RESEARCH ARTICLE

Effects of Feeding Distillers Dried Grains with Solubles (DDGS) on Feed Intake and Milk Production Performance of Crossbred Cows

Mahesh P. Madhavatar[1]*, Shailesh V. Shah[1], Kishan N. Wadhwani[2], Pravin M. Lunagariya[2], Rakesh J. Modi[1], Ashish C. Patel[3]

Abstract

Present experiment was conducted to study the performance of feeding Distillers Dried Grains with Solubles (DDGS) on milk production on 18 HF × Kankrej (75:25) advance pregnant crossbred heifers, which were distributed into three treatment groups (T_1, T_2 and T_3) comprising of 6 animals each. The total duration of experiment was 300 days. Animals were offered three different types of total mixed rations containing 20, 10 and 0% Soy DOC, and 0, 10 and 20% rice DDGS (RDDGS) in T_1, T_2 and T_3 groups, respectively. The overall mean values of DMI (kg/animal/day, and kg/100 kg body weight) in crossbred cows were 11.81±0.12 and 2.66±0.05, respectively. Average DMIs in T_1, T_2 and T_3 groups of crossbred cows were 11.99±0.23, 11.81±0.22 & 11.62±0.19 kg/animal/day ($p>0.05$), and 2.82±0.10, 2.60±0.09 & 2.55±0.08 kg/100 kg body weight ($p<0.05$), respectively. The DMI (kg/100 kg body weight) was significantly ($p<0.05$) lower in T_2 and T_3 groups as compared to T_1 group. The overall average milk yield and FCM yield at 4% fat irrespective of treatments and periods was found to be 20.92±0.24 and 21.06±0.59 kg/animal/day, respectively. Average milk yield and FCM yield at 4% fat was non-significantly higher in T_2 (21.23±0.38 & 21.26±0.42) as compared to T_3 (20.84±0.44 & 21.11±0.48) and T_1 (20.71±0.43 & 20.78±0.46) groups. Feeding rice DDGS up to 20% in total mixed ration had no adverse effect on feed intake and milk yield of crossbred cows, indicating it can effectively replace soybean DOC in dairy rations.

Key words: Crossbred cows, DDGS, Feed intake, Milk production.

Ind J Vet Sci and Biotech (2026): 10.48165/ijvsbt.22.1.17

Introduction

Animal husbandry plays a crucial role in supporting the rural economy of India. In developing country like India, about 70% of cost of milk production is the feed cost (Singh *et al*., 2003). Higher feeding cost and less supply of conventional feeds and fodders are major constraints in future expansion of dairying. In developing country higher cost and less supply of conventional feedstuffs has increased the demand of alternative feed ingredients. In this condition scientists are forced to find new feed resources to fulfil the gap of demand and supply. Use of unconventional feed resources instead of traditional feed stuffs lowers the cost of production. Various types of cereals are in use and millions of tons of fermentation residues are available from ethanol industry which can be fed to animals. Distilleries dried grains with soluble (DDGS) is one by-product from the production of ethanol from grain after fermentation of the starch (Youssef *et al*., 2013) and it can be used as alternative high protein feed source for livestock feed especially for dairy cows. Over the past decade, distillers dried grains with solubles (DDGS) have become a widely used feed ingredient in the diets of growing heifers (Dhami *et al.,* 2023[a,b]) and lactating dairy cows (Anderson *et al*., 2006; Ranathunga *et al*., 2018). Research indicates that DDGS can effectively replace corn and soybean meal in dairy rations at levels of up to 22% of the diet's dry matter (DM) without compromising milk production (Mjoun *et al*., 2010; Ranathunga *et al*., 2018), and in some cases, may even enhance it (Anderson *et al*., 2006; Kleinschmit *et al*., 2006). Hence this study was planned to evaluate the effects of rice DDGS on feed intake and milk production performance of crossbred cows.

[1]Department of Livestock Production Management, College of Veterinary Science & Animal Husbandry, Kamdhenu University, Anand-388001, Gujarat, India

[2]Livestock Research station, College of Veterinary Science & Animal Husbandry, Kamdhenu University, Anand-388001 Gujarat, India

[3]Department of Animal Genetics and Breeding, College of Veterinary Science & Animal Husbandry, Kamdhenu University, Anand-388001 Gujarat, India

Corresponding Author: Dr. Mahesh P. Madhavatar, PVK Waghai & Department of Livestock Production Management, College of Veterinary Science & Animal Husbandry, Kamdhenu University, Navsari-396450, Gujarat, India. e-mail: madhavatarmahendra@gmail.com

How to cite this article: Madhavatar, M. P., Shah, S. V., Wadhwani, K. N. Lunagariya, P. M., Modi, R. J., & Patel, A. C. (2026). Effects of Feeding Distillers Dried Grains with Solubles (DDGS) on Feed Intake and Milk Production Performance of Crossbred Cows. Ind J Vet Sci and Biotech, 22(1), 86-90.

