

Effect of Feeding Varying Processed Forms of Peanut Haulms on Growth Performance of Salt Range Lambs in Pothwar Region of Pakistan

Muhammad Fiaz^{1*}, Muhammad Hassan², Muhammad Mushtaq²,
Tanveer Ahmad¹, Syeda Maryam Hussain¹, Muhammad Shoaib³,
Muhammad Faizan¹ and Muhammad Shakeel⁴

¹Institute of Animal Sciences, PMAS-Arid Agriculture University, Rawalpindi, Pakistan

²Department of Zoology, Wildlife and Fisheries, Faculty of Sciences, PMAS-Arid Agriculture University, Rawalpindi, Pakistan

³Department of Parasitology and Microbiology, Faculty of Veterinary and Animal Sciences, PMAS-Arid Agriculture University, Rawalpindi, Pakistan

⁴Department of Clinical Studies, Faculty of Veterinary and Animal Sciences, PMAS-Arid Agriculture University, Rawalpindi, Pakistan

ABSTRACT

This experiment was planned with main aim to investigate the effect of feeding processed forms of peanut haulms on the production performance of Salt Range lambs under Pothwar region of Punjab, Pakistan. Twelve lambs (4 months old) were randomly assigned to three groups: control, treatment-1, and treatment-2, following a completely randomized design. Each group consisted of four lambs, all naturally grazed under equal conditions, with supplementation of different processed forms of peanut haulm. Lambs were fed unprocessed peanut haulm in control treatment group, whereas chopped peanut haulm in 2nd and ground peanut haulm in 3rd treatment group. Collected data were analyzed through ANOVA using SAS 9.3 software under a Completely Randomized Design (CRD), and blood parameters were analyzed using Sigma Plot Software. It was found that feed intake was significantly higher ($P < 0.05$) in lambs fed ground peanut haulms compared to those given untreated or chopped haulms. The same pattern was found in case of lamb's final weight. Similarly, average daily gain (ADG) was highest ($P < 0.05$) in lambs fed ground haulm (137 ± 10.8 g/day), followed by those given chopped (79 ± 1.0 g/day) and untreated haulms (58 ± 2.3 g/day), though ADG did not differ ($P > 0.05$) between the untreated and chopped groups. Feed conversion ratio (FCR) was found significantly better ($P < 0.05$) in lambs on ground haulm i.e. 5.15 ± 0.31 than in those on untreated (7.64 ± 0.05) or chopped haulms (11.86 ± 0.28). Consequently, cost per kg weight gain was significantly lower ($P < 0.05$) in lambs fed ground haulm. No significant differences ($P > 0.05$) were observed in body height or blood parameters among groups. It is concluded that ground peanut haulm was the promising processed form of peanut haulm for optimal growth performance of Salt Range lambs under Pothwar conditions.

Article Information

Received 20 February 2025

Revised 05 April 2025

Accepted 18 April 2025

Available online 19 December 2025
(early access)

Authors' Contribution

MF developed the project concept, obtained funding and acted as the principal investigator. MH collected the data physically during all stages of the project. MM played a critical role in project design. TA played a critical role in project document composition. SMH provided scholarly guidance throughout the trial period and critically reviewed the manuscript. MS conducted multiple visits to the research area and assisted in the provision of experimental animals. MF supported the study by analyzing data, preparing tables and writing the results and discussing section. MS analyzed lab analysis and helped in proofreading of the manuscript.

Key words

Peanut Haulm, Salt range lambs, Growth performance, Feed conversion ratio, Dietary supplementation

INTRODUCTION

Sheep have evolved into a valuable means of income for farmers in Pakistan, making a substantial share to

mutton and fiber production. Normally, lambs are widely raised for sacrificial purposes, often commanding higher values at the occasion of Muslim Annual Festival Eid-Ul-Azha. Lamb production has witnessed a substantial increase worldwide, especially in arid areas in response to the growing needs of the population (Morshedy *et al.*, 2020). Sheep population in Pakistan has been growing at a rate of 1.25% over the past three years, reaching 32.7 million (GOP, 2023-24).

