LOW MILK FAT SYNDROME IN CROSSBRED DAIRY COWS

BY

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THESIS

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DECLARATION

I hereby declare that this thesis entitled "**LOW MILK FAT SYNDROME IN CROSSBRED DAIRY 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.

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CERTIFICATE

Certified that this thesis, entitled "**LOW MILK FAT SYNDROME IN CROSSBRED DAIRY COWS**" is a record of research work done independently by **Shri. S. Sivaraman**, 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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S. SIVARAMAN

To my beloved parents, Uncle and Teachers

CONTENTS

LIST OF ABBREVIATIONS

ADF	-	Acid Detergent Fiber
A:P	-	Acetic:propionic
CMT	-	California Mastitis Test
Hb	-	Haemoglobin
LMFs	-	Low milk fat syndrome
MBRT	-	Methylene blue reduction test
Min	-	Minutes
NDF	-	Neutral Detergent Fiber
SAT	-	Sedimentation activity time
SNF	-	Solids not fat
TEC	-	Total erythrocyte count
TVFA	-	Total volatile fatty acids
VFA	-	Volatile fatty acid

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Introduction

1. INTRODUCTION

The livestock sector contributes significantly to the economy of our country. Its contribution is estimated to be about eight per cent to the Gross Domestic Product (GDP) and about 26 per cent to the agricultural economy (Bhasin, 1997). Dairying is an important source of income and means of employment to a large number of people in rural India. India with about 18.4 per cent of the world's total cattle and buffalo population, produces only 11 per cent of the world's total milk. Through cross breeding programmes, our country has emerged as the second largest milk producer in the world (58.7 million tonnes) after the United States (68.0 million tonnes) (Gill, 1994). In Kerala the milk production raised from 1334 tonnes in 1986-87 to 2001 tonnes in 1993-94 (Chacko, 1995).

Adoption of intensive cross breeding has tremendously improved the production potential of dairy cattle in Kerala. The per capita availability of milk per day has increased from 30 g in 1964 to 131 g in 1987. It is expected that the per capita daily milk availability would increase at the rate of 18 g every year (Patil, 1988). With the increase in milk yield, composition of milk also underwent changes.

Prasad and Subramanyam (1986) studied the composition of milk of crossbred cattle in Kerala. They found that levels of milk fat percentage in many crossbred cows were lower than the standards prescribed in Prevention of Food Adulteration Act (PFA).

In Kerala, milk from crossbred cows are occasionally rejected by the co-operative milk societies because these samples do not conform to PFA limits. The innocent farmers thereby are often accused of adulterating milk with water. Co-operative societies pay premiums for high fat/high solids-not-fat (SNF) milk above a set standard and pay a flat price below that standard.

Among metabolic disorders, low milk fat syndrome is found apparently associated with increased production under varying dietary and managemental conditions. So far no investigations have been undertaken into the various aspects of this problem in Kerala. Hence this study was proposed with the following objectives.

1. To study the prevalence and epidemiology of low milk fat syndrome in crossbred dairy cows.

2. To study the haematological and biochemical changes in blood and pattern of rumen fermentation in cows with low milk fat syndrome and to suggest suitable corrective measures.

Review of Literature

2. REVIEW OF LITERATURE

Low milk fat syndrome was described as the secretion of a normal volume of milk but with its milk fat reduced often to less than 50 per cent of normal (Rodostits *et al.*, 1994).

According to Clarenburg (1992) low milk fat syndrome was characterised by a marked depression in milk fat content and this constituted an economic loss. It occurred after feeding a high ratio of concentrates over roughage to dairy cows. It was also noted when normal rations were fed, supplemented with protected polyunsaturated fatty acids.

2.1 Biosynthesis of milk fat

Baker (1990) explained the biosynthesis of milk fat as follows:

Bacterial fermentation in the rumen resulted in the production of volatile fatty acids, including acetic, butyric and propionic acids. The fatty acid precursors needed to synthesize milk fat included acetate, beta-hydroxybutryate (BHBA) and plasma lipids. Acetate and BHBA were derived from the fermentation process and were used by the mammary gland to synthesize short and medium-chain fatty acids (denova synthesis). The mammary gland also synthesized some palmitic

acid, but the mammary gland got most of the long-chain fatty acids from the blood.

Denova synthesis of fatty acids within the mammary gland accounted for about 50 per cent of the fatty acids used to produce milk fat. If acetate or BHBA levels were low, fatty acid synthesis in the mammary gland would be limited, resulting in low milk fat. Long-chain fatty acids supplied the other 50 per cent of fatty acids used in the synthesis of milk fat. Long chain fatty acids were not synthesized in the mammary gland, rather they were derived from the fatty acids in the diet, synthesized by the ruminal microbes, or mobilized from adipose tissue.

Short and long-chain fatty acids were combined within the mammary gland to form triglycerides, which were then packed in a fat globule and secreted into the milk. The ratio of short-to long-chain fatty acids was important in the synthesis of the triglycerides, as different chain lengths were required to occupy the various positions on the glycerol-3-phosphate acceptor molecule. Therefore, if deficiencies occurred in either short-chain fatty acid synthesis within the mammary gland or long-chain fatty acid supply to the mammary gland, milk fat synthesis might be depressed, resulting in low milk fat.

2.2 Etiology

Vansoest and Allen (1959) explained that feeding low roughage-high grain ration resulted in low fat milk associated with the changes in the proportion of volatile fatty acids (VFA) in rumen. Similar statements were made by Vansoest, 1963; Jorgenson *et al.*, 1965; Storry and Rook, 1966; Sutton and Morant, 1989 and Beukelen *et al.*, 1988.

Vansoest (1963) putforth various theories involved in the secretion of low fat milk. In the first theory he suggested that milk fat depression was caused by a deficiency in the amount of acetate supplied by the rumen micro-organisms. The second theory suggested the deficiency of Beta-hydroxybutyric acid (BHBA) in the mammary gland resulted in low milk fat. The third theory stated that high grain rations caused some endocrinological disturbances leading to secretion of low milk fat. He also reviewed the factors that led to low milk fat.

High concentrate, low roughage diets were associated with milk fat depression and the condition aggrevated if either the forage or the concentrate were finely ground or pelleted (Jorgenson *et al.*, 1965).

Davis (1967) noted reduction in milk fat percentage when cows were fed with low fiber high grain ration.

Fisher *et al.* (1967) opined that milk fat depression could not be fully explained by the glucogenic effect of propionate.

Orskov *et al.* (1967) stated that cows that received a complete pelleted ration of 20 per cent alfalfa hay and 80 per cent concentrate diet resulted in low milk fat.

O'Dell *et al.* (1968) stated that finely chopped forages depressed milk fat synthesis in dairy cows.

The glucogenic theory stated that increased production of propionate enhanced hepatic gluconeogenesis. The resulted increase in plasma glucose level as well as propionate itself stimulated insulin release. Insulin release suppressed the release of free fatty acids from the adipose tissue and synthesis of hepatic lipoprotein decreased. This diminution reduced availability of milk fat precursors in the blood and resulted in low milk fat (Rao *et al.*, 1973; Yang and Baldwin, 1973; Beukelen *et al.*, 1982; Emmanuel and Kennelly, 1984; Grant *et al.*, 1990a and Gaynor *et al.*, 1995).

Increase in plasma insulin concentration was implicated as a causative factor in low milk fat syndrome. Animals fed high concentrate diets increased ruminal propionate production which resulted in elevated plasma insulin (Walker and Elliot, 1973).

Jenny and Pollan (1975) stated that high grain feeding resulted in low milk fat production.

Feeding a ground pelleted hay with concentrates and limited long hay resulted in milk fat depression (Welch and Smith, 1975).

Deficiency of vitamin B_{12} might result in an accumulation of methylmalonate which in turn could interfere with milk fat synthesis (Frobish and Davis, 1977; Elliot *et al.*, 1979; Croom *et al.*, 1981).

Frobish and Davis (1977) proposed that low milk fat syndrome resulted from alteration in propionate metabolism brought about by increased rumen propionate production coupled with a decrease in the amount of co-factor vit B_{12}.

Production of milk with low fat content in Holstein-Friesian cows on pasture was possibly due to inadequate fiber in rations, low fat intake or subclinical hepatic dysfunctions (Ghergeriu *et al.*, 1986).

Studies indicated that the physical form in which roughage was fed to animals was important in relation to their milk composition. Feeding of pelleted or ground roughages produced low milk fat syndrome (Woodford and Murphy, 1988; Knezo and Hlinka, 1988). Cubing of alfalfa forage after

cutting and pressing lowered milk fat per cent on feeding to cows (Klusmeyer *et al.*, 1990).

Leenanuruksa and McDowell (1988) indicated insulin as a key factor in the aetiology of low milk fat syndrome in ruminants.

Baker (1990) listed the nutritional factors that depressed milk fat and the metabolic pathways involved in the synthesis of milk fat. He also stated that inadequate fiber intake, energy deficiencies and poor feed regimen resulted in low milk fat.

Grant *et al.* (1990a) indicated that reduced size of silage particles altered chewing behaviour, ruminal fermentation and decreased milk fat secretion.

Gaynor *et al.* (1994) stated that reduced synthesis of fatty acids and reduced activity of acyl transferase in mammary tissue contributed to depressed milk fat percentage when cows were abomasally infused with transoctadecenoates.

When dairy cows consumed diets based on high concentrate (or) highly acidic silage resulted in lactic acidosis, liver abscess, reduced fiber digestion and reduced milk fat yield (Tucker *et al.*, 1994).

Fujita (1996) found that the mechanism of milk fat depression in summer was due to decreased metabolic activity, and heat modulated suppression of lipoprotein metabolism.

2.3 Epidemiology

Davis *et al.* (1947) reported the influence of season on the fat and SNF percentage of milk. They found the percentage of fat and SNF in milk to be lowest in summer months and highest during winter months.

Wilcox *et al.* (1958) found that as the age of the cow increased the percentage of SNF in the milk decreased.

Johnson *et al.* (1961) stated that the fat content was lowest in the third month of lactation for the Holsteins and the second month for the Jersey. They also observed that both breeds had the lowest SNF content in the second month of lactation.

Arora and Gupta (1969) observed no significant difference in the SNF content of milk between the stages of lactation.

The milk obtained after the long (14.5 hr) interval was lower in per cent milk fat than that following the short (9.5 hr) interval. Distribution of SNF percentage between

morning and evening milking was not affected by milking intervals (Ormiston, 1967).

Prasad and Subramanyam (1986) reported that the evening milk produced more fat in Jersey cross and Brown swiss cross cows. They also reported that the percentage of samples below 3.5 per cent fat in the first, second and third stages of lactation were 10, 3.8 and 0.65 per cent in the crossbred Jersey and 10.86, 6.14 and 2.82 per cent in the crossbred Brown Swiss animals. They also mentioned that a total of 4.85 per cent of samples collected were below the legal standard in the Jersey crosses and for the Brown Swiss crosses it was 7.41 per cent. The percentage of samples below the legal standard for SNF were 1.55 and 3.52 for the Jersey and Brown Swiss crossbreds respectively.

Iype *et al.* (1994) reported that the evening milk fat percentage was significantly higher than the morning milk fat percentage in crossbred cows of Kerala. They also reported that only 34.9 per cent of the animals had fat per cent above 3.5 in the morning in early lactation while 75.6 per cent of the cows in the evening sample had fat per cent above 3.5.

2.4 Rumen liquor evaluation

2.4.1 Physical characters

2.4.1.1 Colour

Normal colour of the rumen liquor in cattle depended on the nature of the diet, time of feeding and stage of digestion (Alonso, 1979; Dirksen, 1979). The colour varied from yellowish-brown (Misra *et al.*, 1972a; Misra and Singh, 1974), grey and olive to brownish green and pure green (Dirksen, 1979), greenish-brown (Alikutty, 1981) or greenish-yellow (Thomas, 1983).

2.4.1.2 Consistency

Normal consistency of rumen fluid of cattle was viscous or slightly viscous (Misra *et al.*, 1972a; Dirksen, 1979).

2.4.1.3 Odour

Rumen liquor from healthy animals had an aromatic odour and this depended on the nature of rumen contents (Misra *et al.*, 1972a; Misra and Singh, 1974; Alonso, 1979; Dirksen, 1979).

2.4.1.4 pH

Normal values of pH of the rumen liquor of cattle reported by the various workers were 6.7 to 6.9 (Misra *et al.*, 1972a), 6.4 to 6.8 (Alonso, 1979), 6.81 + 0.005 (Alikutty, 1981) 6.81 + 0.44 (Thomas, 1983) and 6.5 to 7.0 (Radostits *et al.*, 1994).

Bringe and Schultz (1969) pointed out that maintenance of higher pH in rumen by feeding Bentonite resulted in higher milk fat per cent.

