Effect of Glucosinolates of Taramira (*Eruca Sativa*) Oilcake on Nutrient Utilization and Growth of Crossbred Calves

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ABSTRACT : Taramira (*Eruca sativa*) cake, an unconventional oil cake, replaced 25 and 50 per cent crude protein of mustard cake in the ration of crossbred calves in an experiment of 90 days duration. Total glucosinolate content of the three concentrate mixture was almost similar (18.19, 17.95 and 17.95 μmol/g dry matter), however, glucouracin was the major glucosinolate of experimental diets. Similar dry matter Intake, nutrient digestibility (except those of fibre fractions) and nitrogen balances as well as similar serum T_3 and T_4 levels and growth rate in all the groups indicated that taramira cake can replace 50 per cent crude protein of mustard cake in the diet of crossbred calves. ***(Asian-Aust. J. Anim. Sci. 2003. Vol 16, No. 6 : 813-817)***

Key Words : Taramira Oilcake, Glucosinolate, Glucoerucin, Nutrient Utilization, Growth, Crossbred Calves

INTRODUCTION

Cruciferous oilcakes are commonly used as a vegetable source of protein supplement in ruminant feeding. Taramira (*Eruca sativa*) oilseed crop which also comes under the same family is believed to be a native of Southern Europe but cultivated as a cash crop in India, Pakistan and Iran. Taramira is recognised by different names such as *rocket* or *salad rocket* (English), *oruga, eruca* (Spanish), *fedorenta* (Portugese), *roquette* (French), *bhutaghna* (Sanskrit) (CSIR,1952; Nuez and Bermejo, 1994). Taramira cake is used as a protein supplement in livestock feeding and also as a ruminotonic. Like other crucifers, taramira cake is pungent in nature. Pungency of cruciferous oilcake is due to the presence of a group of thioglucosides i.e. glucosinolates which on hydrolysis yield a variety of products such as isothiocyanate, nitrile and thiocyanate by the action of endogenous (may be exogenous also) enzyme, known as myrosinase. These products are toxic and are responsible for lower palatability of feed, goitrogenecity, depressed function of thyroid (T_3 and T_4) which ultimately affect the productivity of animals. Total glucosinolate content of taramira and mustard cakes was similar but major glucosinolate in taramira and mustard cakes was glucoerucin (a two sulphur atom containing glucosinolate) and glucanapin, respectively (Das et al., 2001) which is more pungent than glucanapin (Sindhukanya and Kantharaj, 1989). Present study was conducted to compare the effect of taramira and mustard oilcakes on their growth performance, nutrient utilization and thyroid function in crossbred calves.

MATERIAL AND METHODS

Fifteen crossbred male calves (160-300 kg body wt.) were selected from the cattle herd of National Dairy Research Institute, Karnal and randomly distributed into 3 groups of 5 each on the basis of their body weight. All animals were housed in a well-ventilated shed having an arrangement for individual feeding. Hygienic conditions were maintained throughout the experimental period of 3 months. Measures were taken to control the parasitic infestation and FMD before initiating the experimental feeding.

Feeding treatments

First group i.e. control (MC100) was fed on concentrate mixture containing mustard cake as a sole source of protein which was replaced at 25 and 50 per cent levels by taramira cake in Group II (TMC25) and Group III (TMC50) according to the recommendation of NRC (1989) for calves growing at the rate of 500 g/day (table 1). Animals were offered wheat straw *ad lib* as a source of roughage and fresh berseem (*Trifolium alexendrium*) fodder (1 kg/animal/day) to fulfill the Vitamin-A requirement. Concentrate mixture was provided two times a day (10.00 a.m. and 3.30 p.m.) along with wheat straw. Water was offered free choice twice a day. Body weight and dry matter intake of individual animal were recorded at fortnightly intervals and amount of concentrate mixture was adjusted accordingly.

Metabolism trial and balance studies

A metabolism trial of seven days duration was conducted after 5 weeks of experimental feeding. Samples of feed, leftover material and faeces were analyzed for proximate principles (AOAC, 1990) and fibre fractions (Goering and Van Soest, 1970). Urinary nitrogen was estimated as per AOAC (1990). Individual and total glucosinolates of taramira cake and mustard cake were determined using HPLC (Water's model no. 510, USA)

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Table 1. Composition of three concentrate mixtures

Ingredients	Groups		
	I (MC 100)	II (TMC 25)	III (TMC 50)
Maize	37	37	37
Mustard cake (Exp.)	38	28.5	19
Taramira cake (Exp.)	-	9.5	19
Wheat bran	22	22	22
Mineral mixture	2	2	2
Common salt	1	1	1
Total	100	100	100

[a]MC100=Control group fed concentrate mixture containing mustard cake (MC) as a sole source of protein

TMC25=1st treatment group fed on conc. mix of control group in which Taramira oil cake (TMC) replace by MC by 25 % on crude protein (CP) basis.

