EVALUATION OF COFFEE HUSK FOR MILK PRODUCTION IN COWS

BY

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THESIS

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DECLARATION

I hereby declare that this thesis entitled "EVALUATION OF COFFEE HUSK FOR MILK PRODUCTION IN COWS" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

P.I. Geevarghese.

Mannuthy,
28-7-1979.

CERTIFICATE

Certified that this thesis entitled "EVALUATION OF COFFEE HUSK FOR MILK PRODUCTION IN COWS" is a record of research work done independently by Sri. P.I. Geevarghese under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to him.

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INTRODUCTION

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The scope for rural dairying in India is enormous due to the size and socio-economic situation in the country. The human population in India is 560 million and 80 per cent of people live in rural environment and a vast majority depends largely upon cows and buffaloes for the milk production and draught power. Due to long periods of neglect the productivity of our stock has gone down. It is widely recognized that a well planned and interdependent programme of Animal Husbandry and Agriculture can help to reduce the under employment and increase the purchasing power of the people. So every improvement in the efficiency of milk production, processing and marketing directly contributes to the well being of the rural people in India.

According to the livestock census of 1972, the total livestock population in India has been enumerated to be 354.98 million (Dharmendrakumar, 1977) and to feed this livestock population an estimated quantity of 19.57 million tonnes of concentrates, 347.41 million tonnes of dry fodder and 343.57 million tonnes of green fodder are required (Report of National Commission on Agriculture, 1976).

According to the livestock census of 1977 the cattle and buffaloe population in Kerala has been estimated as

3.00 million and 0.447 million respectively (Farm Information Bureau, 1979). The total milk production in the State during 1975-76 was estimated to be 0.55 million tonnes, with an average per capita availability of 65g (Subrahmanyam and Nair, 1979). The productivity of animals in Kerala State is much lower compared to that in many other states of India and the main cause for this is reduction in the availability of grazing facilities to negligible level.

The cost of milk production is higher in Kerala than in many other parts of India, mainly due to the high cost of feed. According to the estimate made in 1975-76 the amount of concentrate required to produce one kg of milk from cows and buffaloes was 0.556 and 0.919 kg respectively (Nair, 1978). If all the available sources are fully tapped the total supply of concentrate will come to two lakh tonnes. Besides, the State at present imports 1.5 lakh tonnes of concentrate from other States to cater to the needs of the livestock in the State (Nair, 1978).

According to the Report of the National Commission on Agriculture (1976) only two-thirds of the fodder and one-fourth of the concentrates required for providing adequate nutrition to the present animal population are available in India. Naik (1977) has also reported that there is a deficiency of 60 to 70 per cent concentrates and 30 to 40 per cent roughages in the country. The shortage of cattle feeds is probably the greatest bottle neck to cattle development and increased milk production in the country. Estimates of the requirement and actual availability of feeds and fodders made in the past have indicated a very wide gap between the demand and supply of feeds and fodders for optimum livestock development. About 60 per cent of the cost of milk production is attributed to the cost of feeds. These facts therefore highlight the need for supply of nutrients required for milk production as cheap as possible.

The present shortage of feeds and fodders for cattle has led the nutritionists to evaluate new feeds from Agricultural by-products and Industrial waste materials and it has been found to be the only possible way to reduce the feed cost. A by-product may be considered as a subsidiary component resulting from the production of a main product in an enterprise (Orskov, 1977).

Ulhas (1976) reported that 80 per cent of the available source of cattle feed is from Agro-Industrial by-products and the rest from cultivated fodder. The country produces a number of Agricultural and Industrial by-products, which normally go as waste. These can properly and economically be exploited for the feeding of cattle, by incorporating them in the ration of cattle.

While evaluating a by-product one should consider the nutritive value, palatability, availability of the material, cost, presence of toxic materials, etc. A great deal of investigations has been carried out under the auspices of Indian Council of Agricultural Research by several workers regarding the utilisation of many of the Agricultural by-products and Industrial wastes for animal feeding. Some of the items such as tapioca starch waste, silk worm pupa, jack fruit waste, sal seed meal, tea waste, rubber seed cake and silk cotton seed cake have been found useful in the feeding of livestock. There are many more of such items available in the country and it is worthwhile to investigate the usefulness of such items for feeding livestock.

Coffee is an important plantation crop in South India. The genus _Coffea_ to which the common coffee belongs has 25 or more species, most of which grow only wild. Of the various species _Coffea arabica_ and _Coffea robusta_ are mostly cultivated (Encyclopaedia Britanica, 1957).

In 1975-76 the total area under cultivation of coffee in India was 1,71,535 hectares (Annual Report, Coffee Board, 1977). Coffee is cultivated in the States of Kerala, Karnataka, Tamil Nadu and in some parts of Andhra Pradesh. Karnataka ranks first in the cultivation and production of coffee. In Kerala about 40,502 hectares of land is under the cultivation of coffee. The total coffee production during the year 1976-77 was 1,02,500 tonnes in India and in Kerala the production was 15,030 tonnes (Annual Report, Coffee Board, 1978).

Coffee is prepared by either a dry or wash process. By the dry method sometimes called as unwashed or natural, the dried coffee cherries are passed in to huller, where the husk is removed and beans separated. Coffee husk is composed of the outer covering of the cherry and a layer of yellowish jelly like substance that surrounds the beans.

The availability of coffee husk in India has been estimated as 44,450 tonnes (Vimal, 1976). In Kerala more than 1,000 tonnes are expected to be available from the Wynad area alone.

Preliminary studies carried out at College of Veterinary and Animal Sciences, Mannuthy, indicated that coffee husk is palatable for bullocks, when mixed with equal quantity of groundnut oil cake. The animals consumed upto 1.5 kg per day. It has also been found that coffee husk can profitably be incorporated upto 10 per cent in the ration for growing calves (Ananthasubramaniam et al., 1977). However, information on the utilisation of coffee husk for dairy cows is lacking.

The coffee husk, obtained as a by-product in the coffee industry, now being used as fuel and manure in this State, if has the potential to successfully replace part of rice bran in the concentrate mixture, the cost of feeding milch cows may be able to be curtailed. Hence the present investigation was undertaken to assess the feeding value of coffee husk for milk production in cows and to find out the effect of coffee husk feeding on the characteristics of butter fat.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Feeding contributes the largest item of cost in milk production and hence it is of utmost importance that feeding cost is kept at the lowest possible level to make milk production profitable. With an increase in agricultural crop production, there will be a greater availability of by-products and possibly of coarse grains. These are to be profitably used as cattle feeds. The compounded livestock feed industry should be encouraged for maximising the use of these products. It is not an easy task to incorporate higher levels of Agricultural and Industrial waste materials in animal rations without detrimental effect. Research in the past paved the way to enumerate more and more Agricultural and Industrial waste materials, which can successfully be incorporated in animal rations.

Coffee husk belongs to the group of husk and hulls, under the class roughages. They possess more than 18 per cent crude fibre and are usually low in crude protein (Crampton, 1956). Several types of husks and hulls are used in animal rations.

Hale et al. (1969) reported that in a 72 per cent cotton seed hull ration, the total digestible nutrients of cotton seed hull on a dry matter basis was estimated to be 44 per cent. Rojas and Zevallos (1972) conducted an experiment in which a concentrate mixture consisting of 25 per cent ground maize cobs, 10 per cent cotton seed hulls, 25 per cent sugarcane molasses and 38 per cent cotton seed meal caused a 11 per cent drop in daily milk yield ($P < 0.01$) as compared to a concentrate mixture comprising of 40 per cent wheat bran, 12 per cent sugarcane molasses and 45 per cent cotton seed meal. On the basis of four per cent fat-corrected milk the drop in milk yield was six per cent.

Bhargava and Talapatra (1969) reported that pea pods contained 10.35 per cent digestible crude protein, 70.18 per cent total digestible nutrients and 55.04 per cent starch equivalent. Ranjhan (1970) has reported that green cowpea pods has the following percentage composition: crude protein 20.3, ether extract 1.48, crude fibre 18.53, nitrogen free extract 52.39, ash 7.29, calcium 0.55 and phosphorus 0.40. The digestible crude protein and total digestible nutrients have been 13.0 per cent and 58.4 per cent respectively.

Horse gram pod shells have been reported to contain 8.45 crude protein, 1.03 ether extract, 44.53 crude fibre, 83.23 total carbohydrates, 1.08 calcium, 0.08 phosphorus and 0.21 magnesium on percentage basis (Amrithkumar et al., 1975). In a feeding trial animals readily consumed the horse gram pod shells thereby indicating the palatability. The average consumption was around nine to ten kg per day, while the dry matter intake was 1.86 kg per 100 kg body weight. The nutritive value in terms of digestible crude protein, starch equivalent and total digestible nutrients was 2.99, 24.87 and 49.00 per 100 kg dry matter respectively.

Bateman and Fresnillo (1967) found that the dried untreated cocoa pod contained 93.3 dry matter, 9.7 ash, 6.8 crude protein, 1.5 ether extract, 35.4 crude fibre, 46.6 nitrogen free extract, 0.63 calcium and 0.17 phosphorus on percentage basis. Ananthasubramaniam et al. (1977) reported that fresh cocoa pods contained 17.00 per cent dry matter, 4.18 crude protein, 39.12 crude fibre, 1.04 ether extract, 49.26 nitrogen free extract and 6.40 total ash. Bateman and Fresnillo (1967) calculated that the digestible organic matter of cocoa pod meal ranged from 28.9 to 32.4 per cent.

Patel et al. (1970) reported that mango seed kernal contained (percentage basis) 5.8 crude protein, 13.2 ether extract, 1.3 crude fibre, 76.7 nitrogen free extract, 3.0 ash, 0.8 silica, 0.27 phosphorus and 0.25 calcium. It was found that mango seed kernal can be incorporated upto 10 per cent level in the ration of dairy cattle, without any adverse effect on milk yield. Patel et al. (1971) found that mango seed kernal can be incorporated upto 20 per cent in the experimental concentrate mixture fed to growing cow calves without affecting the growth rate.