Dirksen (1979) reported that the sample collected through a tube would contain some saliva which would raise pH by 1.0 unit. He also stated that pH was in the higher range on rations rich in crude-fibre and/or protein than on ration rich in starch and sugar.

Shriver *et al.* (1986) found that the digestibility of Neutral detergent fiber (NDF) was depressed at pH 5.8, increased markedly at pH 6.2 and increased slightly at pH 7.0. He also found that the production of Total VFA was highest at pH 6.2 and 6.6.

Maintenance of normal ruminal pH was found to be necessary for normal milk composition (Woodford and Murphy, 1988; Klusmeyer *et al.*, 1990).

Noro *et al.* (1989) clearly revealed that there was no difference in the ruminal pH between cows with low milk fat and controls.

Buffers, as feed additives increased ruminal pH increasing digestion of dietary acid detergent fibre (ADF) (Erdman, 1988).

Baudet (1996) stated that increase in rumen pH favoured higher milk fat level.

2.4.2 Microbial activity

2.4.2.1 Sedimentation activity time (SAT)

Nicholas and Penn (1958) suggested that determination of sedimentation activity time (SAT) was helpful to assess the rumen microbial activity.

According to Hoflund (1965) prolonged sedimentation activity time (SAT) indicated poor microbial activity.

Misra *et al.* (1972a) reported that in cattle sedimentation activity time of rumen liquor varied from 8.0 to 18.0 minutes with an average value of 12.8 min.

Quick sedimentation, unclear sediment and delay in floatation of particulate materials of rumen liquor indicated

various degree of inactivity of rumen microbes (Prasad *et al.*, 1976b).

Normal sedimentation activity time of rumen liquor in cattle from western countries varied from 4.0 to 8.0 min (Dirksen, 1979) and 3.0 to 9.0 min (Radostits *et al.*, 1994).

2.4.2.2 Rumen protozoa

Eadie and Hobson (1962) concluded that there was no evidence of any effect caused by presence or absence of ciliates and reported that all protozoa were established at pH 6.5.

Clarke (1964) enumerated total protozoa in the rumen of cattle as $1.9x10^5$ to $19.7x10^5$ on fresh red clover and as 1.1×10^5 to $4x10^5$/ml on clover hay fed animal.

Christiansen *et al.* (1965) reported fewer protozoa in a ration containing ground roughage.

Hungate (1966) stated that counts varied from none to as high as $5x10^6$ and usually within the range of $2x10^5$ to $2x10^6$/ml. He also observed that the total number of protozoa was $0.8x10^6$ on hay and concentrate ration.

Purser and Moir (1966) stated that urea supplementation caused greater concentration of protozoa.

Misra *et al.* (1972a) described the protozoal motility of rumen liquor of healthy cattle ranging from moderate (++) to vigorous (+++) with 10 to 30 protozoa per low power microscopic field.

Sankaranarayanan and Nambiar (1972) reported total protozoal count to be varying from $1.66x10^5$/ml to $2.56x10^5$/ml.

Dirksen (1979) suggested that the protozoa in the rumen liquor normally varied according to composition of the ration, feeding time and level of rumen fluid from where the samples were collected.

Rosenberger (1979) stated that the number fluctuated normally according to composition of rumen fluid, feeding time, and part of rumen from where the sample was collected.

Winagradowa and Winagradowa (1979) observed that the protozoal count ranged between $0.7x10^5$/ml and $1.5x10^5$/ml with hay and grain ration.

Dennis *et al.* (1983) observed that the total protozoal concentration for low, medium and high concentrate diets were 1.5, 2.5 and $4.1x10^5$/ml. They also concluded that an active and complex population of rumen protozoa could exist with diet free of natural protein presumably by using engulfed bacteria.

Lundquist (1985) observed that the total ciliated protozoa were higher when cows were fed DL-methionine than methionine hydroxy analog or sodium sulfate.

Bragg *et al.* (1986) stated that the number of protozoa varied considerably with time after feeding and tended to be higher on whey diet.

Mohammed *et al.* (1988) observed that the protozoal numbers were reduced with free oil and whole seed but were not affected by addition of roasted oil seed.

Shimada *et al.* (1989) explicitly stated that the number of protozoa increased from 2.85×10^5/ml in the pre treatment period to 9.61×10^5/ml in the post treatment period when ruminal buffers were added to the feed.

Noro *et al.* (1989) stated that there was no difference in the total protozoal count between control cows and cows with low fat milk.

2.4.3 Volatile fatty acids

Concentration of total volatile fatty acids (TVFA) in rumen liquor of healthy cattle was reported to be 60-120 mEq/L (Phillipson, 1977), 87.8 + 3.3 mEq/L (Joshi and Misra, 1976), 86 mEq/L (Prasad, 1977), 65 to 95 mEq/L (Dirksen, 1979), 84.3 mEq/L (Sankaranarayan and Venkatayan, 1980).

Card and Schultz (1956) reported that the rations fed to cows significantly affected the molar proportion of acetic, propionic, and butyric acids. Silage caused a decrease in acetic acid and an increase in propionic acid and butyric acid production. Acetate was most variable with reciprocal changes in butyrate. The propionic acid level was least variable.

Williams and Christian (1956) found that there was a close correlation between rumen volatile fatty acids and the daily food intake. They found that the ratio of ruminal acetate, propionate, and butyrate might be altered quantitatively by varying the feed intake.

McClymont (1958) observed acetic acid 60 per cent, propionic acid 21.8 per cent and butyric 14.4 per cent on molecular basis in ruminal contents.

Elliot and Loosli (1959) stated that an increase in the roughage of the dairy cattle ration increased the proportions of acetic acid.

Shaw and Ensor (1959) realized that high level of unsaturated fat would cause a depression of acetate production in the rumen and thus depressed milk fat.

Volatile fatty acids when infused into the rumen of lactating cows have caused variable responses in milk

production. Acetic acid increased milk yield and milk fat per cent, but a negative response was caused by propionic acid (Rook and Balch, 1961; Rook *et al.*, 1965).

Brown *et al.* (1960) reported that the concentration of rumen volatile fatty acid was increased in proportion to the increase in the percentage of concentrate in the diet.

Brown *et al.* (1962) suggested that the relation between rumen acid ratios and low milk fat was not always consistent.

Rhodes and Woods (1962) found alteration in the ratio of intraruminal acetate, propionate and butyrate by pelleting the concentrate diet and noticed an increase in propionic acid concentration due to pelleting of the grains.

The relative proportion of individual ruminal acids varied with type of feed stuffs. (1) Acetic acid from 65 to 70 molar per cent on forage rations to 40 to 55 per cent with grain corn; (2) Propionic acid; from 16 per cent on forage to 28 to 32 per cent with corn; (3) butyric acid, from 7 to 12 per cent on forage to 17 per cent with corn (Hungate, 1966).

McCullough (1966) found that molar per cent of propionic acid above 20 reduced milk fat per cent and the ration which reduced fat content also reduced feed intake.

Colovos *et al.* (1967) fed lactating cows with concentrate ration containing 1.25, 2.00 and 2.50 per cent urea. The mean acetate level ranged from 60.90 to 71.00 moles percentage, propionate level ranged from 16.90 to 20.50 moles percentage, and butyrate level ranged from 10.70 to 13.70 moles percentage.

Davis (1967) concluded that an absolute shortage of acetate produced in the rumen was not responsible for the depression in the fat content of the when a low fibre, high grain diet was fed.

Hoflund (1967) stated that the amount of volatile fatty acids present in the rumen were about 100 mEq/L (Acetic 60-65%; propionic 20%; butyric 15% and higher fatty acids 3%).

Tsai *et al.* (1967) conducted experiment on lactating dairy cows by feeding low fiber ration. They found reduction in the ruminal acetic acid and increase in the ruminal propionic acid associated with reduced milk fat percentage.

Walker and Elliot (1969) observed parallel changes in the ratio of acetate to propionate in rumen fluid when cows were fed with milk fat depressing ration.

Bauman *et al.* (1971) stated that the low milk fat syndrome was associated with an increase of ruminal propionate production.

Sankaranarayan and Nambiar (1972) reported that the peak values of total volatile fatty acids reached at the second hour after feeding and gradually declined from fourth to tenth hour and subsequently increased at the 12th hour.

Tanaka *et al.* (1973) stated that stearic acid had no effect on molar proportions of VFA in rumen liquor but safflower oil resulted in increase in the molar proportion of rumen propionic acid and reduction in the acetic acid.

Kannan *et al.* (1975) stated that maximum acetic acid (51.30 m.mole/L) was produced when chopped straw was fed. While maximum butyric acid was found in case of long straw feeding.

Bandaranayaka and Holmes (1976) reported that the proportion of acetic acid in the rumen content decreased at 30°C ambient temperature in association with small decrease in pH.

Phillipson (1977) observed 60 to 70, 15 to 20 and 10 to 15 per cent of acetic acid, propionic acid and butyric acid respectively in animals fed on hay or other roughages. He

also stated that the concentration of total volatile fatty acids in the rumen varied from 60 to 120 mEq/L and exceptionally high values occurred when animals were grazed on young summer grass or when they were given starch rich diets.

Basmaeil and Clapperton (1980) found decrease in milk fat and SNF in lactating goats when administered with chloroform intraruminally. He also observed reduced level of rumen VFA, and increase in propionic acid and decrease in acetic acid.

Ridell *et al.* (1980) recorded 62.8, 17.7, 15.2 and 4.4 molar percentage of acetic, propionic, butyric and valeric acid in the rumen liquor of cattle fed with standard ration supplemented with 5 per cent urea.

Donald (1982) conducted an experiment by increasing the amount of grain and other concentrates and reducing the amount of hay and other roughages in a dairy cattle ration. He found changes in the normal pattern of ruminal fermentation resulting in the production of less acetic acid and more propionic acid in the rumen. The changes in the ruminal fermentation were accompanied by a depression in milk fat percentage.

Illeko *et al.* (1983) found that the decrease in milk fat content during metabolic acidosis was associated with increase in rumen propionate and decrease in acetate concentration.

Milk fat depression was accompanied by increased rumen propionate and decreased acetate content several hours after feeding (Beukelen *et al.*, 1983).

Ozkan *et al.* (1983) stated that when the intake of hay was increased, milk production decreased, milk fat increased, acetate and butyrate increased and propionate decreased.

Decreased forage to grain ratio of diets resulted in decreased ruminal pH and decreased ruminal acetate:propionate ratio (Santini *et al.*, 1983; Woodford *et al.*, 1986).

Sutton (1989) found that increased feeding frequency might result in a higher and more stable acetate to propionate ratio which in turn might cause milk fat concentration to increase.

Radostits *et al.* (1994) classified VFA into ketogenic and glycogenic and these two groups were produced under normal conditions in the ratio 4:1.

Mohammed *et al.* (1988) observed that the proportion of propionate in ruminal VFA was higher and that of butyrate lower as a result of feeding free oil.

Noro *et al.* (1989) found that the production of VFA and the acetic acid, propionic acid ratio were reduced in the low milk fat cows.

Brown *et al.* (1990) observed increased ruminal acetate and decreased propionate when straw was added in the diet.

Ferguson *et al.* (1990) stated that the rumen fluid, acetate:propionate ratio decreased with increasing dietary fatty acids.

Firkins *et al.* (1990) found that feeding fat decreased ruminal molar ratio of acetate:propionate.

Grant *et al.* (1990a) investigated the effect of particle size of lucerne silage on lactating cow metabolism with reference to milk fat depression. He observed that the acetate:propionate ratio decreased when cows consumed fine ration.

Ruminal pH and acetate:propionate ratio decreased when cows consume fine ration. Results indicated that reduced size of silage particles altered chewing behaviour, ruminal fermentation and decreased milk fat secretion (Grant *et al.*, 1990).

Klusmeyer *et al.* (1990) observed decreased ratio of acetate:propionate in cows consuming the cubed diet which resulted in the depression of milk fat percentage.

Punnia and Sharma (1990) noticed higher ratio of volatile fatty acid production and concentration, in cattle and

buffaloes fed with barely and molasses than in straw supplemented diets. The production of acetic acid, propionic acid, and butyric acid were higher for barley and molasses than for straw supplemented diets.

Cows fed with larger amount of treated out oat hulls had lower ruminal concentration of total VFA with greater acetate:propionate ratio (Cammeron, 1991).

Hadjipanayiotou *et al.* (1992) found increased molar proportion of acetic acid and decrease in propionate and to a less extent butyrate by including salts of saliva in the diet of dairy cows, wherein milk fat showed a positive correlation with acetate to propionate ratio.

Santini *et al.* (1992) stated that acetate to propionate ratio increased with Acid Detergent Fibre (ADF) intake.

