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INFLUENCE OF SUBSTITUTING COTTONSEED CAKE WITH RAPESEED CAKE AND MAIZE GLUTEN FEED AS PROTEIN EQUIVALENT BASIS ON GROWTH RATE, DIGESTIBILITY AND ECONOMIC BENEFITS IN SAHIWAL CALVES

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ABSTRACT

The experiment was conducted to investigate the possibility of replacing cottonseed cake (CSC) with rapeseed cake (RSC) and maize gluten feed 30% (MGF) as protein equivalent basis in Sahiwal calves fed maize silage as basal diet. Twelve male calves (about 12-14 months old, and average body weight 110.5±9 kg) were randomly divided into I, II and III groups with 4 calves in each. Three iso-nutritious (CP 15% and TDN 72%) concentrates with CSC, RSC and MGF silage *ad-libitum* as basal diet. Results revealed non-significant difference (P>0.05) in total dry matter (DM) intake among the groups, however, daily weight gain (kg/head) by group III (0.78) was 18% and 23% higher (P<0.05) compared to group I (0.66) and II (0.63). Similarly, better feed conversion ratio was observed in group III (5.51) followed by group II (6.46) and I (6.53). The digestibility of DM, neutral detergent fibre and acid detergent fibre was alike among the groups whereas, CP digestibility and N retention was significantly (P<0.05) higher in group III compared to other groups. The economic benefits (ratio of output to input) was higher with MGF (1.29) followed by RSC (1.08) and CSC (1.00). These results suggest that MGF protein source is the best when compared with CSC or RSC on protein equivalent basis in terms of higher growth rate, nutrient digestibility and economic benefits in calves fed maize silage as basal diet.

Key words: Sahiwal calves, Growth rate, Nutrient digestibility, Plant protein sources.

INTRODUCTION

Growth rate of calf is influenced by many factors like genetics, health, age, breed, colostrum feeding, management and seasonal stress etc. To exploit optimum genetic potential and efficiency of production in calves, balance nutrition with adequate energy and protein levels and quality is utmost necessary. Usually high yielder dairy and fattening animals are provided forage-concentrate based diets that contribute 50-60% of total animal production cost (Anjum *et al*., 2012; Yildiz and Todorov, 2014). Therefore, cheaper feed resources with appropriate nutrients should be exploited to meet the nutritional demand of increasing trend of animal/calf fattening. In ruminant's diet plant protein sources are being used including oilseed cakes/meals, by-products of food production, and forage legumes etc. Their inclusion in fattening and dairy rations ranges from 15-20%. However, plant protein sources are more expensive than other ingredients of compound feed.

Traditionally cottonseed cake (CSC) is used as concentrate in the feed of ruminants. But due to fluctuation in supply and seasonal availability of CSC, its price becomes high compared to other oil seed cakes. Comparatively, rapeseed cake (RSC) is cheaper protein source with balanced amino acid composition (Robbelen *et al*., 1989) that can be included in ruminant's diet.

Recently, expansion of hybrid corn cultivation in Pakistan is resulting in increased production of it's by products like maize gluten feed 30% (MGF), obtained after maize wet milling process. It has high protein with methionine contents that complements other common protein sources (Anonymous, 2006).

The average approximate cost of one kilogram is Rs. 43 (1US$ = 106 Rupees) for CSC with 23% CP; Rs. 35.50 for RSC with 36% CP and Rs. 26 for MGF with 27% CP. The cost of one kg CP obtained from CSC, RSC and MGF is 186.96, 98.61 and 96.30 rupees, respectively. Due to vast price difference among protein sources, there is need to exploit suitable and cheaper protein source for optimum production and economic returns. Ludden *et al*. (1995) described that some protein sources showed better results than others in terms of better feed efficiency and digestibility when used in diets on protein equivalent basis. The present study was therefore, planned to investigate the possibility of replacing CSC with RSC or MGF on protein equivalent basis in the concentrate supplement on intake, growth rate, nutrient digestibility and economic benefits in Sahiwal calves fed maize silage as basal diet.

