RESEARCH ARTICLE

Comparative Evaluation of Rice and Maize DDGS on Growth Performance and Blood Biochemical Parameters of Crossbred Heifers

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Abstract

The present study was conducted to evaluate the impact of feeding rice- and maize-based Distillers Dried Grains with Solubles (DDGS) on growth performance and blood profile of crossbred heifers. Eighteen crossbred heifers (75% Holstein Friesian × 25% Kankrej; Av. age 13.78±0.38 months, b.wt. 178.54±6.38 kg) were randomly allotted to three treatment groups: T1 (basal total mixed ration-TMR without DDGS), T2 (TMR with 10% rice DDGS), and T3 (TMR with 10% maize DDGS), and fed iso-nitrogenous and iso-caloric TMR, except DDGS. The experiment was carried out for 112 days under uniform management conditions. The results revealed no significant differences among treatments for body weight, daily body weight gain, indicating that inclusion of DDGS up to 10% supported normal growth. Haematological and serum biochemical parameters also remained within normal physiological ranges across all groups, indicating safe on health status. The findings demonstrate that both 10 % rice and maize DDGS can be safely incorporated in the diet of crossbred heifers as an alternative to conventional protein sources without compromising growth performance or blood health.

Key words: Crossbred heifers, Distillers dried grains with solubles, Growth, Haematological profile, Serum biochemistry.

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Introduction

The growth phase of dairy heifers plays a crucial role in determining their future milk production, reproductive efficiency, and longevity in the herd. Proper nutritional management during developmental stage is essential to ensure optimal body growth, timely attainment of puberty, and appropriate body condition at first calving (Heinrichs, 1993; Hoffman, 1997). An inadequate or imbalanced feeding during the rearing period can impair mammary gland development and reduce the lifetime productivity of dairy animals (Van Amburgh and Drackley, 2005). Therefore, considerable attention has been devoted to identifying alternative feed resources that can support efficient growth while maintaining economically viable feeding strategies. Distillers dried grains with solubles (DDGS), a major co-product of the ethanol industry, has emerged as an important feed ingredient in ruminant nutrition due to its high concentrations of protein, energy, digestible fibre, and essential minerals (Klopfenstein *et al*., 2008; Liu, 2011). The most starch in cereal grains is fermented to produce ethanol, resulting in a nutrient-dense by-product rich in crude protein, fat, and rumen undegradable protein (Spiehs *et al*., 2002), used as a partial substitute for conventional protein in cattle diets and that support growth in developing heifers (Manthey *et al*., 2016).

The nutritional value of DDGS may vary depending on the source grain and processing conditions during ethanol production. DDGS derived from different cereal grains, particularly maize and rice, can differ significantly in nutrient composition, amino acid profile, fibre content, and rumen undegradable protein fraction (Belyea *et al*., 2010; Liu, 2011). Such variations may influence growth rate, feed utilisation

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efficiency, and metabolic responses of growing animals. An assessment of physiological and metabolic health is also essential when introducing new feed ingredients into animal diets. The haematology, and metabolites related with energy, protein, liver and kidney function are widely used to evaluate impact on health and physiology (Radostits *et al*., 2007; Kaneko *et al*., 2008). The scientific information on comparative effects of rice- and maize-based DDGS on growth performance and haemato-biochemical profiles of crossbred dairy heifers is limited. The present study was undertaken to evaluate the effect of incorporating 10% rice DDGS or maize DDGS in total mixed rations on growth, haematology, and serum biochemical profile of crossbred heifers.

Materials and Methods

The present experiment was conducted at Livestock Research Station, College of Veterinary Science and Animal Husbandry, Kamdhenu University, Anand, Gujarat, India (20°35'N, 72°55'E; 43 m above sea level) for a period of 112 days (16 weekly periods) after approval by Institutional Animal Ethics Committee (No. 479/LRS/25 dated 19-7-2025). A total of 18 crossbred heifers (75% Holstein Friesian × 25% Kankrej) of uniform age (13.78±0.38 months) and body weight (178.54±6.38 kg) were selected and randomly distributed into three treatment groups, each comprising six animals. The treatment groups were as follows: T1: Basal Total Mixed Ration (TMR) without DDGS (control), T2: TMR containing 10% Rice DDGS (RDDGS), and T3: TMR containing 10% Maize DDGS (MDDGS), composition of total mixed ration was as per our earlier publication (Tomar *et al.,* 2026). All rations were iso-nitrogenous and iso-caloric. Before initiation of the trial, all heifers were dewormed using Fenbendazole (10 mg/kg body weight) and maintained under identical housing, feeding, and managemental conditions in a well-ventilated shed. Heifers were tied individually in front of separate mangers, fed TMR *ad libitum* to achieve an average growth rate of 800-1000 g/day, and provided clean drinking water three times daily. Exercise was allowed for two hours every morning under supervision.