Ruminal acetate:propionate ratio decreased linearly when diets lower in forage Neutral Detergent Fibre (NDF) were fed, but it increased quadratically when dietary non-structural carbohydrate were reduced (Sarwar *et al.*, 1992).

Grummer *et al.* (1994) concluded that the ruminal acetate to propionate ratio decreased as propylene glycol dose was increased in diet.

Jenkins *et al.* (1996) reported that the supplementation of soyabean oil disrupted the ruminal fermentation, causing decline in the total VFA and acetate concentration, which resulted in reduction of milk fat yield.

2.5 Milk

2.5.1 California mastitis test (CMT)

Schalm and Noorlander (1957) stated that the individual quarters were considered positive for mastitis if they scored either two or three. He also explained that a cow was considered positive if one or more of her quarters scored two or three.

Braund and Schultz (1963) used CMT on quarter samples under field conditions and determined the physiological and managemental factors responsible for positive reactions. He also stated that CMT is the most convenient as a barn test at the side of the cow.

2.5.2 Fat and SNF percentage

Bailey (1952) concluded that changes in the SNF content of milk was due to changes in the feeding practices that occurred concurrent with the change in season.

The effect of acetic acid supplementation on composition of cows milk was studied by Rook and Balch (1961); Rook *et al.* (1965); Storry and Rook (1966); Orskov *et al.* (1969); and Omel'yanenko and Shliko (1982).

Ueyama *et al.* (1972) reported that the milk fat per cent was decreased by intraruminal infusion of propionic acid alone but returned towards normal when acetic acid or butyric acid were infused with propionic acid.

For maximum production of milk fat, diet should contain optimum quantity of Neutral Detergent Fibre (NDF) and Acid Detergent Fiber (ADF). Woodford *et al.* (1986) recommended an NDF level of 24 per cent and an ADF level of 8 per cent in dairy ration.

Sutton (1989) reviewed the effect of feeding on milk fat concentration.

Milk fat concentration is influenced by several factors including nutrition, temperature, humidity, genetics, and the cow's stage of lactation. A normal decline in milk fat concentration occurred in early lactation as milk volume increased. Subsequently, milk fat concentration rose during mid to late lactation as milk production declined (Baker, 1990). He also stated that acid detergent fiber should be atleast 19 per cent and ideally 21 per cent, of the dietary

dry matter to ensure adequate cud chewing and to enhance saliva flow.

Baudet (1996) reported that the milk fat level tended to be highest in the final stages of milking. Therefore incomplete milking will give milk with lower fat level. He also suggested that increasing the frequency of milking from 2-3 times/day was associated with higher milk fat yield for the whole lactation.

Singh *et al.* (1995) concluded that the effect of season of calving influenced milk fat yield. They reported that winter calving resulted in highest monthly milk fat yield.

Sathian and Francis (1995) reported that there was no change in the total solid percentage or SNF per cent of milk when cows were fed with 200 ml of 5 per cent acetic acid per day.

2.6 Haematology

2.6.1 Haemogram

Jain (1986) reported the normal haematological values in healthy cattle.

Noro *et al.* (1989) observed no significant differences in the haematological values between low fat milk and control cows.

2.6.2 Triglycerides

Varman and Schultz (1968) studied the blood lipid changes in response to a high grain ration that depressed milk fat.

Varman *et al.* (1968) studied the effect of unsaturated oils on rumen fermentation, blood components and milk composition. They observed that the major change associated with the depression of milk fat was significant decrease in the total plasma triglycerides.

Grummer (1991) explicitly described the role of plasma triglycerides in the formation of milk fat.

2.6.3 Cholesterol

The normal values of serum cholesterol in cattle reported by various workers were 100 mg per cent (Doxey, 1971), 70 mg per cent (Dwivedi *et al.*, 1972), 132-159 mg per cent (Ross and Halliday, 1976), 80-264 mg per cent (Tasker, 1978), 93-169 mg per cent (Baumgartner and Skalicky, 1979), 126 to 204 mg per cent (Sinha *et al.*, 1981) and 80-120 mg per cent (Benjamin, 1985).

Brown and Stull (1967) stated that there were no significant correlation coefficient between the fatty acids of serum cholesterol esters and milk fatty acids.

Miyazaki (1975) found increased cholesterol level in the serum of cows secreting low fat milk.

Palmquist (1976) reviewed the relationship between dietary fat, plasma lipids and milk fat synthesis.

Shimada *et al.* (1989) observed a decrease in the serum cholesterol level of low milk fat cows after treatment with ruminal buffer consisting of 100 gm of sodium bicarbonate and 30 gm of magnesium hydroxide. They observed a decrease in the cholesterol level in the blood after treatment.

Sasaki *et al.* (1994) observed that the total serum cholesterol in middle and late lactation were lower in low milk fat herds.

2.6.4 Glucose

Normal blood glucose level in cattle was reported to be 35.55 mg per cent (Kaneko and Cornelius, 1963), 40 mg per cent (Mullen, 1976), 43.7 mg per cent (Rowlands *et al.*, 1977), 64 + 18 mg per cent (Tasker, 1978), 60-80 mg per cent (Dirksen, 1979) and 35-55 mg per cent (Benjamin, 1985).

Jenny and Pollan (1975) studied the effect of ration on post prandial serum glucose and insulin in lactating Holstein cows. They observed that high grain feeding increased serum glucose and insulin at all hours post feeding as compared to control cows.

Kolb (1977) described that both the glucose value and the insulin level in the blood plasma were increased in the presence of milk fat deficiency syndrome.

Grant *et al.* (1990b) investigated the effect of particle size of alfalfa silage on lactating cow with reference to milk fat depression. They observed increase in the plasma glucose level and serum insulin with decreasing particle size of silage.

Grant *et al.* (1990) conducted two trials to examine the role of particle size of alfalfa hay in modifying milk fat secretion in dairy cows. They observed that ruminal pH decrease and increase with ruminal propionate and plasma glucose level when cows consumed the fine ration.

Materials and Methods

3. MATERIALS AND METHODS

Ten crossbred cows with low milk fat (3.5 per cent or below) selected at random from various milk societies/ veterinary hospitals in and around Thrissur, were used for the study. Six apparently healthy lactating cows maintained under similar field conditions served as the control.

Parameters studied

I. Epidemiology

II. Clinical observations
   - (i) Respiration
   - (ii) Pulse
   - (iii) Temperature
   - (iv) Mucous membrane
   - (v) Rumen motility

III. Rumen fluid
   - (i) Physical characters
     - a. Colour
     - b. Consistency
     - c. Odour
     - d. pH

(ii) Microbial activity

a. Sedimentation Activity Time (SAT)

b. Methylene Blue Reduction Test

c. Protozoal activity

d. Total protozoal count

(iii) Volatile fatty acids

a. Total

b. Fractional

1. Acetic acid

2. Propionic acid

3. Butyric acid

IV. Milk

(i) California mastitis test

(ii) Fat percentage

(iii) Solids-not-fat percentage (SNF)

V. Blood

(i) Haemogram (PCV, Hb, RBC)

(ii) Triglycerides

(iii) Cholesterol

(iv) Glucose

Selection of cases and sampling

All the experimental and control animals were subjected to detailed clinical examination. Dung, urine, milk and blood

were examined and the possibility of any concurrent diseases were ruled out.

A questionnaire was prepared to find out the practice of feeding and management (Annexure-1). Based on the records of the milk societies, twenty animals were examined and ten confirmed cases were selected.

Composite milk samples, blood, and rumen fluid were collected on three occasions viz. 30th, 60th and 90th day of lactation and subjected to investigations.

After collection of samples on the 30th day suitable changes in the feeding and management practices viz. feeding of more paddy straw, split feeding of concentrates and administration of diluted vinegar for ten days were recommended.

Sampling of rumen fluid

Rumen fluid was collected with the help of rumen fluid extraction apparatus. The collected rumen liquor was made into two aliquots. One of the samples was strained through four folded cheese cloth and saturated solution of mercuric chloride was added at the rate of one ml per twenty ml of rumen fluid to arrest further fermentation (Sankaranarayanan and Nambiar, 1972). It was preserved in the freezer at -20°C

and used for estimation of volatile fatty acids. The other aliquot was used for the study of rest of the parameters.

Physical characters

pH of rumen fluid was recorded immediately after collection with strips of wide range pH paper. Physical characters of rumen fluid was assessed as per the method of Misra and Tripathy (1963).

Microbial activity

Assessment of protozoal motility was done as per the method described by Misra *et al.* (1972a), sedimentation activity time was noted soon after collection of rumen fluid as per the method of Nicholas and Pen (1958). Methylene Blue Reduction test was done as per the method of Dirksen (1979).

Total protozoal count

A modified method of Warner (1962) as described by Sankaranarayanan and Nambiar (1972) was used.

The rumen fluid sample was strained through a four folded cheese cloth. Kneading and squeezing of the solids remaining in the cloth after straining was done to minimise the entrapment of micro-organisms by feed particles. Five ml of

the strained rumen fluid was taken and the volume was made upto twenty five ml by adding ten per cent Formol saline (10% formaldehyde v/v in 0.35% sodium chloride). Formalin checked further bacterial and protozoal activity. Ten ml was taken from the above and stained by adding 10 drops of two per cent eosin. It was allowed to set for 5 to 10 minutes for the protozoa to take up the stain. A drop of the fluid was charged in haemocytometer with Neubauer ruling and the total number of protozoa in eight chambers were counted.

Vigorous mixing and rapid handling ensured that the denser micro-organisms did not settle out appreciably during this procedure.

Estimation of total volatile fatty acids

This was estimated by the method of Barnett and Reid (1957).

One ml of the rumen fluid was taken in Markham-apparatus followed by one ml of oxalic acid - Potassium oxalate buffer (0.5 ml of 10% potassium oxalate and 0.5 ml of 5% oxalic acid). The mixture was steam distilled. About 80 ml of distillate was collected and titrated against 0.01N sodium hydroxide using phenophthalein indicator. Total volatile fatty acids were expressed in mEq/L of the sample.

Estimation of individual volatile fatty acids

Individual volatile fatty acids concentration was measured as per the method described by Chase (1990).

Preparation of the sample

Five ml of strained rumen fluid was added with one ml of 25 per cent metaphosphoric acid and mixed thoroughly. It was kept undisturbed for 30 minutes and was then centrifuged at 2000 rpm for 10 minutes. For chromatographic analysis 0.6 microlitres of supernatent solution was used.

Milk

California mastitis test (CMT) was conducted as described by Schalm and Noorlander (1957). Fat percentage in milk was estimated by Gerber method as per the procedure described in IS 1224-Part I (1977). Total solids percentage of milk was estimated by Gravimetric method (IS: 1479 Part II, 1961). Solids not fat (SNF) content of milk was determined by finding the difference between total solids content and fat content of milk.

Blood

Five ml of blood was collected from the jugular vein in a clean dry glass vial with EDTA as anticoagulant. Haematological examination was performed as per Schalm *et al.* (1975). Ten ml of blood was collected in a clean dry sterilized test tube for the separation of serum. Glucose, cholesterol and triglycerides level in the blood were estimated following the methods of Hultman (1959), Zak (1957) and Foosati (1982).

Statistical analysis

The data obtained were subjected to statistical analysis as per Snedecor and Cochran (1967).

Results

4. RESULTS

The parameters were studied on three occasions viz., 30th, 60th and 90th day of lactation.

4.1 Epidemiology

Five hundred and thirty seven crossbred cows were screened for milk fat percentage. Among these, 33.3 per cent recorded a low milk fat of 3.5 per cent or below. Of these, 19.5 per cent animals recorded a milk fat percentage of below 3 in the morning. The month-wise distribution was shown in Fig.1. About 54.1 per cent of the low milk fat animals were in early lactation and 30.16 per cent in mid lactation period (Fig.2). The milk samples screened in the evening were comparatively having a higher fat percentage. Only 3.16 per cent of the animals screened in the evening showed a milk fat percentage of less than 3.5 per cent.

4.2 Clinical observation

On clinical examination of the low milk fat group, no obvious abnormality could be detected. The body temperature, pulse rate, and respiration rate were found to be normal. The rumen motility was also found to be normal.

4.3 Rumen fluid analysis

4.3.1 Physical characters

The colour of the rumen liquor of control animals (group I) was presented in Table 3. The colour of the rumen liquor of group I (control) was olive-green/yellowish brown/ yellowish green/grey during the period of study. It was slightly viscous in consistency and had aromatic odour on all the three occasions. The pH of the rumen fluid ranged from 6.0 to 7.0 (Table 3).

In the low milk fat cows (Group II) rumen liquor was olive green/yellowish green/grey/yellowish brown in colour, slightly viscous in consistency and had aromatic odour. The pH of rumen fluid ranged from 6.0 to 7.0 (Table 4). There was no significant difference between the two groups (Table 7).

