PROPERTIES OF MILK FAT OF CROSSBRED GOATS

BY

BABY GEORGE

THESIS

Submitted in partial fulfilment of the requirement for the degree

Master of Veterinary Science

Faculty of Veterinary and Animal Sciences
Kerala Agricultural University

Department of Dairy Science
COLLEGE OF VETERINARY AND ANIMAL SCIENCES
Mannuthy - Trichur

1981

DECLARATION

I hereby declare that this thesis entitled "PROPERTIES OF MILK FAT OF CROSSBRED GOATS" 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.

Mannuthy,
24-9-1981.

Baby George

CERTIFICATE

Certified that this thesis entitled "PROPERTIES OF MILK FAT OF CROSSBRED GOATS" is a record of research work done independently by Sri. Baby George 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.

Dr. M. Subrahmanyam,
Professor of Dairy Science
(Chairman, Advisory Committee)

Mannuthy,
24-9-1981.

ACKNOWLEDGEMENTS

I wish to express my deep sense of gratitude to -

Dr. M.Subrahmanyam, M.S. (Tennessee), Chairman of the Advisory Committee, for his inspiring guidance and constant encouragement throughout the study and for the preparation of the thesis.

Dr.K.Pavithran, Associate Professor of Dairy Science, for his valuable advice and generous help at various stages of the work.

Dr. C.R.Ananthasubramaniam, Scientist, AICRP on Agricultural By-Products and Dr.G.Mukundan, Professor of Genetics, for their generous help and valuable suggestions.

Dr.C.P.Ananthakrishnan, Dairy Adviser to the Kerala Agricultural University, for his valuable suggestions at various stages of the study.

the members of the staff of the Department of Dairy Science for their esteemed help.

I am indebted to Dr.P.G.Nair, former Dean and Dr.M.Krishnan Nair, Dean, Faculty of Veterinary and Animal Sciences for the facilities provided for the research work.

I cheerfully acknowledge the splendid co-operation and help rendered by my colleagues and friends. I am especially thankful to Dr.B.Baiju, Dr.Simon Daniel, Mr.Vijaya Raghavakumar and Mr.B.Ramesh Nair for their sincere co-operation.

I am thankful to Mr.T.K.Prabhakaran for getting the manuscript neatly typed.

Finally I wish to place on record my gratitude to the Kerala Agricultural University for awarding the fellowship.

BABY GEORGE

CONTENTS

INTRODUCTION

INTRODUCTION

The poor man's cow as it is commonly called in India, goat ranks after the cow and buffalo as the most important dairy species contributing to the total milk production of the country. According to FAO Production Year Book (1976) the milk production from cow, buffalo and goat in India was 8.40, 16.35 and 0.70 million metric tonnes respectively (Jailkhani and Sukumar De, 1978).

Out of the total world population of about 445 million goats (FAO 1979) approximately 70 per cent (310 million) is found in the tropics. India has the largest population in the world and possesses more than 71 million goats but only 8 to 10 million are milch goats. The main reason for this is that the goat in India has been raised mainly for meat production and its potentialities as a milch animal has been realised only recently. The goat population in India is increasing at the rate of one million per year inspite of lack of development programmes for this species (Taneja, 1979). According to 1977 Livestock Census, Kerala has a goat population of 16,83,000.

It is only during the last few years that goat keeping has been recognised as an important rural enterprise by the small stock owners and agricultural labourers. The present plan in respect of goat development in our country is to produce contemporary pure bred locals and crossbreds with one or two exotic breeds like Saanen and Alpine depending on the location and requirements (Shanmugasundaram, 1980).

Excellent reviews on the composition and physico-chemical characteristics of cows' and buffaloes' milk are available, but goats' milk does not appear to have received such systematic and comprehensive attention (Parkash and Jenness, 1968).

Under the present pricing structure for milk, milk fat is the most important constituent. Essentially all dairy products with the exception of skim milk and those made from skim milk contain varying amounts of milk fat. Hence the milk fat has always had an important bearing on the economics and nutritive value of milk products. An adequate understanding of milk fat requires some knowledge about its physical and chemical characteristics.

