STUDIES ON THE EFFECT OF REPLACEMENT OF GROUND NUT CAKE IN CONCENTRATE MIXTURE WITH SUNFLOWER CAKE ON THE QUANTITY AND QUALITY OF MILK IN DAIRY ANIMALS

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CERTIFICATE

This is to certify that this Thesis entitled "Studies on the effects of replacement of groundnut cake in concentrate mixture with Sunflower cake on the quantity and quality of milk in Dairy Animals" submitted for the Degree of M.Sc., in Veterinary Science in the Major Subject of Dairy Science of the Andhra Pradesh Agricultural University is a result of bonafide research carried out by Sri V. Hanumantha Reddy under my supervision and that the Thesis has not formed in whole, or in part, the basis for the award of any degree, diploma or other similar degree or distinction.

The assistance and help received during the course of these investigations have been fully acknowledged.

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CONTENTS

Economy in formulation of rations for milch animals is the key-stone for profitable dairying, more so in a country like India where grains and groundnuts are in great demand for human nutrition.

Sunflower (Helianthus annuus) has its origin in latin America and is an important 45 to 50 per cent edible oil yielding crop in places of temperate climate like U S S R, Bulgaria, Rumania, Canada etc. The oil is having non-cholesterol and anticholesterol properties. Sunflower has not received much attention in India as the varieties other than Russian varieties were low in oil and are highly susceptible for virus. The Russian varieties of Sunflower, being drought resistant with short periods of growth (85 to 110 days) coupled with a capacity to grow in sandy loams and black loams; are being advocated for cultivation, since 1969-70 after successful trials, by Indian Council of Agricultural Research. Further it is observed that Sunflower crop could be fitted into varieties of cropping patterns, in different regions of the country without displacing any major crop. Sunflower can also grow as an inter-crop along with long duration crops like sugarcane. Sunflower appears to have a distinct future in dryland Agriculture as compared to the traditional oil crops of the country. In yielding oil per hectare, Sunflower is distinctly superior to other oil seed crops in

India. Vniimk, Peredavik and Armavirskij-3497 varieties of Russian origin are found to be suitable for Southern States.

Since Sunflower could be cultivated throughout the year in Southern States, a crash programme, for the rapid expansion of area under crop in the States of Andhra Pradesh, Tamilnadu and Karnataka; is under implementation. The central Government visualises the potentialities for increasing Sunflower area in Southern States to about one million hectares by the end of fifth five year plan.

Eventhough groundnut cake protein works out to be cheaper in dairy rations, on unit protein basis in comparison with the other sources of protein; it is becoming increasingly difficult to procure the same with reasonable price due to lower production and greater demand. Though Sunflower cake is comparatively lower in protein than groundnut cake, it is likely to be available in plenty, especially in the Southern states of our country, consequent to the implementation of Governmental Plans to bring more area under Sunflower crops as a major source of oil due to its edible oil and added economic advantages.

Hence an attempt was made in this investigation to study the utility value of Sunflower cake replacing groundnut

cake protein in concentrate mixture of milch animals with Sunflower cake protein at one-third, two-thirds and hundred per cent levels by way of assessing the effects of replacement with Sunflower cake on milk yield, fat yield, four per cent fat corrected milk yield and percentages of fat and SNF. An attempt was also made to observe the changes in palatability, water consumption, body weights of the animals and also the presence of any pathological constituents of urine as a consequence of feeding Sunflower cake. Further an attempt also was made to work out the cost economics of groundnut cake replacement with Sunflower cake.

REVIEW OF LITERATURE

Composition of Sunflower Seed, Cake and Meal:

Earle *et al.* (1969) stated that the hull of the Sunflower seed was primarily cellulose, lignin and pentosans. The hull lipids and proteins differed in composition from the corresponding kernel content.

Kavardakov (1970) reported 15.12 per cent protein 17.2 per cent fibre and 3.14 per cent fat in Sunflower meal.

Dharampal Singh (1971) observed that the oil content was 12.1 per cent in decorticated Sunflower cake and 12.2 per cent in undecorticated Sunflower cake. He further reported 37.1 and 20.5 per cent protein in decorticated and undecorticated Sunflower cake respectively.

Govind Rao *et al.* (1972) noticed that the oil content in Sunflower cake obtained from whole seed was 11.88 per cent and the protein content was 31.11 per cent.

Pustovit *et al.* (1972) reported that the seed of modern Soviet Varieties of Sunflower contained oil between 55.9 and 62.5 per cent and protein between 21.5 and 23.6 per cent. Further they stated that many of the essential amino acids were higher in Sunflower protein than in protein of peas, wheat and maise. Values for methionine, tryptophan

and Arginine were found higher in Sunflower than soyabean protein.

Ramachar et al. (1972) reported 12.1 per cent and 11.5 per cent oil content in decorticated and undecorticated Sunflower cakes respectively. The total protein content was found to be 37.1 per cent in decorticated Sunflower cake and 20.3 per cent in undecorticated Sunflower seed cake. They also reported 14.5 per cent crude fibre in decorticated Sunflower seed cake and 37.9 per cent in undecorticated Sunflower seed cake.

