DOI : 10.5958/2349-4433.2024.00016.3

J Krishi Vigyan 2024, 12(1) : 84-91

Growth Performance and Carcass Characteristics of Ram Lambs Fed with Concentrate Mixture Containing Varying Levels of Rice Dried Distillers Grains with Soluble

Vikas Madhukar, K.Sudha Rani, D.Srinivas Kumar, I.Sathish[1]

Sri Venkateswara Veterinary University, College of veterinary Science, Garividi, Vizianagaram, Andhra Pradesh-535101

ABSTRACT

This experiment was aimed to assess the impact of substituting soybean meal in the concentrate mixture by incorporating rice distillers dried grains with solubles (RDDGS) on the growth and carcass characteristics of Vizianagaram ram lambs. In a completely randomized design 24 ram lambs (3-4 m old, 9-11 kg body weight) were randomly divided into four dietary treatments. All animals received a diet of super napier and concentrate mixture. The soybean meal in the concentrate mixture was replaced with RDDGS at 0% (T1), 50% (T2), 75% (T3), and 100% (T4) levels. The feeding trial lasted for 90 days. The findings of the study suggest that partial or complete replacement of soybean meal with RDDGS did not have any negative impact on body weight gain, average daily gain, and feed conversion ratio in ram lambs. The carcass studies revealed different traits *viz.,* empty body weight, carcass weight and dressing percentage were statistically similar among all treatment groups. The proportion of wholesale cuts (% carcass weight) *viz*., foreshank & brisket, shoulder & neck, rack, loin and leg were numerically higher in T_4 compared to other treatments, but the differences between treatments were statistically non-significant. The yield of visceral organs expressed as percentage of pre slaughter weight and longissimus dorsi muscle chemical composition were also unaffected with dietary any of the treatments. It was concluded that, RDDGS is a nutritionally similar to soybean meal for replacing in the concentrate mixtures fed to growing ram lambs.

Key Words: Carcass, Characteristics, Growth, Lambs, Performance, Ram.

INTRODUCTION

Sheep rearing is an option of sustainable livelihood particularly in semi-arid and arid region and play a very important role in Indian economy. There are 74.26 million sheep in India (20th Livestock Census, GOI, 2019) in India. Productive returns in livestock depend on economically balanced feeding practices. The conventional feed ingredients, especially protein sources are becoming unaffordable for the ruminant feeding. A cost-effective alternative with rich nutrients is needed, ensuring safety and compatibility with regular metabolic processes. Rice distillers dried grain with solubles (RDDGS) is one such agro-industrial byproduct from rice based ethanol producing industry. RDDGS is similar to soybean meal in terms of protein and energy content. In the foreseeable future, there will be more such grain-based products would be available to the feed industry, because the government is encouraging ethanol blending with petrol. RDDGS does not contain any anti-nutritional factor and can be included in the diet either as a protein source or an energy source, depending on the animal nutrient requirements, type of diet being fed, and economic considerations. Thus, the main objective of present experiment was to study the effect of RDDGS as a replacement of soybean meal on growth performance, Carcass characteristics in ram lamb.

MATERIALS AND METHODS

The investigation was carried out at small animal experimental shed of Livestock Research station, Garividi, Vizianagaram district, Andhra Pradesh.Twenty four ram lambs with average body weight and age of 9 - 11 kg and 4 - 6 months were used in the study. Prior consent was obtained from CCSEA via the Institutional Animal Ethics Committee (IAEC)

Corresponding Author's Email: Corresponding Author: drsudha0606@gmail.com

1Srivenkateswara Veterinary University, Livestock Research Station, Garividi, Vizianagaram, Andhra Pradesh-535101

of Sri Venkateswara Veterinary University (SVVU) in order to carry out the study.

Experimental treatments and feeding

In completely randomized design ram lambs were divided based on body weights in four treatment groups with six animals each. Four different concentrate mixtures were prepared by replacing soybean meal with RDDGS at 0 in T1, 50 in T2, 75 in T3 and 100% in T4. Animals were kept in individual pen with *ad libitum* provision of Super Napier and clean water. The concentrate mixture was offered twice between 9:00 to 9:30 A.M and then between 3:00 to 3:30 P.M to meet the growth requirements of ram lambs according to ICAR 2013. The ingredient composition of concentrate mixtures was presented in Table 1.