MATERIALS AND METHODS

Animals, Feed and Management: For experiment twelve growing male calves of Sahiwal cattle breed (about 12 to 14 months old, and average body weight 110.5±9 kg) taken from Livestock Research Station, National Agricultural Research Center, Islamabad were assigned to three groups I, II and III with 4 calves each followed completely randomized design. After de-worming, vaccination and acclimatization to new feed for a period of 10 days the calves were housed in individual tie stall in well ventilated, concrete floor and asbestos sheet roof shed. Daily sweeping and cleaning of floors with water was practiced to provide good hygienic environment. Fresh water was offered 2-3 times per day.

Three iso-nitrogenous (15% CP) and iso-caloric (72% TDN) concentrate supplements with cotton seed cake (CSC), rapeseed cake (RSC) and maize gluten feed 30% (MGF), on protein equivalent basis (as fed) were formulated (Table 1) and fed individually at 1.5% body weight of calves to group I, II and III, respectively. Maize silage was also offered *ad-libitum* to each calf as a basal diet.

Growth performance trial was conducted for 80 days (November, 2015 to January, 2016). Actual amount of supplement/maize silage offered and refusal by individual animal was recorded daily to obtain net feed intake. Growth rate was examined by weighing calves fortnightly with floor scale with two consecutive days. Feed conversion ratio (FCR) was calculated as kilograms of feed intake per kilogram of gain. Followed by feeding trial a five days nutrients digestibility and nitrogen balance trial was performed. Feed, orts, faeces and urine (10% of total) samples were collected daily, composited by animal, dried at 60°C in air forced oven, grinded and analyzed for DM, CP, CF, Ca and P according to AOAC (1990) methods. Cell wall fractionation (NDF, ADF) were determined with the ANKOM fibre analyzer using reagents described by Van Soest *et al*. (1991). Daily urine output was collected in plastic buckets which were acidified by daily addition of 30 ml 6 N H_2SO_4 to avoid N losses due to ammonia volatilization and to prevent bacterial growth. A representative sample (2%) was taken of each animal for N determination (AOAC, 1990) and N retention estimation.

Economic benefit: The economic return value, expressed as the ratio of output to input, is calculated based on feed price, calves body weight and growth performance as follows:

Output/input = (ADG×MPBW)/ (DMI×MPF)

Where ADG is the average daily gain (kg/head), MPBW is the average market price of body weight (Rs/kg), DMI is the daily DM intake (kg/head/d), and MPF is the market price of feeds (Xie *et al*., 2012).

Statistical analysis: The data were given as means ±SE. The data were statistically analyzed with the standard procedure of analysis of variance according to Completely Randomized Design as described by Steel *et al*. (1997) by using Minitab 15 software. Means were compared by Duncan's Multiple Rang Test at 5% level of probability.

RESULTS AND DISCUSSION

Growth performance of Sahiwal calves fed rations containing CSC, RSC and MGF as plant protein sources along with maize silage as basal diet is presented in Table 2. Average total DM intake in calves fed CSC, RSC and MGF was 4.31, 4.07 and 4.15 kg/day, respectively, but statistically the difference was not significant (P>0.05) among the groups. This indicates that when CSC was replaced with RSC or MGF on protein equivalent basis by inclusion of 21, 14 and 18% respectively, the palatability of ration was not affected for Sahiwal calves. These results are partially in agreement with Yildiz and Todorov (2014) who noticed same intake (1.10 vs 1.08 kg, respectively) in calves fed with or without RSM diets. Wahlberg (2009) reported that intake of DM did not influence by inclusion level of maize gluten feed even up to 50% of the ration. However, our results are contradicted with the work done by Hayaz-uddin *et al*. (2013) who observed 11% higher DM intake in Holstein Friesian cross bred cows fed total mix ration (TMR) having 35% CSC than TMR with 40% mustard seed cake. The difference in DM intake might be due to higher inclusion level (40%) of mustard seed cake compared to present study i.e., 14%.

