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Research Article

Effect of dietary inclusion of spent grains on the performance of growing buffalo calves

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Abstract

A study of four-month duration was carried out to assess the effect of including spent grains in the diets of growing buffalo calves on their performance. Eighteen Murrah buffalo calves of similar body weight and age were selected and distributed randomly into three groups *viz*. CON (control), SG25 and SG50. Nutrient requirement of calves was met (as per ICAR, 2013) with wheat straw, oat green fodder and concentrate mixture. Concentrate mixture fed to CON group comprised of maize (35 parts), barley (22 parts), GNC (25 parts), mustard cake (15 parts), mineral mixture (2 parts) and common salt (1 part). 25% and 50% CP of CON concentrate mixture was replaced with CP of spent grain to prepare concentrate mixture for SG25 and SG50, respectively. Feed intake, BW, ADG and relative change in body measurements in SG25 and SG50 were at par (P>0.05) with CON. Although feed intake and ADG in SG50 were less than SG25, difference was non-significant. DMI, DCP intake and TDN intake remained unaffected by diets. Digestibility of nutrients was not affected (P>0.05) by spent grains, but it was numerically lower in SG50 as compared to CON and SG25. Feeding spent grains did not influence (P>0.05) the serum biochemical profile of calves. A net saving of Rs. 0.47 and Rs. 1.38 per kg gain of body weight was reported in SG25 and SG50, respectively. It was concluded that 25% CP of calves' concentrate mixture could be replaced with spent grains' protein, while higher replacement level needs more investigations.

Keywords: Blood biochemical, Buffalo calves, Nutrient utilization, Performance, Spent grains

Highlights

- Spent grains contain a good percentage of protein, fibre, phenolic compounds and micronutrients.
- About 25% of the crude protein in the concentrate mixture fed to growing buffalo calves can be spared by spent grains without any adverse effect on the feed intake, BWG, nutrient intake, nutrient digestibility and nutritive value of the ration.
- Spent grains, a major by-product of malt industries, can be included in the feed of ruminants.

INTRODUCTION

India is predominantly an agricultural country with a huge livestock population. However, undernutrition in animals is the key reason for the low productivity of livestock in the country. Due to industrialization and urbanization, the cultivable land is shrinking, leading to widening of the gap between demand and supply of feeds and fodders. Therefore, non-conventional agro-industrial by-products need to be explored and used for animal feeding. Spent grains are the major co-product of the malt industries left after separation of malt-extract, which is used as functional ingredients in food industries and health supplements as nutraceuticals. It constitutes about 85 percent of total brewery waste (Mussatto, 2014). Spent grains can be fed to the ruminants, as they are able to utilize a good portion of the nutrients from spent grains (Colby, 2016). Protein and high fibre concentration of spent grains support the ruminal function. Fresh spent grains have high moisture content ranging between 75% and 85%. While the remaining solid matter is comprised of fibre, protein and other associated organic matter (Ikram *et al*., 2017). The fibre includes the husk, pericarp, and seed coat of the malted kernels. This fibre is digestible by

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ruminants. Spent grains contain around 20-30% protein of their dry weight. Although some soluble protein is leached and drained during the malting process, insoluble and some residual soluble proteins are left (Jaeger *et al*., 2023). A small amount of simple sugar e.g., maltose and crude fat remains in spent grain. Spent grain also contains a number of minor components including vitamins and minerals, essential amino acids and non-essential amino acids (Farcas *et al*., 2014). The spent grains are also considered a rich source of phenolic compounds such as hydroxycinnamic acids (benzoic acid, ferulic, p-coumaric and caffeic acids), flavonoids, pro-anthocyanidins, tannins, and amino phenolic compounds (Martín-García *et al*., 2020; Alonso-Riaño *et al*., 2021), which have many biofunctions like anti-oxidant, anti-carcinogenic and anti-inflammatory activities (McCarthy *et al*., 2013). Majority of the studies conducted so far are on the application of spent grains either in beef or dairy cattle ration. Therefore, based on the above facts about spent grains, the current study was planned to explore the inclusion of malt-spent grains in the dietary regimen of growing buffalo calves.