Growth Trial

In a controlled growth trial, twenty-four ram lambs (age: 4-6 months; weight: 9-11 kg) were thoughtfully randomized into four groups of six. The study focused on individualized housing, precise feeding, and constant access to fresh water. As a part of deworming protocol all lambs received strategic deworming with Ivermectin (1 mL/50 kg body weight) before the trial's commencement and midway through, prioritizing their health and well-being. Weighing sessions were conducted as a crucial step in assessing the lambs' growth. Prior to the initiation of the experiment, these sessions occurred early in the morning over three consecutive days. The average weight obtained from these measurements was considered as the initial body weight for each lamb. Subsequently, the animals were weighed at weekly intervals, again in the early morning before being offered feed and water, throughout the duration of the experiment. Feed samples were analyzed for proximate composition as per AOAC, (2007), fiber fractions (Van Soest *et al*, 1991) and calcium and phosphorus Talapatra *et al* (1940).

Carcass studies

At the end of growth trial, a meticulous selection process identified two animals from each group whose body weights closely mirrored the respective group averages. These selected lambs were subjected to a comprehensive slaughter analysis aimed at understanding both slaughter performance and carcass traits. Prior to slaughter, the lambs underwent a 12-hour fasting period and were processed using the halal method. The procedure involved measuring and documenting blood loss during exsanguination. Subsequently, the skin was methodically removed, and the weights of the skin, skull, and feet were meticulously recorded. The slaughtering process followed a systematic approach based on the methodology outlined by Gerrand (1964), encompassing procedures such as stripping, legging, dressing, and evisceration. Organ weights, along with that of the hot carcass, were carefully measured. Adhering to the guidelines established by the National Livestock and Meat Board of the USA (Brandly *et al*, 1968), the carcass was segmented into five distinct cuts: fore shank and brisket, neck and shoulder, rack, loin, and leg. For the determination of empty body weight (EBW), the stomach fill weight was subtracted from the pre-slaughter weight. An extensive list of weights, including those of the gastrointestinal system (GIT, both full and empty), skin, dressed head, feet, lungs with trachea, kidney, spleen, heart, and testes, were meticulously recorded. Further analysis included the weighing and separation of meat, bone, and fat from each cut, the cumulative sum of which was expressed as a percentage of the entire carcass. Additionally, samples of the longissimus dorsi muscle were carefully collected for subsequent analysis of proximate composition.

Statistical Analysis

The data were subjected to one-way analysis of variance procedure using SPSS (2012), using the linear model. The post-hoc comparison of means was done for the significant difference by Tukey and Duncan multiple range tests. Significant differences of treatments were considered at ($P<0.05$).

RESULTS AND DISCUSSION

The daily weight gain (g/d) of ram lambs (Fig 1) slightly increased numerically at 100% level of inclusion but the difference was not statistically significant ($P>0.05$). In line with present findings, Waffa and Mahmoud (2016) reported that inclusion of DDGS up to 50% levels had no effect ($P>0.05$) on total body weight gain in lambs but insignificant improvement in ADG observed at 40 and 50% levels due to improvement in nutrients digestibility of the rations. Schauer *et al* (2008) also reported no effects ($P\geq0.15$) on the final BW and performance related

attributes of Ram bouillet lambs fed on DDGS up to 60 %. Abudabos *et al* (2021) reported that the insignificantly lower feed intake with the 50% DDGS diet had no effect (P>0.05) on body weight gain. McKeown *et al* (2010) reported that including corn DDGS, wheat DDGS or triticale DDGS at 20% in the diets did not affect (P >0.05) ADG. Feed conversion ratio (kg DMI/kg gain) was not affected at 100% replacement of soybean meal with DDGS in concentrate mixture of growing ram lambs but better FCR was reported at 100% replacement of RDDGS. In line with this, Schauer *et al* (2008) reported that inclusion of DDGS up to 60% level for part of the maize and soybean meal had no difference (P >0.05) in feed to gain ratio, it appears that feed to gain ratio is trending downward as the level of DDGS inclusion increases. This trend is supported by the increase in DM intake with no change in ADG as DDGS inclusion increased. Similarly, Huls *et al* (2006) observed that replacing soybean meal (SBM) and a portion of the corn with dried distiller's grains with solubles (DDGS) had no effect (P>0.05) on feed to gain ratio in lambs.