The calves fed ration with MGF gained significantly (P<0.05) higher weights (0.78 kg/d) compared to those fed CSC (0.66 kg/d) and RSC (0.63 kg/d) based rations, but the difference between CSC and RSC was non-significant (P>0.05). Similarly, FCR was better (P<0.05) with MGF (5.51) while poorer with CSC (6.53), however, FCR of CSC based ration did not differ from RSC. Better daily weight gain and FCR in calves fed ration with MGF are might be due to higher content of ruminally un-degradable protein (RUP) in MGF as compared to CSC and RSC protein sources. Marghazani *et al*. (2013) reported RUP values of CSC, RSC and MGF as 40, 44 and 61%, respectively. Literature reported that protein sources with increased RUP are highly digestible in small intestine (Mirza *et al.,* 2004) and are essential for growing calves to meet their metabolizable protein requirements (NRC, 2001). The present findings are in line with those of Rehman *et al.* (2000) who reported non-significant difference (P>0.05) in DM intake but found higher (P<0.05) weight gain (0.76 vs. 65 kg/d) and better FCR (8.89 vs. 10.25) in Sahiwal calves fed TMR with 15% MGF+15% CSC than those fed 30% CSC. Similar results were previously documented by

Yunus *et al*. (2004) who reported higher weight gain and better feed efficiency in growing cattle and buffalo calves that were supplemented with plant protein sources having increased RUP values.

Average nutrient intake of DM, crude protein (CP), crude fiber (CF), neutral detergent fibre (NDF) and Acid detergent fibre (ADF) and their digestibility are presented in Table-3. Statistically, the differences in intake of nutrients were non-significant (P>0.05) among the groups. In the current study, Sahiwal calves consumed 1.09 to 1.25 liters of water for every one kg of DM intake that is lower as reported by Banerjee (1998), possibly due to seasonal effects as the digestibility trial was executed during January. Khan (2009) also suggested that water intake is influenced by seasonal effects, DM intake and sodium intake etc.

Except CP, the apparent digestibility of DM, NDF and ADF were alike among all groups, which was significantly (P<0.05) higher in MGF group possibly due to high RUP value as compared CSC and RSC groups but the difference between CSC and RSC was non-significant (P>0.05). Paengkoum *et al*. (2004) reported that CP digestibility increased linearly (P<0.05) as the level of RUP increased from 0 to 6% in Saanen goats diets. Nitrogen balance was positive for all calves; however, N retention whether expressed as grams per day or as a percentage of N intake was higher (P<0.05) in calves fed MGF compared to CSC and RSC. These results are also supported by Paengkoum *et al*. (2004); Bahrami *et al*. (2014) who reported higher N retention in goats and dairy cows supplemented with proteins having increased RUP values.

Economic benefits have been shown in Table 4. In this experiment, on DM basis, price of one kg of maize silage was Rs. 24.24 (1US$ = 106 Rupees), while concentrate consisting of CSC, RSC and MGF was Rs. 28.93, 26.07 and 25.12, respectively. Whereas, price of one kg live weight of animal was considered as Rs. 175. The feed cost per kg gain in calves of group III (Rs. 136.07) was 27% and 19% less than those of group I (Rs. 173.54) and II (Rs. 162.53), respectively. Therefore, economic benefits (ratio of output/input) with MGF based diet were higher compared to CSC and RSC diets, respectively (1.29 vs 1.00 vs. 1.08). The results of the current study were supported by Shi *et al*. (2014) who reported that profit returns were mainly relying on efficiency of feed utilization by animals and feed cost. Xie *et al*. (2012) and Mirza *et al*. (2004) suggested that economic returns can be obtained by comparing the cost of the supplements and basal feed with the value of the live body weight produced.