Source of support: Nil

Conflict of interest: None

Submitted 27/09/2025 **Accepted** 03/11/2025 **Published** 10/01/2026

© The Author(s). 2026 Open Access This work is licensed under a Creative Commons Attribution-Non Commercial-No Derivatives 4.0 International License.

Materials and Methods

The proposed work was carried out, following approval of IAEC, on eighteen advanced pregnant crossbred heifers (HF x Kankrej; 75:25) selected from the herd of Livestock Research Station, College of Veterinary Science and Animal Husbandry, Kamdhenu University, Anand, Gujarat (India). They were divided into three treatment groups based on dam's first standard lactation milk yield (kg; 300 days), body weight of heifers and heifers' dam's parity. The experiment was conducted from 60 days prepartum (advance pregnancy) to 150 days postpartum. There were three treatment groups (T_1, T_2 and T_3) with six animals in each group. Each group was offered different type of concentrate in TMR containing 0, 10 and 20% rice DDGS (RDDGS) replacing soy DOC. Concentrate and roughage were given to the experimental animals in the form of total mixed ration (TMR), *viz*., T_1: 10 kg green fodder + TMR (compound concentrate mixture + *ad libitum* wheat straw + *ad libitum* groundnut/mung gotar + 20% soy Doc + 1% mineral mixture + 1% salt), T_2: 10 kg green fodder + TMR (compound concentrate mixture + *ad libitum* wheat straw + *ad libitum* groundnut/mung gotar + 10% soy Doc + 10% DDGS + 1% mineral mixture + 1% salt), and T_3: 10 kg green fodder + TMR (compound concentrate mixture + *ad libitum* wheat straw + *ad libitum* groundnut/mung gotar + 20% DDGS + 1% mineral mixture + 1% salt). The protein requirement of the cows under different treatment was met as per the ICAR (2013) feeding standard.

Throughout the experimental period half of the measured quantity of total mixed ration was offered to animals during morning and another half at afternoon after tying animals at appropriate places as per experimental schedule. Green fodder @ 10 kg/animal/day was offered during morning hours. Clean wholesome drinking water was offered to animals 3 times in winter & monsoon and 4 times in summer season in 24 h on *ad libitum* basis. During the postpartum period 50 g of bypass fat was offered to all experimental animals from calving to 60 days postpartum.

Measured quantity of total mixed rations and green fodder were offered to the experimental animals as per the treatment and left-over feed was measured next day morning. The leftover was subtracted from the initial feed supplied to know the actual amount of feed consumed by animal. Utmost care was taken while feeding animals to get actual feed intake. Mangers were partitioned with cement bricks keeping sufficient space for individual animals. Strict supervision was done to prevent eating the animals from others' ration when they were let-loose.

Milk Yield

All the experimental cows were milked by pipeline milking machine (DeLaval®) two times a day at an interval of twelve hours, *i.e*.. 6:30 a.m. and 6:30 p.m. The teats and udders were washed and cleaned with a $KMnO_4$ solution. Before each milking, teats and udders were gently massaged to initiate letdown of milk. The cows were handled gently and calmly. Total milk yield (kg) was measured and recorded for each animal of all the treatment groups up to 150 days of lactation.

Milk Composition

Twenty mL of representative milk samples of each experimental animal was collected in a clean plastic bottle at fortnightly (15-days) interval starting from 4th day up to 150th day of lactation. Morning and evening milk samples were collected separately and stored in a refrigerator until analysis on the same day. Milk samples were analyzed for Fat %, SNF % and Total protein % using automatic milk analyzer (Milkoscreen, IndiFOSS®). Total solid was calculated by adding SNF + Fat.

Fat Corrected Milk and Fat Yield

Four percent fat corrected milk (FCM) yield (kg) was calculated from the values of milk yield and fat percentage of milk using following formula.

FCM = 0.4 (MY) + 15 (FY), where, MY= milk yield and FY= fat yield

Fat yield was calculated by multiplying milk yield and fat percent divided by 100.