Carcass characteristics

The carcass characteristics of ram lambs fed diets containing RDDGS was presented in Table 2 and 3. No significant (P>0.05) difference was observed in carcass characteristics across all treatments. No difference across the all treatments may due the equal body weight gain. These findings support the results of earlier literature on replacing PNC with DDGS up to 100% (Reddy *et al*, 2021), DDGS replacing SBM completely (Kawecka *et al*, 2017), SBM at 0, 20, 40, or 60% DM (Schauer *et al*, 2008), barley grain and Canola meal at 20% DM (McKeown *et al*, 2010), and soybean meal at isonitrogenous levels (Abudabos *et al*, 2021; Huls *et al*, 2006). Present findings aligns with the findings of Abdelrahim *et al* (2014) who reported that the inclusion of DDGS either 12.7or 25.4% did not result in any significant (P>0.05) alterations in carcass characteristics such as pre-slaughter weight, carcass weight, and dressing percentage in lambs. Van Emon *et al* (2012) reported that inclusion of DDGS had no effect on (P>0.05) on carcass weight and dressing percentage in lambs. Zelinsky *et al* (2006) also found no effect (P>0.05) on hot carcass weight in lambs when fed with corn or soya hulls supplemented with DDGS at 17.3%. Eun *et al* (2009) reported that inclusion of DDGS in the diets of steers had no effect (P>0.05) on carcass characteristics. Beliveau *et al* (2008) reported that inclusion of wheat based DDGS had no effect (P>0.05) on carcass weight or dressing percentage in steers. In contrast, Felix *et al* (2012) found that the inclusion of DDGS at a 20% level resulted in increased carcass weight (P=0.03) compared to the 40 and 60% levels.

The wholesale cuts as a percentage of carcass weight in ram lambs fed a concentrate mixture containing RDDGS up to 100% showed no significant (P>0.05) difference. However, there were numerical increases in the weights of primal cuts in T_4 compared to the control due to slightly increase in body weight and best utilization of diet to muscle build up. In line with the present findings Hatamleh and Obeidat (2019) reported that no significant (P>0.05) differences, were observed in carcass cuts weight across the treatment when DDGS was fed to the lambs. Similarly, McKeown *et al* (2010) also found that DDGS derived from corn, wheat, or triticale replacing barley grain and Canola meal at 20% DM in lambs had no effect (P>0.05) on wholesale meat cuts. Schauer *et al* (2008) also reported that increasing levels of DDGS up to 60% in lamb finishing diets had no impact (P>0.05) on carcass cuts. Abdelrahim *et al* (2014) revealed that the inclusion of DDGS either 12.7 or 25.4% did not significantly (P>0.05) affect carcass characteristics.

The increase in the level of inclusion of RDDGS from 0 to 100% in the concentrate mixtures had no significant effect (P>0.05) on the lean, bone, and fat proportions in ram lambs. a similar was obtained by Kawecka *et al* (2018) who reported that inclusion of DDGS at 45% had no effect (P>0.05) on the chemical composition of the meat. Castro-Pérez *et al* (2014) reported that inclusion of DDGS in the diet of lambs had no effect (P>0.05) on composition of carcass. Whitney *et al* (2010) reported that inclusion of DDGS had no effect (P>0.05) on meat, bone and fat composition. Zelinsky *et al* (2006) also reported similar findings.

Increasing the level of incorporation of RDDGS from 0 to 100% in the concentrate mixtures had no effect (P>0.05) on the yield of visceral organs in ram lambs. Castro-Pérez *et al* (2014) reported that inclusion of DDGS in the diet of lambs had no effect (P>0.05) on visceral organ yield. O'Hara *et al* (2011) similarly conveyed that substituting a combination of

canola meal and barley grain with either low or high oil content corn dried distillers' grains with solubles (DDGS) or wheat DDGS in the diet had no impact (P≥0.19) on the yield of visceral organs in lambs.

CONCLUSION

It could be concluded that up to 100% of soybean meal could be replaced by RDDGS in the concentrate mixture without affecting palatability of ration, growth performance, FCR and carcass characteristics in ram lambs.

ACKNOWLEDGEMENT

The support from the SVVU, Director of Research, Sri Venkateswara Veterinary University are thankfully acknowledged.