MATERIALS AND METHODS

Feeding experiment on growing Murrah buffalo calves was carried out at the Buffalo farm of the Department of Livestock Production Management, and laboratory work for processing and analysis of feed, fodder and faecal samples was performed in the Department of Animal Nutrition, LUVAS, Hisar. The experiment was undertaken after due approval from the Institutional Animal Ethics Committee (IAEC, LUVAS).

Eighteen Murrah buffalo calves with an average body weight of 160.11±12.98 kg and 16.00±0.78 months of age were assigned randomly to three groups *viz*. CON (control), SG25 and SG50. Experimental feeding was carried out for a period of four months with roughages (wheat straw and oat green fodder) and concentrate parts in a ratio of 60:40. A total mixed ration containing wheat straw, green fodder and concentrate ingredients was prepared as the calculated nutrient requirements of calves according to ICAR (2013) feeding standards. Calves in CON group were offered concentrate mixture which comprised of maize (35 parts), barley (22 parts), groundnut cake (GNC: 25parts), mustard cake (15 parts), mineral mixture (2 parts) and common salt (1 part). The mineral mixture contained 16% calcium, 9% phosphorus, 4% magnesium, 1.4% sulphur, 0.64% zinc, 0.02% iodine, 0.07% copper, 0.1% manganese and 0.009% cobalt. Crude protein (CP) content of CON concentrate mixture and spent grains was 21.78% and 21.52%, respectively. The concentrate mixture of group SG25 and SG50 was prepared by replacement of 25% and 50% of the protein of CON concentrate mixture with that of spent grains, respectively. Since the CP level of CON concentrate mixture and the spent grain was almost similar, the SG25 and SG50 concentrate mixture composed of 75:25 and 50:50 of CON concentrate mixture and spent grain, respectively.

Feed intake was recorded at each fortnight interval to detect palatability issues related to spent grains, if any, at early stage and body weight was recorded at monthly intervals for two consecutive days to find out the feed intake and body weight gain (BWG) during different progressive period of experiment. To determine dry matter intake (DMI), nutrient digestibility and nutritive value, a digestion trial was conducted during the last month of experiment for 7 days including 2 days of adoption and 5 days of collection. The representative samples of feed offered, residue left and faeces voided were preserved and analysed for proximate composition (AOAC, 2005) and fibre fraction (Van Soest *et al*., 1991).

Statistical analysis: Data was recorded in mean ± S.E. of six replicates. Analysis of variance (ANOVA) was used to calculate the SEM of all the observations. Significant differences between means of the observations of different groups were determined using Duncan test at a level of significance of $p< 0.05$.

RESULTS

The chemical composition of sun-dried spent grains, wheat straw, oat green fodder and different concentrate mixtures are given in Table 1. Moisture content of the fresh spent grains was 82.03%, which were sun dried with intermittent raking to a moisture content of 11.70% before storage and start of experiment. The rate of fresh spent grains was Rs. 4.50 per kg (equivalent to Rs. 22.11/kg of sun-dried spent grains). Sun-dried spent grains had 21.52% CP; 2.75% EE; 7.74% CF; 5.10% total ash; 23.75 NDF and 8.22% ADF. Crude protein content of concentrate mixture of CON, SG25 and SG50 was 21.78, 20.83 and 21.70%, respectively. The prevailing market price of wheat straw and green fodder was Rs. 4.00 and 2.50 per kg, while the price of concentrate mixture of CON, SG25 and SG50 came out to be Rs. 24.32, 23.98 and 23.26 per kg, respectively.

Feed intake, body weight gain, average daily gain and relative change in the body measurements (Table 2) were not affected due to replacement of conventional protein in the concentrate mixture of growing calves up to 50% with spent grains. Although statistically non-significant, there was a tendency for reduced feed intake and average daily gain (ADG) in T_3 as compared to T_2. Relative change in the various body measurements remained similar among different treatment groups.

Table 3 shows the nutrient intake, nutrient digestibility and nutritive value of different rations. Nutrient intake in terms of DMI (kg/d or % BW), DCP intake (g/d) and TDN intake (kg/d) remained unaffected among the different dietary treatment groups. Nutrient digestibility was not affected by the different dietary treatment types, but the digestibility of nutrients was numerically lower in T_3 as compared to T_1 and T_2. DCP and TDN percentage of different rations were 9.62, 9.28 & 8.94; 59.43, 58.92 & 58.40, respectively, reflecting that the spent grains did not affect the nutritive value of the rations. Serum biochemical parameters (Table 4) of the calves given different dietary treatments was not altered and were within normal range.