4.3.2 Microbial activity

Mean sedimentation activity time in control animals on 30th, 60th and 90th days of lactation were 6.5 ± 0.67, 7.1 ± 0.79 and 7.8 ± 0.75 minutes respectively (Table 5).

The mean sedimentation activity time among the low milk fat cows (Group II) on 30th, 60th and 90th days were 6.3 ± 0.63, 7.0±0.57 and 6.6 ± 0.12 minutes respectively (Table 6).

Mean values of the methylene blue reduction test (MBRT) in control group on 30, 60 and 90 days were 3.5 ± 0.22, 3.6 ± 0.33 and 3.5 ± 0.72 minutes respectively (Table 5).

In low milk fat cows, the mean values of MBRT was 3.9 ± 0.31, 3.7 ± 0.21 and 3.3 ± 0.15 minutes on 30, 60 and 90 days respectively (Table 6).

The protozoal motility was vigorous (+++) in both the control and low milk fat groups. It was presented in Table 7.

The mean protozoal count in the control group was found to be 8.26 ± 1.08, 7.13 ± 0.62 and 10.75 ± 1.74 x 10^5/ml on 30, 60 and 90 days respectively (Table 5).

In low milk fat group the mean protozoal count was 7.48 ± 0.83, 7.74 ± 1.27 and 8.06 ± 1.04 x 10^5/ml on 30, 60 and 90 days respectively (Table 6).

There were no statisticaly significant differences in SAT, MBRT and protozoal count between the control and low milk fat groups on all the three occasions (Tables 9,10,11).

4.3.3 Volatile fatty acids (VFA)

4.3.2.1 Total VFA

The mean total volatile fatty acid concentration in the rumen liquor was 97.5 ± 4.04, 96.8 ± 6.0 and 99.2 ± 4.04 mEq/L

on 30, 60 and 90 days respectively in the control group (Table 7).

In the low milk fat group, the mean total volatile fatty acid concentration in rumen liquor was 83.4 ± 3.16, 82.9 ± 2.43 and 85.6 ± 3.83 mEq/L on 30, 60 and 90 days respectively (Table 7).

The difference between the values of the control group and low milk fat group was statistically significant ($P<0.05$) on all the three occasions (Tables 9,10,11).

4.3.3.2 Individual volatile fatty acids

Data presented in Table 7. The mean acetic acid concentration in rumen liquor of control cows were 72.7 ± 1.91, 73.18 ± 0.86 and 73.10 ± 0.59 per cent on 30, 60 and 90 days respectively. In low milk fat group the mean acetic acid concentration in rumen liquor was 67.8 ± 0.68, 70.23 ± 0.88 and 72.28 ± 0.91 on 30, 60 and 90 days respectively.

The difference between the two groups was significant ($P<0.05$) on 30 and 60 days (Tables 9 and 10). Within the low milk fat group highly significant difference was noticed between 30 and 90 days ($P<0.01$) (Table 12).

In the healthy control group, the mean values of propionic acid concentration on 30, 60 and 90 days were 17.52

± 1.05, 16.29 ± 0.62 and 17.96 ± 0.48 per cent respectively (Table 7). In low milk fat group, the mean values of propionic acid concentration in rumen liquor were 23.52 ± 1.02, 20.78 ± 0.64, and 18.86 ± 0.67 per cent on 30, 60 and 90 days respectively (Table 7). Significant difference was evident within the low milk fat group between 30 and 90 days ($P<0.05$) (Table 12).

Analysis of the data revealed significant difference ($P<0.05$) between control and low milk fat groups on 30 and 60 days (Tables 9 and 10). It was not significant on 90th day (Table 11).

The mean butyric acid concentration on 30, 60 and 90 days were 10.37 ± 1.27, 10.52 ± 0.58 and 8.92 ± 0.60 per cent respectively in the control group. The mean butyric acid concentration in low milk fat group was 8.68 ± 0.92, 8.98 ± 1.0 and 8.67 ± 0.52 per cent on 30, 60 and 90 days respectively (Table 7).

Analysis of the data did not reveal any significant difference in butyric acid concentration between control and low milk fat groups on all the three occasions.

The mean acetic: propionic acid ratio (A:P) in control group was 4.2 ± 0.36, 4.5 ± 0.22 and 4.04 ± 0.12 on 30, 60 and 90 days respectively (Table 7). The mean acetic: propionic

acid ratio (A:P) in low milk fat group was 2.89 ± 0.13, 3.36 ± 0.12 and 3.85 ± 0.16 on 30, 60 and 90 days respectively (Table 7). Significant difference was noticed between the periods of 30 days, 60 days and 90 days in the low milk fat group ($P<0.05$) (Table 12).

On statistical analysis, significant difference was noticed on 30 and 60 days between the control and experimental groups (Tables 9,10).

4.4 Milk

The milk samples collected were tested for subclinical mastitis by California mastitis test (CMT) and all the samples of control and low milk fat groups revealed negative reaction. The values of the fat and solids-not-fat percentage of control group were shown in Table 1 and low milk fat group in Table 2.

On statistical analysis, the fat and SNF percentage within the control group was significantly different between 30 and 90 days ($P<0.05$). In low milk fat group also, the fat and SNF percentage were significantly different between 30 and 90 days of lactation ($P<0.01$) (Table 12).

There was positive correlation between milk fat per cent and acetic acid and significant negative correlation existed between milk fat and propionic acid on all the three

occasions. Significant high positive correlation was noticed between milk fat percentage and A:P ratio on all the three occasions (Table 13).

4.5 Blood

4.5.1 Haemogram

The mean haemoglobin values in the control group were 10.70 ± 0.61, 10.46 ± 0.33 and 10.23 ± 0.50 g/dl on 30, 60 and 90 days respectively (Table 8). For the low milk fat group the mean haemoglobin levels observed were 10.42 ± 0.38, 10.77 ± 0.36 and 10.50 ± 0.27 g/dl on 30, 60 and 90 days respectively (Table 8).

There was no significant difference between the control and low milk fat groups on all the three occasions (Tables 9, 10 and 11).

4.5.2 Haematocrit

Mean haematocrit value of the control group was 32.0 ± 0.73, 34.0 ± 0.73 and 32.33 ± 0.80 per cent on 30, 60 and 90 days respectively (Table 8). In the low milk fat group the mean values of haematocrit were 32.6 ± 0.98, 33.3 ± 0.75 and 32.2 ± 0.42 per cent respectively on 30, 60 and 90 days of lactation (Table 8).

On statistical analysis, no significant difference was noticed between the control and low milk fat groups on 30th, 60th and 90th days of lactation (Tables 9, 10 and 11).

4.5.3 Erythrocyte count

The mean RBC count among the control group on 30, 60 and 90 days were 6.13 ± 0.35, 6.25 ± 0.19 and 6.25 ± 0.26 x $10^6/\mu l$ respectively (Table 8). In low milk fat group the values were 5.79 ± 0.29, 6.11 ± 0.28 and 6.33 ± 0.23 x $10^6/\mu l$ respectively on 30, 60 and 90 days of lactation (Table 8) (Tables 9, 10 and 11).

There was no significant difference between the control group and low milk fat group on all the three occasions.

4.5.4 Triglycerides

The mean triglyceride levels in the control group was 32.5 ± 4.3, 22.25 ± 1.82 and 33.91 ± 2.81 mg per cent on 30, 60 and 90 days of lactation respectively (Table 8).

Mean values in the low milk fat group were 28.95 ± 2.20, 28.61 ± 2.63 and 28.82 ± 2.22 mg per cent on 30, 60 and 90 days respectively (Table 8).

Analysis of the data did not reveal any statistically significant difference between the control and low milk fat groups on all the three occasions (Tables 9, 10 and 11).

4.5.5 Cholesterol

The mean values of cholesterol level in control group were 119.0 ± 9.14, 100.06 ± 7.6 and 116.8 ± 7.72 mg per cent on 30, 60 and 90 days of lactation (Table 8).

The mean values in low milk fat cows were 133.15 ± 14.02, 130.2 ± 12.73 and 138.72 ± 16.71 mg per cent on 30, 60 and 90 days respectively (Table 8).

On statistical analysis, no significant difference was noticed between the control and low milk fat groups on 30, 60 and 90 days of lactation (Tables 9, 10 and 11).

4.5.6 Glucose

In the control group the mean serum glucose level was 62.6 ± 3.03, 58.4 ± 5.73 and 70.9 ± 3.73 mg/dl on 30, 60 and 90 days of lactation (Table 8).

The mean glucose levels in the low milk fat group was 64.0 ± 1.93, 61.32 ± 1.1 and 59.2 ± 1.54 mg/dl on 30, 60 and 90 days of lactation respectively (Table 8).

Significant difference between the control and experimental groups was noticed on 90th day of lactation (Tables 9, 10 and 11).

Table 1. Milk: Fat percentage and SNF percentage in control group

Sl. No.	30 days		60 days		90 days	
	Fat%	SNF%	Fat%	SNF%	Fat%	SNF%
1.	3.6	8.5	3.7	8.9	4.1	8.8
2.	3.7	8.7	3.9	9.0	3.7	[illegible]
3.	3.6	8.7	3.7	8.6	3.9	8.9
4.	3.7	8.9	3.6	8.9	3.7	8.7
5.	3.6	8.8	3.9	8.7	3.9	8.9
6.	3.8	8.9	4.0	9.0	4.3	8.8
Mean value	3.6± 0.033	8.75± 0.061	3.8± 0.061	8.85± 0.065	3.9± 0.094	8.78± 0.043

Table 2. Milk: Fat and SNF percentage in low milk fat group

Sl. No.	30 days		60 days		90 days	
	Fat%	SNF%	Fat%	SNF%	Fat%	SNF%
1.	2.3	8.3	2.7	8.4	3.1	8.6
2.	2.4	8.2	2.6	8.5	3.3	8.4
3.	2.2	8.4	2.5	8.3	3.4	8.6
4.	2.5	8.3	2.7	8.3	3.2	8.4
5.	2.5	8.4	2.4	8.5	2.9	8.5
6.	2.6	8.5	3.0	8.5	3.7	8.8
7.	2.1	8.2	3.3	8.6	2.9	8.4
8.	3.3	8.1	3.1	8.3	3.5	8.7
9.	3.4	8.4	3.6	8.4	3.7	8.9
10.	3.1	8.2	3.0	8.5	3.0	8.4
Mean value	2.64± 0.145	8.3± 0.031	2.89± 0.120	8.43± 0.035	3.2± 0.120	8.57± 0.057

Table 3. Evaluation of rumen liquor for physical characters in the control group

		Animals					
		1	2	3	4	5	6
Colour	30 days	Olive green	Yellowish brown	Yellowish brown	Yellowish brown	Olive green	Grey
	60 days	Olive green	Yellowish brown	Yellowish brown	Yellowish brown	Greenish yellow	Grey
	90 days	Olive green	Yellowish brown	Olive green	Olive green	Greenish yellow	Grey
Consistency	30 days	Slightly viscous	Slightly viscous	Slightly viscous	Slightly viscous	Slightly viscous	Slightly viscous
	60 days	Slightly viscous	Slightly viscous	Slightly viscous	Slightly viscous	Slightly viscous	Slightly viscous
	90 days	Slightly viscous	Slightly viscous	Slightly viscous	Slightly viscous	Slightly viscous	Slightly viscous
Odour	30 days	Aromatic	Aromatic	Aromatic	Aromatic	Aromatic	Aromatic
	60 days	Aromatic	Aromatic	Aromatic	Aromatic	Aromatic	Aromatic
	90 days	Aromatic	Aromatic	Aromatic	Aromatic	Aromatic	Aromatic
pH	30 days	6-7	6-7	6-7	6-7	6-7	6-7
	60 days	6-7	6-7	6-7	6-7	6-7	6-7
	90 days	6-7	6-7	6-7	6-7	6-7	6-7