Jack fruit waste, the discarded portion of the fruit after the removal of the edible portion has been reported to contain 21.1 dry matter, 7.9 crude protein, 5.7 ether extract, 14.1 crude fibre, 65.3 nitrogen free extract, 7.0 total ash, 0.5 acid insoluble ash, 0.80 calcium and 0.10 phosphorus on percentage basis. When fed as the sole ingredient in the ration, the cattle were found to consume upto 1.7 per cent of the body weight. The material possessed a digestible crude protein and total digestible nutrients of 1.2 per cent and 19.9 per cent respectively on fresh basis (Ananthasubramaniam et al., 1978).

Tea waste which is a by-product of instant tea manufacturing industry contained 9.7 per cent digestible crude protein and 43.0 per cent total digestible nutrients. The material was found to be palatable and animals consumed upto 1.5 kg per day (Ananthasubramaniam and Menachery, 1976). Prasad (1978) found that feeding tea waste at the rate of 15 or 25 per cent reduced milk yield significantly as compared to the control group having no tea waste in the ration. However, quality of the milk remained unaltered.

Several reports regarding the utilisation of by-products like spent ani seed (Nath et al., 1966), sea weeds (Shukla et al., 1974; Desai and Shukla, 1974), pineapple cannery waste (Sathapathy, 1978), pineapple bran and pineapple hay

(Otagaki et al., 1961), pineapple silage (Biship and Nell, 1974), cassia tora seeds (Patel et al., 1971), dried tomato residue (Ralo et al., 1964), tomato waste (Patel et al., 1971), bajada cake (Sastry et al., 1973), warai bran (Desai and Rangnekar, 1978) and mustard cake (Paliwal et al., 1976) for incorporation in the ration of livestock.

On a dry matter basis the green coffee has been reported to contain 50 to 60 per cent carbohydrates including one per cent simple reducing sugars, seven per cent sucrose and two per cent pectins with the remainder as various poly and oligosaccharides (De Burry, 1975). Beans of Coffea arabica contained 1.558 per cent of caffeine on dry matter basis (Somorin, 1974).

The feeding value of spent coffee grounds for ruminants has been studied by Mc Niven et al. (1977). Coffee grounds, a by-product of instant coffee industry, was found to contain on percentage basis crude protein 10, crude fibre 4.4, ether extract 26, ash 0.75, moisture 8 and tannic acid 0.9. In two trials of latin square design conducted on six Holstein bullocks, they were given a basal diet with maize and sorghum or added with 5, 10 or 20 per cent coffee grounds, to replace some of the grains, giving more ether extract and crude fibre. When the percentage of coffee grounds was increased the digestibility of dry matter, crude protein and energy decreased and that of ether extract rose and the output of urine increased. With incorporation of 5 or 10 per cent coffee grounds, retention of nitrogen decreased and that with 20 per cent loss in nitrogen noticed (Campbell et al., 1976).

Cabezas et al. (1975) conducted nitrogen balance experiments with three diets on five male Holstein calves. The constant parts of these diets were cotton seed meal 25, sugar 10 and minerals 3 per cent and variable parts contained maize meal 52 and coffee husk 10 per cent, maize meal 32, coffee husk 5 and dried coffee pulp 20 per cent, maize meal 22 and coffee pulp 40 per cent. The intake of coffee pulp on the three diets were 0, 12 and 24 per cent of the total feed. Absorption and retention of nitrogen decreased as the amount of coffee pulp in the diet increased and urinary nitrogen rose. Also the volume of urine increased when higher levels of coffee pulp were fed. Cabezas et al. (1976) found that replacing cotton seed hulls by coffee pulp in the diets of calves produced a significant decrease in the body weight gain as compared to the control group which was not fed with coffee pulp.

Coffee husk, a by-product in coffee seed processing industry, is not having much use in animal feeding. In addition to being used as a fuel (Annual report of the East

African Research Organization for 1958-59) it is also used as a manure. In some parts of India, people prefer to drink beverage made out of roasted outer husks of cherries (Wellman, 1961).

It is reported that coffee husk contained (percentage basis) 92.30 dry matter, 7.70 crude protein, 2.50 ether extract, 26.50 crude fibre, 57.90 nitrogen free extract, 5.4 total ash, 0.30 calcium and 0.13 phosphorus (Ananthasubramaniam and Menachery, 1976). On fractionation of the carbohydrates in the coffee husk Jarquin _et al_. (1976) reported that in the soluble carbohydrates, hexoses were 0.45 g per 100 g and in the structural carbohydrates pentoses 20.30, hexoses 45.90, lignin 24.40 and nitrogen extract plus crude fibre 96.21 g per 100 g.

Kehar and Sahai (1951) reported that coffee husk has 3.38 per cent digestible crude protein, 42.54 per cent total digestible nutrients and 18.27 per cent starch equivalent. Ananthasubramaniam and Menachery (1976) reported similar values ie., 3.1 per cent digestible crude protein and 50.0 per cent total digestible nutrients. The digestibility of the dry matter by pepsin and hydrochloric acid _in vitro_ was reported as 10.30 per cent (Jarquin _et al_., 1976).

Kehar and Sahai (1951) reported that buffaloes hesitated to eat the husk, but after an acclimatisation period of four to five days the consumption became three to five pounds daily. Coffee husk has been found to be palatable for bullocks when mixed with equal amount of groundnut oil cake and that the animals consumed upto 1.5 kg of husk per day (Ananthasubramaniam et al., 1977).

Tannins generally bring about reduction in feed intake and digestibility of proteins. In ruminants they affect microbial protein synthesis at a level of 1.25 per cent. The tannic acid content of coffee husk has been reported to be 2.8 per cent (Ananthasubramaniam and Menachery, 1976). This value is much less as compared to the tannin content of 3.5 to 13.33 per cent reported in sal seed meal (Arora et al., 1978).

Ananthasubramaniam et al. (1977) carried out growth studies in calves fed with coffee husk replacing half the portion of rice bran (10%) in a concentrate mixture as against a control ration with 20 per cent rice bran. No significant difference ($P \angle 0.05$) between groups in respect of gain in body weight was reported and indicated that coffee husk can be profitably incorporated upto 10 per cent level in the ration for growing calves.

Ledger and Tillman (1973) fed 32 bullocks to study the effect of replacing ground maize in a highly concentrated fattening diet with 10, 20 or 30 per cent coffee husk. Feed intake and feed conversion were not affected by addition of 10 or 20 per cent, but addition of 30 per cent reduced them. Jarquin et al. (1976) fed seven Holstein calves with diets having 0, 15 or 30 per cent coffee husk. The weight was found to decrease as the percentage of husk in the diets increased. Feed intake was less with 30 per cent coffee husk than with none. In another trial with bullocks, pelletting the diet with coffee husks did not increase the weight gain.

From the foregoing it is noted that studies for inclusion of Agricultural by-products and Industrial waste materials, in the ration of cattle, have always been in progress. As regards the utilisation of the various industrial by-products of the coffee industry some work has been done on the chemical composition, nutritive value and utilisation of materials like coffee grounds, coffee pulp and coffee husks. The studies have been mostly on utilisation of these products for obtaining growth rate in animals and very little on the effect of using these materials for milk production.

MATERIALS AND METHODS

MATERIALS AND METHODS

The experiment was carried out at the University Livestock Farm, Mannuthy, to determine the effect of feeding rations containing different levels of coffee husk for milk production. Coffee husk was included in the concentrate mixture at 0, 10 and 20 per cent levels. A switch-over design of three dietary treatments, spread over a period of 30 days each was followed.

Nine Jersey x Sindhi crossbred cows formed the animals for the feeding trial. The animals were divided into three groups of three animals each, as uniformly as possible, with respect to the yield and stage of lactation. The details of animals selected for this study are presented in Table 1 and the grouping of animals for different dietary treatments are given in Table 2.

The coffee husk used for the experiment was supplied by M/s L.R. Rangier and Sons, Coffee Board Agents, Calicut-1. The material was analysed for proximate principles as per the Standard Methods described in A.O.A.C. 1970.

The composition of concentrate mixtures used for the eding trial is given in Tables 4, 5 and 6. The analysis of the concentrate mixture for their contents of crude protein, crude fibre, ash, acid insoluble ash and ether extract were carried out as per Standard Methods described in A.O.A.C. (1970).

The requirements of concentrate for each animal were computed as per the Sen and Ray StandardS(1971). The animals were housed in stalls and fed individually. The total amount of concentrate required for an animal for a day was divided into two equal parts and fed in the morning and evening. The total quantity of concentrate consumed by each animal in a day was calculated by difference from the quantity given and the quantity left over as not eaten.

Paddy straw formed the roughage portion of the diet and six to eight kg paddy straw was fed daily to each animal. Animals were provided with clean water ad libitum. The order in which the rations were interchanged at the termination of each phase of experiment, lasting for 30 days was as indicated below.

	Group I			Group II			Group III		
Tatoo number of the animal	559	561	621	476	415	C-57	648	644	T-63
First phase	C	A	B	B	A	C	A	B	C
Second phase	B	C	A	A	C	B	C	A	B
Third phase	A	B	C	C	B	A	B	C	A

Diet A = Concentrate mixture containing 20% coffee husk.
Diet B = Concentrate mixture containing 10% coffee husk.
Diet C = Concentrate mixture containing 0% coffee husk.

The body weight of cows used for the feeding trial was recorded in the morning before feeding making use of a platform balance with an accuracy of 500 g. The animals were weighed at the commencement of the experiment and at the end of every phase.

The total daily milk yield of the individual animals was recorded by means of a herd recorder having an accuracy of 100 g. The samples of milk in relation to the yield at each milking was collected from individual cows at the middle and end of each trial period. The samples were thoroughly mixed before the analyses were made.

The fat content of the milk was estimated using the Gerber's method as described in Indian Standards, I.S. 1224 (1958). The total solids content in the milk was determined by gravimetric method as per the procedure described in Indian Standards, I.S. 1479, Part II (1960). The solids-not-fat content in the milk samples was derived by substracting the fat percentage from the total solids percentage.

