

Effects of Substituting Cottonseed Meal with Sunflower Meal in Rations for Growing Buffalo Calves

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ABSTRACT : A growth trial of 60 days with 16 male buffalo calves (10 to 11 months age; 100±7 kg live weight mean) was conducted to investigate comparative efficacy of cottonseed meal (CSM) and sunflower meal (SFM). Cottonseed meal was substituted isonitrogenously with SFM at 0, 12, 24 and 36% levels in four rations viz. A, B, C and D. Daily feed consumption was 5.07, 4.30, 4.17 and 3.20 kg, while daily weight gain was recorded to be 0.98, 0.74, 0.57 and 0.33 kg under rations A, B, C and D, respectively. In the digestibility and nitrogen balance trial using eight calves, digestibility of organic matter was 63.2, 62.9, 62.1 and 61.7, respectively. Nitrogen retained as percent of intake did not differ significantly. Sunflower meal was purchased at half the price of CSM but economics of weight gain did not favor SFM inclusion in rations. Results suggested that SFM should not be fed to buffalo calves gaining more than 0.7 kg/day. (*Asian-Aust. J. Anim. Sci.* 2004, Vol 17, No. 5 : 659-662)

Key Words : Sunflower Meal, Buffalo Calves, Weight Gain, Digestibility, Nitrogen Balance

INTRODUCTION

Sunflower (*Helianthus annuus*) is one of the four major annual crops in the world grown for edible oil. Pakistan started research and development for sunflower production in early 1960's (NODP, 1995). However, during 1990's it was grown in increasing quantities in the country. Area under cultivation and production of sunflower was 31.4 thousand hectares and 34.6 thousand tons in 1990-1991, which increased to 114.3 thousand hectares, and 150 thousand tons in 1999-2000, respectively (MINFAL, 2002). Consequently, production of sunflower meal (SFM) increased substantially. It is mentioned that country's 71% demand of edible oil is still met from imports of oil and oilseeds. The imported oilseeds are mainly canola and sunflower (GOP, 2003). In this context, sunflower is expected to increase in popularity among oilseed growers. As a result, SFM production would definitely increase further.

Due to higher fiber contents of SFM, its inclusion in poultry rations is limited from 3 to 4% only. Ruminants are, however, capable of utilizing higher dietary fiber and various scientific evidences suggest that SFM can be used as a sole source of supplemental protein for adult cattle and young calves (Lardy and Anderson, 2002). However, SFM has not yet gained popularity among farmers in spite of its abundant availability and lower price i.e. US \$0.07 per kg versus US \$0.17 per kg of traditionally used cottonseed

meal (CSM) and rapeseed meal (one US \$ is equal to 58 Pakistani Rs). In Pakistan, only the experiments of Karim et al. (1996) with calves, and Jabbar et al. (1998) with calves and adult cattle, attempted to use SFM in total mixed rations. Where, Karim et al. (1996) in an attempt to replace CSM with SFM reported 250 g lower daily weight gain with SFM while Jabbar et al. (1998) reported SFM and CSM as of equal feeding value. Present study was therefore conducted to investigate the effects of substituting CSM with SFM in total mixed rations for growing buffalo calves.

MATERIALS AND METHODS

Growth, digestibility and nitrogen (N) balance trials were conducted to determine effects of replacing cottonseed meal with sunflower meal in growing buffalo calf rations. The SFM used was partially dehulled and solvent-extracted.

Calves, rations and housing

Sixteen male buffalo calves (10 to 11 months age; 100±7 kg live weight mean) were used to test four rations viz. A, B, C and D. These rations were formulated so as to keep them isocaloric, isonitrogenous and isofibrous without varying the notable ingredients (Table 1). Cottonseed meal was included at 30, 20, 10 and 0% levels, while SFM isonitrogenously substituted CSM at 0, 12, 24 and 36% levels, in rations A, B, C and D, respectively. For growth trial, calves were weighed on 16 h shrunk basis, ear tagged and then divided into four weight groups by Randomized Complete Block Design. After growth trial, eight calves were used to test digestibility and N balance in Completely Randomized Design.

During both trials, calves were housed in individual pens (measuring 4 ft×9 ft), in a well ventilated and cement

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Table 1. Ingredient and chemical composition of experimental rations

Ration	A	B	C	D
Ingredients				
Cottonseed meal*	30	20	10	0
Sunflower meal*	0	12	24	36
Rice polish	20	20	20	20
Molasses	12	12	12	12
Maize	6	6	6	6
Corn cobs*	30	28	26	24
DCP	1	1	1	1
NaCl	0.5	0.5	0.5	0.5
Mineral premix ¹	0.5	0.5	0.5	0.5
Chemical analysis				
DM	91.2	91.5	91.6	91.8
CP	15.6	15.6	15.6	15.6
CF	23.1	23.4	23.9	24.2
ADF	22	24	26	27
NDF	40	37	35	32
ADL	3.46	4.78	5.76	6.36
UDP ²	4.7	3.9	3.2	2.6
ME (MJ/kg) ²	9.12	9.10	9.00	8.97

* CSM=36.0% CP, 11.8% CF; SFM=30.5% CP, 19.5 CF; Corn cobs=4.5% CP, 32.6% CF.