Chatrapati (1973) observed 41.0 per cent of protein in expeller extracted Sunflower meal and 46.8 per cent in solvent extracted Sunflower meal. He has also reported 7.6 per cent and 2.9 per cent ether extract in expeller and solvent extracted Sunflower seed meals respectively. He further stated that the expeller Sunflower seed meal contained 13.0 per cent crude fibre and also reported 11.0 per cent crude fibre in solvent extracted Sunflower seed meal.

Yousuf Ali Khan et al. (1973) have reported the composition of new strains of Indian Sunflower seed varieties EC 68414 (Peredavik-of Russian origin) and EC 68415(Armavirskij-3497-of Russian origin). They reported that the oil content

ranged from 35.3 to 46.3 per cent. Further they stated that the protein content ranged from 17.2 to 23.3 per cent.

Effect of Processing:

Morrison et al. (1953) stated that the processing conditions employed in production of Sunflower seed oil meal were shown to affect the nutritive value of the meal. The nutritive value of the meal increased as the processing temperatures were lowered. Sunflower seed oil meal of equivalent nutritive value to solvent extracted soyabean oil meal was produced by lowering the processing temperatures from 240°F. in the cooker to 200°F.

Feeding of Sunflower seed meal and Cake to Livestock:

Shamkov et al. (1954) stated that feeding 3 kg. of Sunflower cake per head daily, to cows in third and fifth lactation receiving grass as basic fodder, resulted in a 0.47 per cent increase in butter fat content of milk.

Gulkhov and Mordovina (1955) reported that replacing a part of grain in the basic ration by chick peas or Sunflower cake (about 110 grams fed per kg. milk produced) resulted in a slight increase in protein content and butter fat percentage and some decrease in sodium and potassium

levels of the milk. They further reported that the quality of butter was not affected.

Klain et al. (1956) stated that a complete replacement of soyabean oil meal with Sunflower seed oil meal, in chick starter rations, markedly decreased growth. The addition of lysine improved growth considerably but did not quite restore it to that given by soyabean oil meal ration. Lysine appeared to be the main, if not the only limiting amino acid, in the rations containing high levels of Sunflower seed oil meal.

Morzov and Borisenko (1956) observed that feeding of more than 1.50 kilograms of Sunflower seed cake per cow daily, in addition to a basic ration of maize, adversely affected the taste and consistency of butter. The deterioration in the quality of the butter was particularly noticeable when the quantity was raised to 3 kilograms per head daily. The butter was soft, sticky and had a pronounced feed flavour.

Nadaeva (1959) reported feeding 3 or 5 kilograms of Sunflower seed cake in concentrate rations, that the mean milk yields in the experimental periods were 5.9 per cent to 9.6 per cent less than the preliminary period in which Sunflower seed cake was not fed in the concentrate rations. Further he stated that there was no significant effect on

the composition or quality of whole dried milk even after storing upto two years.

Starodubcev (1960) stated that there was no significant change in fat content of milk by feeding Sunflower seed cake in the experimental groups but milk protein rose from 3.41 and 3.46 per cent in the preliminary period to 3.49 and 3.67 per cent. The increase of milk protein was not economical, as it was obtained by a large increase of protein intake.

Peteu and Calotoiu (1965) noticed satisfactory gains in live weight and efficiency of feed conversion in young Rumanian bulls of 8 to 12 months of age with the inclusion of Sunflower meal in the rations.

Roberts and McKirdy (1966) reported that on inclusion of Sunflower seed oil in rations of bullocks there was more efficient conversion of feed than in the case of other diets. Digestibility of crude fat in the diet was less with Sunflower seed oil inclusion in the ration than with other fats.

Tkaccv et al. (1966) stated that there was no significant difference between groups in milk yield or intake of food units per litre of milk on feeding sunflower oil meal prepared by hydraulic and expeller process. They further reported that the young growing pigs given the low temperature

oil cake utilised digestible N of the feed and Ca and P better than other given the same amounts of high temperature oil cake.

Sreekovic (1967) reported that Sunflower meal can replace soyabean meal as a source of vegetable protein for pigs.

Earle et al. (1969) stated that the amino acid composition of Sunflower kernel protein suggested that the meal may be a valuable ingredient.

Silveira et al. (1969) studied the effect of Sunflower oil meal as a substitute for soyabean meal in rations for broilers. The increase in the Sunflower seed meal content in the rations tended to decrease the weight gains and conversion rate.

Coit and Rose (1970) observed that the hen-day egg production was slightly reduced when either Sunflower seed meal replaced 100 per cent of soyabean meal protein, and feed required for dozen eggs was increased by only Sunflower seed meal when used at this dietary level. Supplemental lysine slightly improved feed efficieney when diets contained Sunflower seed meal.

Raleev (1970) from trials lasting 3 years stavropol fine wooled wethers were given Sunflower seed meals extracted

at 105°or 130°C. reported that there was little difference in live weight or fineness of wool. Meal extracted at the high temperature gave wool with greater tensile strength and a fleece with more suint.

Stewart et al. (1970) infused 500 ml. of 15 per cent Sunflower oil emulsion into a Jersey cow, and observed parallel increase in the fat and protein contents of milk with simultaneous decrease in lactose content. There was an increase of 5 per cent in linoleic acid content at second post infusion milking. Consequently there was an increase in unsaturated fatty acids in milk fat. The appearance of large extra alveolar fat droplets, 3 to 85 microns in diameter and the prolonged effect of infusion, milk fat composition was considered as indication that the emulsion was cleared from the blood stream and stored as milk fat precursors until they could be used for the formation of milk fat by the secreting alveolar cells.