Parkash and Jenness (1968) have reported that a large quantity of goat milk is used for product manufacture in European countries. In Spain, for instance goats' milk represents 11 per cent of the milk used for cheese making and in Greece nearly 3 per cent. In India goats' milk in general is considered inferior to cows' or buffaloes' milk and is used for beverage purposes; which may be due to lack of information available on the processing technology of goats' milk. Jailkhani and Sukumar De (1979) suggest that goat milk could be suitably used for the preparation of khoa, which could be used for preparation of peda of acceptable quality.

For better utilisation of goats' milk for product manufacture in a country like India where buffaloes and cows contribute the major share of milk production, it may even be necessary to combine it with cow or buffalo milk and to make products. The study of physical and chemical properties of goat milk fat will greatly help the processing technology and storage of dairy products.

Information on the physical and chemical properties of goat milk fat is scanty. Therefore it was thought necessary to make a study on these aspects. The present work envisages a detailed study on the physical and chemical properties of crossbred goat milk fat. The present study will reveal the suitability of using goat's milk for product manufacture either alone or in combination with cows' or buffaloes' milk. It may also aid in the selection of suitable animal for breeding and may help in the detection of goat milk fat in an admixture of cow or buffalo milk fat.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Two excellent reviews on the composition and characteristics of goat milk have been published recently and they cover most of the information available on the physical and chemical properties of goats' milk in detail (Parkash and Jenness, 1968; Jenness, 1980).

Size of fat globule

Fahmi et al.(1956) reported that the range of size of fat globules was the same in goats' and cows' milk (1 to 10 microns diameter) but the content of smaller globules were more in goats' milk. Up to a size of 4.5 microns diameter, the percentage distribution of fat globules was 82.77 per cent in goats, 85.7 per cent in sheep, 62.4 per cent in cows and 40.9 per cent in buffaloes' milk. The average sizes of fat globule reported were 3.49, 3.30, 5.55 and 5.92 microns respectively for goat, sheep, cow and buffalo.

Fahmi (1956) reported that the goats' milk creamed by gravity much less rapidly and completely than cows' milk. This was particularly noticeable when warm milk was cooled quickly to a low temperature and set for creaming. The fundamental factor responsible for rapid formation of a cream layer on cows' milk has been shown to be a heat denaturable protein preferentially adsorbed on cold fat globules which has the characteristics of euglobulin and which promotes clustering of globule (Sharp and Krukovsky, 1939).

Jenness and Parkash (1971) found that milk reconstituted from goats' cream and cows' skim milk creamed readily where as those made by combining cows' cream and goats' skim milk creamed very poorly. In their opinion, the fact that goats' milk does not cream when cooled implies either that the fat globules are unable to absorb such proteins or it does not contain euglobulin capable of being adsorbed; and not due to the smaller size of fat globules as has often been stated.

Nutritionally the high concentration of small fat globules is advantageous but for butter making milk fat of goat milk is more difficult to separate than that of cow or buffalo (Fahmi, 1956). Jailkhani and Sukumar De (1978) also quoted that the fat globules of goat milk had much the same range of size as that of cow milk, but proportion of smaller globules were larger.

Singh <u>et al.</u>(1968) found some increase in size and decrease in number of milk fat globules upon heating milk of cows, ewes, goats and buffaloes. Pasteurization at 61°C for 30 minutes increased average globule size in goat milk by about 12 per cent as a result of coalescence.

In a study on factors affecting the size and distribution of fat globules in the milk of Sahiwal cows, Katiyar _et al_. (1973) showed that the size of fat globules decreased and the number of smaller globules increased as lactation advanced and with increase in milk fat content. Larger and less numerous globules were observed in strippings compared with fore milk, and also in evening milk after a 10 hour milking interval compared with morning milk after a 14 hour interval.