Table 1. Ingredients and chemical composition (%) of experimental diets.

Ingredients	Concentrate with plant protein sources*			Maize silage
	CSC	RSC	MGF	
Cottonseed cake	21	-	-	-
Rapeseed cake	-	14	-	-
Maize gluten feed 30%	-	-	18	
Maize grains	10	10	10	-
Rice polishing	26	28.25	25	-
Wheat bran	24.75	30	29	-
Molasses	15	15	15	-
Di-calcium phosphate	1	1	1	-
Limestone	0.5	0.5	0.5	-
Salt	0.5	0.5	0.5	-
Urea (feed grade)	0.75	0.25	0.5	-
Mineral pre-mix	0.5	0.5	0.5	-
Total	100	100	100	-
Chemical composition (% DM)				
Dry matter	91.04	90.89	90.20	33.00
Crude protein	15.20	15.15	15.08	8.90
Neutral detergent fibre	29.13	31.73	32.19	42.50
Acid detergent fibre	21.16	19.78	19.67	25.90
Total Digestible Nutrients**	71.88	72.22	72.17	-
pH	-	-	-	3.82

*Maize silage was offered *ad-libitum* as basal diet to all animals while concentrate containing cottonseed cake (CSC), rapeseed cake (RSC) and maize gluten feed 30% (MGF) was supplemented @ 1.5% body weight to group I, II and III, respectively.
** Calculated values.

Table 2. Growth performance of Sahiwal calves fed maize silage as basal diet supplemented with concentrate comprising plant protein sources during whole period of trial.

Parameters	Treatments*		
	I (CSC)	II (RSC)	III (MGF)
Number of calves	4	4	4
Average initial weight (kg/head)	112.0±4.1	109.5±3.5	110.0±3.4
Average final weight (kg/head)	164.8^{ab}±4.8	159.9^{b}±4.9	172.5^{a}±5.2
Average weight gain in 80 days (kg/head)	52.8^{b}±2.2	50.4^{b}±2.2	62.5^{a}±2.7
Average weight gain (kg/head/day)	0.66^{b}±0.04	0.63^{b}±0.04	0.78^{a}±0.05
Concentrate (DM) intake (kg/head/day)	2.15±0.15	2.05±0.11	2.17±0.16
Maize silage (DM) intake (kg/head/day)	2.16±0.15	2.02±0.10	2.13±0.13
Total DM intake (kg/head/day)	4.31±0.15	4.07±0.10	4.13±0.14
Feed conversion ratio (FCR)	6.53^{a}±0.44	6.46^{a}±0.42	5.51^{b}±0.37
Feed cost per kg gain, Pak Rs** (1US$ = 106 Rupees)	173.31	162.82	136.16

Values with different superscripts in the same row differ significantly ($p<0.05$)

*Maize silage was offered *ad-libitum* as basal diet to all animals while concentrate containing cottonseed cake (CSC), rapeseed cake (RSC) and maize gluten feed 30% (MGF) was supplemented @ 1.5% body weight to group I, II and III, respectively.

**On dry matter basis price of one kilogram of maize silage was Rs. 24.24 while concentrate consisting of CSC, RSC and MGF was Rs. 28.93, 26.07 and 25.12, respectively,

n=4 Sahiwal cattle calves per treatment.

Table 3. Nutrients intake, digestibility and nitrogen metabolism in Sahiwal calves fed maize silage as basal diet supplemented with concentrate comprising plant protein sources during last 5 days

