RESEARCH ARTICLE

Effect of Feeding Distillers Dried Grains with Solubles (DDGS), and Legume Non-Legume Roughage on Growth Rate and Haematological Profile of Crossbred Heifers

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Abstract

The study was undertaken on HF x K heifers (n=24) to evaluate the effect of feeding distillers dried grains with soluble (DDGS) and Soy DOC alone or in combination with cereal and/or legume straws as TMR from average 8 months till 19 months of age on their growth, health and haematological profile. Heifers were uniformly distributed into six treatment groups and were fed concentrate and roughage 50-50 ratio. They were offered three different types of concentrates containing 0, 20 and 40% rice DDGS, each half with wheat straw (25%) and another half as a mixture of wheat straw and groundnut gotar. Heifers were also offered green hybrid Napier @ 2 kg/h/d up to 100 kg BW and 4 kg/h/d for above 100 kg BW and Amul's Chelated Mineral Mixture @ 35 g/animal/d. Higher body weight gain (BWG) was observed in 40% DDGS and legume straw fed groups as compared to 40% soy DOC and cereal straw fed groups. The average Hb, and PCV were significantly ($p<0.05$) higher, while WBCs and platelets were lower in T2 group heifers fed concentrate with 20% soya DOC + 20% RDDGS, irrespective of roughage, as compared to 40% soya DOC (T1) and 40% RDDGS (T3), and there was no significant effect on RBCs, granulocytes, lymphocytes and monocytes. When concentrate source was ignored, only the platelet count was significantly higher in R2 group fed a mixture of legume-nonlegume than R1 group fed only the wheat straw in TMR. There was significant ($p<0.05$) interaction between concentrate and roughage source on WBC count. Lowest WBC ($10^3/\mu L$) count was found in T1R1 and highest in T1R2 group crossbred heifers. The effect of period x treatment was significant particularly on WBCs, granulocytes and monocytes for first 3-4 months of feeding, perhaps due to adaptive effect of solvent present in RDDGS. Overall the average haematological profile in experimental heifers was close to the reference range for healthy bovine. So it can be concluded that feeding DDGS in place of soy DOC in concentrate and feeding a mixture of groundnut gotar and wheat straw to growing crossbred heifers from 8 months till puberty/19 months improves growth rate without adverse effect on the health and haematological profile.

Key words: Crossbred heifers, DDGS, Growth performance, Haematology, Legume-nonlegume roughage, Soy DOC.

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Introduction

In raising livestock, feed alone constitutes the single largest expenditure to at least 60% of the total expenditure of the farm (Chatterjee *et al*., 2016). The hike in prices, limited supply of feed and reducing land under fodder production are important constrains in livestock productivity in the present scenario. One of the main reasons for lower productivity is inadequate and unbalanced feeding. The cost of conventional protein sources such as soybean cake and groundnut cake is high and affected by seasonal variation in availability; hence an investigation on alternate feed resources has received considerable importance.

Distillers dried grains with soluble (DDGS) is one of the residual coproduced of ethanol production from the grain after fermentation (Youssef *et al*., 2013) and is rich in protein, fat, fibre, vitamins and minerals. DDGS product obtained from rice distillery is called RDDGS, which contains approximately 3-fold higher nutrients (NRC, 1994). The presence of dead yeast cells gives the protein better amino acids composition and very good nutritive value (Pecka-Kiełb *et al*., 2017).

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Intensification of ethanol industry has increased availability of DDGS and its use as animal feed. It has potential to replace conventional protein sources and generating favourable economic output. Protein is extremely important in the diet of growing heifers to ensure adequate body size. DDGS can be added to the ration of growing heifers at a level up to 40% of dry matter intake to achieve an improved growth rate and feed conversion (Kalscheur and Garcia, 2004).