Upadhyaya _et al_. (1973) conducted a similar study in the milk of Murrah buffaloes. They also found that the number of fat globules increased while their size decreased with advancing stage of lactation. But unlike in the case of cows' milk, they observed that buffaloes' fore milk samples contained larger and more numerous fat globules compared with samples of strippings. Inspite of equal intervals of 12 hour between a.m. and p.m. milkings, a.m. milk contained smaller and more numerous fat globules than p.m. milk.

Melting point

Woodman (1941) reported that when the fat consisted mainly of glycerides of fatty acids of saturated or acetic series its melting point would increase as the mean molecular weight of the mixed acids increased whereas if unsaturated acids were present, the melting point decreased proportionately. A melting point of 32°C was reported for butter fat.

Volchenko (1959) studied the chemical properties of milk fat of Karakul sheep and found that it contained more of low molecular, low melting point, volatile water soluble fatty acids in comparison with cows' milk fat. Basu (1962) reported an increase in melting point by 1 to 4°F towards the end of lactation.

DeMan (1964) studied the various factors which would cause a difference in melting point and consistency of milk fat. The most important ones attributed were season and feed. It has been shown that the effect of lowering the melting point of a glyceride by the incorporation of a short chain fatty acid was probably greater than by the inclusion of an unsaturated fatty acid. The way in which the various types of fatty acids, long chain saturated and short chain are joined in glyceride molecules was of importance. On studying the effect of season on melting point, it has been shown that the summer milk fat was relatively soft and winter milk fat hard. Joshi and Vyas (1976) reported a higher melting point, acidity and grain size of buffalo ghee in winter than that for monsoon or summer ghee.

Refractive index

Milk fat of Karakul sheep showed a refractive number of 36.2 (Volchenko, 1959). A butyrorefractometer number of 42.6 was given by Basu (1962) for milk fat of Surti goats. On a spectrophotometric study of milk fat by Colmenar *et al.* (1965) the refractive indices reported were 1.4540, 1.4552 and 1.4537 for cows', ewes' and goats' milk fat respectively.

Parodi and Dunstan (1971) studied the relationship between the fatty acid composition, the softening point and the refractive index of milk fat. A seasonal variation in refractive index was found to be correlated with variation in oleic acid content but there was no significant correlation with softening point. There was a tendency for butters with high softening point to have low content of low molecular weight fatty acids.

Fahmi and Fahmy (1972) noticed that the refractive index tended to increase with advancing stage of lactation in the case of both cow and buffalo samna. Joshi and Vyas (1976) noticed no significant seasonal variation in the butyrorefractometer values for buffalo ghee.

Iodine value

Volchenko (1959) reported an iodine value of 34.78 for the milk fat of Karakul sheep. Basu (1962) reported that iodine value for ghee from goats and different breeds of cows varied from 32.8 to 33.9, while buffalo ghee showed a lower value of 29.4. This was based on analytical data on the ghee of Surti goat, and various Indian breeds of cows and buffaloes.

Eckles and Palmer (1916) pointed out that all types of underfeeding caused an increase in the degree of unsaturation of the fat. Reagan and Richardson (1935) showed that at an environmental temperature of 95°F the iodine value increased sharply.

Jenness and Parkash (1968) in their review on goat milk composition stated that goat milk fat had a higher content of saturated fatty acids with chain lengths of

4 to 12 C atoms than those of cows or buffaloes.

Jack and Smith (1956) reported that the consumption of feed containing octadeceenoic acid resulted in a fluctuation in iodine value of milk fat. They also reported that nitrogen fertilised pastures enabled the cows to produce fat with an iodine value 3.7 units higher than that from non nitrogen fertilised pasture.

Muzaffar <u>et</u> <u>al</u>. (1970) on studying the effect of dietary changes on the fatty acid composition of goat milk observed that on various diets the saturated fatty acids of the fat globule consisted primarily of arachidic (1.0 to 2.5%) stearic (14.9 to 15.0%) palmitic (19.9 to 34.8%) myristic (6.1 to 8.0%) and caprylic (2.4 to 2.8%) acids. Among the unsaturated acids oleic (18.4 to 30.0%) linoleic (2.7 to 3.0%) and linolenic (1.3 to 1.5%) acids were most common.