Blood samples were collected aseptically from the jugular vein of each heifer before morning feeding on 0 (initial), 56 (mid), and 112 (final) day of experiment, into EDTA vacuette for haematological analysis and clot-activated vacuettes for serum separation (Greiner Bio-One GmbH, Austria). The whole blood in EDTA vacuette was analysed for haematological parameters on automated haematology analyzer (Mindray BC-2800 VET, Shenzhen Mindray Bio-Medical Electronics Co., Ltd., China). The blood samples in clot-activated vacuettes were centrifuged at 550 g for 15 min, and serum collected into sterile Eppendorf tubes was stored at –20°C until analysis. The serum glucose, total protein, albumin, serum glutamic oxaloacetic transaminase (SGOT), serum glutamic pyruvic transaminase (SGPT), creatinine, and BUN were estimated using a Merilyzer AutoQuant 200i VET autoanalyzer (Meril Diagnostics Pvt. Ltd., Gujarat, India). The globulin and albumin-to-globulin (A:G) ratio were derived from the measured total protein and albumin values.

The data were presented as mean with standard error and analysed as per Snedecor and Cochran (2014) as one-way ANOVA. The difference between means were taken as significant if $p<0.05$.

Results and Discussion

Body Weight, Weight Gain and Average Daily Gain

The body weight, and weight gain of crossbred heifers fed different levels of DDGS are presented in Table 1. The mean and gain (weekly, daily) in body weights were comparable among the treatment groups and revealed no significant difference. The growth response during entire sixteen periods was progressively increasing and comparable, with initially taking eight-week period to adopt to DDGS (Fig. 1), may be owing to adaptation taken by rumen microbes to newer fermented feeds ingredients. The non-significant variation in growth supports the finding that both RDDGS and MDDGS can be safely incorporated at 10% in total mixed ration without affecting growth performance. The marginally lower daily gain in MDDGS-fed group (T3) may be attributed to the slightly higher fibre and lower lysine content in maize-based DDGS compared to rice-based DDGS (Youssef *et al*., 2013) and growth rate values fall were within the expected range for crossbred heifers of similar age and breed (Heinrichs *et al*., 2022). The similar finding on body weight gain in dairy cows was observed on feeding diet with DDGS partial replacing soybean meal (Ranathunga *et al*., 2018). Chandrika *et al*. (2021) and Pandey (2021) also reported that RDDGS and MDDGS can be included up to 10-15% in the diet of buffalo calves and crossbred heifers, respectively without statistical effect on growth.

Table 1: Body weight and weight gain of crossbred heifers fed with various DDGS

Parameters	T1	T2	T3
Body weight (kg)	235.09±4.50	233.50±4.20	230.13±4.17
Weekly weight gain (kg)	6.95±0.10	6.83±0.10	6.67±0.11
Daily weight gain (g/day)	993.01±14.07	975.30±13.62	952.98±15.32