The legume straws contain more crude protein (40-100%), larger energy and lesser cell wall content, and are nutritionally better than cereal straws, thus have overall better nutritive value (Mahesh and Mohini, 2014). Leguminous crop residues have a positive effect on growth rate and fibre digestion. Feeding of concentrates could be saved by feeding legume straw in comparison to cereal straw feeding (Shelke *et al.*, 2014). Only few researches have been conducted on feeding alternate protein sources to replacement heifers. Hence, this study was planned on growing crossbred heifers to study the effect of feeding DDGS, soya DOC and roughage on growth, health and haematogical profile of crossbred heifers.

Materials and Methods

This work was carried out on 24 HF × Kankrej crossbred heifers of average 8 months of initial age till 19 months of age at LRS, Anand Agricultural University, Anand (Gujarat, India). Selected heifers were divided randomly on the basis of body weight and age into following six isometric groups (3 concentrate, 2 roughage; 4 animals/replicates in each) under factorial RBD and were fed accordingly with 50% concentrate and 50% roughage as TMR for 10-12 months, *i.e.*, till all heifers evinced puberty, and then were followed till all conceived.

Concentrate (50%)	Roughage (50%)
T1: 60% Amul Dan + 40% Soy DOC	R1, 50% Cereal straw
	R2, 25% each Cereal & Legume straw
T2: 60% Amul Dan +20% Soy DOC + 20 % rice DDGS	R1, 50% Cereal straw
	R2, 25% each Cereal & Legume straw
T3: 60% Amul Dan + 40% rice DDGS	R1, 50% Cereal straw
	R2, 25% each Cereal & Legume straw

Heifers were also offered green hybrid Napier @ 2 kg/h/d up to 100 kg BW and 4 kg/h/d for above 100 kg BW and Amul's Chelated Mineral Mixture @ 35 g/animal/d. The protein requirement was met as per the ICAR (2013) feeding standard. Heifers were offered measured extra wheat straw if no leftover was observed from next day.

All the experimental animals were de-wormed and kept tied under iso-managerial conditions in well ventilated hygienic shed and fed individually. The animals were left loose for 2 h each in the morning and evening, and were closely observed for heat/estrus signs. Known quantity of ration as TMR, and wholesome drinking water were provided to the animals 3-4 times a day. Representative samples of individual feed ingredient, concentrate mixtures and TMR offered were analyzed for proximate principle as per AOAC (2000). The rice DDGs and Soy DOC had very high CP (43-44%) and low CF (2-9%) over other feeds. Moreover, concentrate containing 40% RDDGS had 3-fold higher ether extract and 15% lower CF than the feed containing 40% Soy DOC (Dhami *et al.*, 2021). The proximate composition of six TMR used was as shown in Table 1.

Table 1: Proximate composition of different TMR offered to heifers (% DM basis)

Particulars	TMR-1	TMR-2	TMR-3	TMR-4	TMR-5	TMR-6
OM	86.94	88.38	87.73	88.76	88.58	89.38
CP	15.46	17.35	15.68	17.72	15.86	17.85
EE	2.52	2.18	3.23	2.86	3.71	3.54
CF	25.90	23.48	24.86	22.43	24.68	22.36
Ash	13.06	11.69	12.27	11.24	11.42	10.62
NFE	43.06	45.30	43.96	45.75	44.33	45.63

The general health and behaviour of all animals was observed regularly. Body weight (kg) was taken on digital platform and blood sampling was done for all animals at monthly interval. The haematological profile was determined on auto-blood analyzser (Mindray, China). The data were analyzed using factorial RBD and CD tests on SPSS software (Snedecor and Cochran, 1994).

Results and Discussion

The findings on body weight and haematological profile are presented in Tables 2, 3 and Figure 1.