In a study on butter fat Hyghebaert and Hendrickx (1970) calculated co-efficient for the correlation between iodine value and butyrorefractometer number. They found that iodine value was positively correlated with C 18:0 (r = 0.81) C 18:1 (r = 0.87) and C 18:3 (r = 0.51) and negatively correlated with lower fatty acid (r = -0.35 to -0.70). Since the properties of butter fat are mainly determined by the content of C 16:0, C 18:0 and C 18:1 acids, equations were calculated for regression between their percentage and iodine value.

Cook *et al.* (1976) determined the influence of feeding fat encapsulated in formaldehyde treated casein to protect it from alteration in the rumen and to be released in the abomasum. Feeding safflower oil in this way increased the content of C 18:2 acids (more unsaturation) in the goat milk fat from about 3 to 15 moles per cent. However feeding protected seed oil of *Stercula foetida* increased the ratio of 18:0/18:1 from 0.4 to 1.4 (*Stercula foetida* is reported to contain cyclopropene acids which apparently inhibit desaturases of the mammary gland; the result in that more 18:0 is incorporated in the milk fat). Bickerstraffe and Johnson (1972) had earlier demonstrated this effect by injecting sterculic acid intravenously into goats.

Fahmi and Fahmy (1972) found that with advancing stage of lactation iodine value of both cows' and buffaloes' samna (a form of clarified butter fat produced in Egypt) tended to increase. Iodine value at the beginning of lactation and the relative rates of increase during the lactation period were higher in cows' than in buffaloes' samna; trends were not affected by change in ration.

Joshi and Vyas (1976) studied the effect of seasonal variation in the fatty acid composition and other properties of buffalo ghee. They observed that the buffalo ghee in winter contained higher amounts of C 12:0, C 14:0 and total saturated acids and lower amounts of C 14:1, C 16:1 and C 18:1 and total unsaturated acids, than the ghee in summer and monsoon seasons. Its iodine value was lower than that of summer ghee but similar to that of monsoon ghee.

Reichert-Meissl and Polenske values

Eckles and Palmer (1916) reported that all types of underfeeding caused a decline in volatile acids. Volokhenko (1954) reported a value of 35.81 and 4.9 as Reichert-Meissl and Polenske values respectively for the milk fat of Karakul sheep. Hilditch (1956) in his data on the chemical constituents of natural fats reported a Reichert-Meissl number of 20 to 29 and Polenske number 3.2 to 9.8 for goat milk fat.

Arun Sengupta <u>et al</u>. (1958) by doing a Reichert-

Meissl-Polenske distillation found that the RM fraction contained butyric, caproic and caprylic acids. Caprylic and capric acids were the principal components of Polenske fraction, but it also contained some higher and lower fatty acids.

Basu (1962) reported a value of 32.54 and 5.30 respectively for Reichert-Meissl and Polenske values based on analytical data on Surti goat ghee. He gave a range of 2.81 to 7.81 for Polenske value and 24.16 to 31.96 for Reichert-Meisel value in goats.

A milk fat that yielded a high Reichert-Meissl value also gave a high saponification value though the latter dropped considerably at the end of lactation (Webb and Johnson, 1965).

In a spectrophotometric study on milk fat of goats Colmenar *et al.* (1965) obtained a Reichert-Meissl number of 20.33 and a Polenske value of 9.29.

Hyghebaert and Hendrickx (1970) estimated the percentage of each of the fatty acids by the aid of gas chromatography. RM fraction contained butyric (59.7%) caproic (32.4%) and caprylic acid (7.4%) representing averages of 97.6 per cent, 91.9 per cent and 41.2 per cent of these acids in the butter fat.

Joshi and Vyas (1976) could observe no significant seasonal variation in Reichert-Meissl and Polenske values in the case of buffalo ghee.