Table 1. Ingredient and chemical composition (% DM basis) of experimental diets fed to ram lambs.

Nutrient	Super Napier	RDDGS	CM-1	CM-2	CM-3	CM-4
Ingredient composition (%DM basis)						
Maize	-	-	31	34	35	31
DORB	-	-	36	33	32	36
Soybean meal	-	-	30	15	7.5	0
Rice DDGS	-	-	0	15	22.5	30
Mineral mixture	-	-	2	2	2	2
Salt	-	-	1	1	1	1
Chemical composition (%DM basis)						
Dry matter	24.32	91.02	91.34	91.30	91.32	91.33
Organic matter	88.05	94.18	90.67	91.15	90.57	91.28
Crude protein	11.68	47.32	20.05	20.07	20.07	20.08
Ether extract	3.47	6.25	2.96	2.78	3.43	3.84
Crude fibre	37.95	5.70	14.76	15.17	12.84	12.23
Nitrogen free extract	34.95	34.91	52.90	53.13	54.23	55.13
Total ash	11.95	5.82	9.33	8.85	9.43	8.72
Neutral detergent fibre	77.75	41.12	33.92	33.23	32.16	33.09
Acid detergent fibre	42.27	22.78	15.87	14.63	16.08	15.56
Hemicellulose	35.48	18.33	18.05	18.6	16.08	17.53
Cellulose	36.54	9.58	13.14	11.55	10.69	15.14
Acid detergent lignin	7.14	9.70	8.63	5.86	6.33	6.78
Silica	3.66	1.34	1.71	1.49	1.57	1.65
Calcium(%)	0.50	0.83	0.61	0.65	0.81	0.70
Phosphorous (%)	0.41	0.89	0.69	0.83	0.79	0.66

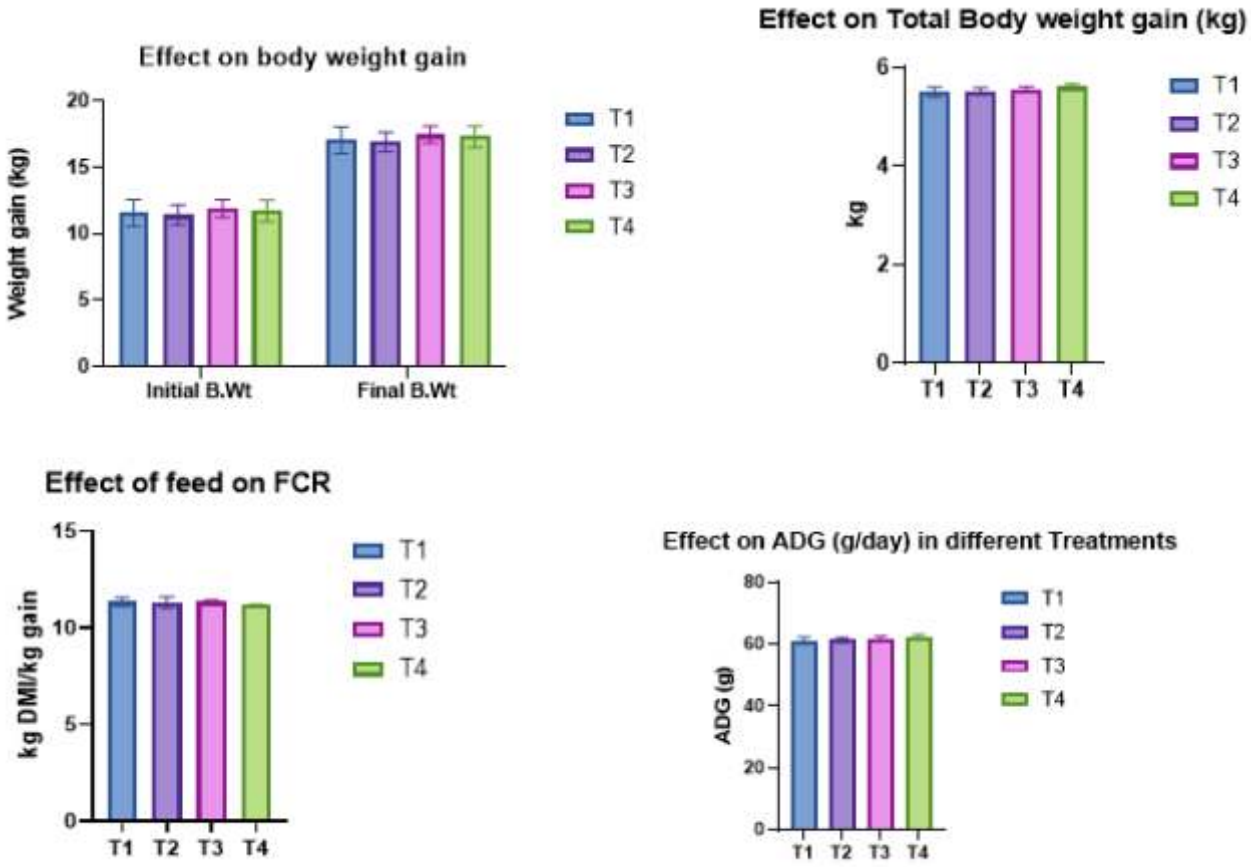
Table 2. Effect on carcass characteristics and wholesale cuts (% carcass weight) of ram lambs fed diets containing different levels of RDDGS

