Research Article

Beer Waste as a Feed Additive: Impacts on the Health and Performance of Sheep

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Abstract | There is a growing trend in identifying alternative feed ingredients to address the issue of high production costs in sheep fattening systems. This research aims to determine the effect of utilizing beer waste on the performance and health of sheep. The study involved 24 female thin-tailed sheep, each approximately 7 months old. They were divided into four groups: a control group and three groups that received beer waste at 5%, 10%, and 15% of their ration. Feed consumption was measured by calculating the difference between the amount of feed given and the remaining feed. Initial body weight measurements were taken weekly before morning feeding. Blood samples were drawn from the jugular vein and analyzed for hematology and serum chemistry in a laboratory. The results did not show significant differences in productivity parameters (feed consumption, average daily gain, feed conversion, and income over feed cost) between control and beer waste fed groups. Health parameters, including hematology (hemoglobin, erythrocytes, leukocytes) and blood chemical parameters (total protein, blood urea nitrogen, creatinine), remained within normal ranges in all beer waste fed groups. The study concludes that incorporating beer waste into sheep rations provides the benefits of low cost and high protein content, with no detrimental effects on the health or performance of the sheep.

Keywords | Beer waste, Feed additive, Health, Performance, Sheep

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INTRODUCTION

The local sheep fattening production system is facing extremely high production costs, particularly concerning feed requirements. There is an urgent need for research into the utilization of beer dregs as an alternative and sustainable source of animal feed (Aragão et al., 2023). Beer dregs, a by-product of the beer brewing industry, offer a potential solution for reducing production costs associated with animal feed in livestock feedlots (Mussatto, 2014). The abundant protein content of beer dregs, available at an affordable price, presents an attractive alternative that holds promise for enhancing the economic sustainability of the livestock sector (Wen et al., 2019).

Utilizing beer dregs as animal feed extends beyond experimental endeavors to become a strategic initiative aimed at reducing production costs. According to Wang et al. (2021), by transforming waste into a valuable source of nutrition, the primary objective is to establish a business model characterized by enhanced efficiency, cost-effectiveness, and environmental friendliness. Mission to reduce animal feed production costs can involve utilizing agro-industrial waste. However, in recent years, this waste has been studied for its positive effects on animal health, methane reduction, and protein protection, as demonstrated by Baihaqi et al. (2020a, b, c, 2022, 2023) and Lisnanti et al. (2023). Stahn et al. (2023) and Ran et al. (2021) indicated that the beer dregs can use in animal feed but the scientific research is crucial. Questions regarding the impact of beer dregs supplementation on growth, nutritional balance, and overall animal health necessitate thorough investigation to substantiate such assertions.

The substantial protein content inherent in beer dregs provides a robust foundation for considering its integration as a protein source in animal diets (Tongtong et al., 2022). By harnessing this overlooked resource, a significant contribution is anticipated towards alleviating the persistent challenge of high feed costs within the livestock industry (Naik et al., 2023). This study aims to investigate the effects of beer waste in sheep diets on production and health. The research not only promises new insights into the potential of beer dregs as animal feed but also seeks to establish a solid scientific framework by confirming the impact of beer dregs on livestock productivity and health, with the goal of optimizing livestock production amidst an evolving landscape of economic challenges.

MATERIALS AND METHODS

Study period and location

The present study was conducted from August 2023 to December 2023, at the Kalvin Farm, Nganjuk sheep farm in East Java. Nutrient analysis was carried out at the animal feed laboratory at Gadjah Mada University, Yogyakarta, while hematological and blood chemistry analyses were performed at Brawijaya University, Malang.

Experimental design

During the livestock preparation phase, the sheep were grouped according to body weight, underwent health checks, and received vitamin supplementation. Prior to the experimental work, a four-week adaptation period was observed, with feed provided twice daily. The study utilized 24 female thin-tailed sheep, approximately 7 months old, which were randomly assigned to four treatment groups based on their body weight. Beer dregs were incorporated into the basal feed at varying proportions for each treatment. The treatment groups were; P0: ration + 0% beer waste, P1: ration + 5% beer waste, P2: ration + 10% beer waste, P3: ration + 15% beer waste. The chemical analysis of ration used in the study are presented in Table 1.

Table 1: The results of proximate analysis of rations offered to various groups of sheep.