Body Weight (kg)

The initial and final body weights of heifers at 8 and 19 months of age were 116.13±4.56 and 354.16±5.98 kg, respectively. The effect of concentrate as well as rough source significantly influenced the body weight of experimental crossbred heifers. Average body weight of heifers recorded during the study period was significantly higher in 40% RDDGS fed group (T3, 236.03±8.19 kg) and also in legume-cereal mixed roughage (R2, 235.63±6.56 kg) group as compared to other contemporary groups (Table 2, Fig. 1). Monthly gain in body weight was also correspondingly better in these groups. Eun *et al.* (2009) also reported significant ($p<0.05$) improvement in body weight of steer fed corn-DDGS during the growing phase. Dey *et al.* (2019) observed a non-significant but linear increase in body weight when crossbred calves were fed a diet replacing soybean meal with 0, 20 and 40% of DDGS on DM basis. Manthey *et al.* (2016) in dairy heifers and Huang *et al.* (2020) in water buffaloes however reported no change in body weight on feeding DDGS. Increase in body weight of crossbred heifers that received a mixture of wheat straw and groundnut gotar (R2) was in agreement with the findings of Misal (2017) in Gaolao heifers and Mahalle *et al.* (2019) in Sahiwal heifers. Further, Desai (2020) observed significant ($p<0.05$) improvement in body weight, when crossbred calves

Table 2: Average body weight and haematological profile of crossbred heifers fed soy DOC, rice DDGS and legume, non-legume straws from 8 months to 19 months of age

Particulars	Group						Overall	
	T1		T2		T3		R1	R2
	R1	R2	R1	R2	R1	R2		
B. Weight (kg)	218.63 ±10.18	231.77 ±11.44	225.16 ±10.44	233.46 ±11.72	233.43 ±11.45	238.64 ±11.81	225.74X ±6.16	235.63Y ±6.56
	225.20A ±7.65		229.31AB ±7.78		236.03B ±8.19		230.54 ±4.54	
RBCs (x10^6^/ μL)	8.10 ±0.10	8.21 ±0.16	8.30 ±0.12	8.38 ±0.15	8.43 ±0.10	7.79 ±0.11	8.28 ±0.06	8.15 ±0.08
	8.15AB ±0.09		8.38A ±0.08		8.11B ±0.08		8.22 ±0.05	
Hb (g/dL)	9.39 ±0.19	9.25 ±0.21	9.78 ±0.22	9.52 ±0.20	9.30 ±0.21	9.00 ±0.21	9.49 ±0.12	9.26 ±0.16
	9.32BC ±0.14		9.65A ±0.15		9.15C ±0.15		9.37 ±0.09	
PCV (%)	32.37 ±0.55	32.79 ±0.61	33.90 ±0.53	32.17 ±0.72	31.40 ±0.51	31.30 ±0.45	32.56 ±0.32	32.23 ±0.31
	32.58AB ±0.41		33.26A ±0.37		31.35B ±0.34		32.10 ±0.22	
Platelet (10^3/μL)	519.08 ±18.22	517.44 ±22.39	489.54 ±23.32	457.17 ±21.14	467.56 ±21.66	507.46 ±18.94	492.06 ±12.27	498.58 ±11.71
	518.26A ±14.36		480.19B ±15.08		487.51B ±14.45		495.32 ±8.48	
WBCs (x10^3/μL)	10.41 ±0.22	11.19 ±0.24	11.44 ±0.24	10.66 ±0.44	11.14 ±0.16	11.15 ±0.20	11.00 ±0.12	10.88 ±0.13
	10.80B ±0.17		10.86B ±0.16		11.15A ±0.13		10.94 ±0.09	
Granulocytes (%)	36.50 ±0.82	36.67 ±0.73	34.04 ±0.72	35.47 ±0.86	36.17 ±0.82	36.31 ±0.69	35.57 ±0.46	36.06 ±0.42
	36.59 ±0.55		34.62 ±0.53		36.24 ±0.53		35.82 ±0.31	
Lymphocytes (%)	56.10 ±0.84	56.38 ±0.79	58.31 ±0.79	57.07 ±1.32	56.60 ±0.80	56.36 ±0.80	57.00 ±0.47	56.90 ±0.48
	56.23 ±0.57		58.13 ±0.60		56.48 ±0.56		56.95 ±0.34	
Monocytes (%)	7.04 ±0.24	6.93 ±0.22	7.59 ±0.21	7.80 ±0.72	7.07 ±0.22	7.43 ±0.23	7.23 ±0.13	7.15 ±0.13
	6.98B ±0.16		7.64A ±0.15		7.25AB ±0.16		7.19 ±0.09	