Smorodin and Skorobogatyh (1971) reported that in 62 days daily live weight gains were 1280, 1037 and 650 to 700 grams with urea, Sunflower cake and protein deficient diets and dressing percentages were 51.8 and 53.6 with urea and Sunflower cake in male black pied cattle.

Cockoljic et al. (1974) with 20 Friesian cows in a 4 X 4 latin square experiment with 20 days periods and 4 rations showed that there was no significant difference in the four per cent FCM yields, fat tests and percentages of total solids due to the inclusion of Sunflower seed meal in the rations.

Seerley et al. (1974) evaluated Sunflower meal as a replacement for soyabean meal in corn-soyabean meal diets for swine and rats. Experiments with both swine and rats showed that supplementation of Sunflower meal diets with lysine was essential for good animal performance since the Sunflower meal was lower in lysine than soyabean meal even-though higher in methionine than soyabean meal.

MATERIALS AND METHODS

A twelve-week feeding experiment, with the incorporation of Sunflower cake, in concentrate mixtures at one-third, two-thirds and hundred per cent protein levels, replacing corresponding quantities of groundnut cake protein; was conducted with lactating Murrah buffaloes arranged in 4 X 4 latin square design.

Selection of Experimental Animals:

Eight lactating Murrah buffaloes ranging in body weights from 415 to 492 kilograms were selected for this experiment from the herd of dairy experimental station, Rajendranagar, belonging to Andhra Pradesh Agricultural University, Hyderabad. These animals were in the range of 37 to 89 days of lactation period with an average of 68 days. The Murrah buffaloes were divided into four groups with two animals arranged in each group so that the weekly averages of the two animals in respect of milk yield, fat test and solids-not-fat percentage were seen comparable with each other in that group with negligible differences, as was shown in Table1.

Feeds and Feeding:

Morrison's feeding standards modified by Sen (1964) for Indian cattle were adopted to calculate the maintenance requirements of each animal. Ten kilograms of paragrass and

Table 1. Particulars of the lactating Murrah buffaloes of the groups selected for the experiment

Sl. No.	Animal No.	Body weight (kg)	Lactation (No.)	Stage of lactation (days)	Weekly milk yield (kg)	Weekly fat yield (kg)	Fat (%)	S.N.F. (%)
Group-I								
1	18	472	4	73	52.10	2.81	5.39	10.03
2	714	415	2	60	52.20	2.77	5.36	9.90
Total		887		133	104.30	5.58	10.75	19.93
Average		443.5		66.5	52.15	2.79	5.38	9.66
Group-II								
1	41	469	4	81	38.80	2.24	5.77	9.94
2	92	431	2	67	39.90	1.96	4.90	10.24
Total		900		148	78.70	4.20	10.67	20.18
Average		450		74	39.35	2.10	5.34	10.09
Group-III								
1	760	482	5	84	57.20	3.26	5.66	10.22
2	658	480	3	53	56.50	3.45	6.11	10.18
Total		962		137	113.70	6.71	11.77	20.40
Average		481		68.5	56.85	3.36	5.89	10.20
Group-IV								
1	47	435	2	37	42.40	2.30	5.42	10.10
2	772	492	4	89	41.10	2.56	6.22	10.25
Total		927		126	83.50	4.86	11.64	20.35
Average		463.5		63	41.75	2.43	5.82	10.18

three kilograms of green berseem were fed to each animal in addition to ad libitum feeding of mixed hay. Since the mixed hay was of poor quality, to ensure the intake of maintenance requirements, one kilogram of corresponding experimental ration of the concerned experimental period was given to the animal. The quantities of feeds and fodder offered took care of the nutrients, bulk, dry matter requirements, vitamin A requirements and other unindentified grass juice factors considered necessary. Scientific feeding principles of the ruminants and the normal feeding practices were observed in feeding the rations to the experimental animals.

Experimental Concentrate Rations:

The concentrate mixtures with their levels of ingredients used in this experiment were presented in Table 2.

The concentrate rations were specifically formulated with maize to meet the requirements of unidentified lactation factor(s) of grain for production purposes. In all the four rations formulated the levels of wheat bran, mineral mixture and common salt were the same. Whereas the levels of maize were lowered progressively with the progressive replacement of groundnut cake protein duly with the simultaneous substitution in large quantities of Sunflower cake to formulate

Table 2. Percentage composition of experimental concentrate rations

Ingredient	Rations			
	A	B	C	D
Maize (crushed)	35	29	23	17
Groundnut cake	42	28	14	-
Sunflower cake	-	20	40	60
Wheat bran	20	20	20	20
Mineral mixture	2	2	2	2
Common salt	1	1	1	1
Total	100	100	100	100
Calculated CP%	21.03	21.23	21.43	21.63
Calculated DCP%	17.83	18.28	18.73	19.18
Calculated TDN%	74.91	75.50	76.08	76.66

isonitrogenous rations; since these sizable quantities of Sunflower cake contributed to the TDN values as well facilitating the reduction in maize levels in the rations. Ration A was a conventional concentrate mixture without Sunflower cake. In rations B, C and D, the groundnut cake protein was replaced at one-third, two-thirds and hundred per cent protein levels respectively and substitution was done with such quantities of Sunflower cake in all these three rations so as to ensure isonitrogenous nature of the rations. The calculated values of TDN and DCP of all the four experimental rations were almost similar. These rations were fed in accordance to the milk production of the experimental animals at the rate of 1 kilogram concentrate mixture for every 2 kilograms of milk produced.