Salt range is a well-known singular fat-tailed sheep breed primarily raised for meat production (Afzal and Naqvi, 2004) and quite prevalent in Pothwar region of northern Punjab comprises four districts: Attock, Jhelum, Chakwal, and Rawalpindi. In recent era, farmers in the

* Corresponding author: dr.fiaz@uaar.edu.pk
0030-9923/2025/0001-0001 \$ 9.00/0



Copyright 2025 by the authors. Licensee Zoological Society of Pakistan.

This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

Pothwar region intend to increase number of this breed not solely for profitable sacrificial occasions but also to meet the demands of restaurants in significant urban hubs like Islamabad and Rawalpindi (Qureshi *et al.*, 2020).

Sheep meat is reported as enriched source of omega-3 polyunsaturated fatty acids, protein, essential vitamins, and minerals (Chikwanha *et al.*, 2018; Sohaib and Jamil, 2017). It is also high in conjugated linoleic acid which aids in diabetes prevention and body fat reduction (Schmid *et al.*, 2006). Moreover, lamb meat is also recommended for children's diets due to its essential fatty acids and lower allergenicity compared to other meats (Nudda *et al.*, 2011). In spite of popularity of Salt Range lambs in Pothwar region, producers face serious challenges; lamb mortality due to malnutrition (Fiaz *et al.*, 2022). Due to forage scarcity especially during drought environment conditions, animals graze on low quality pastures and crop residues like wheat straw with little or no concentrate supplementation which may impacted sheep performance by their poor nutritional quality, DMI and limited digestibility (Khan and Habib, 2012). But, prices of wheat straw are progressively increasing due to its multiple usage in animal feeding, fuel burning and paper industry touches at its peak during winter season. Keeping in view the importance of feed availability for adequate lamb growth, it is the dire need to explore some other feeding resource specifically in Pothwar region of Punjab.

Pothwar region is blessed with abundant peanut production in the area (Shah *et al.*, 2012). Left over plant material after peanut harvesting has the great feeding value high in CP 11.4% which may be fed as supplement (Yami, 2008; Etela and Dung, 2011) or either fresh, dried or ensiled (Hill and Ballinger, 2004). Feeding peanut haulms for adequate body growth is also reported (Fiaz *et al.*, 2022; Etela and Dung, 2011). Peanut is a leguminous crop due to its nutritional worth, palatability and its contribution to soil fertility through nitrogen fixation ability (Konlan *et al.*, 2013). It can be fed either sole or as supplementary diet (Prasad *et al.*, 2010; Ayantunde *et al.*, 2017) to increase the productivity of sheep's growth. Keeping in mind the nutritional importance of peanut haulms, this study aimed to investigate the effect of dietary supplementation of processed forms of peanut haulms on growth performance of Salt Range lambs under Pothwar environment conditions. The specific objective was to identify the most cost-effective processing method based on cost per kilogram of weight gain.

MATERIALS AND METHODS

Location of study area

The experiment was conducted at the University

Research Farm, Koont, along Mandra-Chakwal Road, Tehsil Gujar Khan, District Rawalpindi. The site, located at 33.11677 latitude and 73.01149 longitude (Google Maps), has a semi-arid climate with hot summers, mild winters, and moderate rainfall.

Experimental treatments

Twelve lambs, 4 months old and similar body condition were selected from the Salt Range flock at University Research Station Koont and randomly allocated to three groups following a completely randomized design, comprising the control group (T_0), second treatment group (T_1), and third treatment group (T_2). All experimental animals were naturally grazed in the field and treated equally. However, experimental animals were supplemented with different types of processed peanut haulm. The feed of lambs in the control group (T_0) was added with unprocessed or raw peanut haulm, whereas animals in T_1 and T_2 were given chopped peanut haulm and ground peanut haulm, respectively. The experiment period was executed during Feb-March, 2023 which was comprised of 60 days with additional 10 days adaptation time, prior to trial.

Data collection

The lambs were weighed prior to the start of the trial, and their weights were recorded weekly using a digital dial balance. Body measurements were taken on a fortnightly basis using measuring tape method. Blood samples were collected monthly from the jugular vein into EDTA tubes. These samples were stored in an ice cooler to ensure safe transport to the laboratory for analysis. The survival rate of the lambs was determined by tallying the number of live and deceased animals and calculating the percentage.