Description	Treatments*		
	I (CSC)	II (RSC)	III (MGF)
Average daily intake (kg/day)			
Dry matter (last 5 days)	5.45±0.21	5.21±0.19	5.64±0.25
Crude protein	0.650±0.06	0.619±0.04	0.665±0.06
Neutral detergent fibre	1.59±0.11	1.65±0.10	1.82±0.14
Acid detergent fibre	1.15±0.10	1.03±0.07	1.11±0.09
Water intake (lit) per kg DM intake	1.25±0.11	1.09±0.10	1.15±0.10
Nutrients digestibility (%)			
Dry matter	64.88±1.69	64.23±1.75	65.48±1.89
Crude protein	69.80^{b}±1.80	70.13^{b}±1.83	74.08^{a}±1.93
Neutral detergent fibre	65.55±2.05	62.66±1.96	62.97±1.91
Acid detergent fibre	61.12±1.85	59.55±1.81	58.66±1.77
Nitrogen retention (g/day)			
Nitrogen intake	104.00±4.10	99.04±3.74	106.40±4.22
Nitrogen outgo (faeces+urine)	66.69±1.85	62.41±1.71	63.12±1.70
Nitrogen retention	38.31^{b}±1.25	36.63^{b}±1.22	43.28^{a}±1.34
Retention % of intake N	36.87^{b}±1.28	36.98^{b}±1.26	40.68^{a}±1.32

Values with different superscripts in the same row differ significantly ($p<0.05$)

*Maize silage was offered *ad-libitum* as basal diet to all animals while concentrate containing cottonseed cake (CSC), rapeseed cake (RSC) and maize gluten feed 30% (MGF) was supplemented @ 1.5% body weight to group I, II and III, respectively.

n=4 Sahiwal cattle calves per treatment.

Table 4. Economic analysis of experimental rations fed to Sahiwal calves during whole period of trial.

Description	Treatments*		
	I (CSC)	II (RSC)	III (MGF)
Dry matter intake (kg/head/day)			
Concentrate	2.15	2.05	2.17
Maize silage	2.16	2.02	2.13
Total	4.31	4.07	4.30
Cost of feed (Rs/day)** (1US$ = 106 Rupees)			
Concentrate	62.19	53.44	54.51
Maize silage	52.35	48.96	51.63
Total cost (Rs/head/day)	114.54	102.40	106.14
Average weight gain (kg/head/day)	0.66	0.63	0.78
Feed cost per kg gain (Rs.)	173.54	162.53	136.07
Economic benefits (output/input)	1.00	1.08	1.29

*Maize silage was offered *ad-libitum* as basal diet to all animals while concentrate containing maize gluten feed 30% (MGF), cottonseed cake (CSC) and rapeseed cake (RSC) was supplemented @ 1.5% body weight to group I, II and III, respectively.
**On dry matter basis price of one kilogram of maize silage was Rs. 24.24 while concentrate consisting of CSC, RSC and MGF was Rs. 28.93, 26.07 and 25.12, respectively, whereas price of one kilogram live weight of animal was considered to be Rs. 175.
n=4 Sahiwal cattle calves per treatment.

Recommendations: The present results may advocate that maize gluten feed 30% as protein source is the best when compared with cottonseed cake and rapeseed cake on protein equivalent basis in terms of higher growth rate, nutrient digestibility and economic benefits in Sahiwal calves fed maize silage as basal diet. However, cottonseed cake and rapeseed cake are comparable with each other for the same parameters.

REFERENCES

Anonymous. (2006). Corn wet milled feed products 4th Ed. Corn Refiners Association 1701-Pennsylvania Avenue, Washington D.C., USA.

AOAC. (1990). Official Methods of Analysis, 15th Ed. Association of Official Analytical Chemists, Washington, DC, USA.

Bahrami, Y.H., M. Khorvash, G.R. Ghorbani, M. Alikhani, R. Jahanian and E. Kamalian (2014). Effects of decreasing metabolizable protein and rumen un-degradable protein on milk production and composition and blood metabolites of Holstein dairy cows in early lactation. J. Dairy Sci. 97(6): 3707-14.

Banerjee, G.C. (1998). A Textbook of Animal Husbandry. 8th Ed. Oxford and IBH Pub. Co. Pvt. Ltd. New Delhi, India.