Statistical Analyses

The data recorded during the experiment was statistically analyzed by completely randomized design and one-way ANOVA using SPSS software, as per statistical method described by Snedecor and Cochran (2002).

Results and Discussion

Dry Matter Intake (kg/animal/day, & kg/100 kg live weight)

Average dry matter intake (kg/animal/day, & kg/100 kg body weight) of crossbred cows during the experiment is pesented in Table 1. Irrespective of the treatments and periods overall average dry matter intake was 11.81±0.12 kg/animal/day. Irrespective of the periods, it was statistically non-significant between treatments (Table 1), which might be due to use of total mixed ration of similar nutritive value (crude protein). The feeding of DDGS did not have any adverse effect on feed intake of the cows as it was highly palatable and nutritive as indicated by similar dry matter intake. Gibb *et al*. (2008) concluded that replacing half or full barley with wheat DDGS did not affect DMI (6.65±0.20 vs. 6.72±0.20 vs. 6.86±0.11 kg/d) during background period (55 days) which supports the present findings. Sasikala-Appukuttan *et al*. (2008) also did not find significant difference in postpartum dry matter intake of cows at various DDGS inclusion rate, *i.e*. 0% DDGS (control), 18.5 % DDGS, 10% CCDS (condensed corn distillers solubles) and 20 % CCDS (DMI was 21.3, 22.0, 20.8 and 21.3 kg/d, respectively). Contrary to the results of present study, Manthey and Anderson (2016) observed

a linear and significant ($p<0.05$) decrease in DMI (kg/d) of Hostein heifers with increasing DDGS concentration in diet (6.49 vs. 6.21 vs. 5.84) by replacing forage with DDGS. In an another study, dry matter intake in dairy cows fed distilleries dried grain with solubles was significantly higher in 30% DDGS as compared to 20%, 10% and control group (Janicek *et al*., 2008).

The overall average dry matter intake (kg/100 kg body weight) irrespective of treatments and periods was 2.66±0.05 during the entire experimental period. Regardless of periods, average dry matter intake was significantly ($p<0.05$) lower in T_2 and T_3 treatments as compared to T_1 group (Table 1). Present findings supported the previous results of Manthey and Anderson (2016) in Holstein heifers. They found significantly ($p<0.05$) reduced DMI with increase in concentration of DDGS in diet (2.45 vs. 2.33 vs. 2.19). Pandey *et al*. (2021) reported average DMI (kg/100 kg body weight) of crossbred heifers fed rice DDGS and combination of straw (wheat + groundnut) to be lower as compared to control group. Contrary to the results of present study, Adangale (2005) observed the dry matter intake (kg/100 kg body weight) in crossbred calves to be statistically at par in T_0, T_1 and T_2 groups (3.05, 3.26 & 3.17, respectively). Dey (2016) also found that total DMI did not differ due to RDDGS feeding in crossbred cattle. Dhami *et al.* 2023[a,b]) reported improved growth rate without adverse effect on the health, haematology or serum biochemical profile in growing crossbred heifers by feeding DDGS in place of soy DOC in concentrate and feeding a mixture of groundnut gotar and wheat straw from 8 months till puberty/19 months. However, a significantly reduced serum urea level and increased cholesterol levels on feeding RDDGS suggested it a good source of rumen degradable protein and fat enhancing steroidogenic function (Dhami *et al.* 2023[b]).

Milk Yield and FCM

Average milk yield and 4% FCM (kg/animal/day) of crossbred cows during the experiment are presented in Table 2. The overall average milk yield of crossbred cows irrespective of treatments and periods was found to be 20.92±0.24 kg/animal/day. Regardless of the periods, average milk yield (kg/animal/day) was non-significantly higher in T_2 (21.23±0.38) as compared to T_3 (20.84±0.44) and T_1 (20.71±0.43) groups. Results of present study concurred with Owen and Larson (1991) and Murdock *et al*. (1980), who fed diet containing soybean meal as control and distillers dried grains with solubles (DDGS) as treatment. Both diets had 14.50 % CP. They found that the yields of milk were not significantly different for the soy and distillers' diets. However, the distillers diet produced 34.3 kg milk as compared to the control diet 33.8 kg. Contrary to the present study, Soliman *et al.* (2013) in an experiment using TMR formulated to contain 0, 10, 20 and 30% of corn DDGS, found significant increase in milk yield with 20% DDGS compared with other diets. Similarly, Alvaran *et al*. (2018) also found that soyabean meal supplemented (23.12 kg/d) groups had higher milk production as compared to 25% and 50% DDGS fed groups (20.14 vs 19.28 kg/d, respectively).