The total cost of feeding (Rs.) for the entire feeding trial was least in T_3 (8275.20) followed by T_2 (8643.60) and T_3 (8745.60) (Table 5). The cost of feed per kg body weight gain was Rs. 147.40, 146.93 and 146.02 in T_1, T_2 and T_3, respectively. There was a net saving of Rs. 0.47 and 1.38 per kg of body weight gain by replacing 25% and 50% crude protein of concentrate mixture with that of spent grains, respectively.

Table 1. Chemical composition of different feed ingredients and concentrate mixtures*

Parameter (%)	Sun dried spent grains	CON	SG25	SG50	Oat greens	Wheat straw
Dry matter	88.30	90.06	89.62	89.73	22.95	88.54
		(%DMB)				
Organic matter	94.90	90.97	90.00	90.44	88.80	91.90
Crude protein	21.52	21.78	20.83	21.70	11.02	3.03
Ether extract	2.75	4.20	3.40	3.00	2.50	1.21
Crude fibre	7.74	9.50	10.50	10.00	30.03	35.68
Total ash	5.10	9.03	10.00	9.56	11.20	8.10
Nitrogen free extract	64.99	55.49	55.27	55.74	45.25	51.98
Neutral detergent fibre	23.75	16.75	17.11	16.84	56.53	74.10
Acid detergent fibre	8.22	9.10	8.76	9.06	34.87	48.65

* Each value represents the mean of three observations

Table 2. Feed intake (DMI, kg/day), body weight gain and change in body measurement parameters of calves under different groups

Months	CON	SG25	SG50
Feed intake (kg/day)			
I	4.231±0.03	4.219±0.02	4.202±0.02
II	4.675±0.05	4.653±0.02	4.609±0.01
III	5.157±0.03	5.130±0.02	5.060±0.04
IV	5.431±0.01	5.412±0.01	5.342±0.05
Overall mean	4.809±0.05	4.783±0.07	4.717±0.08
Body weight, kg			
Initial	160.17±13.66	160.00±12.04	160.17±13.24
I	176.17±14.69	179.67±12.012	175.67±14.08
II	190.50±14.56	192.67±14.27	190.17±13.53
III	207.50±15.54	212.00±15.90	206.17±13.17
IV	219.50±16.40	218.83±16.29	216.83±13.21
Total gain, kg	59.33±2.97	58.83±4.61	56.67±2.35
ADG, kg	0.494±0.03	0.490±0.04	0.472±0.02
Relative change in body measurement parameters			
Height	1.99±0.11	2.02±0.09	1.99±0.11
Heart girth	3.76±0.32	3.90±0.24	3.70±0.25
Abdominal girth	4.28±0.32	4.44±0.27	4.20±0.27
Length	1.86±0.12	1.84±0.08	1.81±0.12

Table 3. Nutrient intake, nutrient digestibility and nutritive value of rations fed to calves

Attributes	CON	SG25	SG50
Nutrient intake			
DMI, kg/d	5.417±0.15	5.355±0.13	5.126±0.12
DMI, %BW	2.56±0.26	2.53±0.22	2.46±0.20
DCPI, g/d	519±18	495±31	458±27
TDNI, kg/d	3.221±0.10	3.155±0.09	2.992±0.06
Nutrient digestibility (%)			
Dry matter	61.61±0.90	61.32±0.50	59.50±1.22
Organic matter	61.81±0.80	60.70±1.43	60.97±0.56
Crude protein	71.37±0.63	70.73±0.77	69.35±0.59
Ether extract	69.64±0.42	70.60±0.58	69.12±0.51
Crude fibre	52.17±0.81	52.35±1.47	51.98±0.72
Nitrogen free extract	70.43±0.96	70.16±0.73	69.76±0.93
Neutral detergent fibre	60.37±0.64	59.94±0.52	59.93±0.83
Acid detergent fibre	48.07±1.12	47.85±0.67	47.05±1.70
Nutritive value			
CP% TMR	13.47±0.58	13.12±0.92	12.89±0.65
DCP%, TMR	9.62±0.44	9.28±0.67	8.94±0.48
TDN%, TMR	59.43±0.43	58.92±0.83	58.40±0.52