The fat-corrected milk was calculated using Gaine's formula. Four per cent fat-corrected milk = 0.4 M + 15 F, where M = weight of milk and F = weight of fat contained in it (Maynard and Loosli, 1969). The solids-corrected milk was derived by the formula SCM (kg) = 12.3 (F) + 6.56 (SNF) minus 0.0752 (M), where SCM is the solids-corrected milk, F = fat, SNF = solids-not-fat, M = milk expressed in kilogram (Tyrell and Reid, 1956). Dairy merit was calculated by using the formula, $100 \times \frac{340 \times FCM}{1814 \times TDN}$ where FCM is the fat-corrected milk, TDN = total digestible nutrient (Brody, 1945). Maynard and Loosli (1969) substituted a value of 2000 KCal per pound of TDN instead of 1814 by Brody, for calculating digestible energy from TDN. The quantity of concentrate required to produce one kg milk (feed efficiency) for individual animals in different phases of the experiment was also calculated.

The milk samples from animals in each group was pooled at the end of every phase of experiment and butter was prepared. The melting point, saponification value and iodine number of the butter fat were estimated as per the methods described by Woodman (1941).

Blood samples for laboratory examination were collected using a reagent grade Ethylenediamine tetra acetic acid disodium salt (EDTA) as anticoagulant at the rate of 10 mg for every 10 ml of blood. Blood was drawn for haematological studies from the jugular vein, under aseptic conditions at the commencement and at the end of every phase of the experiment. The method described by Coffin (1953) was adopted for finding out the R.B.C. count. The haemoglobin content was estimated by Wongs method as described by Oser (1964). The Wintrobe method as described by Kolmer et al. (1969) was used for the estimation of packed cell volume.

The data obtained from the experiment were arranged in tables for statistical analyses. For the purpose of statistical analyses the data collected during the first seven days of each period of treatment have been excluded and the same for the next 23 days only have been included, since the first seven days period has been considered as the pre-trial period to eliminate the carry over effect. Statistical analyses were done according to the Standard Methods (Snedecor and Cochran, 1967). The data from the three groups of animals on total milk production, butter fat yield, total solids yield, fat-corrected milk and solids-corrected milk were compared using analysis of variance technique.

RESULTS

RESULTS

The coffee husk was analysed for the estimation of proximate principles. It was found that it contained 6.75 per cent moisture. The composition on dry matter basis is presented in Table 3. The composition and the cost of the concentrate mixtures containing 0 per cent (C), 10 per cent (B) and 20 per cent (A) coffee husk are presented in Tables 4, 5 and 6 respectively. The cost per kilogram concentrate worked out to be Rs.1.21, 1.20 and 1.25 for mixtures A, B and C respectively. The total digestible nutrients and digestible crude protein were almost same for the three concentrate mixtures. The chemical composition of the concentrate mixtures is presented in Table 7. All the three concentrate mixtures were almost similar in their contents of crude fibre, crude protein and ether extract.

The body weight of the cows used for the study taken at the commencement and end of each phase of the experiment are given in Table 8. At the commencement of the experiment the body weight (kg) of the cows ranged from 234 to 296.

The quantity of concentrate consumed by the animals in each phase and the total quantity of the concentrate consumed by the animals during the experimental period are set out in Table 10. The maximum and the minimum feed consumption recorded by individual animals were 331.0 (Cow No. 559) and 263.5 kg (Cow No. C-57) respectively. The total quantity of the concentrate (kg) consumed by animals in the first, second and third phases was 805.5, 903.0 and 960.5 respectively. During the entire period of this experiment the animals on treatment A, B and C consumed 858.0, 912.0 and 899.0 kg of concentrate respectively.

The daily as well as total milk yield of the individual cows for the three different phases are given in Tables 11, 12 and 13 respectively. The highest and lowest daily milk yield (kg) recorded for an individual animal was 9.5 and 3.0 respectively. The total quantity of milk (kg) produced by individual cows during the experimental period is given in Table 14. The maximum and minimum quantity (kg) of milk produced by an individual cow in a phase was 196.3 and 66.6 respectively. During the first, second and third phases the total milk production (kg) was 1350.9, 1214.7 and 1135.7 respectively. The total milk production (kg) for the entire period for the three different treatments A, B and C was 1271.5, 1195.1 and 1234.7 respectively. The analysis of variance of the total milk yield of the cows is given in Table 15.

The data pertaining to the average percentage of fat in milk of cows are given in Table 16. A highest percentage of fat obtained was 6.15 and the lowest being 3.90. The analysis of variance regarding the percentage of fat is given in Table 17. The quantity of milk fat (kg) produced by cows during each phase and total production for the entire trial period are tabulated in Table 18. The total milk fat production (kg) for all animals during the first, second and third phases was 66.83, 55.36 and 52.24 respectively. During the entire period of this experiment the animals on treatment A, B and C produced 60.13, 54.35 and 59.95 kg of milk fat respectively. The analysis of variance of the total milk fat yields of the cows is given in Table 19.

The total quantity of four per cent fat-corrected milk (kg) produced by cows during each phase and the total yield for the three phases are presented in Table 20. The total quantity of fat-corrected milk (kg) during the first, second and third phases was 1542.81, 1316.28 and 1237.88 respectively. The highest and lowest yield (kg) obtained for individual animals in a phase was 259.37 and 82.59 respectively. The total amount of four per cent fat-corrected milk (kg) for the different treatments A, B and C during the period of study was 1410.55, 1293.29 and 1393.13 respectively. The analysis of variance of the total fat-corrected milk yield of the cow is presented in Table 21.

The percentage of total solids in the milk of individual cows ranged from 12.30 to 14.59 (Table 22). The analysis of variance with respect to the percentage of total solids in milk is presented in Table 23. The quantity of total solids (kg) in milk of individual cows for each phase and total for the three phases are given in Table 24. During the first, second and third phases the animals produced a total quantity of 189.80, 162.17 and 154.66 kg of total solids respectively. The animals on the different treatments A, B and C produced 171.57, 163.30 and 171.76 kg of total solids respectively during the period of study. The analysis of variance of the total solids in milk of the cows is given in Table 25.

The percentage of solids-not-fat content in milk ranged from 7.94 to 9.79 for individual animals (Table 26). The animals getting ration B (10% coffee husk) had a higher percentage of solids-not-fat in milk. Table 27 shows the analysis of variance of the percentage of solids-not-fat in the milk. Table 28 gives the quantity of solids-not-fat (kg) in milk during each phase and total for the three phases for the individual cows. A minimum of 5.26 and maximum of 17.72 kg of solids-not-fat were obtained during the different phases. The total quantity of solids-not-fat produced by the nine cows during the first, second and third phases was 122.95, 106.75 and 102.39 kg respectively. During the entire period of the experiment the animals on diet A, B and C produced 111.41, 108.91 and 111.77 kg of solids-not-fat in milk respectively. The analysis of variance of the solids-not-fat content in the milk of the cows is given in Table 29.

The quantity of solids-corrected milk (kg) produced by individual cows during the different phases and the total quantity produced during the trial period are presented in Table 30. The quantity varied from 75.51 to 249.94 kg for individual cows. The total quantity (kg) of solids-corrected milk in the first, second and third phases was 1527.01, 1289.48 and 1228.79 respectively. The total amount of solids-corrected milk by the animals on diets A, B and C was 1374.90, 1292.64 and 1377.72 kg respectively for the entire period of the experiment. The analysis of variance of the solids-corrected milk of the cows is presented in Table 31.

The total erythrocyte count (million/mm^3), haemoglobin content (g/100 ml), packed cell volume (%) of the blood samples collected from individual cows during the course of the experiment are given in Tables 32, 33 and 34. The erythrocyte count (million/mm^3) ranged from 4.02 to 7.13. The values obtained for the haemoglobin content (g/100 ml) varied from 8.0 to 12.0. The range for packed cell volume (%) was 29.0 to 46.0.

Samples of butter fat obtained from the milk of the experimental cows were analysed for physical and chemical constants such as melting point (0°C), iodine number (g/100 g) and saponification number (mg/g). The values are presented in Table 35. The melting point (0°C) ranged from 30 to 34. The values obtained for the saponification number (mg/g) varied from 230.58 to 240.04. The range for iodine number (g/100 g) was 24.12 to 29.78. The analysis of variance of the physical and chemical constants of the butter fat samples analysed are tabulated in Table 36.

The gross efficiency of milk production (dairy merit) is presented in Table 37. The gross efficiency was more in the animals on diet A. The quantity of concentrate required to produce one kg milk (feed efficiency) was also calculated for the individual animals for the different phases (Table 38) The analysis of variance for feed efficiency is presented in Table 39.

The economics of incorporating coffee husk in the concentrate ration of cows for milk production has been worked out and presented in Fig. 1.

TABLES

Table 1. Age and details of lactation of experimental cows.

Sl. No.	Cow No.	Date of birth	Date of last calving	Average daily milk yield (kg)	No. of days in milk at the commencement	Lactatio number
1	559	26-12-75	30-10-78	7.92	66	I
2	C-57	21-5-76	23-9-78	8.87	103	II
3	T-630	26-6-74	5-12-78	8.30	30	II
4	621	5-9-76	23-10-78	9.34	73	I
5	476	13-10-74	16-9-78	11.79	110	II
6	644	2-1-75	16-11-78	11.99	49	II
7	561	3-1-76	24-10-78	7.89	72	I
8	415	8-12-73	20-9-78	9.58	106	II
9	648	1-3-75	11-11-78	11.84	54	II

Table 2. Grouping of animals for different treatments.

Treatment	First phase	Second phase	Third phase
	559	561	621
Diet C	C-57	415	476
	T-630	648	644
	621	559	561
Diet B	476	C-57	415
	644	T-630	648
	561	621	559
Diet A	415	476	C-57
	648	644	T-630

Diet C = Concentrate mixture containing coffee husk at 0% level.
Diet B = Concentrate mixture containing coffee husk at 10% level
Diet A = Concentrate mixture containing coffee husk at 20% level

Table 3. Chemical composition of coffee husk (on Drymatter basis - percentage).