Hayaz-uddin, A. Rehman, R. Khan, B.D. Khan, D. Muhammad, K. Farid, K. Anwar, Sibghat-ullah and Z. Ali (2013). Effect of cottonseed cake on cattle milk yield and composition at livestock research and development station Surezai, Peshawar, Pakistan. Pakistan J. Nutr. 12(5): 468-475.

Khan, M.A. (2009). Buffalo: The animal of future. 1st Ed., Pub. Idara Matbuaat-e-Sulemani, Lahore, Pakistan.

Ludden, P.A., J.M. Jones, M.J. Cecava and K.S. Hendrix (1995). Supplemental protein sources for steers fed corn based diets: II. Growth and estimated metabolizable amino acids supply. J. Anim. Sci. 73:1476-1486.

Marghazani, I. B., M. A. Jabbar, T. N. Pasha and M. Abdullah (2013). Ruminal degradability characteristics in vegetable protein sources of Pakistan. The J. Anim. Plant Sci. 23(6): 1578-1582.

Mirza, I. H., M. I. Anjum, A.G. Khan and A. Azim (2004). Comparative evaluation of cotton seed meal and sunflower seed meal in urea molasses blocks versus commercial concentrate as supplement to basal ration of wheat straw with stall-fed buffalo calves. Asian-Aust. J. Anim. Sci. 17: 193-198.

NRC. (2001). Nutrient Requirements of Dairy Cattle. 7th Ed, National Research Council, National Academy Press, Washington, DC, USA.

Paengkoum, P., J.B. Liang, Z.A. Jelan and M. Basery (2004). Effects of ruminally un-degradable protein levels on nitrogen and phosphorus balance and their excretion in Saanan goats fed oil palm fronds. Songklanakarin J. Sci. Technol. 26(1): 15-22.

Rehman, A., Z. Rehman, I.U. Haq, M.Z. Karim and G.R. Khan (2000). Effect of corn gluten feed and cottonseed cake as protein supplements in feedlot fattening of male Sahiwal calves. Asian-Aus. J. Anim. Sci. 13 (Suppl.): 264-265.

Robbelen, G., R.K. Downey and A. Ashri (1998). Oil Crops of the World: Their Breeding and Utilization, McGraw Hill Pub. Co., New York, USA. pp: 339-362.

Shi, F.H., L. Fang, Q.X. Meng, H. Wu, J.P. Du, X.X. Xie, L.P. Ren, Z.M. Zhou and B. Zhou (2014). Effects of partial or total replacement of maize with alternative feed source on digestibility, growth performance, blood metabolites and economics in Limousin crossbred cattle. Asian-Aust. J. Anim. Sci. 27: 1443-1451.

Steel, R.G.R., J.H. Torrie and D.A. Dickey (1997). Principles and procedures of statistics. A biochemical approach 3rd. Ed. McGraw Hill Book Co. Inc. NY, USA.

Van Soest, P.J., H.B. Robertson and B.A. Lewis (1991). Methods of dietary fibre, NDF and non-starch polysaccharides in relation to animal material. J. Dairy Sci. 74: 3583-3595.

Wahlberg, M.L. (2009). Alternative feeds for beef cattle. Virginia Cooperative Extension. (http://pubs.ext.vt.edu/400/400-230_pdf.pdf)

Xie, X.X., Q.X. Meng, L.P. Ren, F.H. Shi and B. Zhou (2012). Effect of cattle breed on finishing performance, carcass characteristics and economic benefits under typical beef production system in China. Ital. J. Anim. Sci. 11e58: 312-316.

Yildiz, E. and N. Todorov (2014). The comparison of the main protein sources for dairy cows. A review. Bulgarian J. Agric. Sci. 20(2):428-446.

Yunus, A.W., A.G. Khan, Z. Alam, J.I. Sultan and M. Riaz (2004). Effect of substituting cottonseed meal with sunflower meal in rations for growing buffalo calves. Asian- Aust. J. Anim. Sci. 17: 659-662.