The overall average 4% FCM yield of crossbred cows irrespective of treatments and periods was found to be 21.06±0.59 kg/animal/day during entire experimental period of 150 days. FCM yield (kg/animal/day) was non-significantly higher in T_2 (21.26±0.42) as compared to T_3 (21.11±0.48) and T_1 (20.78±0.46) groups (Table 2). These results concurred with Weiss *et al*. (1988), Owen and Larson (1991), and Kleinschmit *et al*. (2006), who also did not find significant difference in yield of FCM for soy DOC and distillers' diets. However, the distillers diet produced 2.3 kg more FCM daily than the control. Contrary to the present study, Janicek *et al*. (2008) reported that FCM in Holstein cows differed by the proportion of DDGS replacing both forage and concentrate ingredients.

Milk Composition

The fat per cent of crossbred cows irrespective of the periods and treatments, was found to be 4.13±0.03 % during entire experimental period up to 150 days postpartum. Irrespective of the periods, average fat (%) content of milk was maximum in T_3 (4.17±0.05) followed by T_1 (4.13±0.06) and T_2 (4.10±0.05) groups. However, the differences among the treatment groups were found non-significant. Results of

Table 1: Average dry matter intake (kg/animal/day, and kg/100 kg body weight) in crossbred cows during the experiment

Parameters	Treatments			
	T_1	T_2	T_3	Overall
Dry matter intake (kg/animal/day)	11.99±0.23	11.81±0.22	11.62±0.19	11.81±0.12
Dry matter intake (kg/100 kg body weight)	2.82^{y}±0.10	2.60^{x}±0.09	2.55^{x}±0.08	2.66±0.05

Means with dissimilar superscripts in a row and column differs significantly ($p<0.05$).

Table 2: Average milk yield and fat corrected milk yield (kg/animal/d) crossbred cows during the experiment

Parameters	Treatments			
	T_1	T_2	T_3	Overall
Milk yield (kg/animal/day)	20.71±0.43	21.23±0.38	20.84±0.44	20.92±0.24
4% Fat corrected milk yield (kg/animal/day)	20.78±0.46	21.26±0.42	21.11±0.48	21.06±0.59

present study agreed with Powers *et al*. (1995) and Anderson *et al*. (2006), who compared blood meal, soybean meal and DDGS. The cows fed DDGS had higher (p=0.029) milk fat as compared to soybean meal (3.55 vs. 3.36%). Dey (2016) and Alvaran *et al.* (2018) found that milk fat percent was similar for cows fed control (4.12 %) and DDG (4.19%) diets. Contrary to present study, Huang *et al.* (1999) observed lower fat % in 20% dried rice distillers' grain (DRDG) group (2.98) as compared to cows fed 10 % DRDG and control diets (3.63 vs. 3.52).

Overall average milk SNF percent, irrespective of the treatments and periods was 8.89±0.04%. Regardless of periods, average milk SNF (%) was found significantly (p<0.05) higher in T3 (8.99±0.06) and T1 (8.99±0.07) as compared to T2 (8.68±0.06) groups. Overall SNF content of milk was 0.00 and 3.45 % more in T3 as compared to T1 and T2 groups, respectively. These results corroborated with Alvaran *et al.* (2018). They found milk SNF per cent statistically comparable though numerically buffalo given 50% DDGS (9.97) and control group (9.84) had highest SNF percent as compared to 25 % DDGS (9.70). Islam *et al*. (2021) also recorded milk SNF % to be higher in treatment group (8.52±0.04) as compared to control group (8.22±0.04). Contrary to the present study, Kale (1984) reported overall average of milk SNF % for the first 10 weeks of lactation as 9.29, 9.38 and 9.35 % in low, medium, and high concentrate fed groups, respectively.

Irrespective of the treatments and periods, overall average total solids were 13.02±0.06 %. If time interval (period) is ignored, average total solid (%) content of milk was significantly (p<0.05) more in T3 (13.16±0.09) and T1 (13.12±0.11) as compared to T2 (12.79±0.10) group. Total solid content of milk in T3 was 0.30 and 2.81 % higher than T1 and T2 groups, respectively. Alvaran *et al.* (2018) found milk total solids per cent to be statistically comparable in buffaloes given roughage dairy concentrate (RDC) +25% DDGS (16.72) and control (RDC) group (16.43). However, the result was contrary to Ranathunga *et al*. (2018) who fed DDGS in low-forage (12.1%) and high-forage diets (12.2 %). Total solid was not affected by diets.