Crude protein	-	7.58
Crude fibre	-	30.05
Ether extract	-	2.04
Nitrogen free extract	-	54.34
Total ash	-	5.99
Acid insoluble ash	-	1.37
Calcium	-	0.45
Phosphorus	-	0.31

Table 4. Percentage composition and cost of the concentrate mixture C (control diet - 0% coffee husk).

Ingredients	Percentage	DCP	TDN	Cost per 100 kg (Rs)
Groundnut cake	30	12.52	21.30	58.80
Maize	32	2.36	27.16	44.80
Rice bran	35	2.10	21.00	18.51
Coffee husk	..	..	..	..
Common salt	2	..	..	0.64
Mineral mixture*	1	..	..	2.00
Total	100	16.98	69.46	124.75

* Calciphos supplied by M/s Cheeran and Co., Trichur.
Vitamin A and D_3 (Vitablend - Glaxo - for livestock) added at the rate of 20 g/100 kg of mixed feed.

Table 5. Percentage composition and cost of the concentrate mixture B (experimental diet with 10% coffee husk).

Ingredients	Percentage	DCP	TDN	Cost per 100 kg (Rs)
Groundnut cake	30	12.52	21.30	58.80
Maize	32	2.36	27.16	44.80
Rice bran	25	1.50	15.00	13.23
Coffee husk	10	0.30	5.00	1.00
Common salt	2	..	..	0.64
Mineral mixture*	1	..	..	2.00
Total	100	16.68	68.40	120.47

* Calciphos supplied by M/s Cheeran and Co., Trichur.
Vitamin A and D_3 (Vitablend - Glaxo - for livestock) added at the rate of 20 g/100 kg of mixed feed.

Table 6. Percentage composition and cost of the concentrate mixture A (experimental diet with 20% coffee husk).

Ingredients	Percentage	DCP	TDN	Cost per 100 kg (Rs)
Groundnut cake	32	13.36	22.72	62.72
Maize	34	2.51	28.90	47.60
Rice bran	11	0.66	6.60	5.72
Coffee husk	20	0.60	10.00	2.00
Common salt	2	..	..	0.64
Mineral mixture*	1	..	..	2.00
Total	100	17.13	68.22	120.68

* Calciphos supplied by M/s Cheeran and Co., Trichur. Vitamin A and D_3 (Vitablend - Glaxo - for livestock) added at the rate of 20 g/100 kg of mixed feed.

Table 7. Chemical composition of concentrate mixture used for the experiment - percentage basis.

Sl. No.	Constituents	Concentrate mixture with 0% coffee husk (C)	Concentrate mixture with 10% coffee husk (B)	Concentrate mixture wit 20% coffee husk (A)
1	Moisture	5.82	5.84	5.90
2	Crude protein	22.37	22.41	21.20
3	Ether extract	3.92	2.25	3.75
4	Crude fibre	10.69	12.75	10.69
5	Nitrogen free extract	54.41	53.61	56.94
6	Total ash	8.63	8.95	7.40
7	Acid insoluble ash	5.38	5.04	4.22
8	Calcium	1.02	1.19	1.04
9	Phosphorus	0.83	0.67	0.69

Table 8. Body weight (kg) of cows used for the experiment.

Animal number	At the commencement	At the end of the first phase	At the end of the second phase	At the end of the thi[rd] phase
		DIET-C	DIET-B	DIET-A
559	263.5	235.0	230.0	230.0
C-57	290.0	275.0	272.0	278.0
T-630	240.0	231.0	230.0	226.0
		DIET-B	DIET-A	DIET-C
621	234.0	217.0	221.0	219.0
476	288.0	282.0	275.0	262.0
644	252.0	251.0	232.0	234.0
		DIET-A	DIET-C	DIET-B
561	294.0	270.0	262.0	258.0
415	296.0	286.0	282.0	280.0
648	276.0	261.0	244.0	248.0

Table 9. Body weight of cows. Analysis of variance.

Source	df	SS	MSS	F
Between animals	8	12702.29	1587.79	
Between periods within squares	6	424.29	70.72	
Between treatments	2	71.68	35.84	1.44
Error	10	248.20	24.82	
Total	26	13446.46		

Table 10. Quantity of concentrate mixture (kg) consumed by cows.

Animal number	During the first phase	During the second phase	During the third phase	Total
	DIET-C	DIET-B	DIET-A	
559	93.0	113.0	125.0	331.0
C-57	80.5	91.0	92.0	263.5
T-630	101.0	103.5	103.5	308.0
Total	274.5	307.5	320.5	902.5
	DIET-B	DIET-A	DIET-C	
621	89.5	92.0	101.0	282.5
476	94.0	84.5	103.5	282.0
644	89.0	102.5	103.5	295.0
Total	272.5	279.0	308.0	859.5
	DIET-A	DIET-C	DIET-B	
561	78.0	111.0	125.0	314.0
415	88.5	103.0	103.5	295.0
648	92.0	102.5	103.5	298.0
Total	258.5	316.5	332.0	907.0
Grand total	805.5	903.0	960.5	2669.0

Total A - 858.0
B - 912.0
C - 899.0

Table 11. Daily milk yield (kg) of animals during the first phase.

Diet	Animal number	Days											
		1	2	3	4	5	6	7	8	9	10	11	
C No coffee husk	559	6.4	7.6	7.3	7.1	7.3	6.8	7.4	7.3	7.1	7.2	7.7	7
	C-57	5.3	5.0	5.6	5.8	5.4	5.2	5.1	5.4	4.7	5.5	6.4	5
	T-630	8.4	8.8	9.5	8.9	8.8	8.7	8.1	8.3	8.2	8.4	9.1	9
B Coffee husk at 10% level	621	5.2	5.0	5.1	4.6	4.9	4.9	4.8	5.0	5.0	5.1	5.2	3
	476	6.2	6.1	6.5	5.5	6.6	5.9	6.2	6.9	6.3	6.9	7.4	6
	644	7.0	6.8	5.0	6.7	7.4	5.9	6.4	7.0	8.2	8.2	8.5	7
A Coffee husk at 20% level	561	5.9	6.1	6.8	6.2	6.1	6.3	6.6	6.4	6.6	6.5	7.9	6
	415	6.8	6.5	6.8	6.8	6.5	6.6	6.9	7.0	6.9	7.0	7.3	7
	648	6.6	6.7	6.3	5.9	5.8	5.7	5.0	6.2	6.2	5.8	6.0	5

(Table 11 contd..

Diet	Animal number	Days 13	14	15	16	17	18	19	20	21	22	23	Total
C No coffee husk	559	7.2	7.1	6.9	7.3	6.7	8.9	6.6	6.5	6.9	6.4	6.5	163.2
	C-57	5.9	5.9	5.2	5.7	5.6	5.7	5.0	5.6	4.6	4.7	3.9	122.5
	T-630	8.4	7.8	8.2	7.9	8.8	8.0	8.6	8.5	9.1	8.2	8.4	196.3
B Coffee husk at 10% level	621	5.2	4.9	5.2	5.1	5.4	4.1	5.6	5.4	5.3	4.7	5.1	114.5
	476	6.6	6.7	6.6	6.0	6.6	6.5	6.6	5.7	7.1	7.0	6.6	149.2
	644	8.0	7.8	7.2	5.9	8.4	8.7	8.2	7.4	6.9	7.6	7.1	168.3
A Coffee husk at 20% level	561	7.9	6.1	6.0	6.2	6.8	6.2	6.3	5.8	6.3	6.1	5.6	147.2
	415	7.0	7.0	6.7	7.0	6.0	6.6	5.9	6.7	7.2	7.0	7.2	156.5
	648	5.2	5.3	5.7	5.2	5.5	6.0	6.0	5.3	5.7	5.8	5.5	133.2

(Table 11 concl.)

Table 12. Daily milk yield (kg) of animals during the second phase.

Diet	Animal number	Days											
		1	2	3	4	5	6	7	8	9	10	11	12
B Coffee husk at 10% level	559	6.1	6.3	6.4	6.4	6.9	6.6	6.7	6.6	6.9	7.0	7.0	6.9
	C-57	3.1	3.7	2.9	3.3	3.1	3.6	3.1	3.3	3.9	3.7	3.6	4.2
	T-630	6.9	6.8	6.8	7.1	7.1	6.6	6.2	5.9	6.8	7.0	7.3	8.4
A Coffee husk at 20% level	621	4.6	4.7	5.0	4.7	4.8	4.7	5.0	5.0	5.1	5.2	5.2	5.0
	476	4.9	6.3	6.6	6.4	7.2	7.1	7.0	7.7	6.3	7.4	7.0	7.1
	644	7.4	7.4	7.9	7.1	8.2	8.1	8.3	8.7	9.0	8.3	8.4	8.0
C No coffee husk	561	6.4	5.1	5.1	5.8	5.3	6.0	5.9	5.6	5.6	5.6	6.1	5.5
	415	5.4	5.4	5.7	5.7	5.4	5.9	6.0	5.6	5.7	5.1	6.0	6.1
	648	4.6	4.2	3.8	4.1	3.3	4.0	4.1	3.7	3.9	4.5	3.9	4.2

(Table 12 contd....)

Diet	Animal number	Days 13	14	15	16	17	18	19	20	21	22	23	Total
B Coffee husk at 10% level	559	7.2	7.0	6.7	6.4	7.7	7.2	6.5	6.1	7.2	6.5	5.5	153.8
	C-57	4.1	4.8	3.7	3.7	3.8	3.6	3.6	3.6	3.2	3.6	3.2	82.6
	T-630	7.1	6.8	6.9	7.2	7.1	6.9	6.9	7.8	7.1	7.2	7.0	160.9
A Coffee husk at 20% level	621	5.1	5.0	5.2	4.8	4.8	4.9	5.3	4.8	4.8	5.1	4.8	113.6
	476	7.2	7.3	7.2	6.7	6.5	6.0	6.0	6.9	7.1	7.4	7.2	156.5
	644	9.3	8.7	9.0	8.6	6.7	8.4	8.8	8.4	9.1	9.4	8.8	192.0
C No coffee husk	561	6.3	5.0	5.3	5.1	4.8	4.6	4.9	5.5	5.7	5.3	5.9	126.4
	415	5.7	5.7	5.4	5.3	5.4	6.3	6.1	5.7	5.8	6.6	5.6	131.6
	648	4.1	4.6	4.0	4.7	4.4	3.4	4.6	4.9	4.5	4.7	4.9	97.1

(Table 12 concl.)