Laruelle **et al.** (1976) estimated the fatty acid contents of RM and Polenske fractions of 10 Belgium butters by gas liquid chromatography of the propyl fatty acid esters. The RM fraction contained 55.14 per cent C4, 33.16 per cent C6, 9.19 per cent C8 and 1.62 per cent C10 fatty acids. The Polenske fraction contained mainly C10 capric acid (33.87%) with 14.10 per cent C12, 13.73 per cent C14, 13.04 per cent C18, 12.98 per cent C16 and 3.27 per cent C6 fatty acids.

Saponification value

Volchenko (1959) obtained an average saponification value of 230.8 for the milk fat of Karakul sheep. A saponification value of 231.2 for goat ghee was reported by Basu (1962). Towards the end of lactation a decrease in the saponification value was also reported.

Webb and Johnson (1965) stated that a butter fat which yielded a high Reichert-Meissl value gave a high saponification value also although the latter dropped considerably in the last stages of lactation. A significant decrease in the saponification value was noticed by Fahmi and Fahmy (1972) for cows and buffaloes during the course of lactation.

Arora et al. (1976) obtained an average unsaponifiable matter content of 10 batches of ghee prepared from goats' milk as 460 mg/100 g of fat.

Joshi and Vyas (1976) in their study on seasonal variation in the properties of buffalo ghee reported that the saponificatio value of winter ghee was similar to that of summer ghee.

Fatty acid composition

Studies on fatty acid composition of goat milk have been reviewed by Parkash and Jenness (1968) and Swaminathan and Daniel (1970). Iizuka et al. (1964) made a study on the volatile fatty acids as precursors of milk constituents in the lactating goat. During two feeding trials on three goats, the effect of an increase in ration on the utilization of acetate, propionate and butyrate in milk synthesis was studied. Acetates were largely utilized for the fatty acids of milk fat, the rate of utilization being greatly increased by the overfeeding of trial two (The diet of trial one was at a normal level for milk production). The activity of propionate in trial two was five times greater in milk fat, and twice as great in protein and lactose than in trial one. The activity of butyrate in milk fat, protein and lactose was twice as great in trial one as in trial two.

Cerbulis and Zittle (1965) developed a thin layer chromatographic method for the detection of milk fat (from cows', ewes' and goats') in various fats of animal and vegetable origin. Silica Gel was used as the absorbent layer. The triglyceride spots were developed by means of iodine vapour. All milk fats gave two triglyceride spots, whereas all other fats gave only one spot. Admixture of 1 to 2 per cent milk fat could be detected.

Glass et al.(1967) expressed the weight percentage of goat milk fatty acids as C 4:0 (2.6%), C 6:0 (2.9%), C 8:0 (2.7%), C 10:0 (8.4%), C 12:0 (3.3%), C 14:0 (10.3%), C 16:0 (24.6%), C 16:1 (2.2%), C 18:0 (12.5%), C 18:1 (28.5%) and C 18:2 (2.2%).

Klobasa and Senft (1970) determined the fatty acid composition of goats' milk by gas liquid chromatography. During colostral stage C4 to C 12 acids reached a maximum, by the fourth milking C 14 and C 16 acids fell and C 18 and C 18:1 acids rose. During the milk stage C4 to C 8 acids remained fairly constant, C 10 and C 16 acids rose and C 18 and C 18:1 acids fell.

Muzaffar et al. (1970) studied the effect of dietary changes on the fatty acid composition of goats' milk. The goats were kept on a fat free basal, butterfat or maize oil diet for a period of four weeks. The milk fat contained 82 to 92 per cent triglycerides, 1.8 to 2.5 per cent cholesterol and 0.2 to 0.7 per cent phospholipids for various diets. Of the total milk fat 88 to 96 per cent was in the fat globule. No significant change was observed in the amount of total milk fat when one diet was replaced by another. However the value for total cholesterol was found to be significantly higher when a butter fat diet was compared with a diet containing maize oil was fed.

Parodi (1973) observed that the gas liquid chromatography of goat milk triglycerides resembled those of other ruminant milks in having a wide spectrum of molecular weights. Molecules with even numbers of acyl carbons predominated. The distribution of acyl carbon numbers exhibited maxima at C 40 and C 52 and a minimum at C 48.

