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K Hari Haranath Reddy

Department of Animal Nutrition,
Veterinary College and Research
Institute, Namakkal, Tamil Nadu
Veterinary and Animal Sciences
University, Tamil Nadu, India

S Naveenkumar

Department of Animal Nutrition,
Veterinary College and Research
Institute, Namakkal, Tamil Nadu
Veterinary and Animal Sciences
University, Tamil Nadu, India

G Raguprasath

Department of Animal Nutrition,
Veterinary College and Research
Institute, Namakkal, Tamil Nadu
Veterinary and Animal Sciences
University, Tamil Nadu, India

S Senthilkumar

Department of Animal Nutrition,
Veterinary College and Research
Institute, Namakkal, Tamil Nadu
Veterinary and Animal Sciences
University, Tamil Nadu, India

V Sankar

Department of Animal Nutrition,
Veterinary College and Research
Institute, Namakkal, Tamil Nadu
Veterinary and Animal Sciences
University, Tamil Nadu, India

P Vasanthakumar

Department of Animal Nutrition,
Veterinary College and Research
Institute, Namakkal, Tamil Nadu
Veterinary and Animal Sciences
University, Tamil Nadu, India

Corresponding Author:

K Hari Haranath Reddy

Department of Animal Nutrition,
Veterinary College and Research
Institute, Namakkal, Tamil Nadu
Veterinary and Animal Sciences
University, Tamil Nadu, India

Effect of feeding of corn Distillers Dried Grains with Solubles (DDGS) in sheep: A review

**K Hari Haranath Reddy, S Naveenkumar, G Raguprasath, S
Senthilkumar, V Sankar and P Vasanthakumar**

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Abstract

Corn distillers dried grains with solubles (DDGS) a co product of the bioethanol industry is a concentrated source of crude protein, metabolizable energy, rumen undegradable protein, digestible fiber and essential fatty acids. The fermentation process used in the ethanol production process makes corn DDGS nutritionally superior to the conventional grain. However its chemical composition is variable and affected by factors such as source of corn, oil extraction and processing methods. Feeding of corn DDGS to sheep at moderate dietary levels has been reported to maintain carcass yield, composition and no adverse effects on dressing percentage, hot and cold carcass weights, rib eye area or fat deposition. Improvements in carcass weight have been noticed and can be attributed to the likely increase in nutrient availability as well as the improvement in the feed efficiency. Inclusion of DDGS does not have effect on important meat quality characteristics such as tenderness, juiciness, flavour and overall acceptability. Meat colour characteristics are mostly maintained with an occasional improvement in redness. However DDGS feeding may alter intramuscular fatty acid composition by increasing n-6 polyunsaturated fatty acids which may influence the nutritional value and oxidative stability of meat. Hence, Corn DDGS is a nutritionally and economically viable feed ingredient for sheep which is capable of replacing the conventional protein and energy sources partially without compromising animal performance or product quality.

Keywords: Distillers Dried Grains with Solubles, growth performance, carcass characteristics and meat quality

Introduction

The rapid expansion of the ethanol industry has resulted in the increased availability of distillers dried grains with solubles (DDGS) as it is a byproduct of ethanol industry. The increased production of DDGS has drive DDGS into commercial applications both in ruminant and monogastric industries (Brunetto *et al.*, 2025) [3].

DDGS is an alternative cheap source of protein as well as energy compared to conventional protein (soybean meal) and carbohydrates source (cereal grains). DDGS supplementation has also been reported to increase higher propionate production and decrease methane output in the rumen which enhances energy efficiency and environmental sustainability. The protein fraction of corn DDGS is partially rumen undegradable providing substantial amount of bypass protein that can contribute to supply of metabolizable protein and amino acids in small intestine. These nutritional and economic benefits that have increased the interest in the inclusion of DDGS in the diet of growing, finishing as well as with partial success in reproducing sheep (Chelkapally *et al.*, 2023) [5].