Irrespective of the treatments and periods, overall average milk protein was 3.48±0.04%. If ignored period, average milk protein (%) was higher in T2 (3.52±0.07) as compared to T_1 (3.47±0.07) and T3 (3.44±0.07) groups. These results were similar to Powers *et al*. (1995) and Huang *et al.* (1999), who found that milk protein was lower in control group as compared to DRDG and higher than 20% DRDG (3.28%) group, but did not differ from each other. However, Janicek *et al*. (2008) and Foth *et al.* (2015) found that milk protein per cent increased in diet containing DDGS as compared to diet containing 0% DDGS.

Conclusion

The findings of the present study indicate that RDDGS can serve as a potential alternative protein source for the dairy cattle. The improvement of production performance may be the resultant of several factors such as better chemical profile of RDDGS, improvement of digestibility of nutrients, presence of yeast cells and some other hidden factors. The dry matter intake of cows was at par with feeding soy DOC and RDDGS. Milk yield and FCM yield were higher in T_2 and T_3 compared to those in T_1 group indicating that RDDGS feeding group performed better than soy DOC feeding group. Also, milk composition like Fat & SNF percent were higher in RDDGS fed groups.

Acknowledgment

The authors express their sincere gratitude to the Research Scientist & Head, Livestock Research Station, College of Veterinary Science and A.H., Anand, and to the Director of Research, Kamdhenu University, Gandhinagar, for providing research facilities and financial assistance.

References

Adangale, S.B. (2005). Effect of replacement of jowar straw by soybean straw on growth performance of crossbred calvers (HF× Deoni). *M.Sc. Thesis*. Marathwada Agricultural University, Parbhani, Maharashtra, India. Retrieved from https://krishikosh.egranth.ac.in.

Alvaran, C.A.P., Domingo, I.J., & Aquino, D.L. (2018). Influence of distillers dried grain solubles (DDGS) on intake, nutrients digestibility and milk production of dairy buffaloes. *Journal of Biological Engineering Research and Review*, *5*(1), 24-29.

Anderson, J.L., Schingoethe, D.J., Kalscheur, K.F., & Hippen, A.R. (2006). Evaluation of dried and wet distiller's grains included at two concentrations in the diets of lactating dairy cows. *Journal of Dairy Science*, *89,* 3133-3142.

Dey, D. (2016). Effect of feeding rice distillers grain with soluble on growth rate and milk production of crossbred cattle. *M.V.Sc. Thesis*. ICAR-National Dairy Research Institute, Deemed University Karnal, Haryana, India. Retrieved from https://krishikosh. egranth.ac.in.

Dhami, A.J., Patel, D.N., Pathan, M.M., Shah, S.V., & Lunagariya, P.M. (2023[a]). Effect of feeding distillers dried grains with solubles (DDGS), and legume non-legume roughage on growth rate and haematological profile of crossbred heifers. *The Indian Journal of Veterinary Science & Biotechnology, 19*(3), 6-11

Dhami, A.J., Patel, D.N., Pathan, M.M., Shah, S.V., & Lunagariya, P.M. (2023[b]). Effect of feeding distiller's dried grains with solubles (DDGS) and legume roughage on serum biochemical profile in HF x Kankrej crossbred heifers. *The Indian Journal of Veterinary Science & Biotechnology, 19*(4), 14-19.

Foth, A.J., Brown-Brandl, T., Hanford, K.J., Miller, P.S., Gomez, G.G., & Kononoff, P.\J. (2015). Energy content of reduced-fat dried distillers grains with solubles for lactating dairy cows. *Journal of Dairy Science*, *98*(10), 7142-7152.

Gibb, D.J., Hao, X., & McAllister, T.A. (2008). Effect of dried distillers' grains from wheat on diet digestibility and performance of feedlot cattle. *Canadian Journal of Animal Science*, *88*(4), 659-665.

Huang, H.J., Chioua, P.W.S., Chiang, C.R., & Yu, B. (1999). Effects of dried rice distillers' and grain supplementation on the performance of lactating cows. *Animal Feed Science and Technology, 77,* 303-315.

