lactic acid bacteria in rumen digestion, both of which lead to an increase in weight growth. Zhang et al., (2021) discovered that the fermented feedstuffs had a positive effect on growth performance and that the species of the incubated strains and the fermented substrate strongly correlated with feed efficiency. *S. cerevisiae* improves the intake of dry matter, fiber, and crude protein digestibility while increasing the number of ruminal bacteria. According to several studies, yeast-fermented feed can substitute up to 75% of the standard protein sources improving rumen fermentation and dry matter intake (Khampa et al., 2010).

The consequently, this has positive effects on rumen fermentation and nutrient digestion (Erasmus et al., 2005). The reason is because of its distinctive flavor and aroma as well as its improved palatability(Ghazanfar et al., 2015).The higher nitrogen concentration of the rumen, which facilitated the expansion of the microbiome and boosted digestibility, may be responsible for the increased digestibility (Ullah et al., 2012). A favorable ecological environment provided by yeast encourages the growth and activity of microorganisms, particularly cellulolytic bacteria that improve fiber breakdown (Crossland et al., 2018). Therefore, yeast can help animals function better. Digestibility may increase with greater consumption of dry materials. It is possible that the addition of yeast, which increases the amount of helpful bacteria that break down the connections between various feed components, is the cause of the enhanced nutrient digestibility observed in animals fed at various levels of yeast dose (Ullah et al., 2017). Sawsan et al., (2012), found the increased number of helpful bacteria that break down the molecules in the rumen that boost nitrogen usage in the rumen may be the cause of the higher CP digestibility progress. Similar outcomes were also found by Haddad and Goussous, (2005) when yeast culture was offered to animals at different amounts. However, the current result does not agree with Putnam et al., (1997). According to their findings, yeast has no function on the digestion of

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nutrients. With the addition of yeast, there might not be any increase in the diversity of rumen microflora. Akinfemi and Ogunwole, (2012) found delignification causes a change in cell wall structure that increases the rumen microbes' voluntary access to it. According to Phesatcha et al. (2021), live yeast in feed boosted DM intake and the digestibility of DM, OM, CP, NDF, and ADF. *S. cerevisiae* stabilizes the rumen environment for the growth of fibrinolytic bacteria by minimizing variations in ruminal pH and redox potential in a concentrate-rich diet (Li et al., 2021). This led to more fiber being digested, which suggests that live yeast boosted the rates of fiber transit and digestion, leading to higher intake and overall digestibility (Khalouei et al., 2020).The rumen's anaerobic and less acidic environment encourage the growth of fiber-degrading microorganisms and speed up fiber degradation. By changing the rumen bacteria to encourage the growth and activity of fibrinolytic microbes as well as those that metabolize lactate, live yeast enhances animal performance. This could be helpful in diets that promote the rumen's ability to synthesize short-chain fatty acids, which would reduce the rumen's pH (Sousa et al., 2018). *S. cerevisiae* supplementation slows down the rate of starch digestion in the rumen in cows consuming more DM, which may lead to a more stable rumen ecology (Dias et al., 2018). The average daily weight gain tended to rise in the group that consumed fermented foods. There were no significant variations in nutritional digestibility between the dietary regimens (Promkot et al., 2015). The digestibility of nutrients in straw is considerably increased by microbial treatment. These enhancements might be brought about by changes in the straw's non-structural carbohydrate to structural carbohydrate ratio (Tan et al., 2002). Yeast to lamb feed to increase dry matter digestibility were also reported by Haddad and Goussous, (2005). *S. cerevisiae* considerably impacted the digestion of fiber in a diet high in sugar cane bagasse, claim (Kafilzadeh and Prayed, 2005).