Parameters studied

The effects of differently processed peanut haulms were evaluated based on feed intake, average daily gain (ADG), feed conversion ratio (FCR), feed economics, body measurements, and blood parameters. A complete blood analysis was conducted at Biotech Commercial Lab, including total leukocyte count (TLC), red blood cell (RBC) count, hemoglobin (Hb), packed cell volume/Hematocrit (PCV/HCT), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), platelet count, neutrophils, lymphocytes, monocytes and eosinophils. Additional blood parameters included total protein, liver function tests (LFTs) such as total bilirubin, alanine aminotransferase (ALT/SGPT) and alkaline phosphatase (ALK-Phos); renal function tests (RFTs) including blood urea, creatinine, and uric acid; and lipid profile parameters

such as serum cholesterol, serum triglycerides, serum high-density lipoprotein (S-HDL) cholesterol and serum low-density lipoprotein (S-LDL) cholesterol.

Statistical analysis

The data were analyzed through ANOVA technique using SAS 9.3 software under a Completely Randomized Design. Blood parameters were evaluated with Sigma Plot Software and the Duncan Multiple Range Test was used for mean comparisons.

RESULTS AND DISCUSSION

Effect of feeding different processed forms of peanut haulms in Salt Range lambs was determined through the following parameters.

Feed intake

The feed intake of Salt Range lambs given ground peanut haulms was higher ($P<0.05$) than that of those fed untreated and chopped peanut haulms (Table I). The higher intake of ground peanut haulms might have been attributed to the softened straw texture and smaller particle size. Consumption of ground straw feed may be enhanced in small ruminants as physical form plays a substantial role in feed consumption, and smaller particles might be easier to chew and digest, ultimately leading to higher feed intake (Findeisen *et al.*, 2021).

Findings of this study regarding higher feed consumption in ground peanut haulms were also supported by previously published literature. The ground form of peanut haulms might enhance feed intake in sheep due to improved palatability and nutrient absorption (Tsafiyo *et al.*, 2022), whereas it may also increase growth performance (Ansah *et al.*, 2017) and overall productivity (Ayantunde *et al.*, 2007). However, a few studies have reported that animals might not increase feed intake if fed peanut haulms exclusively (Prasad *et al.*, 2010). The reason for this contradiction might be differences in breed and environmental conditions.

Average daily weight gain

Lambs fed ground peanut haulms had the highest ADG ($P<0.05$) at 137 ± 10.8 g/day, followed by those fed chopped haulms at 79 ± 1.0 g/day and untreated haulms at 58 ± 2.3 g/day. However, there was no significant difference ($P>0.05$) in ADG between lambs fed untreated and chopped haulms (Table I). The findings of this study revealed that processing peanut haulms into a ground form enhanced its nutritive value and subsequent animal growth performance compared to untreated or chopped haulms.

Previously published literature has supported

the findings of the present study. ADG in lambs was reportedly improved by the supplementation of peanut haulm-based diets (Sallam *et al.*, 2020). Similarly, another study by Abdou *et al.* (2011) substantiated that supplementing groundnut haulms increased lamb weight gain. The improved ADG in Salt Range lambs fed ground peanut haulms might have been attributed to better fiber digestibility due to the mechanical breakdown of cell walls, which could enhance microbial action during the digestion process.

Table I. Effect of dietary supplementation of different processed forms of peanut haulm on growth performance of Salt Range lambs (Mean $\pm$ SE).

Parameters	T ₀ (Control)	T ₁	T ₂
Feed intake (g/d)	691.66 $\pm$ 11.25 ^a	621.33 $\pm$ 8.95 ^b	678.00 $\pm$ 14.87 ^a
ADG (g/d)	58.33 $\pm$ 2.33 ^b	79.00 $\pm$ 1.00 ^b	137.33 $\pm$ 10.86 ^a
FCR (ratio)	11.86 $\pm$ 0.28 ^a	7.64 $\pm$ 0.05 ^b	5.15 $\pm$ 0.31 ^c
Feed economics (PKR/kg)	118.64 $\pm$ 2.89 ^a	76.49 $\pm$ 0.59 ^b	51.52 $\pm$ 3.19 ^c

^{abc} Means with varying superscripts in rows are different ($P<0.05$). ADG, average daily gain; FCR, feed conversion ratio.