Table 4. Evaluation of rumen liquor for physical characters in low milk fat cows

Parameters		Animals									
		1	2	3	4	5	6	7	8	9	10
Colour	30 days	OG	OG	YB	GY	OG	G	G	OG	OG	OG
	60 days	YB	OG	YB	YB	OG	G	G	OG	OG	OG
	90 days	OG	OG	YB	GY	OG	G	OG	OG	YB	YB
Consis-tency	30 days	Slightly viscous	Slightly viscous	Slightly viscous	Slightly viscous	Slightly viscous	Slightly viscous	Slightly viscous	Slightly viscous	Slightly viscous	Slightly viscous
	60 days	Slightly viscous	Slightly viscous	Slightly viscous	Slightly viscous	Slightly viscous	Slightly viscous	Slightly viscous	Slightly viscous	Slightly viscous	Slightly viscous
	90 days	Slightly viscous	Slightly viscous	Slightly viscous	Slightly viscous	Slightly viscous	Slightly viscous	Slightly viscous	Slightly viscous	Slightly viscous	Slightly viscous
Odour	30 days	Aromatic	Aromatic	Aromatic	Aromatic	Aromatic	Aromatic	Aromatic	Aromatic	Aromatic	Aromatic
	60 days	Aromatic	Aromatic	Aromatic	Aromatic	Aromatic	Aromatic	Aromatic	Aromatic	Aromatic	Aromatic
	90 days	Aromatic	Aromatic	Aromatic	Aromatic	Aromatic	Aromatic	Aromatic	Aromatic	Aromatic	Aromatic
pH	30 days	6-7	6-7	6-7	6-7	6-7	6-7	6-7	6-7	6-7	6-7
	60 days	6-7	6-7	6-7	6-7	6-7	6-7	6-7	6-7	6-7	6-7
	90 days	6-7	6-7	6-7	6-7	6-7	6-7	6-7	6-7	6-7	6-7

Table 5. Evaluation of rumen liquor for microbial activity in control group

Sl. No.	Protozoal motility			Sedimentation activity time (min)			MBRT (min)			Protozoal count x 10^5/ml		
	30	60	90	30	60	90	30	60	90	30	60	90
1.	+++	+++	+++	6	6	8	3	4	4	6.12	9.1	5.90
2.	+++	+++	+++	5	7	6	4	5	4	9.12	6.8	7.93
3.	+++	+++	+++	8	5	7	3	3	3	10.10	5.5	10.34
4.	+++	+++	+++	5	6	10	4	4	4	10.80	7.5	8.60
5.	+++	+++	+++	9	10	6	4	3	3	4.00	5.4	16.8
6.	+++	+++	+++	6	9	10	3	3	3	9.50	8.5	15.0
	+++	+++	+++	6.5± 0.67	7.1± 0.79	7.8± 0.75	3.5± 0.22	3.6± 0.33	3.5± 0.72	8.26± 1.08	7.13± 0.62	10.75± 1.74

Table 6. Evaluation of rumen liquor for microbial activity in low milk fat group

Sl. No.	Protozoal motility			Sedimentation activity time (SAT) minutes			MBRT (min)			Protozoal count x 10^5/ml		
	30	60	90	30	60	90	30	60	90	30	60	90
1.	+++	+++	+++	5	7	5	5	4	4	4.4	5.0	5.8
2.	+++	+++	+++	4	5	6	3	3	3	6.1	7.0	8.7
3.	+++	+++	+++	10	8	5	4	4	3	8.9	9.5	4.6
4.	+++	+++	+++	9	11	8	6	4	3	10.12	11.12	8.7
5.	+++	+++	+++	5	6	5	3	3	4	9.8	16.9	10.8
6.	+++	+++	+++	6	6	7	4	5	3	10.6	5.4	9.5
7.	+++	+++	+++	5	8	8	4	4	3	7.0	8.12	14.0
8.	+++	+++	+++	8	9	11	3	4	4	3.8	4.8	9.8
9.	+++	+++	+++	5	7	6	3	3	3	4.6	2.81	2.8
10.	+++	+++	+++	6	5	5	4	3	3	9.5	6.3	5.9
	+++	+++	+++	6.3± 0.63	7.0± 0.57	6.6± 0.12	3.9± 0.31	3.7± 0.21	3.3± 0.15	7.48± 0.83	7.74± 1.27	8.06± 1.04

Table 7. Physical, microbial and biochemical characters of rumen liquor

Parameters	30 days		60 days		90 days	
	Control	Low milk FAT	Control	Low milk FAT	Control	Low milk FAT
1. Colour	Olive green, Yellowish brown, Yellowish green and Grey	Olive green, Yellowish brown, Grey and Yellowish green	Olive green, Yellowish green, Grey and Yellowish brown	Olive green, Yellowish brown, Grey and Yellowish green	Olive green, Yellowish brown, Grey and Yellowish green	Olive green, Yellowish green, Grey and Yellowish brown
2. Consistency	Slightly viscous	Slightly viscous	Slightly viscous	Slightly viscous	Slightly viscous	Slightly viscous
3. Odour	Aromatic	Aromatic	Aromatic	Aromatic	Aromatic	Aromatic
4. pH	6-7	6-7	6-7	6-7	6-7	6-7
5. Protozoal motility	+++	+++	+++	+++	+++	+++
6. Sedimentation activity time (SAT) minutes	6.5±0.67	6.30±0.63	7.16±0.79	7.09±0.57	7.83±0.75	6.60±0.62
7. MBRT (minutes)	3.50±0.22	3.90±0.31	3.66±0.33	3.70±0.21	3.50±0.22	3.30±0.15
8. Protozoal count x 10^5/ml	8.26±1.08	7.48±0.83	7.13±0.62	7.74±1.27	10.75±1.74	8.06±1.04
9. TVFA (mEq/L)	97.5±4.04	83.4±3.16	96.8±6.00	82.9±2.43	99.2±4.04	85.6±3.83
Acetic acid (A) %	72.7±1.91	67.8±0.68	73.18±0.86	70.23±0.88	73.10±0.59	72.28±0.91
Propionicacid (P) %	17.52±1.05	23.52±1.02	16.29±0.62	20.78±0.64	17.96±0.48	18.86±0.67
Butyric acid %	10.37±1.27	8.68±0.92	10.52±0.58	8.98±1.00	8.92±0.60	8.67±0.52
A:P ratio	4.20±0.36	2.89±0.13	4.50±0.22	3.36±0.12	4.04±0.12	3.85±0.16

Table 8. Haematological and biochemical values IN control and low milk fat cows

Parameters	30 days		60 days		90 days	
	Control	LMF cows	Control	LMF cows	Control	LMF cows
Haemoglobin (g/dl)	10.70± 0.61	10.42± 0.38	10.46± 0.33	10.77± 0.36	10.23± 0.50	10.50± 0.27
Haematocrit (%)	32.00± 0.73	32.60± 0.98	34.00± 0.73	33.30± 0.75	32.33± 0.80	32.20± 0.42
RBC ($10^6/\mu l$)	6.13± 0.35	5.79± 0.29	6.25± 0.19	6.11± 0.28	6.25± 0.26	6.33± 0.23
Serum:						
Glucose (mg/dl)	62.60± 5.03	64.00± 1.93	58.45± 5.73	61.32± 1.10	70.90± 3.73	59.21± 1.54
Cholesterol (mg%)	119.00± 9.14	133.15± 14.02	100.06± 7.60	130.21± 12.73	116.81± 7.72	138.72± 16.71
Triglycerides (mg%)	32.51± 4.30	28.95± 2.20	22.25± 1.82	28.61± 2.63	33.91± 2.81	28.82± 2.22

Table 9. Statistical evaluation of mean values on 30th day of lactation

Parameters	Mean value (control group)	Mean value (LMF group)	`t' value
Sedimentation activity time (SAT) minutes	6.5±0.67	6.3±0.63	0.2058 NS
MBRT (minutes)	3.50±0.22	3.90±0.31	-0.8987 NS
Protozoal count x 10^5/ml	8.26±1.08	7.48±0.83	0.5805 NS
TVFA (mEq/L)	97.5±4.04	83.4±3.16	2.7404 *
Acetic acid %	72.7±1.91	67.8±0.68	2.4113 *
Propionicacid %	17.52±1.05	23.52±1.02	-4.4577 *
Butyric acid %	10.37±1.27	8.68±0.92	0.9714 NS
A:P ratio	4.20±0.36	2.89±0.13	3.4564 *
Blood			
Haemoglobin (g/dl)	10.70±0.61	10.42±0.38	0.4126 NS
Haematocrit (%)	32.00±0.73	32.60±0.98	-0.4296 NS
RBC ($10^6/\mu l$)	6.13±0.35	5.79±0.29	0.7433 NS
Triglycerides (mg%)	32.51±4.30	28.95±2.20	0.8216 NS
Glucose (mg/dl)	62.60±5.03	64.00±1.93	-0.7213 NS
Cholesterol (mg%)	119.00±9.141	33.15±14.02	-0.3081 NS

* Significant at ($P<0.05$)

Table 10. Statistical evaluation of mean values on 60th day of lactation

Parameters	Mean value (control group)	Mean value (LMF group)	`t' value
Sedimentation activity time (SAT) minutes	7.1±0.79	7.0±0.57	-0.0340 NS
MBRT (minutes)	3.66±0.33	3.70±0.21	-0.0886 NS
Protozoal count x 10^5/ml	7.13±0.62	7.74±1.27	-0.4295 NS
TVFA (mEq/L)	96.8±6.00	82.9±2.43	2.5178 *
Acetic acid %	73.18±0.86	70.23±0.88	2.2285 *
Propionicacid %	16.29±0.62	20.78±0.64	-4.6909 *
Butyric acid %	10.52±0.58	8.98±1.00	1.1194 NS
A:P ratio	4.50±0.22	3.36±0.12	4.8980 *
Blood			
Haemoglobin (g/dl)	10.46± 0.33	10.77± 0.36	-0.5703 NS
Haematocrit (%)	34.00± 0.73	33.30± 0.75	0.6238 NS
RBC ($10^6/\mu l$)	6.25±0.19	6.11± 0.28	0.3516 NS
Triglycerides (mg%)	22.25± 1.82	28.61± 2.63	-1.7137 NS
Glucose (mg/dl)	58.45± 5.73	61.32± 1.10	-1.7098 NS
Cholesterol (mg%)	100.06±7.60	130.21±12.73	-0.4922 NS

* Significant at ($P<0.05$)

Table 11. Statistical evaluation of mean values on 90th day of lactation

Parameters	Mean value (control group)	Mean value (LMF group)	't' value
Sedimentation activity time (SAT) minutes	7.8±0.75	6.6±0.62	1.2485 NS
MBRT (minutes)	3.50±0.22	3.30±0.15	0.7638 NS
Protozoal count x 10^5/ml	10.75±1.74	8.06±1.04	1.4168 NS
TVFA (mEq/L)	99.2±4.04	85.6±3.83	2.3110 *
Acetic acid %	73.10±0.59	72.28±0.91	0.6483 NS
Propionicacid %	17.96±0.48	18.86±0.67	-0.9443 NS
Butyric acid %	8.92±0.60	8.67±0.52	0.3155 NS
A:P ratio	4.04±0.12	3.85±0.16	0.8173 NS
Blood			
Haemoglobin (g/dl)	10.23± 0.50	10.50±0.27	-0.5140 NS
Haematocrit (%)	32.33± 0.80	32.20±0.42	0.1635 NS
RBC ($10^6/\mu l$)	6.25±0.26	6.33±0.23	-0.2237 NS
Triglycerides (mg%)	33.91± 2.81	28.82±2.22	1.4160 NS
Glucose (mg/dl)	70.90± 3.73	59.21±1.54	-1.1899 NS
Cholesterol (mg%)	116.81±7.72	138.72±16.71	3.3683 *

* Significant at ($P<0.05$)

Table 12. Analysis of variance

Parameter	Source	Degree of freedom	Sum of sources	Mean squares	F value
TVFA	Between	2	36.467	18.233	0.170
	Within	27	2873.900	107.219	
Acetic acid	Between	2	97.401	48.700	7.052 **
	Within	27	186.458	6.906	
Propionic acid	Between	2	109.699	54.849	8.721 *
	Within	27	169.816	6.289	
Butyric acid	Between	2	0.621	0.310	8.721
	Within	27	190.413	7.052	
A:P ratio	Between	2	4.609	2.304	11.699 *
	Within	27	5.318	0.197	
Milk fat	Between	2	2.013	0.149	6.735 **
	Within	27	4.034	0.149	
SNF	Between	2	0.365	0.182	9.083 **
	Within	27	0.542	0.020	

* Significant at (P<0.05)
** Significant at (P<0.01)

Table 13. Correlation coefficient values between milk fat percentage with rumen VFA

Stage of lactation	Correlation coefficient of milk fat percentage with		
	Acetic acid	Propionic acid	A:P ratio
30th day	0.085	-0.655	0.613 *
60th day	0.310	-0.727	0.766 *
90th day	0.652*	-0.667	0.660 *