Composition and nutritive value of Corn DDGS to Sheep

During the process of production of ethanol in which starch present in the maize is utilized leaving a high nutrient residue. The nutrient composition of corn DDGS varies due to its difference in the feedstock characteristics, oil extraction during fermentation and drying methods resulting in considerable variations in the crude protein (CP), fibre fractions (neutral

detergent fibre (NDF), acid detergent fibre (ADF)), crude fat, energy and minerals (Chelkapally *et al.*, 2023; Lucas *et al.*, 2024; Zhang *et al.*, 2025) ^[5, 19, 37].

DDGS can substitute conventional protein and energy sources in both forage based and concentrate based systems to

formulate the diet but the analysis of nutrient sources are require because of their variability of composition and other problems with sulphur content and mycotoxins (Chelkapally *et al.*, 2023; Lucas *et al.*, 2024; Obeidat, 2017) ^[5, 19, 24].

Table 1: Proximate composition and fibre fractionations of corn DDGS (% DM basis)

Research worker	CP	EE	CF	TA	NFE	NDF	ADF	Hemi cellulose	Cellulose	Lignin
Spiehs <i>et al.</i> (2002) ^[31]	30.2	10.9	8.8	5.8	45.5	42.1	16.2	25.9	-	-
Widyaratne & Zijlstra (2007) ^[35]	30.3	12.8	7	4.8	-	31.2	14.6	-	-	-
Dimova <i>et al.</i> (2009) ^[7]	33.9	5.5	6.7	4.7	49.2	32.2	9.4	-	-	-
Nuez-Ortin & Yu (2009) ^[23]	32	16.5	-	4.32	-	49.5	14.7	34.8	11.9	3.7
Schingoethe <i>et al.</i> (2009) ^[30]	30.8	11.2	-	5.7	-	39	16.1	22.9	-	-
McKeown <i>et al.</i> (2010) ^[20]	32.6	5.7	-	-	-	32.9	15.5	-	-	-
Salim <i>et al.</i> (2010) ^[29]	27.2	10.7	6.21	4.54	-	26.8	8.48	-	-	-
Castro-Pérez <i>et al.</i> (2013) ^[4]	26.3	9	-	5.6	-	42.7	-	-	-	-
Olukosi & Adebisi (2013) ^[25]	27.9	10.8	7.4	4.5	-	36.6	13.6	-	-	-
Abdelrahim <i>et al.</i> (2014) ^[1]	26.6 - 33.9	10.0 - 15.9	-	-	-	28.6 - 38.4	-	-	-	-
Patil <i>et al.</i> (2015) ^[26]	30	9.8	8.4	4.54	47.2	38.93	15.1	-	-	-
Reddy <i>et al.</i> (2017) ^[27]	28.92	11.86	7.68	5.75	47.78	42.34	22.08	20.26	19.1	2.24

Table 2: Nutritive values of DDGS

Author	TDN%	NE	ME	DE
NRC (1998) ^[22]	-	-	3038 (Kcal/Kg)	3449 (Kcal/Kg)
Kim and Dale (2002) ^[18]	-	5.6 MJ/Kg	-	-
Spiehs <i>et al.</i> (2002) ^[31]	-	-	3749 (Kcal/kg)	3990 (Kcal/Kg)
Tjardes and wright (2002) ^[33]	85 – 90	-	-	-
Engel <i>et al.</i> (2005) ^[8]	88	-	-	-
Ahern <i>et al.</i> (2011) ^[2]	94.5	-	-	-