T₀ (Control): Untreated peanut haulm; T₁: Chopped peanut haulm; T₂: Ground peanut haulm

Some researchers have, however, reported different findings. Yin *et al.* (2024) substituted soybean meal with peanut meal in lamb diets and found that it did not significantly impact ADG. This contradiction might be due to substitution rather than processing. The non-significant difference in ADG between untreated and chopped peanut haulms might have been attributed to minimal structural alterations in fiber composition. It is inferred that mechanical breakdown or grinding of forage might significantly improve its digestibility by enhancing its degradation characteristics (Hovell *et al.*, 1987).

Feed conversion ratio (FCR)

FCR was found to be optimal for Salt Range lambs given ground peanut haulms and lower ($P<0.05$) than that of groups given untreated and chopped haulms. Furthermore, FCR was also lower ($P<0.05$) in animals given chopped peanut haulms than in those fed a control diet (untreated peanut haulms). It was observed (Table I) that lambs fed ground peanut haulms had the optimal FCR, suggesting that crushing could enhance feed efficiency in lambs. Previously, Qiongli (2005) reported that incorporating processed peanut haulms in lamb diets might improve feed efficiency by increasing growth performance and economic returns. The promising FCR in lambs fed ground peanut haulms might have been attributed to increased degradation of fiber components, facilitating better nutrient

absorption and reducing wastage. However, chopping only reduced particle size without substantially altering fiber integrity, whereas crushing might have damaged cell walls and enhanced ruminal fermentation efficiency. Consequently, mechanical processing could substantially influence ruminal fermentation and digestibility, which are key factors in improving the feed conversion ratio (Ferreira *et al.*, 2019).

Feed economics

Feed economics in terms of cost per kg weight gain was found to be significantly lower ($P < 0.05$) in Salt Range lambs offered ground peanut haulms compared to those fed untreated and chopped peanut haulms. These findings are in line with a previously published study indicating that peanut haulm feeding could be a better option to enhance production efficiency and reduce feeding costs, ultimately making it a cost-effective choice for rearing lambs (Adu and Lakpimi, 1983). Peanut haulm could be an economical feeding resource with good nutritional value and could help reduce production costs (Ayantunde *et al.*, 2007).

However, transportation from distant areas might increase its initial supplementation costs if locally unavailable (Raineri *et al.*, 2015). Contrary to our findings, Hossain *et al.* (2023) reported that peanut haulms may not always be the most economical option when formulating a balanced ration. This discrepancy might be due to differences in ecological zones.

Body measurements

Body measurements of lambs in terms of body height, length, and heart girth were not influenced ($P > 0.05$) by the dietary supplementation of different processed forms of peanut haulms (Fig. 1). The possible reason might have been the shorter duration of the study, which may not have been sufficient to impact skeletal growth or body conformational traits within the experimental period (i.e., 60 days).

These findings are supported by previously published literature, which indicated that different dietary supplementation regimes might not significantly influence body measurements (Chaturvedi *et al.*, 2003; Padeanu *et al.*, 2008). This highlights that body measurements could be more genetically determined and less influenced by dietary factors. Skeletal growth is a long-term process regulated by genetic and hormonal factors rather than short-term dietary interventions. Genetic mutations in the fibroblast growth factor receptor 3 have been found to influence skeletal growth and frame size in sheep (Smith *et al.*, 2006). Further investigations are recommended to authenticate the impact of dietary supplementation on skeletal growth and structural development in small ruminants.