ICAR (2013). *Nutrients Requirements of Cattle and Buffalo*. Official Publication. Indian Council of Agricultural Research, New Delhi, India.

Islam, M.M., Shah, S.V., Pathan, M.M., & Sarvaiya, N.P. (2021). Effect of different feeding regimes on biochemical and hormonal profile of Holstein Friesian× Kankrej crossbred cows. *Journal of Animal Research*, *12*(2), 291-297.

Janicek, B.N., Kononoff, P.J., Gehman, A.M., & Doane, P.H. (2008). The effect of feeding dried distillers grains plus solubles on milk production and excretion of urinary purine derivatives. *Journal of Dairy Science*, *91*, 3544-3553.

Kale, M.M. (1984). Effects of prepartum feeding on the postpartum performance of crossbred cows. *M.Sc. Dissertation*. Kurukshetra University, Kurukshetra, Haryana, India.

Kleinschmit, D.H., Schingoethe, D.J., Kalscheur, K.F., & Hippen, A.R. (2006). Evaluation of various sources of corn dried distillers grains plus solubles for lactating dairy cattle. *Journal of Dairy Science*, *89*(12), 4784-4794.

Manthey, A.K., & Anderson, J.L. (2016). Feeding distillers dried grains in replacement of forage in limit-fed dairy heifer rations: Effects on post-trial performance. *Journal of Dairy Science*, *100*(5), 3713-3717.

Mjoun, K., Kalscheur, K.F., Hippen, A.R., Schingoethe, D.J., & Little, D.E. (2010). Lactation performance and amino acid utilization of cows fed increasing amounts of reduced-fat dried distillers grains with solubles. *Journal of Dairy Science*, *93*(1), 288-303.

Murdock, F.R., Hodgson, A.S., & Riley Jr, R.E. (1980). Nutritive value of wet brewers grains for lactating dairy cows. *Journal of Dairy Science*, *64*(9), 1826-1832.

Owen, F.G., & Larson, L.L. (1991). Corn distillers dried grains versus soybean meal in lactation diets. *Journal of Dairy Science*, *74*(3), 972-979.

Pandey, M., Shah, S.V., Trivedi, M.M., Pathan, M.M., Lunagariya, P.M., & Patel, Y.G. (2021). Effect of feeding rice distillers dried grains and mixture of non-legume and legume straw on haemato-biochemical and mineral profile of growing dairy heifers. *Indian Journal of Animal Nutrition*, *39*(2), 118-129.

Powers, W.J., Harris Jr, B., & Wilcox, C.J. (1995). Effects of variable sources of distillers dried grains plus solubles on milk yield and composition. *Journal of Dairy Science*, *78*(2), 388-396.

Ranathunga, S.D., Kalscheur, K.F., Anderson, J.L., & Herrick, K.J. (2018). Production of dairy cows fed distillers dried grains with solubles in low-and high-forage diets. *Journal of Dairy Science*, *101*(12), 10886-10898.

Sasikala-Appukuttan, A.K., Schingoethe, D.J., Hippen, A.R., Kalscheur, K.F., Karges, K., & Gibson, M.L. (2008). The feeding value of corn distillers solubles for lactating dairy cows. *Journal of Dairy Science*, *91*(1), 279-287.

Singh, J., Singh, B.M., Wadhwa, M., & Bakshi, M.P.S. (2003). Effect of level of feeding on the performance of crossbred cows during pre and post-partum periods. *Asian-Australasia Journal of Animal Science*, *16,* 1749-1754.

Snedecor, G.W., & Cochran, W.G. (2002). *Statistical Methods*. 7th edn., The Iowa State University Press, Ames, Iowa, USA.

Soliman, M.S., El Ashry, G.M., & Am, E.O. (2013). Evaluation of corn distillers dried grain with solubles in ruminant rations and its effect on milk production. *Journal of Animal and Poultry Production*, *4*(11), 599-614.

Weiss, W.P., Erickson, D.O., Erickson, G.M., & Fisher, G.R. (1988). Barley distillers grains as a protein supplement for dairy cows. *Journal of Dairy Science*, *72*(4), 980-987.

Youssef, A.W., Abd-El-Azeem, N.A., El-Daly, E.F., & El-Monairy, M.M. (2013). The impact of feeding graded levels of distillers dried grains with solubles (DDGS) on broiler performance, haematological and histological parameters. *Asian Journal of Poultry Science, 7*(2), 41-54.