¹ Mineral premix contained (per kilogram): Ca, 134 g; P, 165 g; Na, 130 g; Cl, 28 g; S, 28 g; Mg, 35 g; Zn, 1,400 mg; Cu, 300 mg; Mn, 1,800 mg; Fe, 1,400 mg; Co, 7 mg; Se, 12 mg; I, 80 mg.

² Calculated values.

floored shed with asbestos sheet roof. Individual pens for calves in the digestibility trial enabled quick flow of urine into collection tubs (containing 150 ml of 3 N HCl). Daily sweeping of floors and washing of animals was practiced to keep the animals in good hygienic environment. Maximum and minimum temperature of the shed during the trial was 45 and 35°C.

Procedure and data collection

Seventeen days of adjustment period was given to acclimatize calves to experimental rations and intensive feeding regimen. *Ad libitum* feeding and daily recording of orts was practiced during adjustment period. At the end of adjustment period, calves were weighed on 16 h shrunk basis. Thereafter, these were fed *ad libitum* in two intervals (08:00 and 16:00 h) so as to get about 10% orts/refusal daily. Water was offered free choice twice a day. During the course of experiment, calves were weighed (without shrinking) on weekly intervals. After 60 days, two consecutive weighings were done on 16 h shrunk basis.

After 60 days of growth trial, digestibility trial was conducted and calves were fed 90% of the voluntary intake for five days. Once a day feeding (08:00 h) was adopted at this stage. Feed and orts were recorded and sampled for analysis. Total feces and urine output of the individual animal was recorded daily. Twenty percent urine and 10% feces of each calf was refrigerated separately for analysis.

Table 2. Performance of calves under different treatments

Ration	A	B	C	D	SE
CSM:SFM	30:0	20:12	10:24	0:36	
Wt gain/day (kg) *	0.98 ^a	0.74 ^b	0.57 ^c	0.33 ^d	0.07
Feed intake/day (kg) **	5.07 ^a	4.30 ^b	4.17 ^b	3.20 ^c	0.21
Feed efficiency	5.15 ^a	5.87 ^a	8.65 ^b	10.04 ^c	0.34
Economics					
Cost per kg feed ¹	0.10	0.09	0.08	0.07	-
Feed cost per kg wt gain ¹	0.50	0.52	0.69	0.71	-

* The correlation between wt gain and UDP (%) was found highly significant as 0.99.

** The correlation between ADL and feed intake was negative and highly significant as -0.96.

^{a, b, c} Means in the same row with different superscripts differ ($p < 0.01$).

¹ In US \$ (one US \$=58 Pakistani Rs).

Laboratory analysis and calculations

Weight gain of calves was calculated from difference in the weighings done on 16 h shrunk basis before and after the 60 days growth trial. Daily feed intake values were used to obtain average feed intake/day. The metabolizable energy (ME) contents and undegradable protein (UDP) fractions of diets were calculated based on AFRC (1993).

All feed, fecal and orts samples obtained in digestibility and N balance trial were analyzed for their proximate composition following AOAC (1995). Fiber fractions of rations were determined according to Goering and Van Soest (1970). All urine samples of the individual animals were analyzed for N content using wet digestion technique.

Data obtained for the growth trial was subjected to analysis of variance technique using Randomized Complete Block Design (Steel and Torrie, 1980). Digestibility and N balance data was subjected to analysis of variance technique using Completely Randomized Design. Means were compared using Duncan's Multiple Range test.

RESULTS AND DISCUSSION

Calf performance

Average daily weight gain, feed intake, and feed efficiency data is presented in Table 2. Calves fed on ration A (CSM:SFM, 30:0) made highest gains with maximum voluntary feed consumption. Similarly feed efficiency was best under ration A. Decreasing trend in calf performance with increasing levels of SFM in rations is apparent. These results indicate that SFM is not equivalent to CSM as a protein supplement for growing buffalo calves. A similar decreasing trend in weight gain with increasing SFM levels in buffalo calf rations has been reported by PARC (2002). Results of present study are also in agreement with the work of Karim et al. (1996) for CSM substitution.