Management of the Animals:

All the experimental animals were stall fed during the experimental period. Just before milking, the daily allowance of concentrates was fed twice in a day in equal quantities. The readiness and the speed with which the animals have eaten the concentrates was observed every-day. The green grass was offered both in the morning and evening in two instalments. Water was offered ad libitum four times a day.

The animals were milked twice daily, at 3.30 a.m. and 3.30 p.m. To stimulate 'let-down' phenomenon, the calves were allowed to suckle the dams for two minutes and post milking suckling was not allowed. At each milking, it was assumed that calf may consume about half a kilogram of milk during suckling and the same quantity was added to the milk yield recorded after each milking.

Methods:

The experiment was conducted for a total period of twelve weeks including four one-week preliminary periods that intervene the four experimental periods. The preliminary period of one-week in each case of feeding a ration was observed to ward off residual effects of the previous ration. At the end of the experiment every group received all the four experimental rations with an experimental period of two-weeks duration for each ration.

Milk fat and SNF percentages were estimated daily with the morning and evening individual animal samples. Milk fat test was made by Gerber method and the SNF was calculated as per I.S.I. procedures. From the milk and fat yields of the animals, four per cent FCM was calculated using Gaine's formula.

The experimental animals were weighed for three consecutive days in a week between 12.00 noon and 1.00 p.m. and the average weight of three days of each animal was taken as the average weight of that animal during that week by rounding off the decimals.

Water consumption was noticed by visual observation and the animals were given the water in buckets.

The urine voided in the morning was collected from each animal once in every week and examined for the presence of pathological constituents of urine.

Proximate analysis of the feed ingredients used in the experimental concentrate rations was carried out as per the procedures laid down by A.O.A.C. The nutritive value of the four experimental concentrate mixtures was calculated using the concerned digestion coefficients and the calculated proximate principles of the concentrate mixtures.

Economical aspects of the rations employed were studied basing on the prevailing market rates of the concerned feeds.

Statistical analysis of the data was carried out in accordance with Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

The proximate principles of the ingredients that constitute the experimental concentrate rations were presented in Table 3. The crude protein content of sunflower cake was about three-fourths to the value of groundnut cake protein. The total ash content of Sunflower cake was 9.7 per cent and the acid insoluble ash was 2.68 per cent. The crude fibre content of Sunflower cake was 15.50 per cent and was about three times more than that of groundnut cake used. The NFE content was 30.64 per cent whereas the NFE content of groundnut cake was 40.32 per cent.

The calculated digestible principles of the ingredients used in the experimental rations were shown in Table 4. The percentage of digestible crude protein of Sunflower cake used was found to be four-fifths in value to that of groundnut cake used. The TDN value of Sunflower cake used appeared to be a little more than that of maize used.

The proximate composition of the experimental rations were shown in Table 5. The crude protein and crude fibre contents of these rations were in accordance with I.S.I. requirements specified for compounded feeds for cattle.

The ether extract, the crude fibre and the total ash percentages in the rations increased and the percentage of

Table 3. Percentage composition of the feed ingredients used in the experimental concentrate rations (on oven dry basis)

Principle	Maize	Groundnut cake	Sun-flower cake*	Wheat bran
Crude protein (%)	7.08	39.84	31.02	9.12
Ether extract (%)	4.50	9.54	13.14	2.01
Crude fibre (%)	2.77	4.75	15.50	10.29
Nitrogen free extract(%)	84.41	40.32	30.64	73.93
Total ash (%)	1.24	5.55	9.70	4.65
Total	100.00	100.00	100.00	100.00

* Acid insoluble ash in Sunflower cake: 2.68 per cent

Table 4. Digestible principles of the ingredients used in the Experimental rations

Principle	Maize		Groundnut cake		Sunflower cake		Wheat bran	
	Digestion coefficient	Per cent digestible	Digestion coefficient	Per cent digestible	Digestion coefficient	Per cent digestible	Digestion coefficient	Per cent digestible
Crude protein	55	3.89	90	35.86	92	28.54	77	7.02
Ether extract	82	3.69	97	9.25	90	11.82	63	1.27
Crude fibre	76	2.11	10	0.48	26	4.03	20	2.06
Nitrogen free extract	76	64.15	51	20.56	71	21.75	84	62.10
TDN		78.45		77.71		80.92		74.04

Table 5. Proximate composition of the experimental concentrate rations (oven dry basis)

Principle	Rations			
	A	B	C	D
Crude protein (%)	21.03	21.23	21.43	21.63
Ether extract (%)	5.98	7.01	8.03	9.05
Crude fibre (%)	5.02	7.28	9.56	11.83
Nitrogen free extract (%)	61.28	56.70	52.11	47.53
Total ash (%)	6.69	7.78	8.87	9.96
Total	100.00	100.00	100.00	100.00

Table 6. Total milk, fat, four per cent FCM yields and averages of percentages of fat and SNF of the experimental animal groups