Ration/ Group	DM (%)	CP (%)	Ash (%)	CF (%)	Price (IDR)
P0	88.92	14.92	2.48	17.39	2,800
P1	86.87	15.41	2.54	17.41	2,500
P2	84.36	15.25	2.71	19.68	2,400
P3	81.95	15.33	2.33	20.42	2,200

Note: Proximate analysis were done at Universitas Brawijaya; DM: Dry Matter, OM: Organic Matter, CF: Crude Fiber.

Research materials, including beer dregs and other feed ingredients, were sourced from Sadewa Animal Feed Ltd. in Tulungagung. The basal ration included copra, palm oil meal, corn gluten feed, white pollard, cassava cobs, soybean hulls, and corn slammer. The treatment of animals according to the research design lasted up to 8 weeks. Observations of feed consumption, digestibility, average daily gain (ADG), feed conversion, and income over feed cost (IOFC) were recorded based on the methodology of Suwignyo et al. (2017). Fecal collection, which occurred over seven days before the study completion, involved weighing, drying, and subsequent analysis for dry matter, organic matter, and crude protein. Hematological and blood chemistry analyses were conducted following the methodology of Baihaqi et al. (2020a).

Statistical analysis

The collected data were analyzed using ANOVA. The least significant difference (LSD) test was applied if significant differences ($P < 0.05$) or highly significant differences ($P < 0.01$) were detected.

RESULT AND DISCUSSIONS

The effect of adding beer waste on sheep productivity parameters

The observations on productivity parameters, including feed consumption, ADG, feed conversion, and IOFC, are presented in Table 2.

Based on the data in Table 2, all treatment groups showed non-significant differences ($P > 0.05$) in the feed consumption parameters. The average feed consumption in this study ranged from 711 to 789 g/head/day, average daily gain ranged from 45.28 to 55.00 g/head/day, average feed conversion ranged from 14.33 to 16.96 g/head/day, and the average Income Over Feed Cost (IOFC) ranged from Rp 47,215 to Rp 75,337 per head.

In this study, beer dregs were used as a feed substitute due to their high protein content and relatively low cost. However, this material has the drawback of low Total Digestible Nutrients (TDN), which may potentially impact livestock

Table 2: The effect of inclusion of beer waste in the sheep ration on productivity parameters.

Treatment	Feed consumption (g/head/day)	ADG (g/head/day)	Feed conversion (g/head/day)	IOFC (IDR)
P0	711.79±238.01	45.28±12.33	16.62±6.06	47.215±77.788
P1	751.67±194.34	45.82±8.21	17.27±6.53	47.891±39.304
P2	784.50±202.96	48.90±12.28	16.96±6.56	55.827±43.331
P3	789.50±204.43	55.00±5.56	14.33±3.33	75.337±25.535

Note: The treatments did not show statistically significant differences (P>0.05) in feed consumption, ADG (average daily gain), and IOFC (income over feed cost) of various groups.

productivity parameters. The non-significant impact is attributed to the fact that feed conversion value is highly dependent on dry matter consumption and the daily weight gain of the livestock (Kenny et al., 2018). Factors influencing feed consumption include the specific livestock, the type of feed provided, and environmental conditions. Feed conversion rate depends on the quality of the feed; better digestibility leads to better feed conversion (Oonincx et al., 2015). This is related to the difference between the income from the sale of average daily gain (ADG) production and feed costs. The use of beer dregs in the ration can enhance ADG production while potentially reducing feed costs, as the treatment feed is cheaper, thus improving Income Over Feed Cost (IOFC). IOFC is calculated by subtracting the cost of feed from the value of weight gain during the study. Factors influencing IOFC calculations include the increase in weight gain during fattening, feed consumption, cost per kilogram of feed, and the weight of the livestock. Good growth does not guarantee maximum profit, but optimal growth coupled with efficient feed conversion and minimal feed costs ensures the highest economic returns (Mariyono et al., 2022).

Hematology parameters

Blood hematology is crucial in determining the health status of livestock. The influence of feeding beer dregs can be observed in Table 3. The results showed that the average hemoglobin level in this study ranged from 10.88 to 12.53 g/dL, the average erythrocyte count ranged from 10.60 to 12.00 × 10^6/mm^3, and the average leukocyte count ranged from 5.62 to 6.74 × 10^3/mm^3. The hematological levels of the sheep are within the normal range.