TMC50=2nd treatment group fed on conc. mix of control group in which TMC replace MC by 50% on CP basis.

following the desulphoglucosinolate method (Sang et al., 1984) and their levels in respective concentrate mixtures were calculated.

Blood samples were collected at 0, 45 and 90th day of experimental feeding. Serum was separated and stored in deep freeze. Serum T_3 and T_4 were determined as per the procedure specified for human serum using the RIA Kits procured from Board of Radiation and Isotope Technology, Bombay (India).

The data were subjected to the analysis of variance using Randomised Block Design (RBD) according to Snedecor and Cochran (1968)

RESULTS AND DISCUSSIONS

Chemical composition of treatment rations

Proximate composition and fibre fractions of concentrate mixtures, wheat straw and green berseem are presented in table 2. The concentrate mixtures were isonitrogenous and the variation in NDF and ADF contents may be attributed to variation in proportion and chemical composition of taramira and mustard oil cakes as both the cakes were having varying content of ADF and NDF (Das et al., 2001). Total glucosinolate content of MC100, TMC25 and TMC50 concentrate mixtures was 18.19, 17.95 and 17.59 μmol/g on DM basis, respectively.

Table 2. Chemical composition of different concentrate mixtures and other feed stuffs

Parameters	Concentrate mixture			Wheat straw	Berseem
	MC100	TMC25	TMC50		
Proximate composition (%, DM basis)					
Organic matter	92.28	91.93	92.25	91.64	86.38
Crude protein	22.18	22.50	22.38	3.24	19.13
Ether extract	5.82	5.77	5.86	2.87	2.79
Crude fibre	4.05	3.65	3.68	45.17	18.51
NFE	60.23	60.01	60.33	40.36	45.95
Ash	7.72	8.07	7.75	8.36	13.62
NDF	36.86	40.62	37.63	85.76	49.19
ADF	5.28	3.93	4.43	54.11	25.29
Hemicellulose	31.68	36.69	33.20	31.65	23.90
Glucosinolates (μmol/g, dried sample)					
Sinigrin	1.29	1.14	0.90	-	-
Gluconapin	12.04	9.19	6.34	-	-
Glucobrassicanapin (Pentenyl)	4.86	3.64	2.43	-	-
Glucoerucin	-	3.98	7.92	-	-
Total glucosinolates	18.19	17.95	17.59	-	-

Nutrient utilization

DM digestibility in TMC50 group was significantly ($p<0.05$) higher than in control (MC100) and TMC25 groups, however, difference between later two groups was non significant (table 3). CF digestibility in TMC25 group was significantly higher than in MC100 group. Value in TMC50 group was also significantly higher than in control group. NDF and ADF digestibility followed the pattern of CF digestibility. Tyagi and Singhal (2001) reported similar nutrient digestibility of mustard and rapeseed oilcakes based rations but values were lower than those recorded for groundnut cake based ration. Mathur et al. (1988) recorded similar nutrient digestibility on feeding groundnut cake and

Table 3. Feed intake, nutrient digestibility and plane of nutrition in different groups

Parameters	Groups[a]		
	MC100	TMC25	TMC50
Average BW. (kg)	244.0±16.75	237.2±26.22	243.6±25.49
DM intake (kg/day)			
Through conc. mix.	2.69	2.53	2.49
Through wheat straw	1.94	1.42	1.99
Through green fodder	0.12	0.12	0.12
Total DM intake	4.75±0.37	4.07±0.39	4.60±0.33
DM intake /100 kg B.Wt. kg	1.94	1.71	1.88
Total glucosinolate intake (μmol/g)	10.30	11.16	9.52
Digestibility coefficient			
Dry matter*	50.65±2.07[a]	52.39±2.45[a]	58.17±1.32[b]
Organic matter	55.14±1.86[a]	56.61±2.16[a]	62.29±1.33[b]
Crude protein	62.80±1.38	63.00±1.77	63.37±2.38
Ether extract	79.56±1.29	78.73±2.31	77.58±3.34
Crude fibre	55.32± 3.19	59.68±2.18	69.09±1.85
Neutral detergent fibre	36.12± 2.55	42.97± 3.37	54.12±1.85
Acid detergent fibre	23.26±3.83[a]	27.69±4.82[a]	44.06±5.01[b]
Plane of nutrition			
Average CP intake (g/day)	667.6±33.06	649.2±30.41	637±35.95
Average TDN intake (kg/day)	2.54 0.21	2.43 0.25	2.77 0.20
Average ME* intake (Mcal/day)	9.19±0.74	8.79±0.91	10.01±0.73