Experimental period / items	Group-I	Group-II	Group-III	Group-IV
First period(14 days)	Ration-A	Ration-B	Ration-C	Ration-D
1. Milk yield (kg)	216.10	162.10	211.60	169.10
2. Fat yield (kg)	12.28	8.78	12.90	10.12
3. 4 per cent FCM (kg)	270.49	196.39	277.99	219.44
4. Fat test (%)	5.68	5.42	6.10	5.98
5. SNF (%)	10.37	10.19	10.35	10.16
Second period(14 days)	Ration-D	Ration-A	Ration-B	Ration-C
1. Milk yield (kg)	215.40	170.80	187.70	178.60
2. Fat yield (kg)	14.40	10.68	14.24	12.10
3. 4 per cent FCM (kg)	305.16	229.09	288.38	252.94
4. Fat test (%)	6.49	6.25	7.57	6.77
5. SNF (%)	10.31	10.27	10.25	10.13
Third period(14 days)	Ration-C	Ration-D	Ration-A	Ration-B
1. Milk yield (kg)	224.30	169.90	178.60	193.50
2. Fat yield (kg)	15.06	11.66	13.06	13.00
3. 4 per cent FCM (kg)	313.92	242.71	267.20	271.80
4. Fat test (%)	6.71	6.86	7.32	6.72
5. SNF (%)	10.17	10.19	9.95	10.06
Fourth period(14 days)	Ration-B	Ration-C	Ration-D	Ration-A
1. Milk yield (kg)	231.00	150.50	183.10	212.40
2. Fat yield (kg)	14.88	9.76	12.66	13.72
3. 4 per cent FCM (kg)	314.80	206.45	261.34	290.61
4. Fat test (%)	6.45	6.48	6.86	6.46
5. SNF (%)	9.91	9.87	9.52	9.94

NFE in the rations decreased progressively with the substitution of Sunflower cake in increased quantities to replace groundnut cake protein at different levels in the rations.

The total milk, fat, four per cent FCM yield and the averages of percentages of fat and SNF of animal groups during the four experimental periods; were presented in Table 6.

Milk Yield:

Milk yield in kilograms in each experimental animal group was presented in Table 7 and the statistical analysis of variance of milk yields was presented in Table 8.

During the first, second, third and fourth experimental periods with rations A, D, C and B fed to group I the total milk yields were 216.10, 215.40, 224.30 and 231.00 kilograms respectively. In group II the total milk yields were 162.10, 170.80, 169.90 and 150.50 kilograms during the four experimental periods with rations B, A, D and C respectively. With rations C, B, A and D fed to group III, the milk yields were 211.60, 187.70, 178.60 and 183.10 kilograms respectively during the respective four periods of the experiment. The milk yields were 169.10, 178.60, 193.50 and 212.40 kilograms in group IV during the first, second, third and fourth

Table 7. Milk yield in kilograms in each experimental animal group

Experimental periods (each period 14 days)	Group-I	Group-II	Group-III	Group-IV
First period	216.10 Ration-A	162.10 Ration-B	211.60 Ration-C	169.10 Ration-D
Second period	215.40 Ration-D	170.80 Ration-A	187.70 Ration-B	178.60 Ration-C
Third period	224.30 Ration-C	169.90 Ration-D	178.60 Ration-A	193.50 Ration-B
Fourth period	231.00 Ration-B	150.50 Ration-C	183.10 Ration-D	212.40 Ration-A

Table 8. Analysis of variance of milk yields

Source of variation	Degrees of freedom	Sum of squares	Mean square	F value
Due to periods	3	83.03	27.34	0.09
Due to groups	3	6862.76	2287.59	7.56*
Due to treatments	3	250.53	83.51	0.27
Error	6	1815.54	302.59	

* Significant at 5% level

experimental periods with rations D, C, B and A respectively. comparison of the milk yields of the groups with one another it was observed that there was much variation of the milk yields during all the periods of experiment. On the other hand, in each group on comparison of the milk yields of different periods, with different rations, there was not much variation to be seen.

On statistical analysis of milk yields, no significant difference was observed among the milk yields of the experimental periods as well as due to rations, within each group. Tkacev et al. (1966) stated that there was no significant difference between groups in milk yield on feeding Sunflower oil meal prepared by hydraulic and expeller processes. Significant difference was observed among groups which also existed among groups with regard to milk yields when animals were grouped at the commencement of the experiment.

Fat Yield:

Fat yield in kilograms in each experimental animal group was presented in Table 9 and the statistical analysis of variance of fat yields was shown in Table 10.