Table 13. Daily milk yield (kg) of animals during the third phase.

Diet	Animal number	Days											
		1	2	3	4	5	6	7	8	9	10	11	12
A Coffee husk at 20% level	559	6.2	7.6	7.1	7.5	7.6	7.2	8.1	6.9	6.9	8.4	6.2	5.1
	C-57	3.4	3.8	3.7	3.4	4.4	3.9	3.6	2.9	3.0	3.0	2.4	2.4
	T-630	6.3	6.3	7.1	6.5	7.5	7.0	6.6	6.5	6.7	6.6	6.7	6.4
C No coffee husk	621	4.1	4.9	5.0	4.2	5.9	4.7	5.5	4.7	4.5	4.4	4.4	4.5
	476	4.5	4.4	5.1	5.2	5.7	5.0	4.7	3.8	5.3	6.2	5.3	4.9
	644	8.3	8.0	9.0	8.4	9.3	8.2	9.2	7.9	7.4	7.0	8.3	7.4
B Coffee husk at 10% level	561	5.5	5.4	5.8	5.7	4.0	5.8	5.6	5.6	5.6	5.3	6.0	5.7
	415	5.5	5.7	6.8	6.7	6.1	6.1	6.0	5.9	5.6	5.7	5.7	5.7
	648	4.2	4.7	5.0	4.0	4.6	4.2	4.6	4.2	4.4	4.9	4.6	5.1

(Table 13 contd....)

Diet	Animal number	Days 13	14	15	16	17	18	19	20	21	22	23	Total
A Coffee husk at 20% level	559	6.0	6.7	6.8	6.5	6.7	6.4	6.1	5.7	6.5	5.9	6.5	154.6
	C-57	2.4	2.5	2.4	2.3	2.6	2.3	2.7	2.5	2.7	2.0	2.3	66.6
	T-630	6.3	6.5	6.5	6.6	6.2	6.3	6.4	6.6	7.1	6.1	6.5	151.3
C No coffee husk	621	4.7	4.5	4.2	4.4	4.5	4.5	4.6	4.4	4.5	4.5	4.7	106.3
	476	4.9	5.2	5.0	5.2	4.5	4.5	4.8	4.9	5.6	5.9	5.8	116.4
	644	7.5	6.7	7.1	7.2	6.9	7.1	7.3	6.7	6.5	6.4	7.1	174.9
B Coffee husk at 10% level	561	5.7	4.6	5.0	5.2	5.2	5.3	5.3	5.3	5.7	5.4	5.3	124.0
	415	5.7	5.5	5.5	5.2	5.7	5.7	5.5	5.9	5.6	5.3	6.0	133.1
	648	4.6	4.9	4.3	4.8	4.2	4.4	4.0	4.3	4.2	4.1	4.2	102.5

(Table 13 concl.)

Table 14. Quantity of milk (kg) produced by cows in the different phases.

Animal number	First phase	Second phase	Third phase	Total
	DIET-C	DIET-B	DIET-A	
559	63.2	153.8	154.6	471.6
C-57	22.5	82.8	66.6	271.9
T-630	96.3	160.9	151.3	508.5
Total	482.0	397.5	372.5	1252.[illegible]
	DIET-B	DIET-A	DIET-C	
621	114.5	113.6	106.3	334.4
476	149.2	156.5	116.4	422.[illegible]
644	168.3	192.0	174.9	535.[illegible]
Total	432.0	462.1	397.6	1291.[illegible]
	DIET-A	DIET-C	DIET-B	
561	147.2	126.4	124.0	397.[illegible]
415	156.5	131.6	133.1	421.[illegible]
648	133.2	97.1	108.5	338.[illegible]
Total	436.9	355.1	365.6	1157.[illegible]
Grand total	1350.9	1214.7	1135.7	3701.[illegible]

Total A - 1271.5
B - 1195.1
C - 1234.7

Table 15. Total milk yield - Analysis of variance.

Source	df	SS	MSS	F
Between animals	8	18813.22	2351.65	
Between periods within squares	6	2779.55	463.54	
Between treatments	2	324.44	162.22	0.49
Error	10	3376.84	337.68	
Total	26	25294.05		

Table 16. Average percentage of fat in milk of cows.

Animal number	At the commen- cement	First phase	Second phase	Third phase
		DIET-C	DIET-B	DIET-A
559	4.51	4.35	3.90	4.15
C-57	5.22	4.60	4.70	5.60
T-630	6.32	6.15	4.55	4.96
		DIET-B	DIET-A	DIET-C
621	4.61	4.10	3.90	4.55
476	4.60	4.50	5.05	4.60
644	5.20	4.90	4.05	3.95
		DIET-A	DIET-C	DIET-B
561	4.60	5.50	4.60	4.30
415	5.13	5.20	5.35	5.10
648	4.38	4.60	5.35	4.95

Average A - 4.78 ± 0.21
B - 4.56 ± 0.13
C - 4.83 ± 0.22

Table 17. Percentage of fat in milk - Analysis of variance.

Source	df	SS	MSS	F
Between animals	8	4.30	0.53	
Between periods within squares	6	1.27	0.21	
Between treatments	2	0.39	0.19	0.79
Error	10	2.43	0.24	
Total	26	8.39		

Table 18. Quantity of milk fat (kg) produced by cows.

Animal number	First phase	Second phase	Third phase	Total
	DIET-C	DIET-B	DIET-A	
559	7.10	6.00	6.42	19.52
C-57	5.64	3.89	3.73	13.26
T-630	12.07	7.32	7.50	26.89
Total	24.81	17.21	17.65	59.67
	DIET-B	DIET-A	DIET-C	
621	4.69	4.43	4.84	13.96
476	6.71	7.90	5.35	19.96
644	8.25	7.78	6.91	22.94
Total	19.65	20.11	17.10	56.86
	DIET-A	DIET-C	DIET-B	
561	8.10	5.81	5.33	19.24
415	8.14	7.04	6.79	21.97
648	6.13	5.19	5.37	16.69
Total	22.37	18.04	17.49	57.90
Grand total	66.83	55.36	52.24	174.43

Total A - 60.13
B - 54.35
C - 59.95

Table 19. Quantity of milk fat - Analysis of variance.

Source	df	SS	MSS	F
Between animals	8	50.11	6.26	
Between periods within squares	6	15.56	2.59	
Between treatments	2	1.81	0.91	0.89
Error	10	10.16	1.02	
Total	26	77.64		

Table 20. Quantity of four per cent fat-corrected milk (kg) produced by cows.

Animal number	First phase	Second phase	Third phase	Total
	DIET-C	DIET-B	DIET-A	
559	171.78	151.52	158.14	481.44
C-57	133.60	91.47	82.59	307.66
T-630	259.57	174.16	173.02	606.75
Total	564.95	417.15	413.75	1395.85
	DIET-B	DIET-A	DIET-C	
621	116.15	111.89	115.12	343.16
476	160.33	181.10	126.81	468.24
644	191.07	193.50	173.61	558.18
Total	467.55	486.49	415.54	1369.58
	DIET-A	DIET-C	DIET-B	
561	180.38	137.71	129.55	447.64
415	184.70	158.24	155.09	498.03
648	145.23	116.69	123.95	385.87
Total	510.31	412.64	408.59	1331.54
Grand total	1542.81	1316.28	1237.88	4096.97

Total A - 1410.55
B - 1293.29
C - 1393.13

Table 21. Four per cent fat-corrected milk - Analysis of variance.

Source	df	SS	MSS	F
Between animals	8	25150.02	3143.75	
Between periods within squares	6	6316.06	1052.68	
Between treatments	2	889.68	444.84	1.23
Error	10	3627.43	362.74	
Total	26	35983.19		

Table 22. Percentage of total solids in milk of cows.

Animal number	At the commencement	First phase	Second phase	Third phase
		DIET-C	DIET-B	DIET-A
559	13.51	13.81	13.17	13.31
C-57	13.92	13.88	13.96	13.54
T-630	14.13	15.18	13.49	13.87
		DIET-B	DIET-A	DIET-C
621	12.97	13.10	12.84	14.34
476	13.01	13.16	13.73	13.57
644	13.91	14.59	12.30	12.83
		DIET-A	DIET-C	DIET-B
561	14.21	13.62	13.25	13.49
415	13.27	14.87	13.85	14.15
648	12.32	13.48	14.38	13.85

Average A - 13.51 ± 0.24
B - 13.66 ± 0.17
C - 13.90 ± 0.23

Table 23. Percentage of total solids in milk of cows - Analysis of variance.

Source	df	SS	MSS	F
Between animals	8	3.27	0.41	
Between periods within squares	6	2.56	0.43	
Between treatments	2	0.70	0.35	0.90
Error	10	3.91	0.39	
Total	26	10.44		

Table 24. Quantity of total solids (kg) in milk of cows.

Animal number	First phase	Second phase	Third phase	Tota
	DIET-C	DIET-B	DIET-A	
559	22.54	20.26	20.58	63.3
C-57	17.00	11.56	9.02	37.5
T-630	29.80	21.71	20.99	72.5
Total	69.34	53.53	50.59	173.4
	DIET-B	DIET-A	DIET-C	
621	15.00	14.59	15.24	44.8
476	19.63	21.49	15.80	56.9
644	24.55	23.62	22.44	70.6
Total	59.18	59.70	53.48	172.3
	DIET-A	DIET-C	DIET-B	
561	20.05	16.75	16.73	53.5
415	23.27	18.23	18.83	60.3
648	17.96	13.96	15.03	46.9
Total	61.28	48.94	50.59	160.8
Grand total	189.80	162.17	154.66	506.6

Total A - 171.57
B - 163.30
C - 171.76

Table 25. Yield of total solids in milk - Analysis of variance.