Table 4. Serum biochemical parameters of calves under different treatment groups

Attributes	CON	SG25	SG50
Glucose, mg/dL	44.66±3.72	45.10±3.46	45.6±3.68
Triglycerides mg/dL	79.16±10.83	81.67±9.60	83±4.25
Total cholesterol mg/dL	69.83±3.26	70.50±3.630	68.83±4.26
HDL mg/dL	40.9±3.73	41.95±2.82	40.51±3.88
LDL mg/dL	10.73±1.92	12.13±1.12	11.73±1.42
Serum total protein g/dL	6.64±0.61	6.93±0.64	6.37±0.69
SGPT, IU/L	61.83±4.68	61.88±7.64	63.65±3.87
SGOT, IU/L	133.66±4.36	136.52±8.49	134.43±4.90

Table 5. Economics of feeding spent grains in growing buffalo calves

Attributes	CON	SG25	SG50
Average DMI/d from dry roughage, kg	1.667	1.650	1.643
Average DMI/d from green fodder, kg	1.210	1.213	1.208
Average DMI/d from concentre, kg	1.932	1.920	1.866
Average total DMI/d, kg	4.809	4.783	4.717
Average daily gain, kg	0.494	0.490	0.472
Feed conversion ratio (FCR)	9.73	9.76	9.99
Feed conversion efficiency (FCE)	0.103	0.102	0.100
Cost of feeding, Rs./d	72.88	72.03	68.96
Total feed cost (120 days)	8745.60	8643.60	8275.20
Feed cost, Rs./kg gain	147.40	146.93	146.02
Net saving, Rs./kg gain	—	0.47	1.38

DISCUSSION

The results revealed that fresh spent grains have very high moisture levels and therefore need to be dried below a moisture content of 12% for safe storage and inclusion in animals' diet. As has already been reported by Wadhwa *et al*. (1995) and Wyss (1997) that spent grains contains 75-80% moisture and deteriorate rapidly due to the growth of microorganisms like bacteria, yeasts and fungi. Therefore, it is mandatory to use them as soon as possible after reception or dry to a minimum moisture level before utilization. This is an alternate source of cheaper agro-industrial by-product for ruminants packed with multi-nutrients (21.52% CP, 2.75% EE, 7.74% CF, 5.10% total ash and 23.75% NDF).

Literature related to the studies on use of spent grains for growing buffalo calves is scanty, but they have been widely studied in other species like poultry and pigs. In a study on pigs, Anne (2016) reported that inclusion of brewer-spent grains up to 50% in the diet of growing pigs had no negative effects on growth performance. Gebremedhn *et al.* (2019) found that 40% inclusion of brewery-spent grains in the diet of layers had no negative effects on production and quality of the eggs, and it was economically profitable.

Regarding the effects of including dietary spent grains, previous study by Faccenda *et al.* (2017) reported that DM and OM digestibility were linearly increased ($p<0.05$) with inclusion of dried brewery spent grains in lactating cattle. However, such effect was not observed in the present study. Although the spent grains'

ruminal degradability is lower, but statistically similar digestibly of spent grain-based rations might be due to high intestinal digestibility (Santos *et al*., 1984) that leads to a higher total digestibility. No effects on the serum biochemical parameters of the calves fed spent grains suggest that the ruminal fermentation dynamics remained largely unaffected on the spent grains-based diets.

The finding of the present study revealed that replacement of the crude protein in the concentrate mixture of the growing buffalo calves with spent grains to a level of 25% had no adverse effect on the feed intake, feed palatability, body weight gain, nutrient intake, nutrient digestibility and nutritive value of the ration. Although, replacement level of 50% crude protein of concentrate mixture with that of spent grain was best in terms of Rs./kg gain and net saving in the current study, but there was a tendency for reduced feed intake and weight gain in calves. Thus, it was inferred that spent grains could be incorporated in the rations of growing buffalo calves up to a replacement level of 25% crude protein of concentrate mixture in an economical way. In addition, for higher levels of spent grain inclusion (50% or above), further confirmatory studies are needed.

Conflict of interest: Authors have no conflict of interest in this study.

Author's contribution: SK: Designed the experiment and performed statistical analysis; SS and ZSS: Recorded data, analyzed the samples and helped in writing the manuscript.

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