* Significant at 5 per cent level

Fig.1 MONTHWISE INCIDENCE OF LOW MILK FAT SYNDROME (PER CENT) AMONG CROSSBRED DAIRY COWS

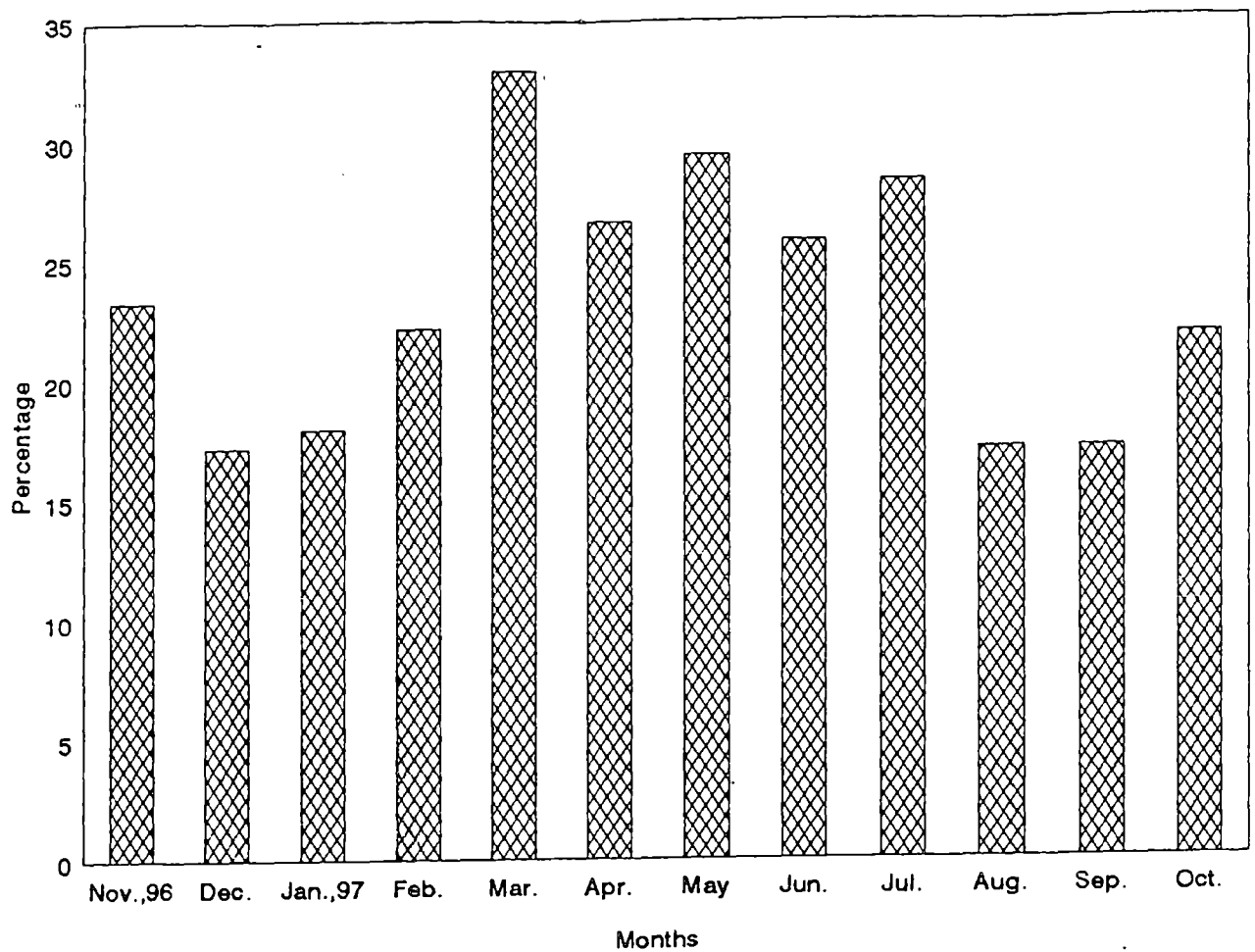


Fig.2 INCIDENCE OF LOW MILK FAT SYNDROME IN DIFFERENT STAGES OF LACTATION

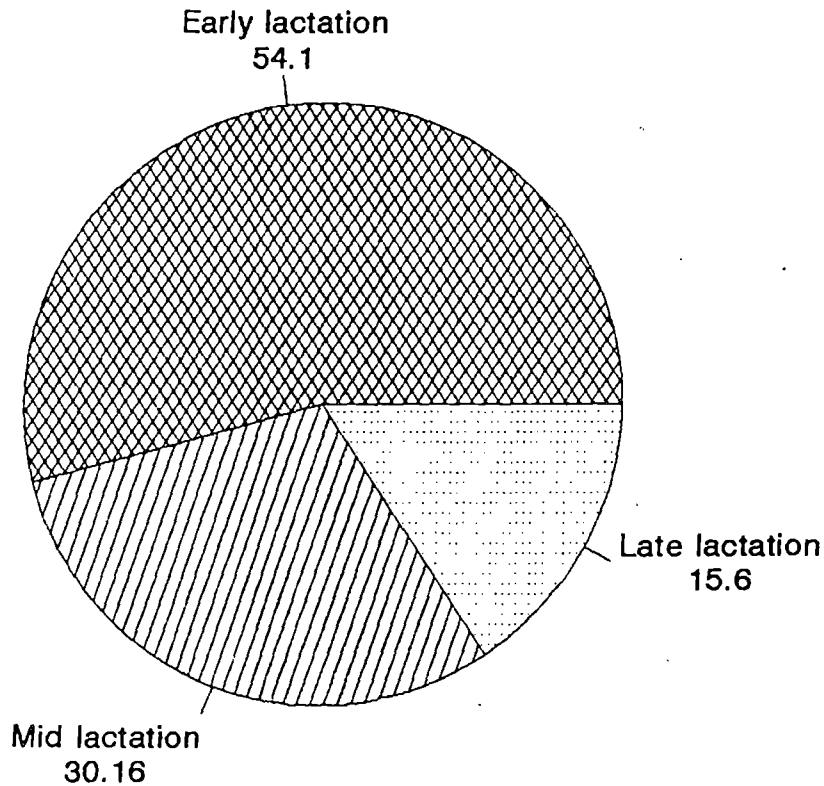


Fig.3 TOTAL VOLATILE FATTYACID CONCENTRATION IN RUMEN LIQUOR: COMPARISION BETWEEN CONTROL AND LOW MILK FAT GROUP

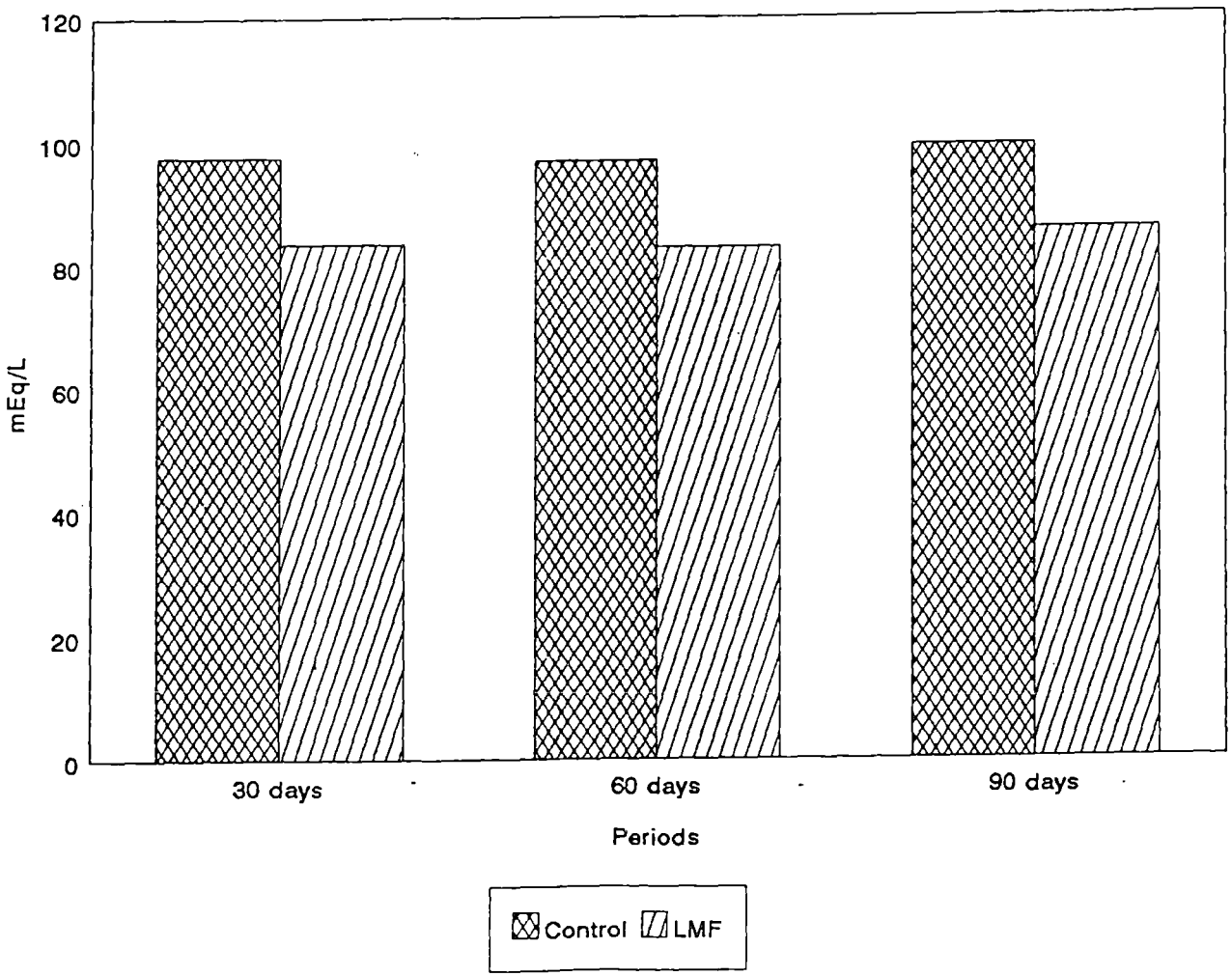


Fig.4 VOLATILE FATTYACID DISTRIBUTION IN RUMEN LIQUOR: COMPARISION BETWEEN CONTROL AND LMF GROUP ON THIRTIETH DAY OF LACTATION

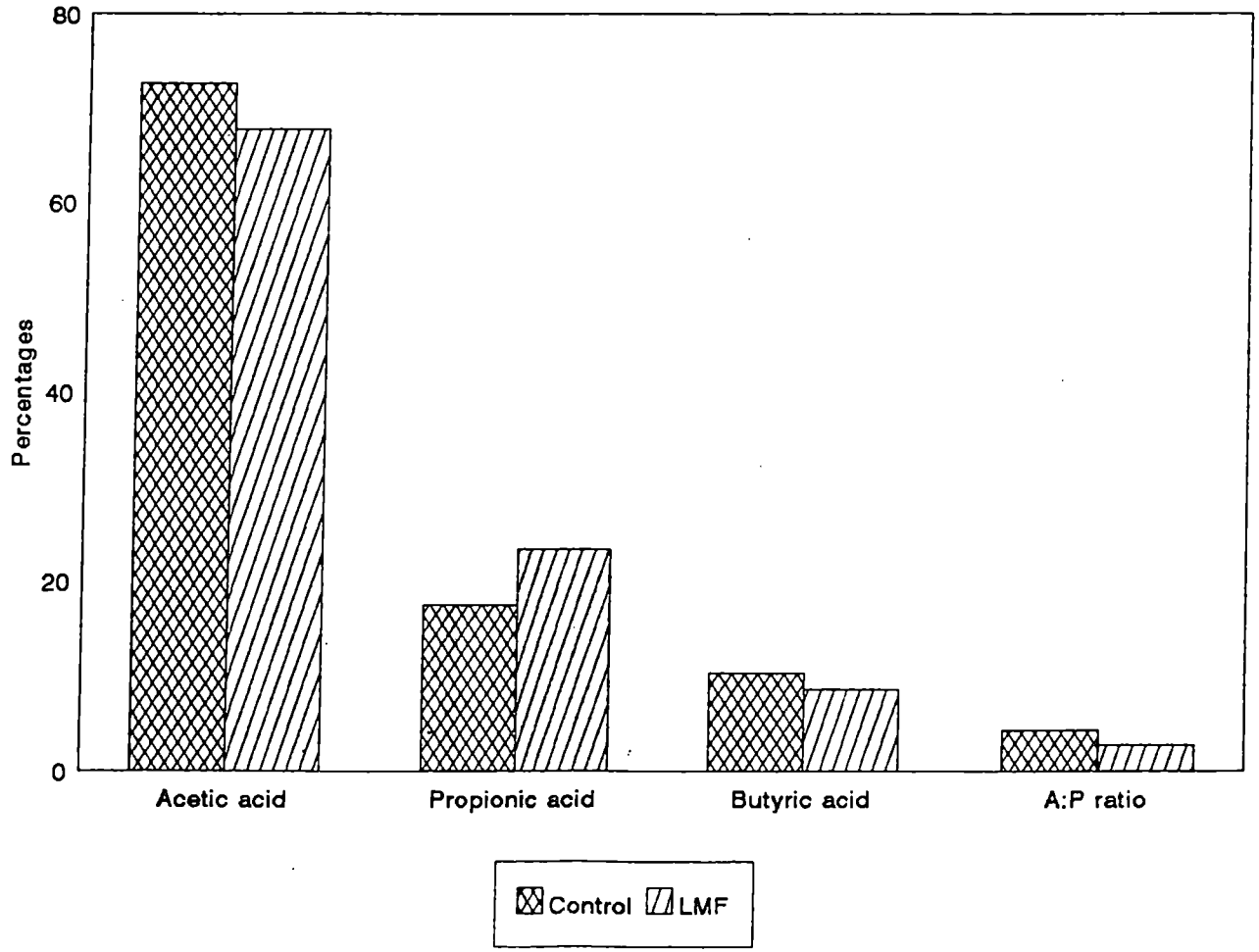


Fig.5 VOLATILE FATTYACID DISTRIBUTION IN RUMEN LIQUOR: COMPARISION BETWEEN CONTROL AND LMF GROUP ON SIXTIETH DAY OF LACTATION