Source	df	SS	MSS	F
Between animals	8	370.34	46.29	
Between periods within squares	6	91.19	15.20	
Between treatments	2	5.18	2.59	0.67
Error	10	38.12	3.81	
Total	26	504.83		

Table 26. Percentage of solids-not-fat in milk of cows.

Animal number	At the commen-cement	First phase	Second phase	Third phase
		DIET-C	DIET-B	DIET-A
559	9.00	9.46	9.27	9.16
C-57	8.70	9.28	9.26	7.94
T-630	7.81	9.03	8.94	8.91
		DIET-B	DIET-A	DIET-C
621	8.36	9.00	8.94	9.79
476	8.41	8.66	8.68	8.97
644	8.71	9.69	8.25	8.88
		DIET-A	DIET-C	DIET-B
561	9.61	8.12	8.65	9.19
415	8.14	9.67	8.50	9.05
648	7.94	8.88	9.03	8.90

Average A - 8.73 ± 0.18
B - 9.11 ± 0.10
C - 9.07 ± 0.13

Table 27. Percentage of solids-not-fat in milk - Analysis of variance.

Source	df	SS	MSS	F
Between animals	8	1.05	0.13	
Between periods within squares	6	1.27	0.21	
Between treatments	2	0.77	0.38	2.00
Error	10	1.93	0.19	
Total	26	5.02		

Table 28. Quantity of solids-not-fat in milk of cows.

Animal number	First phase	Second phase	Third phase	Total
	DIET-C	DIET-B	DIET-A	
559	15.43	14.25	14.16	43.84
C-57	11.36	7.66	5.28	24.30
T-630	17.72	14.38	13.48	45.58
Total	44.51	36.29	32.92	113.72
	DIET-B	DIET-A	DIET-C	
621	10.30	10.15	10.40	30.85
476	12.92	13.58	10.44	36.94
644	16.30	15.84	15.53	47.67
Total	39.52	39.57	36.37	115.46
	DIET-A	DIET-C	DIET-B	
561	11.96	10.93	11.39	34.28
415	15.13	11.19	12.05	38.37
648	1	8.77	9.66	30.26
Total	38.92	30.89	33.10	102.91
Grand total	122.95	106.75	102.39	332.09

Total A - 111.41
B - 108.91
C - 111.77

Table 29. Total solids-not-fat yield - Analysis of variance.

Source	df	SS	MSS	F
Between animals	8	162.66	20.33	
Between periods within squares	6	33.55	5.59	
Between treatments	2	1.52	0.76	0.52
Error	10	14.57	1.46	
Total	26	212.30		

Table 30. Quantity of solids-corrected milk (kg) produced by cows.

Animal number	First phase	Second phase	Third phase	Total
	DIET-C	DIET-B	DIET-A	
559	176.28	155.71	160.23	492.22
C-57	134.68	91.87	75.51	302.06
T-630	249.94	171.88	169.30	591.12
Total	560.90	419.46	405.04	1385.40
	DIET-B	DIET-A	DIET-C	
621	116.64	112.53	119.76	348.93
476	156.06	174.49	125.54	456.09
644	195.74	185.17	173.71	554.62
Total	468.44	472.19	419.01	1359.64
	DIET-A	DIET-C	DIET-B	
561	167.07	133.66	130.96	431.69
415	187.61	150.10	152.56	490.27
648	142.99	114.07	121.26	378.32
Total	497.67	397.83	404.74	1300.24
Grand total	1527.01	1289.48	1228.79	4045.28

Total A - 1374.90
B - 1292.64
C - 1377.72

Table 31. Solids-corrected milk - Analysis of variance.

Source	df	SS	MSS	F
:tweem animals	8	23957.90	2394.74	
:tween periods ithin squares	6	6504.67	1084.11	
:tween treatments	2	518.65	259.33	0.89
ror	10	2913.06	291.31	
otal	26	33894.28		

Table 32. R.B.C. count (million/mm^3) of the blood of cows.

Animal number	At the commen-cement	First phase	Second phase	Third phase
		DIET-C	DIET-B	DIET-A
559	6.32	5.37	5.32	4.82
C-57	6.75	6.02	6.71	7.92
T-630	6.02	4.92	5.42	4.26
		DIET-B	DIET-A	DIET-C
621	5.71	5.71	5.13	4.71
476	5.62	5.01	6.76	4.02
644	5.71	4.81	4.16	4.13
		DIET-A	DIET-C	DIET-B
561	7.01	7.13	5.37	6.41
415	6.01	5.01	4.71	4.24
648	5.01	5.72	4.91	4.12

Table 33. Haemoglobin content (g/100 ml) of the blood of cows.

Animal number	At the commencement	First phase	Second phase	Third phase
		DIET-C	DIET-B	DIET-A
559	10.0	9.5	9.0	10.0
C-57	12.0	11.5	9.5	12.0
T-630	11.0	9.5	9.5	8.5
		DIET-B	DIET-A	DIET-C
621	10.0	9.5	10.0	9.5
476	9.5	9.0	9.5	9.0
644	9.5	8.5	10.5	8.0
		DIET-A	DIET-C	DIET-B
561	12.5	10.5	10.0	12.0
415	10.0	10.0	10.5	9.0
648	8.5	10.0	10.0	8.0

Table 34. Packed cell volume (%) of the blood of cows.

Animal number	At the commen-cement	First phase	Second phase	Third phase
		<u>DIET-C</u>	<u>DIET-B</u>	<u>DIET-A</u>
559	41	39	32	32
C-57	45	46	46	43
T-630	40	36	35	30
		<u>DIET-B</u>	<u>DIET-A</u>	<u>DIET-C</u>
621	39	36	36	35
476	35	34	41	29
644	35	32	30	30
		<u>DIET-A</u>	<u>DIET-C</u>	<u>DIET-B</u>
561	45	46	39	41
415	38	38	31	32
648	35	38	34	29

Table 35. Average physical and chemical constants of the butter fat of cows.

Treatment group	Melting point °C			Saponification number (mg/g)			Iodine number (g/100 g)		
	First phase	Second phase	Third phase	First phase	Second phase	Third phase	First phase	Second phase	Third phase
Group C No coffee husk	31	32	30	240.04	232.78	234.28	28.42	28.01	24.16
Group B Coffee husk at 10% level	32	32	33	231.74	230.58	234.40	28.12	24.12	29.78
Group A Coffee husk at 20% level	33	34	33	235.61	234.25	233.89	26.16	25.76	28.16

Table 36. Physical and chemical constants of butter fat - Analysis of variance.

Melting point

Source	df	SS	MSS	F
Between treatments	2	8.22	4.11	6.72
Between phases	2	0.89	0.44	
Error	4	2.45	0.61	
Total	8	11.56		

Saponification number

Source	df	SS	MSS	F
Between treatments	2	18.74	9.37	1.65
Between phases	2	16.07	8.03	
Error	4	22.70	5.67	
Total	8	57.51		

Iodine number

Source	df	SS	MSS	F
Between treatments	2	0.68	0.34	0.05
Between phases	2	4.57	2.28	
Error	4	26.76	6.69	
Total	8	32.01		

Table 37. Gross efficiency of milk production (dairy merit).

Group	TDN consumption (kg)	Energy value of TDN (TDN x4400) (MCal)	Total 4% FCM production (kg)	Energy value of FCM (FCM x 750) (MCal)	Gross efficier FCMx750 / TDNx440 (%)
Diet-A (20% coffee husk)	1082.13	4761.37	1410.53	1057.91	22.21
Diet-B (10% coffee husk)	1121.16	4933.10	1293.29	967.97	19.66
Diet-C (0% coffee husk)	1121.24	4933.46	1393.13	1044.85	21.17

Table 38. Feed efficiency (quantity of concentrate (kg) required to produce one kg 4% fat-corrected milk.

Animal number	First phase	Second phase	Third phase	Total
	DIET-C	DIET-B	DIET-A	
559	0.54	0.74	0.79	2.07
C-57	0.60	0.99	1.11	2.70
T-630	0.38	0.59	0.59	1.56
Total	1.52	2.32	2.49	6.33
	DIET-B	DIET-A	DIET-C	
621	0.77	0.82	0.87	2.46
476	0.58	0.46	0.81	1.85
644	0.46	0.52	0.59	1.57
Total	1.81	1.80	2.27	5.88
	DIET-A	DIET-C	DIET-B	
561	0.43	0.80	0.96	2.19
415	0.47	0.65	0.66	1.78
648	0.63	0.87	0.83	2.33
Total	1.53	2.32	2.45	6.30

Table 39. Feed efficiency - Analysis of variance.