During the first, second, third and fourth experimental periods with rations A, D, C and B fed to group I the total fat yields were 12.28, 14.40, 15.06 and 14.88 kilograms

Table 9. Fat yield in kilograms in each experimental animal group

Experimental periods (each period 14 days)	Group-I	Group-II	Group-III	Group-IV
First period	12.28 Ration-A	8.78 Ration-B	12.90 Ration-C	10.12 Ration-D
Second period	14.40 Ration-D	10.68 Ration-A	14.24 Ration-B	12.10 Ration-C
Third period	15.06 Ration-C	11.66 Ration-D	13.06 Ration-A	13.00 Ration-B
Fourth period	14.88 Ration-B	9.76 Ration-C	12.56 Ration-D	13.72 Ration-A

Table 10. Analysis of variance of fat yields

Source of variation	Degrees of freedom	Sum of squares	Mean square	F value
Due to periods	3	11.53	3.84	3.57
Due to groups	3	34.58	11.53	10.77**
Due to treatments	3	0.48	0.16	0.15
Error	6	6.43	1.07	

** Significant at 1% level

respectively. In group II, the total fat yields were 8.78, 10.68, 11.66 and 9.76 kilograms during the four corresponding experimental periods with rations B, A, D and C respectively. With rations C, B, A and D fed to group III, the fat yields were 12.90, 14.24, 13.06 and 12.56 kilograms respectively during the respective four periods of the experiment. The fat yields were 10.12, 12.10, 13.00 and 13.72 kilograms in group IV during the first, second third and fourth experimental periods respectively with rations D, C, B and A respectively. On comparison of the fat yields of the groups with one another it can be observed that there was much variation in the fat yields during all the periods of the experiment. Whereas, in each group, on comparison of the fat yields of different periods, with different rations, there was not much variation to be observed.

On statistical analysis of fat yields no significant difference was observed among the fat yields of the experimental periods as well as due to rations, within each group. Significant difference was observed among groups; which was also existed among groups in respect of fat yields when the animals were grouped at the commencement of the experiment.

Four per cent Fat corrected Milk Yield:

Four per cent fat corrected milk yield in each experimental animal group was presented in Table 11 and the statistical analysis of variance for the same was presented in Table 12.

During the first, second, third and fourth experimental periods with rations A, D, C and B fed to group I the total four per cent FCM yields were 270.49, 305.16, 313.92 and 314.80 kilograms respectively. In group II the total four per cent FCM yields were 196.39, 229.09, 242.71 and 206.45 kilograms during the four experimental periods, with rations B, A, D and C respectively. With rations C, B, A and D fed to group III the four per cent FCM yields were 277.99, 288.38, 267.20 and 261.34 kilograms respectively during the respective four periods of the experiment. The four per cent FCM yields were 219.44, 252.94, 271.80 and 290.61 kilograms in group IV during the first, second, third and fourth experimental periods with rations D, C, B and A respectively. On comparison of the four per cent FCM yields of the groups with one another it can be observed that there was much variation of the four per cent FCM yields during all the periods of the experiment. On the other hand, in each group, on comparison of the four per cent FCM yields of the

Table 11. Four per cent FCM in kilograms in each experimental animal group

Experimental periods (each period 14 days)	Group-I	Group-II	Group-III	Group-IV
First period	270.49 Ration-A	196.39 Ration-B	277.99 Ration-C	219.44 Ration-D
Second period	305.16 Ration-D	229.09 Ration-A	288.38 Ration-B	252.94 Ration-C
Third period	313.92 Ration-C	242.71 Ration-D	267.20 Ration-A	271.80 Ration-B
Fourth period	314.80 Ration-B	206.45 Ration-C	261.34 Ration-D	290.61 Ration-A

Table 12. Analysis of variance of four per cent FCM

Source of variation	Degrees of freedom	Sum of squares	Mean square	F value
Due to periods	3	2649.49	883.16	1.79
Due to groups	3	14202.63	4734.21	9.64*
Due to treatments	3	237.46	79.15	0.16
Error	6	2944.08	490.68	

* Significant at 5% level

different periods, with different rations, there was not much variation to be noticed.

On statistical analysis of four per cent FCM yields no significant difference was observed among the four per cent FCM yields of the experimental periods, as well as, due to the rations with in each group. Ocokoljic et al. (1974) showed that there was no significant difference in the four per cent FCM yields due to inclusion of Sunflower seed meal in the rations. However significant difference was observed among groups, which also existed among groups with regard to four per cent FCM yields when animals were selected and grouped at the commencement of the experiment.

Fat Test:

The average fat test in each experimental animal group was presented in Table 13 and the statistical analysis of variance of fat percentages was shown in Table 14.

During the first, second, third and fourth experimental periods with rations A, D, C and B fed to group I, the averages of fat percentages were 5.68, 6.49, 6.71 and 6.45 respectively. In group II, the averages of fat percentages were 5.42, 6.25, 6.86 and 6.48 during the four experimental periods respectively with rations B, A, D and C respectively. With rations C, B, A and D fed to group III

Table 13. The averages of fat test in each experimental animal group

Experimental periods (each period 14 days)	Group-I	Group-II	Group-III	Group-IV
First period	5.68 Ration-A	5.42 Ration-B	6.10 Ration-C	5.98 Ration-D
Second period	6.49 Ration-D	6.25 Ration-A	7.57 Ration-B	6.77 Ration-C
Third period	6.71 Ration-C	6.86 Ration-D	7.32 Ration-A	6.72 Ration-B
Fourth period	6.45 Ration-B	6.48 Ration-C	6.86 Ration-D	6.46 Ration-A

Table 14. Analysis of variance of averages of fat tests

Source of variation	Degrees of freedom	Sum of squares	Mean square	F value
Due to periods	3	2376.29	792.09	17.21**
Due to groups	3	910.76	303.59	6.59*
Due to treatments	3	64.71	21.57	0.46
Error	6	276.08	46.01	

** Significant at 1% level

* Significant at 5% level

the averages of fat percentages were 6.10, 7.57, 7.32 and 6.86 respectively during the respective four periods of the experiment. The averages of fat percentages were 5.98, 6.77, 6.72 and 6.46 in group IV during the first, second, third and fourth experimental periods respectively with rations D, C, B and A respectively. On comparison of the averages of the fat percentages of groups and of the experimental periods it can be observed that there was much variation in the averages of fat percentages. On the other hand in each group, on comparison of the averages of fat percentages with different rations there was not much variation to be noticed.