**Effect of fermentation on nutritional composition of feed**

SSF increase the crude protein content of animal feed due to both a decrease in DM concentration and increased microbial protein synthesis (Hu et al., 2016). The logarithmic growth of various microbe strains during fermentation, which results in the production of proteolytic enzymes, which increases the protein content (Ojokoh et al., 2020). The synthesis of non-protein nitrogen molecules such ammonia, amines, amino acids, and peptides all of which are included in the crude protein content as well as a decline in the mass's carbon ratio and an increase in cell biomass also contributed to the protein content increase (Onyango et al., 2013). The fermenting organisms has the ability to metabolize the fiber could be the cause of the overall decrease in the fiber content. It may also be a result of the fiber's enzymatic degradation during fermentation by microbes which use the fiber as a carbon source (Ojokoh and Bello, 2014). Microorganisms that hydrolyze and metabolize insoluble polysaccharides may secrete extracellular enzymes, which decrease in crude fiber content of fermented products (Minnaar et al., 2017). The lower fiber content seen in the fermented samples may be caused by the loss of carbohydrates and dietary fibers during the fermentation process (Adejuwon et al., 2021). Yeast uses fat as an energy source to build cell biomass as a result the amount of fat in the fermented products decreased due to the biochemical and physiological processes that occur during fermentation demand energy and some of the lipids in the feeds were used to produce energy (Afify et al., 2011). Microbes use fat as an energy source for their metabolic processes.Additionally, the oxidation process that could occur during fermentation may be the cause of the decrease in fat content (Li et al., 2020).Low-fat samples have longer shelf lives since there is less chance of rancidity (Akinola et al., 2017). The fermented feed products had less fat because of yeast needs fat as an energy source to produce cell biomass. Due to the microorganism's exponential growth, it happened (Mbata et al., 2009). During the fermentation of the substrate, the enzyme lipase significantly affects the crude fat level because it utilizes fat as an energy source (Yohanista et al., 2014). The *S. cerevisiae* usage of fermentable sugars for development, energy, and other metabolic processes is what causes the fall in carbohydrate content with fermentation (Ojokoh et al., 2013). Lower energy contents could be the result of fermentation that reduced the amount of fat and carbohydrate (Jan et al., 2022). The reduced carbohydrate content in the fermented feed may be the result of microbes utilizing fermentable glucose for growth or other metabolic processes (Akinola & Osundahunsi, 2017). Starch is hydrolyzed during fermentation into simple sugars and maltodextrins by enzymes such -amylase and maltase. It is possible that the drop in total carbohydrate content following fermentation is partially explained by the fact that the glucose generated during fermentation is a preferred substrate for fermentative microbes in feed (Osman, 2011). The synthesis of cellulase was enhanced by yeast extract across different nitrogen sources. The yeast's cellulases have a wide pH range and high temperature range for hydrolyzing both soluble and insoluble

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substrates (Touijer et al., 2019). The most efficient nitrogen source for cellulase synthesis in solid state fermentation is yeast. Yeast produces more of the cellulolytic enzyme (xylose isomerase) that converts lignocellulolytic materials into glucose (Pothiraj et al., 2015). Damisa et al., (2012) found similar results showed that cellulose enzyme increased with fermentation. Day and Morawicki, (2018) explained that the loss of dry matter during fermentation as microbial break down of protein and carbohydrate may be the cause of the increased mineral content. Fermentation increases the bioavailability of calcium and phosphorous due to degradation of oxalates and phytates that complex with minerals thereby reducing their bioavailability (Sripriya et al., 1997). Minerals are abundant in yeast. According to the species and strain, the amount of ash in the fermented mass can range from 4 to 10 percent the calcium content of the substrate during yeast fermentation rises (Dobrzaski et al., 2006). Due of yeast's powerful capacity to generate enzymes, is the main reason for mineral improvement (Dai *et al.*, 2020). By creating a phytase enzyme that breaks down the phytic acids in feed, fermentation increases the bioavailability of minerals. The amount of calcium, iron, and zinc in feed is multiplied by this phytic acid decrease (Gupta et al., 2015). By lowering $CH_4$ generation, the addition of *S. cerevisiae* improved ruminal fermentation kinetics (Elghandour et al., 2017). However, the generation of $CH_4$ was reduced as the SC *(S. cerevisiae)* dose was increased. According to some research, *S. cerevisiae* culture could encourage the acetogens to compete with or co-metabolize $H_2$ with the methanogens, hence lowering $CH_4$ generation (Elghandour et al., 2014). *S. cerevisiae* has the capacity to reduce methane and ammonia generation as well as increase fermentation efficiency, which can help to lower greenhouse gas emissions (Hristov et al., 2013). The creation of $CO_2$ and $H_2$, which are byproducts of acetate synthesis during carbohydrate fermentation, may have contributed to the lower production of total $CH_4$ in the yeast treatments (Gong et al., 2013). *S. cerevisiae's* capacity to remove extra oxygen would improve the habitat for rumen anaerobic bacteria (Jouany, 2009).According to certain research, giving sheep a fermented complete mixed feed will increase digestibility and reduce methane emissions (Cao et al., 2010). Yeast can shift $H_2$ from methanogenesis to reduced acetogenesis by using homoacetogenic bacteria that can generate acetate from $CO_2$ and $H_2$ (Mwenya et al., 2004).