Source	df	SS	MSS	F
Between animals	8	0.42	0.05	
Between periods within squares	6	0.34	0.06	
Between treatments	2	0.03	0.02	2.00
Error	10	0.12	0.01	
Total	26	0.91		

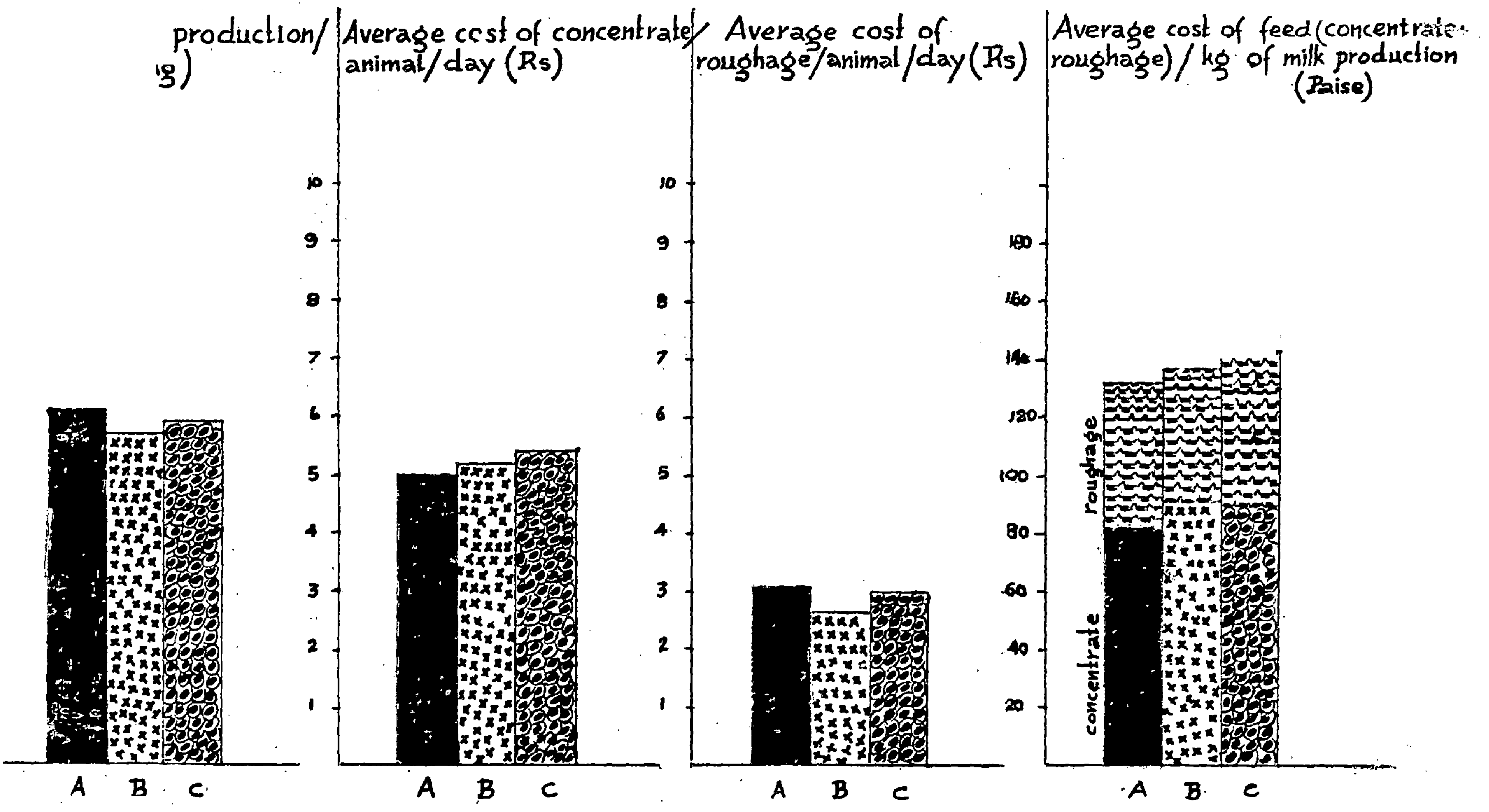

Fig. 1 Economics of feeding coffee husk.

DISCUSSION

DISCUSSION

The world consumption of almost three million tonnes of coffee meant about two million tonnes of husks which contain caffeine, proteinous matter and other substances valuable for animal feeding (Rao and Natarajan, 1974). The present study was undertaken in order to get detailed information on the use of coffee husk for milk production by feeding the material at 0, 10 and 20 per cent levels in the ration of dairy cows.

The results obtained during the course of the experiment are discussed below.

The chemical composition of the coffee husk (Table 3) revealed that it contains 7.58 and 30.05 per cent of crude protein and crude fibre respectively. The percentage of crude protein and crude fibre for Arabica and Robusta cherry have been reported to be 9.2, 39.1 and 9.0 and 38.0 respectively (Rao and Natarajan, 1974).

The quantities of crude protein, crude fibre and ether extract present in the three concentrate mixtures A, B and C used for the experiment were found to be almost identical.

From the data presented in Table 8 it was found that the body weight of animals both in the control and treatment groups decreased at the end of the first phase and thereafter remained almost constant. The decrease in body weight ranged from 1 to 28 kg during the first phase, which lasted for 30 days. Jarquin et al. (1976) have also reported that the body weight of calves decreased when the percentage of husks in the diets increased. However, statistical analysis of the data (Table 9) revealed that the difference in body weight due to treatments was not significant (P $\angle$ 0.05) indicating that the feed had no influence on the body weight of the animals.

Data on the quantity of the concentrate mixture consumed by the cows (Table 10) showed that during the first phase, the consumption of concentrate was less and it gradually increased during the second and third phases. This might be due to the change from the pellet feeding to mash feeding and also due to the incorporation of coffee husk in the concentrate mixture. The group which received the coffee husk at 20 per cent level consumed 258.5 kg of concentrate only during the first phase as compared to the consumption of 272.5 kg and 274.5 kg by the animals that received diet B (10% coffee husk) and diet C (0% coffee husk) respectively. It has been reported by Ledger and Tillman (1973) that inclusion of 30 per cent coffee husk in the ration reduced the feed intake and feed conversion in bullocks. In the second phase the animals on diet A, B and C consumed 279.0, 307.5

and 316.5 kg of concentrate respectively. In the third phase the animals on diet B consumed 332.0 kg concentrate as compared to 320.0 and 308.0 kg consumed by animals on diet A and C respectively.

The data on milk yield of individual cows presented in Tables 11, 12 and 13 showed that there was a gradual reduction in the daily milk yield of the cows in both the control and treatment groups as compared to the average daily milk yield obtained before the commencement of the feeding trial (Table 1). This could be attributed to the advancement of lactation. It was found from the results presented in Table 14 that the milk production of the cows during the first phase on diet C, B and A was 482.0, 432.0 and 436.9 kg respectively. Animals on diet A and B produced less milk as compared to the control group. The less feed consumption by these animals during the first phase might be the reason for this. During the second phase the cows on diet A (20% coffee husk) produced 462.1 kg of milk which was higher than the quantities produced by the animals on the control and treatment group B (10% coffee husk). During the third phase the cows on the control diet produced 397.6 kg of milk, which was higher than the quantities produced by the cows on diet A and B. The total milk production for all the nine animals during the first phase was 1350.9 kg, which gradually reduced to 1214.7 and 1135.7 kg during the second and third phases respectively, due to the advancement in lactation of all the cows. The treatment wise total milk production of the animals fed with diet C, B and A was 1234.7, 1195.1 and 1271.5 kg respectively. Eventhough the animals that received diet A produced more milk than those in the other two groups, the statistical analysis of the total milk yield (Table 15) revealed no significant difference due to the treatments ($P \angle 0.05$).

The average percentage of fat in milk of the cows during the three different phases is presented in Table 16. The average percentage of fat in the milk when the cows received diet C, B and A was 4.83 ± 0.22, 4.56 ± 0.13 and 4.78 ± 0.21 respectively. This indicated that the quality of milk with respect to the percentage of fat remained normal for all the treatments. The analysis of variance of the percentage of fat in milk given in Table 17 showed that there was no significant difference among treatments ($P \angle 0.05$).

The total quantity of butter fat produced by the animals on different diets is given in Table 18. At the end of the first phase the animals on diet C, B and A produced 24.81, 19.65 and 22.37 kg of butter fat respectively. In the second phase the animals on diet C, B and A produced

18.04, 17.21 and 20.11 kg of butter fat respectively. In the third phase the quantity of butter fat remained almost the same for all the different treatments. The cows while receiving diet C, B and A produced 59.95, 54.35 and 60.13 kg of milk fat respectively. Eventhough the total quantity of milk fat produced by the animals on diet A was slightly more, statistical analysis (Table 19) showed that there was no significant difference among treatments ($P \leq 0.05$).

The quantity of four per cent fat-corrected milk (kg) produced by cows is presented in Table 20. During the first phase the animals on diet C produced more milk (564.95 kg) than the animals receiving diet B (467.55 kg) and diet A (510.31 kg). In the second phase the animals receiving 20 per cent coffee husk (diet A) produced 486.49 kg as compared to 417.15 kg and 412.64 kg produced by the animals on diet B and C respectively. In the third phase the production remained almost similar for all the three dietary treatments. The increase in fat-corrected milk production by animals on diet C in the first phase and by those on diet A in the second phase might be due to the increased milk production of these animals, since there was no significant difference in the percentage of fat in milk. A general decline in fat-corrected milk production was noticed during the second and third phases due to the lesser quantity of milk produced during these phases. The total fat-corrected milk production for animals that received diet C, B and A was 1393.13, 1293.29 and 1410.55 kg respectively. The animals that received diet A (20% coffee husk) produced slightly more quantity of fat-corrected milk than those on the other two groups. But on statistical analysis (Table 21) no significant difference could be noticed due to treatments ($P \angle 0.05$).

The average percentage of total solids in milk of animals that received diet C, B and A was 13.90 ± 0.23, 13.66 ± 0.17 and 13.51 ± 0.24. The values obtained as total solids percentage was found to be normal for cows milk (Table 22). The analysis of variance of the total solids percentage in milk (Table 23) revealed that treatments had no effect on percentage of total solids in milk ($P \angle 0.05$).

During the first phase the animals on diet C produced 69.34 kg of total solids as compared to 59.18 and 61.28 kg produced by the cows that received diet B and A respectively (Table 24). In the second phase the animals on diet A produced 59.70 kg of total solids as against 53.53 and 48.94 kg produced by animals on diet B and C respectively. During the third phase the production was 53.38, 50.59 and 50.59 kg for all animals that received diet C, B and A respectively. The increased amount of total solids production in the first phase with diet C and in the second phase with diet A was due to the increased milk production of the animals in those groups since there was no significant difference in the total solids percentage. A gradual decrease in the quantity of total solids in the second and third phases for all animals was due to decreased milk production. The quantity of total solids produced by cows while receiving diet C, B and A was 171.76, 163.30 and 171.57 kg respectively. Analysis of variance (Table 25) revealed no significant effect on total solids yield due to dietary treatments ($P < 0.05$).

The percentage of solids-not-fat in milk of cows on the experiment is given in Table 26. The average percentage of solids-not-fat in milk of cows while receiving ration C, B and A was 9.07 ± 0.13, 9.11 ± 0.10 and 8.73 ± 0.18 respectively indicating that the values were above the legal standard of 8.5 per cent. No significant difference was noticed in the percentage of solids-not-fat in milk due to the dietary treatments ($P < 0.05$) (Table 27).