Lower feed intakes with SFM based rations may be attributed to higher acid detergent lignin (ADL) fractions associated with it (Table 1). Acid detergent lignin fractions of ration D (CSM:SFM, 0:36) were twice of those in ration

Table 3. Digestibility and nitrogen balance under different treatments

Ration	A	B	C	D	SE
CSM: SFM	30:0	20:12	10:24	0:36	
Digestibility (%)					
DM	62.4	60.4	59.5	58.8	1.65
OM	63.2	62.9	62.1	61.7	2.41
CF	62.3 ^a	57.9 ^b	54.7 ^{bc}	51.7 ^c	1.36
N Retained					
% of Intake	31.8	32.6	34.7	34.4	2.55
% of Digested	43.5	45.5	47.3	49.7	2.60

^{a,b,c} Means in the same row with different superscripts differ ($p < 0.05$).

A (CSM:SFM, 30:0) when isonitrogenous substitution of CSM was made. The correlation between ADL and feed intake was negative and highly significant as -0.96 . High ADL fractions result in bulkiness and limit feed intake (Cornu et al., 1994). Also, it was a general observation during the digestibility trial that when 90% of the *ad libitum* intake was offered, almost equal percentages of feed offered were consumed in a given time. Palatability was therefore not a contributory factor. More precisely, differences in feed consumption were partly directed by weight gain, which the respective ration could support during 60 days of the experiment.

The correlation between UDP of rations and weight gain was found to be highly significant as 0.99. Therefore, higher weight gain of calves on rations containing CSM might be due to higher UDP contents of CSM (Table 1). Garg (1998), who recommends use of protein sources having high content of UDP in production concentrates, supports this notion. Arelovich et al. (1993) also reported higher gains with meat meal as compared with SFM supplementation. Sunflower meal, which has a capability of increasing ruminal NH_3 concentrations and bacterial N flow (Erasmus et al., 1994), may be regarded as a good source of rumen degradable protein (RDP). However, while feeding SFM to ruminants it should be kept in mind that appropriate levels of UDP must be incorporated in the rations. This is why, studies using SFM as a source of RDP (Milton et al., 1997) rated SFM as a useful supplement for growing and finishing calves/steers. It is important to note that feedlot operations in Pakistan are aimed at taking advantage of compensatory growth (Müller, 1986). Higher gains in previously underfed young ruminants may require higher UDP, than that recommended by NRC (1988). This assumption is however debatable and necessitates further research.

These findings are not in agreement with the previous work on SFM for replacing CSM in sheep (Richardson et al., 1981) and in calves (Jabbar et al., 1998; Mirza et al., 2004). Patterson et al. (1999) also reported controversial findings in grazing cattle. These may be compared with the present findings on the basis of UDP requirements of gain (NRC, 1988). Use of multiple protein sources (i.e. 8 to 9%

rapeseed meal in all provisions) in experiments of Jabbar et al. (1998) and urea-molasses block feeding in experiments of Mirza et al. (2004) makes these incomparable with the current study. Body weight gain reported by Mirza et al. (2004) was also lower i.e. 174 to 214 g/d. Similarly, Patterson et al. (1999) compared SFM with canola meal and edible beans for grazing beef cows and calves. Dietary degradable protein required may be greater for grazing animals and sunflower is of high value in such conditions (Lardy and Anderson, 2002).

Economics

Sunflower meal was purchased at US \$0.07 per kg while CSM was purchased at US \$0.17 per kg. Inclusion of SFM therefore resulted in least cost rations. Isonitrogenous substitution of CSM resulted in 30% lesser feed cost in ration D (CSM:SFM, 0:36). For a valid comparison, cost of feed per kg weight gain was calculated (Table 2). Feed cost per kg weight gain increased gradually with SFM inclusion. It was 4, 38 and 42% higher in ration B, C and D as compared to that in ration A, respectively. This may be attributed to the higher weight gains obtained with decreasing SFM levels in the diets. It may be concluded that SFM is an economical substitution of CSM only when weight gains are not high.

Digestibility and nitrogen balance

Digestibility and nitrogen balance data is presented in Table 3. Dry matter (DM) and organic matter (OM) digestibilities were found to be inversely related to SFM inclusion, however, differences were non-significant statistically. As seen in Table 3, digestibility of crude fiber (CF) experienced maximum reductions ($p < 0.05$). This may be explained on the basis of higher ADL fractions (Jung and Vogel, 1986; Cornu et al., 1994) associated with SFM (Table 1). All calves were in positive nitrogen balance. Nitrogen retained as percentage of intake and digested increased with SFM inclusion. While replacing CSM with SFM in buffalo calf diets PARC (2002) reported similar trends in nitrogen retention and in the digestibility of DM, OM and CF.

Richardson et al. (1981) reported higher DM, OM and CP digestibility with increasing levels of SFM in steer diets. However CF content of their rations was not more than 10.4% versus 23 to 24% in the present study. Nitrogen digestibility at 12% substitution in the present study is however, comparable to that reported by Richardson et al. (1981) at a similar substitution.

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