[a, b, c] Values bearing different superscript in a row differ significantly

* ($p<0.05$), ** ($p<0.01$)

Table 4. Average daily nitrogen intake, excretion and balance in different treatment groups during metabolic trial

Parameter	Group[a]		
	MC100	TMC25	TMC50
Total N intake (g)	109.47±5.91	102.15±5.87	102.96±7.3
Faecal N excretion (g)	39.89±3.28	37.08±2.49	36.79±4.49
Urinary N excretion (g)	47.63±4.77	43.91±2.81	46.66±3.68
Total N excretion (g)	87.53±3.86	80.99±4.76	83.45±7.76
N balance (g)	21.94±7.03	21.16±2.99	19.50±3.22
N digested (g)	69.57±4.02	65.07±4.96	66.17±4.70
Faecal N as % N intake	36.38±1.92	36.42±2.27	35.58±2.74
Urinary N as % N intake	44.29±6.42	42.95±0.711	45.29±0.92
% retention of total N intake	19.33±5.81	20.63±2.56	19.13±3.13
% retention to digested N	30.59±8.94	32.16±2.86	29.28±3.63

[a]MC100=Control concentrate mixture containing mustard cake (MC) as a sole source of protein

TMC25=1st treatment concentrate mixture in which Taramira oilcake replace MC of control by 25% on CP basis.

TMC50=2nd treatment concentrate mixture in which Taramira oilcake replace MC of control by 50% on CP basis.

taramira cake in the ration of sheep. It is evident from these results that replacement of mustard oilcake with taramira oilcake improved the fibre digestibility which supports its traditional use as a stress relief feed ingredient by the farmers in India. Taramira cake/leave contains some unidentified factors having stomachic and stimulant actions (Nuez and Bermejo. 1994) which might have manipulated the rumen fermentation to improve the fibre digestibility.

Nitrogen metabolism

Data on nitrogen intake. its excretion and balance in different groups are presented in table 4. Concentrate mixture was the main source of dietary nitrogen as per the planning of experiment. The nitrogen balance in MC100, TMC25 and TMC50 groups was positive and nitrogen efficiency (% retention of total N intake) was around 20 per cent and the variations among groups for nitrogen intake. excretion and balance were nonsignificant. Similar nitrogen utilization in all the three groups was due to the similar N intake from MC and TMC having similar amino acid composition (including S containing amino acids). which might have utilized for the efficient microbial protein synthesis (Nolan and Leng. 1972; Gawthrone and Nader, 1976). Further. higher availability of sulfur (as a result of hydrolysis of glucosinolates) might have facilitated microbial protein synthesis. Difference in the type of glucosinolate of both the oilcake did not affect the nitrogen utilization irrespective of their level in the diet of the crossbred calves.

Table 5. Average growth rate and feed conversion efficiency in different treatment groups (during 90 days of experiment period)

Parameters	Group[a]		
	MC100	TMC25	TMC50
Initial body wt. (kg)	219.2±12.72	219.6±27.83	218±26.36
Final body wt. (kg)	257.6±17.48	265±27.04	266±27.01
Body wt. gain (kg)	38.4±5.26	45.4±4.13	47.2±1.53
Body wt. gain (g/day)	426.67±58.46	504.44±45.86	524.44±17.00
Total DMI through conc. mix. (kg)	240.80±5.77	243.09±12.20	225.64±12.84
Total, DMI through roughages (kg)	254.99±18.81	245.04±23.92	262.37±24.84
Total DMI (kg)	495.79±22.72	488.14±35.43	488.01±35.22
Roughage: concentrate	1.05	1.00	1.16
DM intake/kg gain (kg)	12.61±1.45	10.74±1.16	10.33±1.06
Toal CP intake (kg)	63.73±1.71	64.69±3.47	62.26±3.49
CP intake/kg gain (kg)	1.77±0.20	1.48±0.17	1.30±0.06
Total TDN intake (kg)	273.14±12.34	276.41±25.60	299.54±22.42
TDN intake/kg gain (kg)	7.514±0.76	6.23±0.68	6.36±0.49
Total ME intake (Mcal)[#]	988.78±44.6	1,000.98±92.5	1,084.34±81.1
ME intake/kg gain (Mcal)[#]	27.21±2.73	22.56±2.47	23.03±1.77