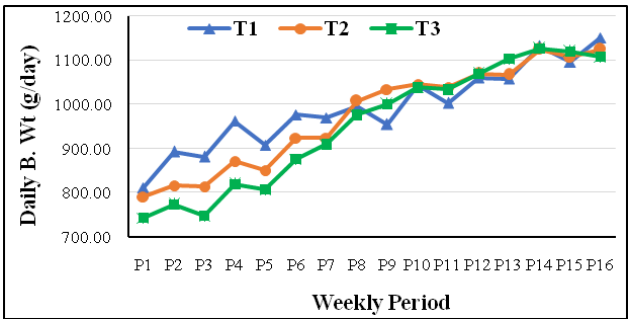

Fig. 1: Daily body weight gain (g/day) of crossbred heifers

Body Measurements

The mean values and gain in heart girth, body length, and wither height are presented in Table 2. The mean heart girth was higher ($p<0.05$) in the MDDGS-fed group T3 compared to control T1 with soybean meal and T2 with rice DDGS group. Similarly, body length was higher ($p<0.05$) in T3 and T1 compared to T2 group. No significant difference was observed in wither height among groups. The significant improvement in heart girth (average, gain) in MDDGS-fed heifers (T3) may be attributed to better nutrient utilization and enhanced protein supply from rumen-undegradable protein in DDGS (Li *et al*., 2011). Similar trends were reported by Harborth *et al*. (2006) and Sahin *et al*. (2013), who noted improved skeletal development and frame growth in heifers receiving DDGS diets. The observed pattern aligns with the findings of Gibb *et al*. (2008) and Brickell *et al*. (2009), who suggested that moderate inclusion of DDGS provides adequate bypass protein and energy to support tissue development in growing heifers. The non-significant variation in body length and wither height indicates that skeletal growth was uniform across treatments, confirming that DDGS inclusion neither hindered nor enhanced vertical growth beyond normal physiological limits.

Table 2: Mean and gain in body measurements (cm) of Crossbred Heifers Fed TMR with Various DDGS

Parameters	T1	T2	T3
Heart girth	$145.15^{a}\pm0.93$	$145.01^{a}\pm0.99$	$149.55^{b}\pm1.15$
Body length	$128.47^{b}\pm0.74$	$125.95^{a}\pm0.78$	$128.57^{b}\pm0.70$
Wither height	120.09±0.58	119.59±0.64	119.02±0.57
Gain in heart girth	$11.40^{a}\pm0.70$	$15.99^{b}\pm0.88$	$15.61^{b}\pm0.88$
Gain in body length	10.59±0.62	10.58±0.57	10.62±0.58
Gain in wither height	9.66±0.55	9.34±0.51	9.35±0.51

Means with different superscripts (a,b) within a row differ significantly ($p<0.05$).

Haematological Parameters

The haematological parameters in crossbred heifers fed different sources of DDGS are presented in Table 4. There were no significant differences in most blood parameters among the treatment groups, except for white blood cell (WBC) counts, which were significantly ($P<0.05$) higher in heifers fed maize-DDGS (T3) compared to control (T1) and rice-DDGS (T2). The increase in WBC count in T3 indicates a potentially stronger immune response or enhanced physiological activity, likely due to the presence of residual yeast and fermentation metabolites in DDGS, which may exert immunostimulatory effects (Soni *et al*., 2020). The haematological parameters in all groups were remained within the normal physiological rangesas reported by Aiello and Moses (2016) and Dey *et al*. (2019). These consistent values indicate that inclusion of DDGS up to 10% in TMR did not cause any adverse effect on erythropoiesis or oxygen-carrying capacity of the blood. The MCV, MCH, and MCHC values also reflected normal erythrocyte indices, suggesting that nutrient utilization was sufficient to maintain red cell morphology and function. Thus, the present study confirms the metabolic safety and nutritional adequacy of DDGS for crossbred heifers. Similar findings were observed by Chandrika *et al*. (2021) in buffalo calves and Pandey (2021) in crossbred heifers, where inclusion of RDDGS and MDDGS had no significant influence on haematological attributes. Overall, the haematological results demonstrate that the inclusion of both RDDGS and MDDGS up to 10% in TMR supported normal physiological functions and did not induce any pathological or stress-related alterations in blood indices, signifying their safe utilization in heifer feeding.

Table 4: Haematological parameters of crossbred heifers fed various DDGS

Parameters	T1	T2	T3
White blood cells ($x10^3/\mu L$)	$9.08^{a}\pm0.31$	$9.88^{a}\pm0.32$	$11.17^{b}\pm0.41$
Lymphocytes ($x10^3/\mu L$)	4.81±0.77	4.42±0.32	5.90±0.27
Monocytes ($x10^3/\mu L$)	0.73±0.06	0.77±0.05	0.84±0.05
Granulocytes ($x10^3/\mu L$)	4.88±0.32	4.69±0.23	4.43±0.18
Red blood cells	8.45±0.27	9.28±0.34	8.48±0.40
Haemoglobin (g/dL)	10.05±0.19	10.66±0.34	9.97±0.22
Packed cell volume (%)	32.89±1.22	35.89±1.65	33.53±0.92
MCV (fL)	39.30±1.78	38.70±0.80	40.20±1.53
MCH (pg)	11.96±0.33	11.49±0.20	11.88±0.37
MCHC (g/dL)	30.74±0.60	29.85±0.52	29.78±0.56
RDWC (%)	20.28±0.55	20.08±0.39	20.25±0.50
Platelets ($x10^3/\mu L$)	436.75±23.08	437.00±29.25	503.17±28.70