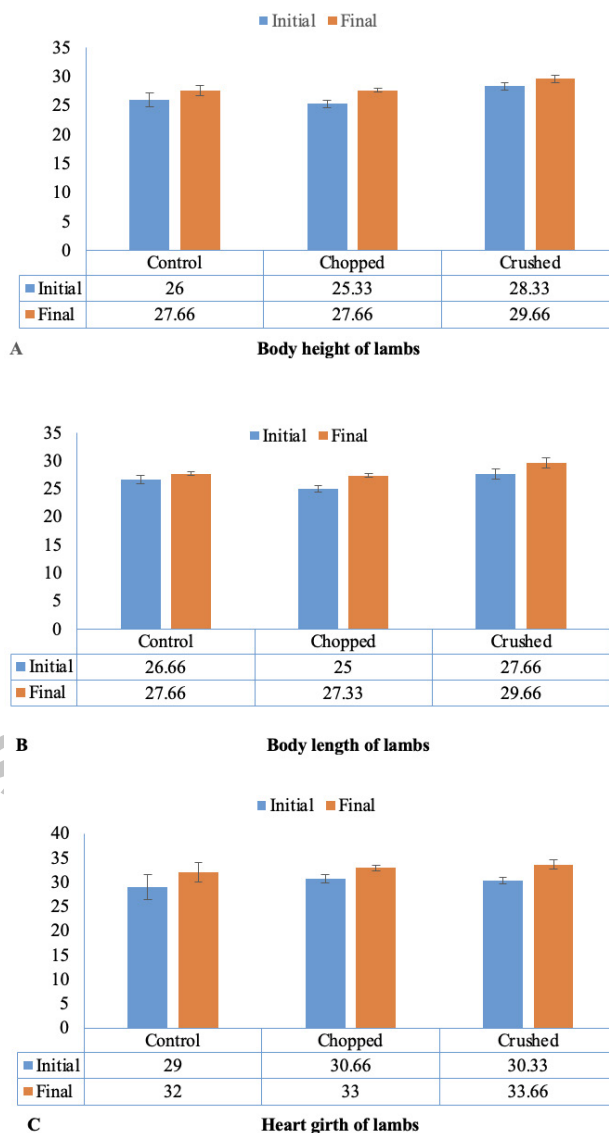


Fig. 1. Effect of dietary supplementation of processed forms of peanut haulms on body height (A), body length (B), and heart girth (C) in Salt Range lambs.

Blood parameters

Dietary supplementation of different processed forms of peanut haulms in salt range lambs did not significantly influence various blood parameters. The reason might have been that peanut haulms are an alternative roughage source, and their dietary supplementation may not alter key physiological parameters, including the complete blood picture, clinical chemistry, liver function tests (LFTs), renal function tests (RFTs), and lipid profile.

Some published studies have supported these findings, reporting that while peanut haulm supplementation affects growth performance, it does not have a significant impact

on blood metabolites, suggesting that essential metabolic functions remain stable across different dietary treatments (Fiaz et al., 2022). However, further research is needed to assess the long-term impact and potential benefits of peanut haulm supplementation on overall health and immunity in lambs.

Table II. Effect of dietary supplementation of different processed forms of peanut haulm on blood parameters in Salt Range lambs (Mean).

Parameters	T ₀ (Control)	T ₁	T ₂
Haematological parameters			
TLC (cumm)	10212	10220	10217
RBC count (million/cmm)	2.52	2.48	2.54
Haemoglobin (g/dl)	7.2	7.5	7.4
PCV/HTC (g/dl)	8.44	8.34	8.40
MCV (fl)	37.68	37.77	37.59
MCH (pg)	33.73	33.33	33.78
MCHC (g/dl)	74.36	74.40	74.29
Platelet count (cumm)	10322716	1032610	103227520
Neutrophils (%)	56	53	55
Lymphocytes (%)	40	42	45
Monocytes (%)	9.62	6.55	6.69
Eosinophils (%)	7.5	7.5	7.3
Protein count (g/dl)	6.78	6.69	6.75
Renal function test			
Blood urea (ml/dl)	38	39	36
Creatinine (mg/dl)	1.17	1.15	1.15
Uric acid (mg/dl)	4.75	4.70	4.72
Liver function test (LFTs)			
Total bilirubin (mg/dl)	0.71	0.70	0.73
ALT (SGPT) (U/L)	21	22	20
ALK-Phos (U/L)	220	222	218
Lipid profile			
S. cholesterol (mg/dl)	124	126	122
S. triglycerides (mg/dl)	89	91	90
SHDL cholesterol (mg/dl)	28	30	29
SLDL cholesterol (mg/dl)	93	94	95

TLC, total leucocytic council; RBC, red blood cell; PCV, packed cell volume; HTC, hematocrit; MCV, mean corpuscular volume; MCH, mean corpuscular hemoglobin; MCHC, mean corpuscular hemoglobin concentration; ALT, alanine transaminase; ALK-Phos, alkaline phosphatase; SHDL, serum high density lipoprotein; SLDL, serum low density lipoprotein.