Means with different superscripts in a row differ significantly for concentrate (A, B) and for roughage (a,b) source (p<0.05).

were offered a mixture of wheat and soybean straw over jowar hay. This is attributed to higher availability of quality proteins from DDGS and legumes for muscle mass built up.

Haematology:

Haematological findings revealed age related changes in all groups, with drop in most values around 11-14 months of age. The higher WBCs and platelets count observed during first 2-4 months of experiment might be an adaptive response to DDGS solvent. All the haematological parameters improved after 15 months of age with adaptation to the DDGS diet and were within normal limit.

Red Blood Cell Count (10^6/μL)

Average RBC count (10^6/μL) of T2 group heifers (20% each DDGS and soy DOC) was significantly ($p<0.05$) higher than T1 (40% soy DOC) and T3 (40% DDGS) group heifers. When concentrate source was kept aside, RBC counts (10^6/μL) of heifers that received a mixture of wheat straw and groundnut gotar (R2) and heifers that received only wheat straw (R1) were statistically similar (8.28±0.06 vs. 8.15±0.08). The interaction between concentrate and roughage source on RBC count was found to be significant. The average RBC count (10^6/μL) was highest in T2R2 group heifers (8.32±0.13) and lowest in T3R2 heifers (7.43±0.07). RBC count of crossbred heifers was within the normal range, as depicted in Merck's Veterinary Manual as well as reported by Kraft and Durr (2005), *i.e.*, 5-10×10^6/μL for cattle.

RBC counts of Hariana, Frieswal and Manipuri heifers reported by Mahima *et al*. (2013), Mayengbam (2014) and Mili *et al*. (2020) were lower than average RBC counts of crossbred heifers observed in the present study. While, Aggarwal *et al*. (2016) reported a higher average RBC count of Karan-fries heifers during different seasons ranging from 8.41±0.08 to 9.22±0.09 x10^6/μL.

Haemoglobin (g/dL) and Packed Cell Volume (%)

When roughage source was ignored, there was a significant ($p<0.05$) difference in Hb and PCV concentrations among treatment groups. But the change in values was non-linear; replacing half soya DOC with DDGS resulted in a significant ($p<0.05$) increase in Hb and PCV, and on full replacement there was a significant decrease in both Hb and PCV concentrations. When concentrate source was ignored, average Hb (g/dL) in R1 and R2 group heifers was found to be 9.49±0.12 and 9.26±0.16, and PCV (%) 32.56±0.32 and 32.23±0.31, respectively, which did not differ significantly.

Table 3: Overall monthly mean (±SE) body weight and haematological profile of experimental HF x K heifers under experiment from 8 months to 19 months of age