Parameter^{NS}	T_1 (Control)	T_2	T_3	T_4
Pre slaughter weight (Kg)	17.75 ± 1.48	17.75 ± 1.12	17.84 ± 0.62	17.93 ± 1.36
Empty Body weight (Kg)	15.74 ± 1.32	15.76 ± 1.02	15.83 ± 0.63	15.86 ± 1.01
Carcass weight (Kg)	8.84 ± 0.79	8.85 ± 0.52	8.90 ± 0.25	8.95 ± 0.61
Dressing Percentage (%)				
(On pre slaughter weight)	49.78 ± 0.30	49.91 ± 0.37	49.91 ± 0.38	49.97 ± 0.37
(On empty body weight)	56.12 ± 0.33	56.21 ± 0.41	56.26 ± 0.76	56.37 ± 0.30
Wholesale Cuts (% carcass wt.)				
Foreshank &Brisket	16.67 ± 0.10	16.68 ± 0.02	16.70 ± 0.07	16.71 ± 0.11
Neck & Shoulder	25.40 ± 0.24	25.50 ± 0.24	25.58 ± 0.15	25.85 ± 0.25
Rack	11.18 ± 0.16	11.28 ± 0.06	11.30 ± 0.09	11.35 ± 0.06
Loin	10.27 ± 0.80	10.89 ± 0.95	11.18 ± 1.11	11.46 ± 0.58
Leg	35.35 ± 0.27	35.69 ± 0.14	35.63 ± 0.12	35.66 ± 0.13

Table 3. Yield of visceral organs (% of pre slaughter weight) of ram lambs fed concentrate mixtures containing different levels of RDDGS

Parameter^{NS}	T_1 (Control)	T2	T3	T4
Pluck	3.11 ± 0.14	3.15 ± 0.15	3.15 ±0.16	3.20 ± 0.15
Liver	1.20 ± 0.13	1.23 ± 0.14	1.26 ± 0.13	1.27 ± 0.13
Kidney	0.28 ± 0.04	0.29 ± 0.04	0.30 ± 0.05	0.31 ± 0.05
Heart	0.58 ± 0.08	0.59 ± 0.09	0.58 ± 0.09	0.61 ± 0.09
Testes	0.94 ± 0.07	0.97 ± 0.09	0.99 ± 0.10	0.99 ± 0.10
GIT (Full)	21.04 ± 0.52	21.43 ± 0.17	21.30 ± 0.14	21.44 ± 0.50
GIT(Empty)	6.39 ± 0.20	6.39 ± 0.09	6.38 ± 0.13	6.40 ± 0.10
Spleen	0.25 ± 0.04	0.23 ± 0.05	0.25 ±0.06	0.27 ±0.05
Pluck	1.15 ± 0.09	1.23 ± 0.09	1.21 ± 0.12	1.27 ± 0.12
Skin	8.23 ± 0.17	8.22 ± 0.18	8.23 ± 0.16	8.19 ± 0.15
Head	6.79 ± 0.11	6.52 ± 0.15	6.67 ± 0.23	6.88 ± 0.09
Blood	3.06 ± 0.10	3.05 ± 0.11	3.06 ± 0.12	3.45 ± 0.22
Intestines	2.33 ± 0.10	2.37 ± 0.10	2.32 ± 0.12	2.31 ± 0.14
Limbs	2.34 ± 0.12	2.32±0.13	2.16 ± 0.10	2.30 ± 0.13