For other abbreviations, see Table I.

CONCLUSION

It was concluded that processing peanut haulm through grinding significantly enhanced its potential as a valuable feed resource for improving the growth performance of Salt Range lambs raised under Pothwar conditions. The grinding process made the haulm more digestible and easier to consume, thereby increasing nutrient availability and overall feed efficiency. Based on the findings, it was inferred that crushing peanut haulm into ground form enhanced feed intake, digestibility, and ADG, and improved FCR, thereby reducing feed costs.

DECLARATIONS

Acknowledgements

Special thanks are due to staff of Koont Research Farm, PMAS -AAUR for providing the research facilities and animals required for the research.

Funding

This study was financially supported by the Pakistan Science Foundation, Islamabad, Pakistan, under Project No. PSF/NSLP 861.

Ethical approval

This study was approved by the Department of Livestock Production and Management (Protocol number DLPP/272/27-11-2023). The selected animals were ensured all five freedoms, which included adequate access to food and water, freedom from stress and illness and the ability to express their natural behaviors within suitable and protected environments. During the day, the animals were allowed to graze freely on the range while in the evening, they were housed in small ruminant shelters under consistent housing and management practices.

Generative AI and AI-assisted technology statement

The authors declare that they have not used generative AI or AI-assisted technologies in the writing or editing of this manuscript.

Statement of conflict of interests

The authors have declared no conflict of interest.

REFERENCES

- Abdou, N., Nsahlai, I.V. and Chimonyo, M., 2011. Effects of groundnut haulms supplementation on millet stover intake, digestibility and growth performance of lambs. *Anim. Feed Sci. Technol.*, **169**: 176-184. <https://doi.org/10.1016/j.anifeedsci.2011.07.002>