On statistical analysis of the averages of fat percentages no significant difference was observed among the averages of fat percentages due to rations, within each group. Starodubcev (1960) stated that there was no significant change in fat content of milk by feeding Sunflower cake to the cows. Ocokoljic et al. (1974) stated that there was no significant difference in the fat tests due to inclusion of Sunflower seed meal in the rations fed to Friesian cows. But significant difference was observed among groups in respect of averages of fat percentages, which existed among groups, when animals were grouped at the commencement of the experiment. Highly significant

difference was observed among periods. But in milk yields, fat yields, four per cent FCM yields, there was no significant variation among the periods in all the groups. Whereas the fat test had highly significant variation indicating strong negative correlation between milk yield and fat test.

Solids-Not-Fat:

The averages of solids-not-fat percentages in each experimental animal group were presented in Table 15 and the statistical analysis of variance of the averages of solids-not-fat percentages was presented in Table 16.

During the first, second, third and fourth experimental periods with rations A, D, C and B fed to group I, the averages of solids-not-fat percentages were 10.37, 10.31, 10.17 and 9.91 respectively. In group II the averages of solids-not-fat percentages were 10.19, 10.27, 10.19 and 9.87 during the four experimental periods respectively with rations B, A, D and C respectively. With rations C, B, A and D fed to group III the averages of solids-not-fat percentages were 10.35, 10.25, 9.95 and 9.52 respectively during the respective four periods of the experiment. The averages of solids-not-fat percentages were 10.16, 10.13, 10.06 and 9.94 in group IV during the first, second, third and fourth experimental periods respectively with rations D, C, B and A respectively. On comparison of the averages

Table 15. The averages of SNF percentages in each experimental animal group

Experimental periods (each period 14 days)	Group-I	Group-II	Group-III	Group-IV
First period	10.37 Ration-A	10.19 Ration-B	10.35 Ration-C	10.16 Ration-D
Second period	10.31 Ration-D	10.27 Ration-A	10.25 Ration-B	10.13 Ration-C
Third period	10.17 Ration-C	10.19 Ration-D	9.95 Ration-A	10.06 Ration-B
Fourth period	9.91 Ration-B	9.87 Ration-C	9.52 Ration-D	9.94 Ration-A

Table 16. Analysis of variance of the averages of SNF percentages

Source of variation	Degrees of freedom	Sum of squares	Mean square	F value
Due to periods	3	306.09	102.30	12.23**
Due to groups	3	59.10	19.70	2.35
Due to treatments	3	11.72	3.91	0.46
Error	6	50.15	8.36	

** Significant at 1% level

of solids-not-fat percentages of different periods it was observed that there was variation of the averages of solids-not-fat percentages. On the other hand, in each group, on comparison of the averages of solids-not-fat percentages, with different rations and groups, not much variation was noticed.

On statistical analysis of the averages of solids-not-fat percentages no significant difference was observed among the averages of solids-not-fat percentages due to rations and among different groups. Ocokoljic et al. (1974) stated that there was no significant difference in the fat tests and percentages of total-solids due to inclusion of Sunflower seed meal in the rations fed to Friesian cows. In this investigation significant difference was observed during the different periods of the experiment.

There were no appreciable changes in the body weights of the animals during the experimental periods with different experimental rations as shown in Table 17.

The economic aspects of the experimental concentrate rations, with the prevailing market rates at the time of this investigation, as influenced by the inclusion of Sunflower seed cake at different levels were presented in Table 18. On comparison with the cost of conventional

Table 17. Weekly average body weights of the Animals during experimental periods

Animal No.	18	714	41	92	760	658	47	772
	(kg)	(kg)	(kg)	(kg)	(kg)	(kg)	(kg)	(kg)
Initial weight	472	415	469	431	482	480	435	492
	Ration-A		Ration-B		Ration-C		Ration-D	
Second week	472	415	470	430	495	481	438	493
Third week	474	414	472	428	500	483	438	495
	Ration-D		Ration-A		Ration-B		Ration-C	
Fifth week	471	432	471	430	493	477	433	493
Sixth week	472	434	469	429	488	474	430	490
	Ration-C		Ration-D		Ration-A		Ration-B	
Eighth week	478	435	485	434	486	484	434	510
Ninth week	480	438	500	440	496	496	439	515
	Ration-B		Ration-C		Ration-D		Ration-A	
Eleventh week	490	434	505	448	492	491	432	521
Twelth week	492	436	505	448	493	493	433	520