Means with different superscripts (a, b) within a row differ significantly ($P<0.05$). Where MCV= Mean corpuscular volume, MCH= Mean corpuscular haemoglobin, MCHC=Mean corpuscular haemoglobin concentration, RDWC=Red cell distribution width

Serum Biochemistry

The serum biochemical profile of crossbred heifers fed with various DDGS sources is presented in Table 5. Most serum metabolites were within the normal physiological range (Hussein *et al*., 2020), indicating good health and metabolic status of animals across all treatments. Serum glucose, total protein, SGPT, SGOT, serum creatinine, and BUN levels showed no significant differences among treatments, except for serum albumin, globulin, and the albumin-to-globulin ratio, which differed significantly ($p<0.05$). The variations in albumin, globulin levels and A:G ratio among treatments could be attributed to differences in rumen-undegradable protein supply and amino acid balance in RDDGS and MDDGS (Li *et al*., 2011; Kaninde *et al*., 2023). Elevated albumin in T2 may reflect better hepatic protein synthesis from RDDGS, while the higher globulin in T3 suggests enhanced immune protein production due to increased microbial activity associated with DDGS inclusion.

Table 5: Serum biochemical parameters of crossbred heifers fed various DDGS

Parameters	T1	T2	T3
Serum glucose (mg/dL)	79.64±1.92	81.00±2.88	77.68±1.78
Serum total protein (g/dL)	6.95±0.13	6.95±0.11	7.11±0.17
Serum albumin (g/dL)	3.10^{a}±0.09	3.41^{b} ±0.08	3.05^{a}±0.12
Serum globulin (g/dL)	3.85^{ab} ±0.15	3.54^{a} ±0.14	4.06^{b}±0.21
Serum A: G	0.82^{ab}±0.05	0.98^{b}±0.06	0.78^{a}±0.06
Serum creatinine (mg/dL)	0.88±0.02	0.86±0.03	0.93±0.02
SGPT (IU/L)	29.39±1.65	33.13 ±0.95	30.65±2.01
SGOT (IU/L)	79.76±4.50	69.74 ±3.22	73.33±2.29
BUN (mg/dL)	15.34^{a}±0.55	17.53^{b} ±0.65	15.59^{a}±0.63

The serum creatinine and BUN levels were within normal physiological limits, suggesting efficient protein metabolism and no renal stress, consistent with findings of Yogi *et al*. (2017) and Chandrika *et al*. (2021). The value of SGPT and SGOT were also remained within reference ranges (25-40 U/L and 60–90 U/L, respectively), confirming that DDGS inclusion did not affect hepatic enzyme activity or liver integrity. These results reaffirm that rice and maize DDGS can be safely included in the diet of crossbred heifers without impairing liver or kidney function.

Conclusions

An inclusion of rice- and maize-based distillers dried grains with solubles (DDGS) at a 10% level in the total mixed ration of crossbred heifers had no significant effect on growth performance, blood haematology and serum metabolites related with energy, protein nutrition, liver and kidney function. Thus, both rice and maize DDGS can be safely incorporated up to 10% in heifer diets without any adverse impact on growth and health.

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ANNOUNCEMENT - I

XIII Annual Convention and National Conference of SVSBT-2026

XIII Annual Convention of the Society for Veterinary Sciences & Biotechnology ***(SVSBT)*** and ***National Conference on "Transforming Animal Health, Disease Diagnosis and Sustainable Livestock Production through Genomics, Artificial Intelligence and Biotechnology"*** will be **organized** by the Bihar Veterinary College (BVC), Bihar Animal Sciences University (BASU), **Patna-800014, Bihar, India, during October 6-7, 2026**. The detailed Brochure cum Announcement showing Theme Areas / Sessions, Registration Fee, Bank Details for online payment and deadlines for abstract submission/registration, etc. is floated on the Society's Website (https://www.svsbt.com), Whatsapp groups and individual LMs' e-mails too.

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