Fig1: Effect on growth performance and FCR of ram lambs fed different levels of RDDGS containing diets



REFERENCES

Abdelrahim G M, Khatiwada J and Gurung N K (2014). Effects of dried distillers grains with solubles on performance and carcass characteristics of lamb. *J Anim Res Tech* **1(2):** 25-30.

Abudabos A M, Abdelrahman M M, Alatiyat, R M, Aljumaah M R, Al Jassim R and Stanley D (2021). Effect of dietary inclusion of graded levels of distillers dried grains with solubles on the performance, blood profile and rumen microbiota of Najdi lambs. *Heliyon* 7 (1):1.

AOAC. (2007). *Offificial Methods Of Analysis.* 18th ed. Association of official analytical chemists, Washington DC: AOAC International.

Beliveau R M and McKinnon J J (2008). Effect of graded levels of wheat-based dried distillers' grains with solubles on performance and carcass characteristics of feedlot steers. *Can J Anim Sci* **88(4):** 677-684.

Brandly P J, George Migaki, Kenneth E, Taylor (1968). *Meat Hygiene.* 3rd edition. Lea and Febiger, Philadelphia, U.S.A.

Castro-Pérez B I, Estrada-Angulo A, Ríos F G, Dávila-Ramos H, Robles-Estrada J C, Contreras-Pérez G and Plascencia A (2014). Effects of replacing partially dry-rolled corn and soybean meal with different levels of dried distillers grains with solubles on growth performance, dietary energetics, and carcass characteristics in hairy lambs fed a finishing diet. *Small Rumin Res* **119**(1-3): 8-15.

Chandrika R N, Kaur J, Singh C, Lamba J S and Grewal R S. (2021). Effect of Feeding Dried Distillers Grains with Solubles on Nutrient Utilization and Blood Biochemical Profile of Buffalo Calves. *J Anim Res* **11(3):** 409-414

Dey D, Sharma B, Mohammad A, Mandal D K, Bhakat C, Dutta T K and Chatterjee A. (2020). Effect of feeding rice distillers dried grain with solubles as major protein source on nutrient

digestibility and growth performance of Jersey crossbred calves. *Indian J Anim Res* **54(4):** 446-451.

Duncan D B. (1955). Multiple Range and Multiple F-Test. Biometrics, **11:** 1-42.

Hatamleh S M and Obeidat B S (2019). Growth performance and carcass traits responses to dried distillers' grain with solubles feeding of growing Awassi ram lambs. *Animals* **9**(11): 954.

Eun J S, ZoBell D R and Wiedmeier R D.(2009). Influence of replacing barley grain with corn-based dried distillers grains with solubles on production and carcass characteristics of growing and finishing beef steers. *Anim Feed Sci Technol* **152**(1-2): 72-80.

Gerrand F (1964). Meat Technology 3rd Edition Leonard Hell Limited, London.

Hatamleh S M and Obeidat B S. (2019). Growth performance and carcass traits responses to dried distillers' grain with solubles feeding of growing Awassi ram lambs. *Animals* **9(11):** 954.

Huls T J, Bartosh A J, Daniel J A, Zelinsky R D, Held J and Wertz-Lutz A E (2006). Efficacy of dried distiller's grains with solubles as a replacement for soybean meal and a portion of the corn in a finishing lamb diet. *Sheep Goat Res J* **2I:** 30-34.

ICAR (2013). *Nutrient Requirements of Sheep And Goats*. Indian Council of Agricultural Research, New Delhi.

Kawęcka A, Sosin-Bzducha E, Puchała M and Sikora J (2018). Effect of maize DDGS addition on carcass and meat quality of lambs of native sheep breed. *J Appl Anim Res* **46(**1): 301-305.

Manthey A K, Anderson J L and Perry G A (2016). Feeding distillers dried grains in replacement of forage in limit-fed dairy heifer rations: Effects on growth performance, rumen fermentation, and total-tract digestibility of nutrients. *J. Dairy Sci* **99**(9)**:** 7206-7215.