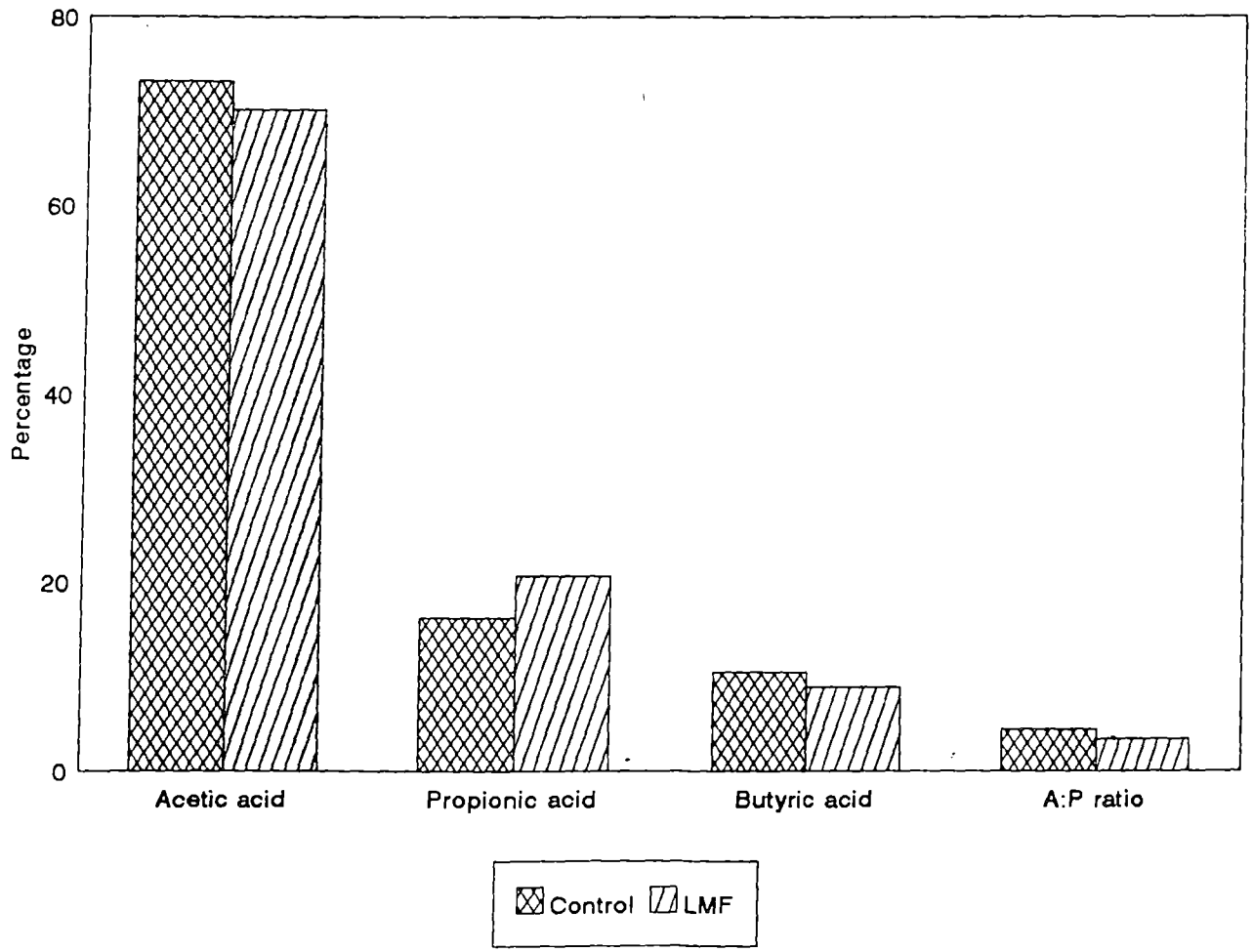
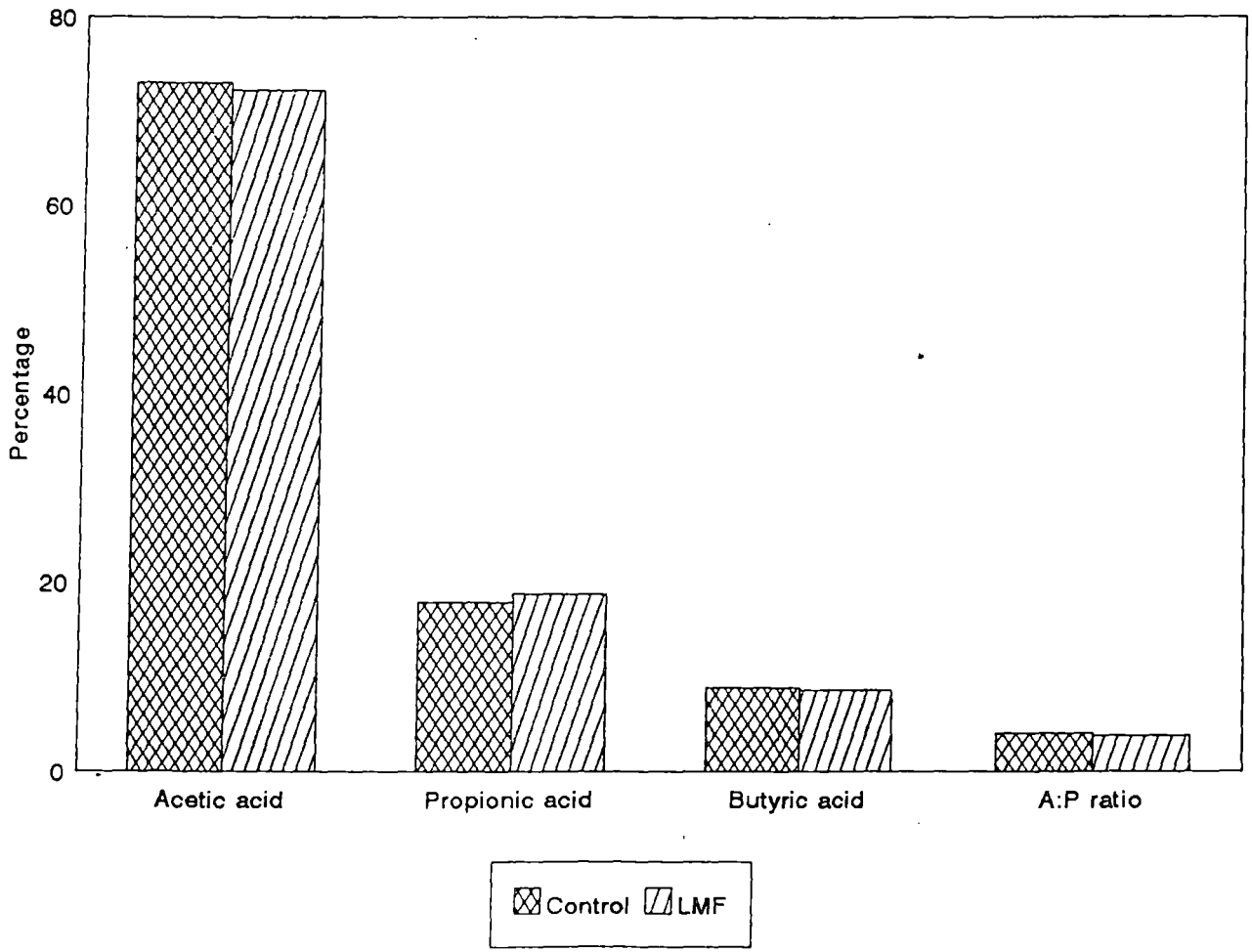


Fig.6 VOLATILE FATTYACID DISTRIBUTION IN RUMEN LIQUOR: COMPARISION BETWEEN CONTROL AND LMF GROUP ON NINETIETH DAY OF LACTATION



Discussion

5. DISCUSSION

5.1 Epidemiology

In the present study 33.30 per cent of the animals recorded low milk fat and 19.50 per cent of these animals were having milk fat below three per cent. Effect of season was apparent on the incidence of low milk fat syndrome. The percentage of occurrence was more during the summer months and the initial period of rainy season (February to July) (Fig.1). The incidence was lower in winter months. The morning milk recorded low milk fat when compared to evening milk. The stage of lactation also influenced the fat percentage as the highest occurrence was observed in the early lactation followed by mid and late lactation (Fig.2). The incidence was more when there was lack of roughages as reported by Iype *et al.* (1994). Engvall (1980) also observed low fat milk in cows that consumed less quantity of roughages. Feeding pattern was not uniform throughout the year. Season had significant effect on chemical composition of milk and lowest value of milk fat percentage was observed in summer (Patwardhan *et al.*, 1986). According to Ormiston (1967), as the interval between the milking increased, milk fat decreased.

In winter season, the availability of green fodder is more and it would remain fresh for a longer period. The cow's

feed consumption would be spread out more evenly throughout the day. In addition to the climatic advantages this could be a reason for increased milk fat percentage during this season. The dry matter intake is reduced during periods of high temperature and humidity, and cows tend to eat less roughage, because digestion of forage produces more heat than digestion of grains. In addition, availability of roughage is less during this period. If dietary fiber is inadequate, milk fat will be depressed. The ADF content of the feed should be atleast 19 per cent and ideally 21 per cent of the dietary dry matter to ensure adequate cud chewing and to enhance saliva flow. In early lactation a normal decline in milk fat percentage is expected due to increase in the volume of milk (Baker, 1990).

5.2 Clinical observations

Clinical examination of the low milk fat cows did not reveal any abnormalities. This was in accordance with the report of Miyazaki *et al.* (1975).

5.3 Rumen fluid

5.3.1 Physical characters

The colour, consistency and odour were similar in both the control and low milk fat groups (Table 7). The predominant

colour noticed in the low milk fat group was olive green which indicated that the animals were fed with green forages. Yellowish brown and brown colour were less in number which indicated the lack of roughage feeding particularly paddy straw. The physical characters of rumen liquor in both the control and experimental groups (Table 7) were within the normal range as mentioned by Misra *et al.* (1972a).

Rumen pH of both control and low milk fat groups were within the normal range as reported by Misra *et al.* (1972a). This is in accordance with Noro *et al.* (1989). A decrease in rumen pH was reported in low milk fat cows which were overfed with concentrates (Shimada *et al.*, 1989). Low pH is known to decrease the number of bacteria and protozoa (Chalupa and Kutches, 1968, Huber *et al.*, 1967). Hence it could be assumed that the animals in this study were not overfed with concentrates.

5.3.2 Microbial activity

The mean values of sedimentation activity time, methylene blue reduction test, protozoal activity and total protozoal count (Table 7) were within normal limits. There was no significant difference between the control and low milk fat groups. The observations in the present study were in accordance with Noro *et al.* (1989). Dennis *et al.* (1983) reported that the total protozoal concentrations for low,

medium, and high concentrate diets were 1.5, 2.5 and $4.1x10^5$/ml respectively. Fluctuations of total numbers of protozoa in relation to feeding were attributed to dilution by feed, water and saliva. Shimada *et al.* (1989) reported less number of protozoa in low milk fat animals and stated that variation in number and kinds of protozoa resulted in low milk fat syndrome as decreased population of protozoa caused reduction of acetate level. As there was no alteration in the rumen pH, only a nonsignificant decrease in total protozoal count was observed in the present study.

5.3.3 Volatile fatty acids

The mean total volatile fatty acid concentration in the rumen liquor of control group was 97.5 ± 4.04, 96.8 ± 6.0 and 99.2 ± 4.04 mEq/L on 30, 60 and 90th day of lactation respectively. The mean total volatile fatty acid concentration in the low milk fat group was 83.4 ± 3.16, 82.9 ± 2.43 and 85.6 ± 3.83 mEq/L on 30, 60 and 90th day of lactation respectively.