Growth Performance

Gustad *et al.* (2006) ^[12] and Jones *et al.* (2015) ^[16] reported a linear increase in average daily gain (ADG) of steer calves grazing corn residue and as the level of DDGS supplementation increased suggesting an efficient utilization of DDGS as an energy and protein supplement under residue based diets. Similarly, Felix *et al.* (2012) ^[9] reported that grazing lambs supplemented with DDGS at 2.5% of body weight gained significantly more average daily gain (ADG) than controls group and those receiving soybean hulls as a supplement indicating the superior growth response to supplementation with DDGS. Likewise, Susin *et al.* (2008) ^[32] showed positive results in ADG measured in grazing ewe lambs when supplemented with DDGS (1.3% of body weight) as evidence of its growth promoting effect in pasture based systems. Held (2006) ^[14] found that there was no negative response of ewe body condition score and suckling lamb growth to the replacement of soybean meal with DDGS in lactating ewe diets. Dimova *et al.* (2009) ^[7] found improved productive and reproductive parameters such as milk yield and fertility when forage based diets were supplemented with DDGS and whole grains compared to conventional feeds. Studies by Tripathi *et al.* (2006) ^[34], Moges *et al.* (2008) ^[21], Dessie *et al.* (2010) ^[6], Hailu *et al.* (2011) ^[13] and Gemechu and Mekasha (2015) ^[10] found that final body weight and ADG were consistently higher in lambs or sheep fed increasing levels of concentrate mixtures or brewer's dried grain than control diets based on roughages alone. Although not all these studies directly included DDGS, the results are in favor of the idea that nutrient rich supplements like DDGS can properly enhance the growth performance of small ruminants.

Characteristics of the carcass and meat Quality

The use of corn DDGS in sheep diets has been widely studied

in regard to influence on carcass characteristics and meat quality. A controlled study of lambs fed with 12.7% and 25.4% DDGS showed no significant differences at hot and cold carcass weight, rib eye area, body wall fat, kidney and pelvic fat depots when compared to control diets indicating that the replacement of parts of corn and soyabean meal with DDGS did not have a negative impact on carcass composition (Abdelrahim *et al.*, 2014) ^[1]. The inclusion of DDGS in 20 - 30% diet may lead to weight gain or retention without adverse effects which may be due to improved nutrient digestibility and energy availability (Chelkapally *et al.*, 2023) ^[5].

In lambs fed with high DDGS diets (~ 45% of concentrate) carcass quality and basic meat composition were quite similar to that of control groups. However DDGS inclusion modified intramuscular lipids increasing linoleic acid (C18:2 n-6) and conjugated linoleic acid and reducing linolenic acid (C18:3 n-3) which slightly altered the polyunsaturated fatty acid (PUFA) n-6:n-3 ratio (Kawecka *et al.*, 2017) ^[17]. In spite of changes in the fatty acid profile, taste quality was improved suggesting corn DDGS may modulate biochemical but also organoleptic properties of sheep meat (Kawecka *et al.*, 2017) ^[17]. Corn DDGS treated feedlot lambs had no adverse effect on tenderness, juiciness or flavour intensity or off-flavour indicative of increased nutritive value and satisfactory sensory scores even at increased inclusion up to 60% DM. (Hodges *et al.*, 2020) ^[15].

Risks associated with DDGS feeding

- **Mycotoxins:** Due to the ethanol fermentation process the non volatile compounds mycotoxins are often concentrated in DDGS to a substantial level than the original corn. Research has revealed that mycotoxin screening (DON, fumonisins, aflatoxins, ZEN) is very important to determine high volume of toxic substances, especially the imported or large deliveries. (Wu *et al.*,

2016)^[36].

- **High sulphur content and metabolic disorders** High amounts of sulphur from processing acids or sulphur rich water may increase the incidence of polioencephalomalacia (PEM) from ruminal H₂S generation if total dietary S is high above safe levels 0.4 to 0.6% of diet DM. Sheep are susceptible to toxicity and it is best to monitor the overall intake of sulphur and exclude a number of high sulphur associated foods to control outbreaks (Gooneratne *et al.*, 1989)^[11].

Conclusion

Corn distillers dried grains with solubles (DDGS) is a profitable and nutritionally beneficial non conventional feed to sheep. Controlled experiments and recent meta analyses show that medium levels of inclusion (between 10 to 30 per cent of dietary DM) have the potential to maintain or enhance growth performance and feed efficiency without having a deleterious impact on the carcass characteristics or meat quality as long as the diets are correct in terms of energy, protein and minerals. It is the irregularity of the composition, the level of sulphur and the risk of mycotoxins that are the elements that need regular analysis and practical development. DDGS has the potential to make sheep production cost effective and sustainable in the long run.

Conflict of Interest

Not available

Financial Support

Not available

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