The hematological values in this research are within the normal range, indicating the safe use of beer waste as feed for maintaining health. Soeharsono et al. (2010) stated that the normal hemoglobin range in sheep is between 11 and 13 g/dL. Hemoglobin levels are influenced by the interaction between treatment (dietary energy and protein balance) and the timing of administration (Lee and Beauchemin, 2014). The results of this study show higher hemoglobin levels compared to Rahayu et al. (2017), which reported ranges of 7.60 to 10.02 g/dL for Garut sheep fed waste feed. This difference may be due to the lower protein content in their diet (approximately 13.63-14.00%) compared to the 15% protein in the diet used in this study, as well as likely differences in iron (Fe) content in the feed. Hemoglobin levels can be influenced by adequate nutrition, especially protein in the diet and its digestibility (Schalm et al., 1986).

Table 3: Blood profile of sheep fed beer waste as a substitute in the ration.

Treatment	Hemoglobin (g/dl)	Erythrocytes (10^6/mm^3)	Leukocytes (10^3/mm^3)
P0	11.47±1.43	11.04±1.08	5.64±1.29
P1	12.53±2.35	11.84±2.09	6.74±0.63
P2	12.22±0.76	12.00±0.65	5.64±0.95
P3	10.88±1.82	10.60±1.42	5.62±1.18

Note: The treatments did not show statistically significant differences (P>0.05) in hemoglobin, erythrocytes, and leukocyte levels of various groups.

The highest average hemoglobin level was observed in sheep from the P1 treatment at 12.53 g/dL, a difference of 1.65 g/dL compared to sheep in the P3 treatment. This suggests differences in the physiological capacity of the animals for the formation and circulation of hemoglobin in erythrocytes throughout the body. The increase in hemoglobin levels is still within normal limits, indicating that the provided feed does not disturb the circulatory system. Hemoglobin levels are influenced not only by sufficient nutrition, particularly protein as a component of hemoglobin, but also by age, gender, and activity (Mushawwir et al., 2017). According to McDowell (1972), animals in tropical regions often experience a decrease in hemoglobin levels, possibly due to mineral deficiencies, heat stress, and the presence of parasites (Baihaqi et al., 2019).

The results showed that the average hemoglobin level in this study ranged from 10.88 to 12.53 g/dL, the average erythrocyte count ranged from 10.60 to 12.00 × 10^6/mm^3, and the average leukocyte count ranged from 5.62 to 6.74 × 10^3/mm^3. These hematological levels are within the normal range for sheep. The normal hematological values observed in this study indicate the safe use of beer waste as a feed ingredient for maintaining health. According to Soeharsono et al. (2010), the normal hemoglobin range in sheep is between 11 and 13 g/dL. Hemoglobin levels can be influenced by the interaction between dietary energy and protein balance, as well as the timing of administration (Lee and Beauchemin, 2014). This study's hemoglobin levels were higher compared to those reported by Rahayu et al. (2017), which ranged from 7.60 to 10.02 g/dL for Garut sheep fed waste feed. This discrepancy may be due to the lower protein content (approximately 13.63-14.00%) in their diet compared to the 15% protein used in this study, as well as potential differences in iron (Fe) content in the feed. Hemoglobin levels can be affected by adequate nutrition, particularly protein, and its digestibility (Schalm et al., 1986).

The highest average hemoglobin level, observed in sheep from the P1 treatment at 12.53 g/dL, was 1.65 g/dL higher than that in sheep from the P3 treatment. This suggests differences in the physiological capacity of the animals to form and circulate hemoglobin in erythrocytes. Despite the increase, hemoglobin levels remained within normal limits, indicating that the provided feed did not disrupt the circulatory system. Hemoglobin levels are influenced by sufficient nutrition, particularly protein, as well as by age, gender, and activity (Mushawwir et al., 2017). McDowell (1972) noted that animals in tropical regions often experience decreased hemoglobin levels, possibly due to mineral deficiencies, heat stress, and parasitic infections (Baihaqi et al., 2019).

Blood chemistry parameters

One potential feed ingredient for sheep is beer dregs, which offer beneficial nutrients, especially in terms of protein content. Although beer dregs contain some anti-nutritional substances, such as alcohol, the amounts are very low. Typically, the alcohol content is so minimal that it does not produce any alcoholic effects on animals when used as a feed ingredient. Utilizing by-products from the food industry and thinking creatively are effective strategies for reducing pollution from industrial activities (Soceanu et al., 2024). The effects of feeding beer dregs on the blood chemistry parameters of sheep are detailed in Table 4. The data revealed that the average total protein level in this study ranged from 6.92 to 7.23 g/dL, the average blood urea nitrogen ranged from 19.28 to 20.65 mg/dL, and the average creatinine ranged from 0.77 to 0.92 mg/dL. All these blood chemical levels were within the normal range for sheep.