There was significant difference between the two groups on all the three occasions (30th, 60th and 90th days of lactation((Tables 9, 10 and 11). Significant reduction in the TVFA level was noticed in the low milk fat group ($P<0.05$) (Fig.3). This finding was in agreement with the observations of Noro *et al.* (1989).

The mean acetic acid concentration in rumen liquor of control cows was 72.7 ± 1.91, 73.18 ± 0.86 and 73.10 ± 0.59 per cent on 30, 60 and 90th day of lactation respectively. In low milk fat group the acetic acid concentration was 67.8 ± 0.68, 70.23 ± 0.88 and 72.28 ± 0.91 on 30, 60 and 90th day of lactation respectively. Significant reduction in acetic acid level ($P<0.05$) was noticed on 30 and 60 days between the low milk fat group and control group. On 90th day there was no significant difference in the acetic acid level between control and low milk fat groups (Fig.6). In the low milk fat group significant difference was observed ($P<0.01$) between the periods of 30, 60 and 90 days.

The mean values of propionic acid concentration in the control group were 17.52 ± 1.05, 16.29 ± 0.62 and 17.96 ± 0.48 per cent on 30, 60 and 90th day of lactation respectively. In low milk fat group the mean values of propionic acid concentration on 30, 60 and 90th day of lactation were 23.52 ± 1.02, 20.78 ± 0.64 and 18.86 ± 0.67 per cent respectively (Table 7). In the low milk fat group significant difference was observed ($P<0.05$) between the periods viz., 30, 60 and 90 days.

Significant difference was noticed on 30 and 60th day of lactation between the control and low milk fat groups. It was not significant on 90th day.

The mean acetic propionic acid ratio, (A:P) in control group was 4.2 ± 0.36, 4.5 ± 0.22 and 4.04 ± 0.12 on 30, 60 and 90 days respectively and in low milk fat group, 2.89 ± 0.13, 3.36 ± 0.12 and 3.85 ± 0.16 on 30, 60 and 90 days respectively (Table 7). Significant reduction in the A:P ratio was noticed in the low milk fat groups ($P<0.05$) (Fig.4 and 5). Significant difference was noticed between the periods in the low milk fat group ($P<0.05$).

Feeding low roughage high grain ration resulted in low fat milk associated with changes in proportion of rumen VFA (Vansoest and Allen, 1959). McCullogh (1966) recorded low milk fat when the molar per cent of propionic acid was above 20. Reduction in the ruminal acetic acid and increase in the ruminal propionic acid were associated with reduced milk fat percentage (Tsai *et al.*, 1967; Bauman *et al.*, 1971; Donald, 1982). Decrease in the acetic acid and propionic acid ratio was responsible for low fat milk (Noro *et al.*, 1989; Klusmeyer, 1990; Grant *et al.*, 1990). The findings of the present study suggested that low milk fat syndrome in and around Thrissur was due to alteration in acetic propionic acid ratio due to inadequate roughage feeding rather than overfeeding with concentrates.

5.4 Milk

The mean values of fat percentage in the low milk fat group on 30th, 60th and 90th days were 2.64 ± 0.12, 2.89 ± 0.12 and 3.27 ± 0.08 respectively (Table 1). There was significant difference ($P<0.01$) between the 30th and 90th days of lactation with regard to fat and SNF per cent in the low milk fat group (Table 12).

Volatile fatty acids when infused into the rumen of lactating cows caused variable responses in milk production. Acetic acid increased milk yield and milk fat per cent, but negative response was caused by propionic acid (Rook and Balch, 1961). McCullogh (1966) stated that there was positive correlation between acetic acid level in the rumen and the milk fat and negative correlation between propionic acid and milk fat. Similar statements were given by Basmaeil and Clapperton (1980); Ozkan *et al.* (1983). The findings in this study were fairly in agreement with that of above authors.

The increase in the mean value of milk fat percentage from 2.64 ± 0.12 on 30th day to 3.27 ± 0.08 on 90th day could be correlated to the changes in the rumen volatile fatty acids proportion. On 90th day, there was no significant difference between the control and low milk fat animals in the A:P ratio which could be attributed to the changes brought in the

feeding practices of LMF animals. It is evident that increase in milk fat percentage on 90th day was due to increase in acetate production and reduction in propionate level in the rumen.

5.5 Blood

5.5.1 Haemogram

The mean values of haemoglobin, haematocrit and RBC were shown in Table 8. There was no significant difference between the control and low milk fat groups. These results were in agreement with Noro *et al.* (1989).

5.5.2 Triglycerides

The mean values of triglycerides in both the control and low milk fat groups on 30, 60 and 90 days were shown in Table 8. There was no significant difference between the control and low milk fat groups. Shimada *et al.* (1989) stated that serum triglyceride level could not be correlated to milk fat. The findings of the present study were fairly in agreement with Varman and Schultz (1968); Storry and Rook (1965); Jorgenson *et al.* (1965); Storry and Sutton (1969); Thomas and Gmery (1969) and Shimada *et al.* (1989).

5.5.3 Cholesterol

The mean cholesterol level in both control and low milk fat groups were represented in Table 8. The changes in cholesterol level in both the groups on 30th, 60th and 90th days were nonsignificant. Both the control and low milk fat group values were within the normal range. Wide fluctuations in the serum cholesterol level were reported in dairy cows (Tasker, 1978 and Radostits *et al.*, 1994). The findings of our study were in accordance with Miyazaki (1975), Shimada *et al.* (1989) and Sasaki (1994).

5.5.4 Glucose

The mean values of serum glucose in both the control and low milk fat groups were shown in Table 8 and were within the normal range (Tasker, 1978). There was no significant difference between the control and low milk fat groups.

Kolb (1977) stated that both the glucose level and the insulin level in blood was increased in the milk fat deficiency syndrome. Emmanuel and Kennelly (1984) suggested that propionic acid stimulated insulin secretion, which in turn, inhibited the release of fatty acids from adipose tissue resulting in low milk fat syndrome. In the present study a non-significant increase in the glucose level was noticed on the 30th and 60th days of lactation in low milk fat animals.

This increase could be due to the increase in production of propionic acid in the rumen which is glycogenic.

Conclusion

The changes in the milk fat percentage were associated with the changes in the rumen VFA proportions. Feeding practices play an important role in milk fat production. To overcome the depression of milk fat percentage hay and other forages may be fed before feeding concentrates in order to achieve better buffering of the rumen. Adequate quantity of straw may be provided to the low milk fat animals and it may be made more palatable so that the animals consume more quantity during the summer season. Oral administration of one litre of 0.5 per cent acetic acid or vinegar/day for two weeks is also recommended.

Summary

SUMMARY

The epidemiology, haematological and biochemical changes in blood and pattern of rumen fermentation in cows with low milk fat syndrome were studied.

Ten crossbred cows with less than standard milk fat (3.5 per cent) selected at random constituted the experimental group and six apparently healthy crossbred cows maintained under similar field conditions served the control group.

Rumen liquor, blood and composite milk samples were collected from both the groups on three occasions viz., 30th, 60th and 90th days of calving and selected parameters were studied. After collection of samples on the 30th day, certain changes were suggested in the feeding and management practices.

Rumen fluid collected was analysed for physical characters, microbial activity and volatile fatty acids (total and fractional). Haemogram, serum triglycerides, cholesterol and glucose level were analysed.

There was no significant difference in the physical characters, pH, SAT, MBRT, protozoal motility and protozoal count of rumen liquor between the two groups, on all the three occasions.

The mean total volatile fatty acid concentration in the rumen liquor was 97.5 ± 4.04, 96.8 ± 6.0 and 99.2 ± 4.04 mEq/L on 30, 60 and 90 days respectively in the control group. Among low milk fat group, the mean total volatile fatty acid concentration in rumen liquor was 83.4 ± 3.16, 82.9 ± 2.43 and 85.6 ± 3.83 mEq/L on 30, 60 and 90 days respectively. Significant reduction in the TVFA level was noticed on all the three occasions in the low milk fat group ($P<0.05$).

The mean acetic acid concentration in rumen liquor of control cows were 72.7 ± 1.91, 73.18 ± 0.86 and 73.10 ± 0.59 per cent on 30, 60 and 90 days respectively. In low milk fat group the mean acetic acid concentration in rumen liquor was 67.8 ± 0.68, 70.23 ± 0.83 and 72.28 ± 0.91 on 30, 60 and 90 days, respectively. Significant reduction in the acetic acid level was noticed on 30th and 60th day of lactation in low milk fat group ($P<0.05$). Within the low milk fat group significant difference was noticed between 30 and 90 days ($P<0.01$).

The mean value of propionic acid concentration in the control group on 30, 60 and 90 days were 17.52 ± 1.05, 16.29 ± 0.62 and 17.96 ± 0.48 per cent respectively. In low milk fat group, the mean values of propionic acid concentration in rumen liquor were 23.52 ± 1.02, 20.78 ± 0.14, and 18.86 ± 0.67 per cent on 30, 60 and 90 days respectively. Significant

increase in propionic acid level was noticed on 30 and 60 days of lactation in the low milk fat group. There was no significant difference in acetic and propionic acid level on the 90th day between the two groups.

The acetic: propionic acid ratio (A:P) in control group was 4.2 ± 0.36, 4.5 ± 0.22 and 4.04 ± 0.12 on 30, 60 and 90 days respectively. In the low milk fat group the A:P ratio was 2.89 ± 0.13, 3.6 ± 0.12 and 3.85 ± 0.16 on 30, 60 and 90 days respectively. Significant reduction was noticed in the low milk fat group on 30th and 60th days of lactation ($P<0.05$). No significant difference was observed on the 90th day between the control and low milk fat group.

No significant difference was noticed in butyric acid concentration between control and low milk fat group on all the three occasions.

The mean haemoglobin, haematocrit and TEC of the control group were not significantly different from that of the low milk fat group. No significant difference was noticed in the serum triglycerides, glucose and cholesterol level between the two groups.

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* Originals not seen

Appendix

APPENDIX-I

LOW MILK FAT SYNDROME IN CROSSBRED DAIRY COWS

Date:

Sl.No.			
Case No.			
Name of the Institution	:		
Owner's Name and Address	:		
Description of the animal	:		
Animal	:		
Breeds	:		
Age	:		
Colour	:		
Anamnesis	:		
Present History	:		
Past History	:		
Stage of lactation	:	Early / Middle / Late	
Average milk yield/day	:	Morning:	Evening:
Reduction in milk yield	:	Morning:	Evening:
Fat percentage	:	Morning:	Evening:
Reduction in fat%	:	Morning:	Evening:
Reduction in fat% since	:	Days/Month	
No. of days in lactation	:		
Milk consistency	:	Watery/Thick	
Presence of foam in milk	:	Yes/No	
Previous occurrence of Fat depression	:	Yes/No	

Rate of depression	:	
No. of days/month	:	
State of lactation	:	Early / Middle / Late
Presence of mastitis	:	Clinical/Subclinical
Previous occurrence of Mastitis	:	Yes/No
Stage of lactation	:	
Treatment given	:	
Result	:	
Presence of digestive disorder	:	Yes/No
Type of disorder	:	
Previous occurrence if any	:	
Parity	:	
Insemination	:	Artificial/Natural
Despatch of milk	:	Societies/Local sales/Home use
Ration	:	
Feeding habit	:	Concentrate/Roughage/Greens
Quantity fed	:	
Feed used (Brand name)	:	
Frequency of feeding	:	
Quantity of feed/day	:	
Water intake/day	:	
Reproductive disorder, if any:		
Frequent use of oxytocin for milking	:	Yes/No

LOW MILK FAT SYNDROME IN CROSSBRED DAIRY COWS

BY

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ABSTRACT OF A THESIS

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1997

ABSTRACT

The epidemiology, haematological and and biochemical changes in blood and pattern of rumen fermentation in low milk fat syndrome cows were studied.

Ten cases (below 3.5% milk fat) and six control animals (above 3.5% milk fat) were investigated. Rumen liquor, blood and composite milk samples were collected on three occasions viz. 30th, 60th and 90th day of lactation and selected parameters were studied.

There was no significant difference in the physical characters, pH, SAT, MBRT protozoal motility and protozoal count of rumen liquor. Significant reduction in the rumen total volatile fatty acid and the acetic:propionic ratio (A:P) was noticed in the low milk fat group. Significant decrease in acetic acid and increase in propionic acid was observed in the low milk fat group.

There was no significant difference in haemoglobin, haemotocrit, and TEC between the control and low milk fat groups. No significant difference was noticed in the serum triglycerides, cholesterol and glucose level between the control and low milk fat groups.