McKeown L E, Chaves A V, Oba M, Dugan M E, Okine E and McAllister T A (2010). Effects of corn-, wheat-or triticale dry distillers' grains with solubles on in vitro fermentation, growth performance and carcass traits of lambs. *Can J Anim Sci* **90**(1)**:** 99-108.

National Livestock census (2019). 20th *Livestock Census*. All India reports. Ministry of Agriculture, Department of Animal Husbandry, Dairying and Fisheries, Krishi Bhawan, NewDelhi .

O'Hara A S, Tanner A, McAllister T A, Gibb D J, Van Herk F and Chaves A V. (2011). Effect of low and high oil corn distillers' grain on rumen fermentation, growth performance and carcass characteristics of lambs. *Anim Prod Sci* **51(8):** 708-716.

Obeidat B S (2018). Influence of corn-dried distiller's grain with solubles on growth performance and blood metabolites of Awassi lambs offered a concentrate diet. *Italian J Anim Sc,* **17(3):** 636-642.

Omer H A A, Abdel-Magid S S, El-Nomeary Y A A, Nassar S A, Nasr S M and Abou-Zeina H A A (2015). Nutritional impact of partial replacement of cotton seed meal with distillers dried grain with solubles (DDGS) on animal performance, digestion coefficients and some blood constituents in crossbred calves. *World Appl Sci J* **33**(4**):** 580-589.

Pandey M, Shah S, Wadhwani K, Lunagariya P, Islam M and Kalola A (2023). Economics of Feeding Rice DDGS and Mixture of Wheat Straw and Groundnut Straw to Growing Crossbred Heifers. *Indian J Anim Prod & Manage* **37**(2): 123-130.

Reddy P P R, Chakrawarthi M K, Reddy D M, Venkateswarlu S, Reddy J B, Babu P R and Reddy P R K. (2021). Effect of dried distillers' grain with solubles as a replacer of peanut cake for sheep fed on low quality forage. *Trop Anim Sci J* **53**: 1-13.

Schauer C S, Stamm M M, Maddock T D and Berg P B. (2008). Feeding of DDGS in lamb rations. *Sheep Goat Res J* **23:** 15-19.

SPSS. (2012). Statistical Packages for Social Sciences Version 22.0. SPSS Inc.

Steppa R, Cieślak A, Szumacher-Strabel M, Bielińska-Nowak S, Bryszak M, Stanisz M and Szkudelska K (2017). Blood serum metabolic profile and fatty acid composition in sheep fed concentrates with Camelina sativa cake and

distillers dried grains with solubles. *Small Rumin Res* **156:** 20-26.

Talapatra S K, Roy S C and Sen K C (1940). The analysis of mineral constituents in biological materials. I. Estimation of phosphorous, Calcium, magnesium, sodium and potassium in food stuffs. *Indian J Vet Sci Anim Husb* **10:** 243-258.

Van Emon M L, Gunn P J, Neary M K, Lemenager R P, Schultz A F and Lake S L (2012). Effects of added protein and dietary fat on lamb performance and carcass characteristics when fed differing levels of dried distiller's grains with solubles. *Small Rumin Res* **103**(2-3): 164-168.

Van Soest P J, Robertson J B, Lewis B A (1991). Methods for dietary fibre, nuutral detergent fibre, and non-starch polysaccharides in relation to animal nutrition. *J Dairy Sci* **74:** 3583-3597.

Wafaa M A G, and Mahmoud A E M. (2016). Impact of dried distillers grains with solubles on productive performance of Barki lambs. *Egyptian J Nutr Feeds* **19**(1): 31-40.

Whitney T R and Lupton C J. (2010). Evaluating percentage of roughage in lamb finishing diets containing 40% dried distillers grains: Growth, serum urea nitrogen, nonesterified fatty acids, and insulin growth factor-1 concentrations and wool, carcass, and fatty acid characteristics. *J Anim Sci* **88(9)**: 3030-3040.

Zelinsky R, Daniel J A and Held J E. (2006). The effect of corn or soybean hull diets supplemented with dried distillers grain with solubles (DDGS) on finishing lamb performance and carcass merit. *Animal science field day proceedings and research reports*, 3.

Received on 10/01/2024 Accepted on 15/02/2024