- Adewuyi, P.A., 2021. *Nutritive value of processed groundnut (Arachis hypogaea L.) haulm-based diets for West African Dwarf rams*. Doctoral dissertation, University of Ibadan, Nigeria.
- Adu, L.F. and Lakpimi, C.A.M., 1983. Effect of feeding chopped and unchopped groundnut haulm (Harawa) on nutrient utilization and the production of some rumen metabolites in Yankasa lambs. *Niger. J. Anim. Prod.*, **10**: 110-113. <https://doi.org/10.51791/njap.v10i.2720>
- Afzal, M. and Naqvi, A.N., 2004. Livestock resources of Pakistan: Present status and future trends. *Quart. Sci. Vis.*, **9**: 1-2.
- Ansah, T., Yaccub, Z.I. and Rahman, N.A., 2017. Growth performance and hematology of Djallonké rams fed haulms of four varieties of groundnut (*Arachis hypogaea* L.). *Anim. Nutr.*, **3**: 406-410. <https://doi.org/10.1016/j.aninu.2017.08.006>
- Ayantunde, A.A., Delfosse, P., Fernandez-Rivera, S., Gerard, B. and Dan-Gomma, A., 2007. Supplementation with groundnut haulms for sheep fattening in the West African Sahel. *Trop. Anim. Hlth. Prod.*, **39**: 207-216. <https://doi.org/10.1007/s11250-007-9009-1>
- Ayantunde, A.A., Karambiri, M., Yameogo, V. and Cofie, O.O., 2017. Multiple uses of small reservoirs in crop-livestock agro-ecosystems of the Volta River Basin with an emphasis on livestock management. *Int. Water Manage. Inst.*, **171**. <https://doi.org/10.5337/2016.215>
- Chaturvedi, O.H., Santra, A., Tripathi, M.K., Jayashankar, J. and Karim, S.A., 2003. Weight gain and body conformational changes in weaner lambs fed high concentrate diets containing graded levels of sodium bicarbonate. *Indian J. Anim. Nutr.*, **20**: 145-150.
- Chikwanha, O.C., Vahmani, P., Muchenje, V., Dugan, M.E.R. and Mapiye, C., 2018. Nutritional enhancement of sheep meat fatty acid profile for human health and wellbeing. *Fd. Res. Int.*, **104**: 25-38. <https://doi.org/10.1016/j.foodres.2017.05.005>
- Etela, I. and Dung, D.D., 2011. Utilization of stover from six improved dual-purpose groundnut (*Arachis hypogaea* L.) cultivars by West African dwarf sheep. *Afr. J. Fd. Agric. Nutr. Dev.*, **11**. <https://doi.org/10.4314/ajfand.v11i1.65879>
- Ferreira, E.M., Eckermann, N.R., Biava, J.S., Avelino, M., Pasqualino, L., Martins, A.S. and Pires, A.V., 2019. PSXII-15 Fiber content in diets for feedlot lambs: ruminal and cecal pH and short chain fatty acids. *J. Anim. Sci.*, **97**(Suppl. 3): 424-425. <https://doi.org/10.1093/jas/skz258.842>
- Fiaz, M., Faisal, M.F.H., Khan, M.I., Ishaq, K., Ahmad, T. and Akbar, Q.J., 2022. Growth performance of salt range lambs fed various dietary levels of peanut haulms in Pothwar region of Pakistan. *Pakistan J. Zool.*, **55**: 1473-1476. <https://doi.org/10.17582/journal.pjz/20210829090842>
- Findeisen, E., Südekum, K.H., Hummel, J. and Clauss, M., 2021. Increasing feed intake in domestic goats (*Capra hircus*): Measured effects on chewing intensity are probably driven by escape of few, large particles from the forestomach. *Comp. Biochem. Physiol. A: Mol. Integr. Physiol.*, **257**: 110972. <https://doi.org/10.1016/j.cbpa.2021.110972>
- GOP, 2023-24. *Economic survey of Pakistan*. Economic Adviser's Wing, Ministry of Finance, Government of Pakistan, Islamabad, Pakistan.
- Hill, R.J. and Ballinger, S., 2004. *Development of a laboratory procedure to determine dry matter in maize forage*. Proceedings of the Agronomy New Zealand.
- Hossain, M.A., Rahman, M.M., Rahman, M.W., Hossain, M.M. and Hashem, M.A., 2023. Effect of supplementary feeding on the production traits, carcass and meat quality of Jamuna basin lambs. *J. Anim. Sci. Technol.*, **65**: 209. <https://doi.org/10.5187/jast.2022.e72>
- Hovell, F.D., Campos-Arce, R. and Kyle, D.J., 1987. The effect of grinding and pelleting of roughages of known degradability on voluntary intake and digestibility by sheep. *Proc. Br. Soc. Anim. Prod.*, **1972**: 57-57. <https://doi.org/10.1017/S0308229600034930>
- Khan, N.A. and Habib, G., 2012. Assessment of *Grewia oppositifolia* leaves as crude protein supplement to low-quality forage diets of sheep. *Trop. Anim. Hlth. Prod.*, **44**: 1375-1381. <https://doi.org/10.1007/s11250-012-0074-8>
- Konlan, S., Sarkodie-Addo, J., Asare, E. and Kombiok, M.J., 2013. Groundnut (*Arachis hypogaea* L.) varietal response to spacing in the Guinea Savanna agro-ecological zone of Ghana: Nodulation and nitrogen fixation. *Afr. J. Agric.*, **8**: 2769-2777. <https://doi.org/10.5251/abjna.2013.4.3.324.335>
- Morshedy, S.A., Abdal Mohsen, A.E., Basyony, M.M., Almeer, R., Abdel-Daim, M.M. and El-Gindy, Y.M., 2020. Effect of prickly pear cactus peel supplementation on milk production, nutrient digestibility and rumen fermentation of sheep and the maternal effects on growth and physiological performance of suckling offspring. *J. Anim.*, **10**: 1476. <https://doi.org/10.3390/ani10091476>
- Nudda, A., McGuire, M.K., Battaccone, G., Manca,