[a] MC00=Control concentrate mixture containing mustard cake (MC) as a sole source of protein

TTMC25=1st treatment concentrate mixture in which Taramira oilcake replace MC of control by 25% on crude protein (CP) basis.

TMC50=2nd treatment concentrate mixture in which Taramira oilcake replace MC of control by 50% on CP basis.

[#] 1 kg TDN = 3.62 Mcal

Plane of nutrition

The plane of nutrition of the calves under different groups during the metabolic trial period was compared with NRC (1989) feeding standard (table 3). Animals were supplied with optimum levels of crude protein to fulfill their nutritional requirements. however, lower TDN intake (20% less than the requirement) may be attributed to the feeding of wheat straw as a source of roughage.

Feed intake and growth performance

Total DM consumed through various sources and growth performance of the animals in different groups during the total experimental period of 90 days are presented in table 5. The fortnightly body weight gain by the animals in different groups is presented in figure 1.

DM intake/kg gain in body weight was lower ($p>0.05$) in experimental groups than in control group. however. values were with in the range recommended by NRC (1989).

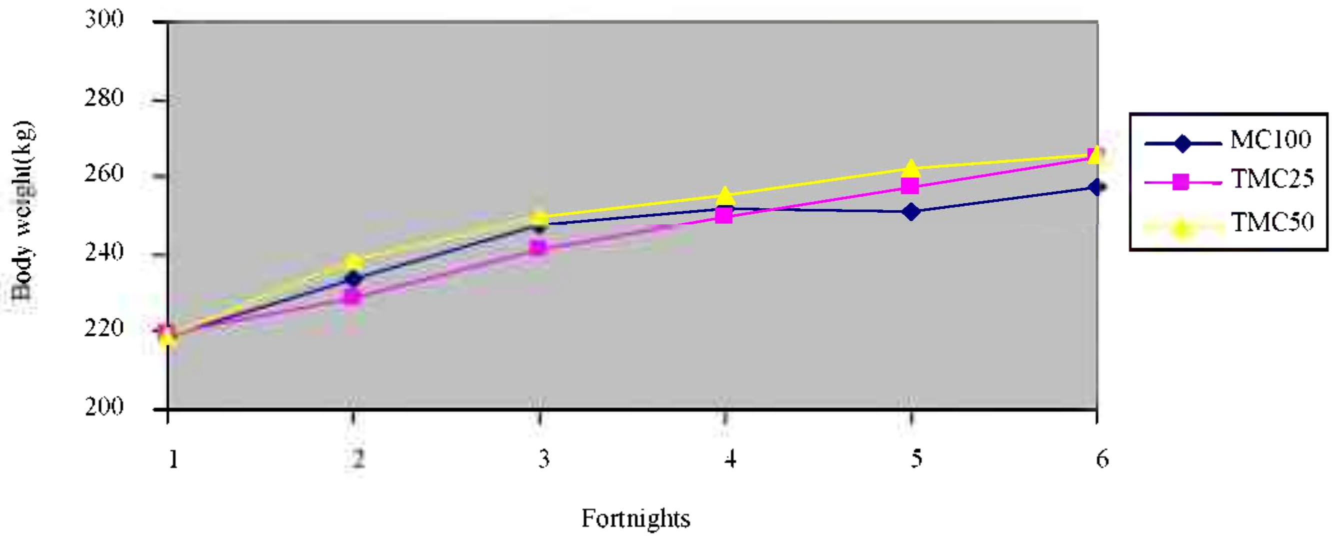

Figure 1. Average body weight changes in different groups during 90 days of experimental feeding

The average roughage to concentrate ratio was 1.05, 1.01 and 1.16 in MC100, TMC25 and TMC50 groups, respectively. Lower palatability of TMC50 ration limited the concentrate intake and promoted the roughage intake of the animals in third group in a bid to fulfill the DM requirement (table 5).