Parameters	Age in months												
	8.0	**9.0**	**10.0**	**11.0**	**12.0**	**13.0**	**14.0**	**15.0**	**16.0**	**17.0**	**18.0**	**19.0**	**Overall**
B. Weight (kg)	116.13 ±4.56	139.07 ±5.00	164.09 ±5.17	181.59 ±5.58	199.28 ±5.61	219.64 ±5.58	239.47 ±5.48	243.97 ±4.75	271.98 ±5.22	299.80 ±5.49	334.60 ±5.96	354.16 ±5.98	232.51 ±3.52
RBCs ($x10^6$/µL)	8.43 ±0.17	8.23 ±0.11	7.98 ±0.12	7.51 ±0.11	7.97 ±0.16	7.91 ±0.13	7.80 ±0.14	8.03 ±0.14	8.72 ±0.16	8.98 ±0.20	8.63 ±0.20	8.41 ±0.16	8.22 ±0.05
Hb (g/dL)	8.96 ±0.13	8.11 ±0.10	8.33 ±0.08	7.82 ±0.09	7.84 ±0.11	8.40 ±0.12	9.68 ±0.17	10.63 ±0.20	11.07 ±0.24	10.81 ±0.25	10.61 ±0.20	10.22 ±0.18	9.37 ±0.09
PCV (%)	26.93 ±0.45	30.94 ±0.38	31.13 ±0.33	29.47 ±0.39	30.58 ±0.42	31.26 ±0.38	33.50 ±0.82	34.64 ±0.64	35.68 ±0.61	35.52 ±0.79	35.10 ±0.65	34.02 ±0.49	32.10 ±0.22
Platelet (10^3/µL)	360.96 ±18.71	654.29 ±19.71	643.25 ±18.70	655.13 ±17.66	600.46 ±19.06	525.88 ±22.68	460.88 ±19.81	494.88 ±28.10	375.75 ±17.49	379.29 ±13.85	395.96 ±11.00	397.13 ±10.14	495.32 ±8.48
WBCs ($x10^3$/µL)	9.80 ±0.31	10.13 ±0.37	10.25 ±0.36	11.23 ±0.31	11.67 ±0.31	11.65 ±0.29	10.93 ±0.31	10.75 ±0.28	10.98 ±0.23	11.03 ±0.26	11.36 ±0.20	11.46 ±0.12	10.96 ±0.09
Granulocytes (%)	33.59 ±1.19	36.09 ±1.11	36.66 ±1.23	33.18 ±1.22	29.92 ±1.37	31.77 ±1.02	38.09 ±0.42	37.07 ±0.54	37.78 ±0.46	37.43 ±0.60	39.09 ±0.58	39.10 ±0.62	35.82 ±0.31
Lymphocytes (%)	60.45 ±1.21	57.40 ±1.06	57.61 ±1.30	59.73 ±1.11	64.04 ±1.26	61.87 ±1.02	53.74 ±0.48	54.22 ±0.51	53.87 ±0.49	54.47 ±0.53	53.34 ±0.68	52.64 ±0.60	56.95 ±0.34
Monocytes (%)	5.88 ±0.24	6.55 ±0.28	5.99 ±0.22	7.09 ±0.35	6.00 ±0.18	6.01 ±0.22	8.10 ±0.18	8.62 ±0.22	8.27 ±0.21	8.06 ±0.26	7.57 ±0.24	8.13 ±0.23	7.19 ±0.09

Period, Treatment and Period x Treatment effects were highly significant at P<0.01 on most of these parameters.

The average Hb and PVC of crossbred heifers were within the normal range reported for cattle (9-14 g/dL and 24-48%) by Kraft and Durr (2005), George *et al*. (2010), and Mayengbam (2014). Mahima *et al*. (2013), Aggarwal *et al*. (2016) and Mili *et al*. (2020) however reported higher Hb (13.15±0.77 g/dL), yet comparable PCV in different breeds of cattle. The reason for lower Hb in present study could be high RBC count of experimental heifers and lower oxygen demand of animals those adapted to low altitude region. Non-significant interaction between concentrate and roughage source on Hb (g/dL) was observed over the experimental period.

Platelets Count (10^3/µL)

Average platelet count (10^3/µL) of T1, T2 and T3 group heifers, ignoring roughage source, was observed to be 518.26±14.36, 480.19±15.08 and 487.51±14.45, respectively. The value was observed to be non-significantly higher in T1 group of heifers as compared to T2 and T3 groups. When concentrate source was ignored, average platelet counts (10^3/µL) of R1 and R2 group were 492.06±12.27 and 498.58±11.71, respectively. The platelet count was statistically similar in R1 and R2 groups. A significant interaction was found between concentrate and roughage source on platelet count of heifers. The highest and lowest platelet count was found in T3R2 and T3R1 group heifers, respectively.