## CONCLUSION AND RECOMMENDATIONS

The majority of Bangladesh's population is undernourished and destitute. Sheep farming is becoming increasingly popular in our country among all livestock because it doesn't demand as much area, feed, or feeding habits as other livestock do. They can eat pastureland grass and leaves. Rural residents may simply maintain a sheep farm because it doesn't require a lot of labor or expertise. There is a protein deficiency in cattle meat in Bangladesh. Sheep meat can satisfy this nation's population's excess need for animal protein. 3.401 million Sheep heads are dispersed around the nation, according to (DLS, 2017). While some crossbreed sheep are raised, the majority of the sheep are native. Due to its subtropical climate and favorable farming conditions, Bangladesh has a large potential for sheep farming. However, by selling its meat and generating jobs, sheep farming could help Bangladesh's economy. In Bangladesh, sheep farming has significant economic potential. It might help lessen poverty in this nation's rural areas. It is necessary to do scientific studies and research on sheep farming. The majority of the family's revenue came from sheep husbandry. But the main obstacles to raising sheep are nutrient deficits. To advance sheep rearing in Bangladesh, information regarding the feeding system and nutrient makeup of feedstuffs is necessary. The future production of livestock products will increase as a result of the continued advancement in animal nutrition. Innovative technologies aimed at increasing feed resource availability, rumen manipulation by natural compounds to boost microbial activity, improving diet quality, lowering feeding costs, and better control of livestock watering should be ensured if we are to improve small ruminant production systems. The goal of new feeding techniques should be to increase animal production while minimizing negative environmental effects. They also need to be economical. Fermentation is one feed improvement technology that can improve the nutritional content of subpar feed for small ruminants. Rice straw and sugarcane bagasse, two locally accessible and low-quality crop leftovers, can be upgraded using a fermentation technology, which enhances the sheep's digestibility, body weight, health, reproductive efficiency, and meat quality. Mutton from sheep is a fantastic source of numerous vitamins and minerals, including iron, zinc, and vitamin B12. Mutton is also a strong source of high-quality protein. Iron and zinc are also abundant in mutton. In the body, iron is largely used in the production of blood and blood cells. It aids in avoiding anemia. Red meat, especially mutton, is indicated for those who are iron deficient. Magnesium, selenium, and omega-3 fatty acids are also abundant in it. About equal amounts of

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monounsaturated and saturated fats are present in cooked lamb. Lamb is a relatively lean and dense source of protein and, in contrast to many other forms of meat, has a high ratio of unsaturated to saturated fats. This study aimed to increase the nutritional content of energy-based concentrate mixtures made of wheat bran, rice polish, and roughage like rice straw and sugarcane bagasse. A technique for enhancing the nutritional value of feed is fermentation. The findings demonstrated that groups receiving fermented feed had the best body growth, FCR, and profit for sheep. The results were Fermented feed containing yeast (S. cerevisiae) can provide animals with a good source of nutrition. Compared to non-fermented feed, feed that has been fermented by yeast enhances feed intake more. Feed that has been fermented has a lower FCR (kg-feed/kg-gain) and a higher percentage of nutrients that can be digested. For improved body growth and performance, sheep can be fed Yeast (S. cerevisiae) fermented feed. The nutritional value of a subpar feed can be improved through fermentation. By adding 5% yeast fermentation and an energy-dense concentrate mixture with a 3% level of yeast fermentation after five days of incubation; low-quality roughage and energy based concentrate can have its nutritional content improved. Solid state fermentation is a suitable biotechnological method for improving the usage of many crop leftovers. Feeding nutritious feed to farm animals ensure good quality livestock product like meat, milk, etc. Animal converts feed into livestock products like meat and milk. Therefore, protein and mineral-rich feed should be provided to them. By solid state fermentation method, we can upgrade the protein and mineral content of feed by reducing anti-nutritional factors like tannin. The fermentation process is both economical and environmentally friendly.

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