The average daily gain in body wt. was 427, 504 and 524 g in Mc100, TMC25 and TMC50 groups, respectively and the variation among groups was not significant. Body weight gain (figure. 1) in first fortnight of all the three groups was higher, as the animals were somewhat debilitated and fed on roughages only before starting the experiment. After being shifted to concentrate diet animal started gaining in body weight sharply. Present results are corroborated by Tyagi and Singhal (2001) who reported similar growth rate of Karan-Fries male calves fed on mustard and rapeseed oilcakes as sole protein supplement. They further reported that in spite of feeding higher levels of glucosinolate through mustard and rapeseed oilcakes, the body weight gain was similar to those fed on groundnut cake. Various other workers also reported that the rapeseed oilcake can replace completely or partially the soybean meal (Wood and Stone, 1970; Ingalls and Seale, 1971; Iwarsson et al., 1973), linseed meal, cottonseed meal (Schwarz and Kirchgessuer, 1989; Ahmad and Malik, 1982) in the ration of growing animals without affecting their growth performance.

Body weight gain of the calves was according to their age as the dietary glucosinolate level (about 12 μmol/g diet) did not exceed the harmful level during the entire experimental period (table 2).

Serum Tri-iodothyronine (T_3) and thyroxine (T_4) levels

The data on serum T_3 and T_4 levels determined at 0, 45 and 90th day of experimental feeding are presented in table 6. The values of serum T_3 and T_4 were with in physiological range. Serum T_3 level did not vary among the groups or among the periods, however, serum T_4 level in TMC25 group was significantly ($p<0.05$) higher than in MC100 and TMC50 groups, which may be attributed to the animal variation rather than feeding effect. Papas et al. (1979) also reported non-significant variation in plasma T_3 and T_4 level between LG-RSM and HG-RSM fed cows. Tyagi and

Table 6. Serum tri-iodothyronine (T_3) and Thyroxine (T_4) concentrations (mg/ml) in different groups

Days of experimental feeding	Group					
	MC100		TMC25		TMC50	
	T_3	T_4	T_3	T_4	T_3	T_4
0	1.48±0.29	28.58±10.74	2.49±0.47	43.2±3.96	1.83±0.54	40.60±10.67
45	1.98±0.45	23.90±6.26	2.78±0.70	31.38±3.01	1.94±0.32	12.66±2.73
90	0.96±0.27	27.04±4.37	2.06±0.65	51.44±8.39	1.91±0.23	24.9±4.91
Average	1.47±0.29	26.50±1.38^a	2.44±0.21	42.01±5.82^b	1.89±0.03	26.05±8.08^a

$^{a, b}$ Values bearing different superscript in a row differ significantly ($p<0.05$)

Each value is based on 10 observations

[a]MC100=Control concentrate mixture containing mustard cake (MC) as a sole source of protein

TMC25=1st treatment concentrate mixture in which Taramira oilcake replace MC of control by 25% on crude protein (CP) basis.

TMC50=2nd treatment concentrate mixture in which Taramira oilcake replace MC of control by 50% on CP basis.

Singhal (1993) reported that feeding of mustard cake reduced the plasma T_3 (0.39 vs 0.30 ng/ml) concentration significantly ($p<0.05$) than groundnut and rapeseed fed groups of crossbred male calves during the 35 weeks of experimental feeding.

Thiocyanate, released as a result of hydrolysis of glucosinolate, affects the circulatory levels of T_3 and T_4 due to the binding of iodine (Pailan, 1995) is related to the level and type of glucosinolate present in different cruciferous oilcakes. Nonsignificant variation among groups for serum T_3 and T_4 was possibly be due to the similar intake of glucosinolate, present in TMC and MC, which might have hydrolysed in to thiocyanate in same proportion.

CONCLUSION

It can be concluded that protein of mustard cake can be replaced with taramira cake up to the 50 percent in the diet of crossbred calves without affecting the growth performances and feed conversion efficiency of crossbred calves. These results also revealed that thyroid functions remained uninfluenced by the dietary glucosinolate intake up to 11 mmol/g diet, irrespective the type of glucosinolate. Keeping in view the potential of taramira cake as a protein supplement for ruminant diet, cultivation of taramira may be encouraged in drought prone areas where rainfall and soil fertility are too low to cultivate cereals and oilseeds.

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