Despite, significant ($p<0.05$) change in platelets count of heifers due to concentrate source, it is of low practical value as platelets counts were within normal reference range depicted in Merck's Veterinary Manual, *i.e.*, 100-800 $x10^3$/µL. The observed platelets count of heifers was also within normal reference range reported by Kraft and Durr (2005), and George *et al*. (2010), *i.e.*, 300-800 and 193-637 $x10^3$/µL, respectively, for healthy cattle.

White Blood Cells (10^3/µL)

Average WBC (10^3/µL) on ignoring roughage source in T1, T2 and T3 group heifers, was observed to be 10.80±0.17, 10.86±0.16 and 11.15±0.13, respectively. There was significant ($p<0.05$) change in WBC count with increasing RDDGS in concentrate. The average WBC (10^3/µL) of R1 and R2 group heifers, on ignoring concentrate source, was observed to be 11.00±0.12 and 10.88±0.13, respectively. It was statistically similar between R1 and R2 group heifers. There was significant ($p<0.05$) interaction between concentrate and roughage source on WBC count of crossbred heifers. Lowest WBC count was found in T1R1 and highest in T1R2 group crossbred heifers.

Average WBC of experimental heifers was within the normal reference range depicted in Merck's Veterinary Manual, and as reported by George *et al*. (2010), *i.e.* 4.9-12 x103/µL for cattle. Aggarwal *et al*. (2016) also reported similar WBC count during hot humid conditions in growing Karan-fries cattle (11.13×10^3/µL). However, Mahima *et al*. (2013) in Hariana heifers reported lower (8.59±6.22) and Mili *et al*. (2020) in Manipuri cattle reported higher value (14.05±0.94) for WBCs (10^3/µL) than our finding.