According to Cynthia and Scott (2005), normal total protein levels in sheep are between 5.90 and 7.80 g/dL. In this study, the highest average total protein level was found in sheep from treatment P1 was 7.23 g/dL, which was 0.31 g/dL higher than in sheep from treatment P0. This increase is still within normal limits, suggesting that the provided feed does not negatively affect the circulatory system or overall health. Factors such as age, breed, environmental conditions, and general health can influence total protein levels (Naseri et al., 2016).

The blood urea nitrogen levels observed in this study are also within the normal range, as defined by Wahjuni and Bijanti (2006), which is 6 to 27 mg/dL. This indicates that the inclusion of beer dregs in the diet at various levels does not significantly alter blood urea nitrogen levels. The use of beer dregs in this study is deemed safe, with no adverse effects observed. Elevated blood urea nitrogen levels can be linked to kidney issues like nephritis, leptospirosis, kidney damage, or kidney failure. In chronic kidney disease (CKD), elevated blood urea nitrogen can reflect the buildup of nitrogenous toxins, potentially contributing to anemia (Christopher, 2008). Increased BUN levels can also result from conditions unrelated to the kidneys, such as heart disorders, shock, urinary stones, prostate enlargement, tumors, and congenital abnormalities.

A normal creatinine level indicates that the sheep is healthy and that there are no infections in the organs, including the kidneys. This means that adding beer dregs to the diet at different levels does not significantly affect creatinine levels (Galen et al., 2022). This result is consistent with the study by Agwa et al. (2023), which found that including canola seed meal as a protein source did not significantly alter creatinine levels in female sheep.

The highest average creatinine level was 0.92 mg/dL in sheep from treatment P2, which is 0.15 mg/dL higher than in sheep from treatment P1. This increase is still within normal limits, indicating that the feed does not negatively impact the sheep's health. According to Kaneko et al. (2008), normal serum creatinine levels for sheep are up to 1.9 mg/dL, so the levels observed in this study are within the expected range. The variations in creatinine levels are not significant.

Table 4: Blood chemical profile of sheep fed with beer waste as a substitution in feed.

Variables	Unit	P0	P1	P2	P3
Total protein	(g/dL)	6.92±0.82	7.23±1.01	7.17±0.66	7.15±0.80
Blood Urea Nitrogen	(mg/dL)	20.65±6.22	19.45±3.46	19.28±2.40	20.32±5.36
Creatinine	(mg/dL)	0.83±0.10	0.77±0.08	0.92±0.15	0.78±0.27

Note: The treatments did not show statistically significant differences (P>0.05) in total protein, blood urea nitrogen and creatinine level of sheep of various groups.

Creatinine levels are typically lower than blood urea nitrogen levels because creatinine is more easily excreted. Creatinine is produced from creatine, a compound made by the liver, and then released into the bloodstream. It moves to the muscles, where it is converted into creatine phosphate and eventually metabolized into creatinine (Gounden et al., 2024; Hosten, 1990). Since creatinine levels are closely related to muscle mass, higher muscle mass usually results in higher creatinine levels. This makes creatinine a useful indicator for assessing weight gain in livestock, as muscle mass and body weight are linked to urinary creatinine excretion (Narayan and Appleton, 1980).

CONCLUSIONS AND RECOMMENDATIONS

The results of the current study showed that feeding up to 15% beer waste does not cause any health disturbances in sheep. Therefore, beer waste, as a high-protein and low-cost feed ingredient, may be used as an alternative feed for animals.

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NOVELTY STATEMENT

This study explores the use of beer waste as an alternative feed ingredient for sheep, addressing high production costs. It demonstrates that incorporating beer waste up to 15% in rations does not negatively impact the performance or health of thin-tailed sheep, providing a cost-effective, sustainable feeding option with high protein content.

AUTHOR'S CONTRIBUTION

ER, NS, MDF, SRB, FS, RM, ZAB, AM and MS: Designed the study, collected samples and performed examinations. All authors have drafted and revised the manuscript. All authors have read, reviewed, and approved the final manuscript.

Ethical approval

The study received ethical clearance from the Animal Care and Use Committee at Universitas Brawijaya with the reference number: 207-KEP-UB-2023

Conflict of interest

The authors have declared no conflict of interest.

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