- M.G., Boe, R. and Pulina, G., 2011. Documentation of fatty acid profiles in lamb meat and lamb-based infant foods. *J. Fd. Sci.*, **76**: H43-H47. <https://doi.org/10.1111/j.1750-3841.2010.02027.x>
- Padeanu, I., Voia, S., Dărăban, S., Sauer, M., Hrinică, G. and Groza, M., 2008. Research regarding the growing speed of crossbreed suckling lambs Charolais × Merinos de Transilvania, in Banat area. *Sci. Pap. Anim. Sci. Biotechnol.*, **41**: 768-768.
- Prasad, K.V., Khan, A.A., Vellaikumar, S., Devulapalli, R., Ramakrishna, R.C.H., Nigam, S.N. and Blummel, M., 2010. Observations on livestock productivity in sheep fed exclusively on haulms from ten different genotypes of groundnut. *Anim. Nutr. Feed Technol.*, **10(Sp. Iss)**: 121-126.
- Qureshi, S.T., Fiaz, M., Khan, M.I., Ishaq, K., Ahmd, T., Shakeel, M., Yaqoob, M., Aslam, M. and Jo, I.H., 2020. Effect of probiotic and varying dietary protein levels in creep feed on growth performance of Salt Range lambs. *Pakistan J. Sci.*, **72**: 198-2020.
- Raineri, C., Nunes, B.C.P. and Gameiro, A.H., 2015. Technological characterization of sheep production systems in Brazil. *Anim. Sci. J.*, **86**: 476-485.
- Sallam, S.M., Kholif, A.E., Amin, K.A., El-Din, A.N.N., Attia, M.F., Matloup, O.H. and Anele, U.Y., 2020. Effects of microbial feed additives on feed utilization and growth performance in growing Barki lambs fed diet based on peanut hay. *Anim. Biotechnol.*, **31**: 447-454. <https://doi.org/10.1080/10495398.2019.1616554>
- Schmid, A., Collomb, M., Sieber, R. and Bee, G.J.M.S., 2006. Conjugated linoleic acid in meat and meat products: A review. *Meat Sci.*, **73**: 29-41. <https://doi.org/10.1016/j.meatsci.2005.10.010>
- Shah, H., Khan, M.A., Azeem, T., Majid, A. and Mehmood, A., 2012. The impact of gypsum application on groundnut yield in rainfed Pothwar: An economic perspective. *Lahore J. Econ.*, **17**: 83-100. <https://doi.org/10.35536/lje.2012.v17.i1.a5>
- Smith, L.B., Dally, M.R., Sainz, R.D., Rodrigue, K.L. and Oberbauer, A.M., 2006. Enhanced skeletal growth of sheep heterozygous for an inactivated fibroblast growth factor receptor 3. *J. Anim. Sci.*, **84**: 2942-2949. <https://doi.org/10.2527/jas.2006-255>
- Sohaib, M. and Jamil, F., 2017. An insight of meat industry in Pakistan with special reference to halal meat: A comprehensive review. *Korean J. Fd. Sci. Anim. Resour.*, **37**: 329. <https://doi.org/10.5851/kosfa.2017.37.3.329>
- Tsafiyo, B., Zewdie, B., Yirga, H. and Teshome, D., 2022. Effect of groundnut (*Arachis hypogaea* L.) haulm and maize bran mixture supplementation on growth and carcass characteristics performance of local sheep fed pasture hay basal diet. *Open J. Anim. Sci.*, **12**: 36-57. <https://doi.org/10.4236/ojas.2022.121003>
- Yami, A., 2008. In: *Sheep and goat production handbook for Ethiopia* (eds. Y. Alemu and R.C. Merkel). Ethiopian Sheep and Goat Productivity Improvement program, USAID and MoARD, Ethiopia. pp. 109-110. <http://esgpiip.langston.edu/content/sheep-and-goat-production-handbook-ethiopia>.
- Yin, X., Chen, M., Yang, C., Duan, C., Ji, S., Yan, H. and Zhang, Y., 2024. Effects of replacing soybean meal with cottonseed meal, peanut meal, rapeseed meal, or distillers dried grains with solubles on the growth performance, nutrient digestibility, serum parameters, and rumen fermentation in growing lambs. *Vet. Sci.*, **11**: 322. <https://doi.org/10.3390/vetsci11070322>