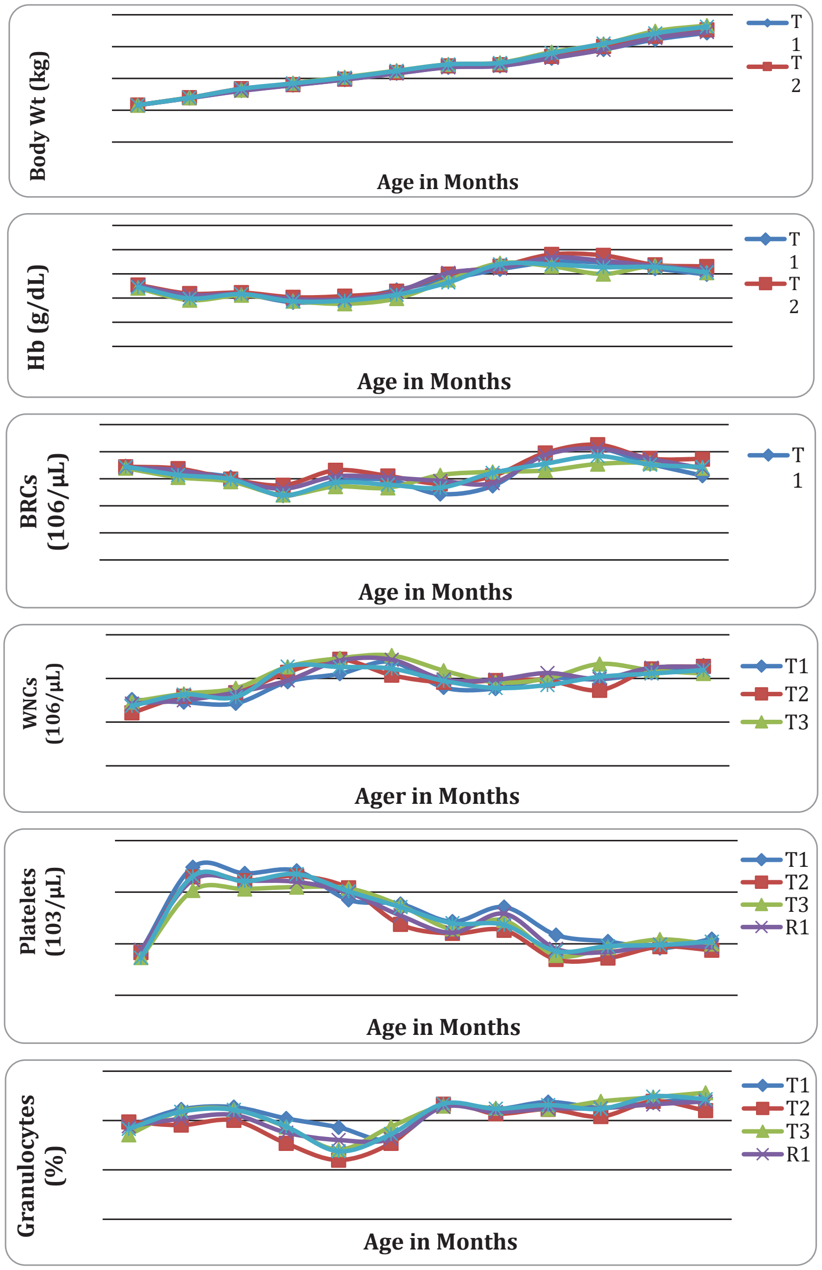

Fig. 1: Overall monthly effect of Concentrate (T) and Roughage (R) on body weight and various haematological parameters over the period of experiment in CB heifers

Differential Leucocytes Count (%)

There was a non-linear significant ($p<0.05$) change in percent granulocytes count, with inverse trend in percent lymphocytes count, for heifers of T1, T2 and T3 group on ignoring roughage source. However, the mean monocyte count (%) recorded was significantly ($P<0.05$) higher in T2 than T1, with value of T3 as intermediate. Keeping concentrate source aside, average values of all, granulocytes, lymphocytes and monocytes (%) were statistically similar between R1 and R2 group heifers. Interaction between concentrate and roughage source (T×R) on granulocytes and lymphocytes counts was found to be significant. The highest granulocytes and lowest lymphocytes percent was observed in T3R1, and lowest granulocytes with highest lymphocytes percent in T2R1 group heifers, however no such interaction was noted for monocytes count.

Average differential leucocytes counts particularly granulocytes and lymphocytes observed in crossbred heifers were within reference range reported in Merck's Veterinary Manual, and by Kraft and Durr (2005) and George *et al.* (2010), however monocytes count of experimental heifers was close to the upper limit of reference range (*i.e.* 2-7%) for healthy cattle. Moreover, granulocytes percent was lower and lymphocytes percent higher as compared to the values reported by Mahima *et al.* (2013) and Mayengbam (2014), while inverse trend was reported by Mili *et al*. (2020). Further, Kraft and Durr (2005), Mahima *et al*. (2013) and Mili *et al*. (2020) reported a lower normal reference range for monocytes count in cattle than the present findings with RDDGS feeding.

Conclusions

The findings of the present study in HF x K heifers (n=24), from 8 months to 19 months of age, showed age related changes in body weight and all haematological parameters with drop in most values around 12-14 months of age in all groups fed graded soy DOC and rice DDGS with legume-nonlegume straws. Body weight gain was significantly higher in 40% DDGS and legume straw fed groups as compared to 40% soy DOC and cereal straw fed groups. The Hb, PCV were significantly higher with lower platelets and granulocytes in group fed 20% each soy DOC and rice DDGS. The higher WBCs and platelets count during first 2-4 months of experiment observed might be an adaptive response to DDGS solvent. All the haematological parameters improved after 15 months of age and were within normal limit. The study concludes that rice DDGS @ 40% in concentrate can be fed with or without legume straw to improve gain in body weight without adverse effect on health and haematology of growing crossbred heifers.

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