The total quantity of solids-not-fat (kg) produced by the animals on different diets is given in Table 28. At the end of the first phase the animals on diet C, B and A produced 44.51, 39.52 and 38.92 kg of solids-not-fat respectively. In the second phase the animals on diet C, B and A produced 30.89, 36.29 and 39.57 kg of solids-not-fat respectively. In the third phase the quantities produced were 36.37, 33.10 and 32.92 kg respectively for diet C, B and A. The cows while receiving diet C, B and A produced 111.77, 108.91 and 111.41 kg of solids-not-fat respectively. The analysis of variance of the quantity of solids-not-fat in milk given in Table 29 showed that there was no significant difference among treatments ($P < 0.05$).

The quantity of solids-corrected milk produced by individual cows on the three dietary treatments is given in Table 30. In the first phase the animals on diet C, B and A produced 560.90, 468.44 and 497.67 kg of solids-corrected milk. During the second phase the animals on diet A produced comparatively more milk ie., 472.19 kg whereas the animals on diet B and C produced 419.46 and 397.83 kg respectively. In the third phase the production of milk for C, B and A was 419.01, 404.74 and 405.04 kg respectively. The total solids-corrected milk production of animals that received ration C, B and A was 1377.72, 1292.64 and 1374.90 kg respectively. The statistical analysis of the data did not reveal any significant difference among treatments ($P < 0.05$) (Table 31), with regard to the solids-corrected milk.

The effect of feeding coffee husk on the physiological status of the cows studied by determining some of the blood values such as erythrocyte count (million/mm^3), haemoglobin (g/100 ml) and packed cell volume (%) are presented in Tables 32, 33 and 34 respectively. These values were found to be within the normal range reported for healthy cows (Pillai, 1972) thereby indicating that the animals getting coffee husk in the diet enjoyed normal physiological status similar to the cows on diets containing no coffee husk.

In order to study the influence of feeding coffee husk on the milk fat composition the physical and chemical constants of the butter fat were determined. The data pertaining to melting point (0°C), saponification value (mg/g) and iodine number (g/100 g) are presented in Table 35. The values obtained appear to be normal for the butter fat of cow's milk (Jenness and Patton, 1969). The analysis of the data indicated no significant difference ($P \angle 0.05$) in the physical and chemical constants of the butter fat by the cows in the control and experimental groups (Table 36).

The dairy merit (%) based on efficiency of feed conversion of the animals while receiving ration A, B and C is given in Table 37. The percentage of dairy merit for the cows on diet A, B and C was 22.21, 19.66 and 21.17 respectively. The values obtained were less compared to the values of 25 per cent reported by Brody (1945) for good dairy cows. Chacko (1975) reported a value of 24.65 per cent for Sindhi x Jersey cows. The dairy merit was found to be less for the animals on diet B (10% coffee husk) because of the reduced milk production and greater feed consumption.

It will be seen from Table 38 that the feed efficiency got reduced as the lactation of the animals advanced. In the second and third phases of lactation more amount of concentrate was required to produce one kg of milk as compared to the first phase. But on statistical analysis no significant difference was noticed among the different treatments (P ∠ 0.05) (Table 39).

The economics of feeding coffee husk for milk production has been calculated and presented in Fig. 1. The average daily milk production for an animal while receiving ration C, B and A was 5.96, 5.77 and 6.14 kg respectively and the corresponding value of milk calculated at the rate of Rs.2/- per kg was Rs.11.92, 11.54 and 12.28 respectively. The average daily consumption of concentrate by an animal in group C, B and A was found to be 4.34, 4.41 and 4.14 kg respectively and the cost of the concentrate consumed was Rs.5.42, 5.29 and 5.00 respectively. The average daily consumption of paddy straw by the animal on diet C, B and A was 6.91, 6.10 and 7.19 kg respectively and the cost was Rs.3.04, 2.68 and 3.16 respectively. Thus the total cost of the feed for a day for an animal in group C, B and A was Rs.8.46, 7.97 and 8.16 respectively. The income per day derived over the cost of the feed for an animal on diet C, B and A was Rs.3.46, 3.57 and 4.12 respectively. The income over the feed cost was greater by an amount of Re.0.66 per animal per day for the group receiving coffee husk at 20 per cent level as compared to those getting no coffee husk in the ration. By feeding coffee husk at 10 per cent level this amount get reduced to Re.0.11 per animal per day as compared to the animals in the control group.

The cost of feed (roughage plus concentrate) for producing one kg of milk by an animal on diet C, B and A was Rs.1.42, 1.38 and 1.33 respectively. This indicated that the cost of the feed for producing one kg of milk was less by Re.0.09 and 0.04 for the animals on diet A and B respectively as compared to those on diet C.

SUMMARY

DISCUSSION

The world consumption of almost three million tonnes of coffee meant about two million tonnes of husks which contain caffeine, proteinous matter and other substances valuable for animal feeding (Rao and Natarajan, 1974). The present study was undertaken in order to get detailed information on the use of coffee husk for milk production by feeding the material at 0, 10 and 20 per cent levels in the ration of dairy cows.

The results obtained during the course of the experiment are discussed below.

The chemical composition of the coffee husk (Table 3) revealed that it contains 7.58 and 30.05 per cent of crude protein and crude fibre respectively. The percentage of crude protein and crude fibre for Arabica and Robusta cherry have been reported to be 9.2, 39.1 and 9.0 and 38.0 respectively (Rao and Natarajan, 1974).

The quantities of crude protein, crude fibre and ether extract present in the three concentrate mixtures A, B and C used for the experiment were found to be almost identical.

From the data presented in Table 8 it was found that the body weight of animals both in the control and treatment produced 36.8 kg more milk than those in the control group. No significant difference in milk production was noticed due to treatments.

The analysis of the data pertaining to the total quantity of butter fat produced by cows on different treatments showed no significant difference due to treatments. The cows receiving diet C, B and A produced 59.95, 54.35 and 60.13 kg of butter fat respectively. The quality of milk with reference to the percentage of fat remained normal for all the treatments.

When the total milk production was converted into four per cent fat-corrected milk, the animals on diet C, B and A produced 1393.13, 1293.29 and 1410.55 kg respectively. Animals receiving 20 per cent coffee husk produced slightly more quantity of fat-corrected milk than those on the other two groups. The analysis of the data revealed no significant difference due to treatments.

The treatments had no effect on the percentage of total solids in milk. All the cows gave milk containing the normal percentage of total solids. The quantity of total solids for the animals on diet C, B and A was 171.76, 163.30 and 171.57 kg respectively. The dietary treatments had no effect on total solids yield.

No significant difference was noticed either on the solids-not-fat percentage in the milk or the total quantity of total solids-not-fat produced by animals on the three dietary treatments.

The animals getting 0, 10 and 20 per cent coffee husk in the ration produced 1377.72, 1292.64 and 1374.90 kg of total solids-corrected milk. However, no significant difference due to treatments was noticed.

The analysis of blood samples for blood values like haemoglobin content, packed cell volume and total erythrocyte count indicated that all animals enjoyed normal physiological status. The blood values obtained during the course of the experiment were within the normal range reported for healthy cows.

The data relating to some of the physical and chemical constants such as melting point, iodine number and saponification value of butter fat indicated that the values were normal and within the range, for all cows included in the study and no significant difference due to treatments.

The milk production and the quality of the milk remained the same for all the animals included for the study and no significant difference was noticed due to treatments.

The dairy merit (%) based on the efficiency of feed conversion for the animals on group C, B and A was 21.17, 19.66 and 22.21 respectively. The dairy merit was found to be less for animals on diet B, due to reduced milk production and greater feed consumption.

The cows receiving ration C, B and A produced a daily average of 5.96, 5.77 and 6.14 kg of milk respectively. The daily consumption of concentrate by an animal in group C, B and A was 4.34, 4.41 and 4.14 kg respectively. When the value of the paddy straw consumed by the animals was included in the feed cost it worked out to be Rs.8.46, 7.97 and 8.16 per day for an animal in group C, B and A respectively. The total cost of the feed for producing one kg of milk on diet C, B and A was Rs.1.42, 1.38 and 1.33 respectively. This indicated that the cost of the feed for producing one kg milk was less by nine and four paise for the animals getting 20 per cent and 10 per cent coffee husk in the ration as compared to those not getting coffee husk in the ration.

The inferences drawn above indicate that coffee husk can profitably be incorporated in the ration of dairy cows up to 20 per cent level without any deleterious effect.

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EVALUATION OF
COFFEE HUSK FOR MILK PRODUCTION IN COWS

BY

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ABSTRACT OF A THESIS

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ABSTRACT

An investigation was carried out to find out the feeding value of coffee husk for milk production in cows using a total of nine Sindhi x Jersey cross bred cows, divided into three groups of three animals each. The experiment was for a period of 90 days. Coffee husk was included in the concentrate mixture at 0, 10 and 20 per cent levels. A switch-over design was used for the experiment.

Coffee husk fed at 10 and 20 per cent levels in the concentrate ration did not significantly influence the body weight of animals. The total milk production of the animals getting coffee husk in the ration did not significantly differ from that of the animals on the control diet. The percentage of fat in milk, the total quantity of milk fat produced, the amount of four per cent fat-corrected milk, the percentage of total solids, the amount of total solids in milk, percentage of solids-not-fat, total quantity of solids-not-fat and the amount of solids-corrected milk remained the same for all the three groups of animals included for the study and no significant differences were noticed due to treatments.

The physiological status of the cows in all the groups was normal and satisfactory.

No significant difference due to treatments was noticed in some of the physical and chemical constants of butter fat.

The dairy merit (percentage) based on efficiency of feed conversion was less for animals getting ten per cent coffee husk due to the reduced milk production and the greater feed consumption.

The total cost of feed for producing one kg milk was Rs.1.42, 1.38 and 1.33 for animals getting 0, 10 and 20 per cent coffee husk in the concentrate mixture respectively.

It was concluded that coffee husk upto 20 per cent level can profitably be incorporated in the concentrate mixture of dairy cows.