Table 18. Cost of concentrate rations used in this experiment

Sl. No.	Ingredient	Cost of in redient per quintal* (s.)	Ration-A		Ration-B		Ration-C		Ration-D	
			Qty. (kg)	Cost (s.)	Qty. (kg)	Cost (Rs.)	Qty. (kg)	Cost (Rs.)	Qty. (kg)	Cost (Rs.)
1.	Maize	185.00	35	64.75	29	53.65	23	42.55	17	31.45
2.	Groundnut cake	150.00	42	63.00	28	42.00	14	21.00	-	-
3.	Sunflower cake	100.00	-	-	20	20.00	40	40.00	60	60.00
4.	Wheat bran	90.00	20	18.00	20	18.00	20	18.00	20	18.00
5.	Mineral mixture**	400.00	2	8.00	2	8.00	2	8.00	2	8.00
6.	Common salt	25.00	1	0.25	1	0.25	1	0.25	1	0.25
Total			100	154.00	100	141.90	100	129.80	100	117.70
Cost per unit DCP in the ration				8.64		7.76		6.93		6.14
Cost per unit TDN in the ration				2.06		1.88		1.71		1.53

* As per the prevailing market rates at the time of this investi ation

** Supermindiff of M/s. Boots Pure Drug Co., (India) Limited.

concentrate ration, a net saving of Rs.26.30 per quintal of the concentrate mixture was observed in the preparation of the ration which contained cent per cent replacement of groundnut cake protein with Sunflower cake protein. For one-third and two-thirds replacement of groundnut cake protein with Sunflower cake protein, the cost of the ration was proportionately decreased and the net savings expected are Rs.12.10 and 24.20 per quintal of the concentrate mixture respectively. When progressive replacement of groundnut cake protein had taken place with the substitution of Sunflower cake in order to formulate isonitrogenous rations, reductions in the quantities of maize and groundnut cake were in fixed proportions. For every twenty units substitution of Sunflower cake in conventional concentrate ration, there was a reduction of six units of maize and fourteen units of groundnut cake protein. On calculation it was observed that for every unit quantity of inclusion of Sunflower cake by way of substitution in conventional concentrate ration, there was a saving of 0.3 units of maize and 0.7 units of groundnut cake.

When water was offered ad libitum to all the animals throughout the periods of experimentation no worth-noting variations in quantities of water consumed by them were observed. The examination of urine did not reveal the

presence of any pathological constituents throughout the experimental periods.

Milk secretion is such a delicate physiological process which will be affected immediately within a day due to any errors in feeds and feeding. The ration which contained only Sunflower cake as the protein supplement was utilised apparently by the animals with equal efficiency in maintaining production and gross composition of milk as that of conventional concentrate mixture. As the milk yield, fat and solids-not-fat percentages remained unchanged throughout the experimental period due to rations, it had become an indirect evidence that there was probably no disturbance in rumen metabolism of buffaloes during the period of experimentation even with the ration that contained Sunflower cake as the sole protein supplement. Taparia (1969) reported that the change in rumen fermentation pattern with a shift in acetate, propionate ratio will not only affect the fat percentage but also the solids-not-fat percentage of milk to a certain extent.

The buffaloes have adjusted to the changes of rations within a short intervening preliminary periods of one week, which fact was arrived at due to absence of variations in milk yield, fat and solids-not-fat percentages throughout

the experimental periods. Mudgal (1966) in a review cited that the buffaloes take less time to adjust for a change to a new ration. It was observed that the animals when fed with the ration which contained Sunflower cake solely have not eaten the ration readily and took comparatively more time to clear up the quantities offered indicating that the Sunflower cake was less acceptable and palatable to the animals than groundnut cake. But the rations with the combination of groundnut cake and Sunflower cake were readily eaten with the same acceptability as observed in the case of conventional concentrate mixture.

SUMMARY AND CONCLUSIONS

An investigation was made by conducting a twelve week experiment with lactating Murrah buffaloes to findout the effects of replacement of groundnut cake protein in concentrate mixture with Sunflower cake protein at one-third, two-thirds and hundred per cent protein levels; on the yields of milk, fat, four per cent fat corrected milk and on the percentages of fat and solids-not-fat.

The inclusion of Sunflower cake replacing hundred per cent groundnut cake protein in concentrate mixture appears to have no significant effect in buffaloes, under the experimental conditions on milk yield, fat yield, four per cent fat corrected milk yield, fat and solids-not-fat percentages.

The buffaloes have readily eaten the concentrate rations which contained the combination of Sunflower cake protein and groundnut cake protein, with equal appetite exhibited by the animals which received conventional concentrate mixture. The buffaloes when fed with a ration which contained Sunflower cake solely have not eaten the ration readily and took comparatively more time to clear up the quantities offered indicating that the Sunflower cake was less palatable to the animals than the groundnut cake.

Water consumption by the experimental animals was normal throughout the period. No pathological constituents were observed in the urine of the experimental animals throughout the period. There was no loss or gain in body weights of the experimental animals throughout the period of experimentation.

Hundred per cent replacement of groundnut cake protein with the Sunflower cake protein in the concentrate mixture resulted in the reduction of the cost of concentrate mixture by Rs.363/- per tonne. For every unit inclusion of Sunflower cake by way of substitution, replacing groundnut cake, in conventional concentrate ration, there was a saving of 0.3 units of maize and 0.7 units of groundnut cake protein.

This being a preliminary investigation to findout the utility value of Sunflower cake in lactating Murrah buffaloes further trials under the same experimental conditions and feeding regieme, are necessary for inference and confirmation of these observations recorded during this investigation.

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