Smith et al. (1974) infused separately tracer quantities of Beta Hydroxy Butyric Acid (BHBA) and acetate into the jugular vein and butyrate into the portal vein of a lactating goat to study the relative importance of BHBA and acetate as precursors of milk fat. An increase in butyric acid produced in the rumen lead to an increase in the yield of milk fat, and was accompanied by an increase in the level of BHBA in the plasma. Since butyrate produced in the rumen was converted to D-BHBA and since it was taken up in large quantities by the lactating mammary gland, it has been suggested that this increase in the output of milk fat occurred through a role of beta-hydroxy butyrate in milk fat synthesis.

Cook _et al_. (1976) observed the effect of feeding cyclopropene fatty acids on the composition of cow and goat milk fat. Seed oil extracted from _Sterculа foetida_ and treated with formaldehyde fed in amounts sufficient to supply cyclopropene fatty acids at the rates of 1 g/day for goats and 3 g/day for cows. An increase in the proportion of stearic acid and decrease in the proportion of oleic acid in milk fat was observed both in cows and goats. This effect on stearic oleic ratio in milk fat was probably a result of inhibition of mammary desaturase enzyme by cyclopropene (only a slight effect was seen after feeding seed oil not treated with formaldehyde suggesting cyclopropene fatty acids are hydrogenated in the rumen).

Morand-Fehr (1978) reported that increased energy intake increased the milk yield, decreased the milk fat but, increased the proportion of C 18 acids and palmitic acids. A level of 2.7 per cent fat in the ration seemed to be the optimum to maintain milk fat content in a goat. Altering the proportion of long chain unsaturated fatty acids in the diet had a slight but detectable influence on the composition of milk and cheese lipides.

Fatty acids such as C 4:0, C 6:0, C 8:0 and C 10:0 were present mainly on position three of goats' milk triglycerides while C 12:0 and C 14:0 were mainly on positions two and three C 16:0 was on one and two and three and C 18:0 and C 18:1 were on one and three. Addition of stearate and acetate to the diet did not significantly modify these results (Revollon <u>et al</u>. 1978).

Gono <u>et al</u>. (1979) determined the composition of goat milk fat by gas chromatographic analysis. Goats' milk fat contained 16.3 per cent C 4 to C 12 acids in comparison with 9.6 per cent in buffaloes' milk and 11.6 per cent in cows' milk. Goat milk fat also had a high linoleic acid content (2.8%) than buffalo milk fat and cow milk fat (1.2% and 1.7%) respectively.

Skjevdal (1979) is of the opinion that the flavour of goats' milk was influenced by the free fatty acid contents especially C 6 to C 10 acids. Flavour was negatively correlated to the organic substances in the milk. Flavour intensity was the lowest at the start and towards the end of the lactation cycle. High feeding of concentrates increased the flavour.

Devendra (1980) in his review stated that goat milk had a relatively high content of C 6:0, C 8:0, C 10:0, C 12:0 and C 14:0 fatty acids. Cow milk had a high content of C 16:0, C 18:0, C 18:1 and C 18:2 fatty acids. Buffalo milk fat was high in C 16:0 but was low in C 18:1 acid. The saturated fatty acid in goat milk fat comprised about 67 per cent of the total weight of fatty acids.

MATERIALS AND METHODS

MATERIALS AND METHODS

The samples of milk for the study were collected from six each of Alpine X Malabari and Saanen X Malabari goats maintained at the All India Co-ordinated Research Project on Goats for milk at Mannuthy. The samples were collected from the beginning to the end of the lactation of the experimental animals at weekly intervals.

The experimental animals in groups were kept in pens. They were fed as per a feeding schedule recommended by the National Dairy Research Institute, Karnal with partial modification to suit the local conditions. Apart from the maintenance ration of 400 g of concentrate and 3 kg of roughage, the milking animals were allotted an extra amount of 400 g concentrate for every one litre of milk produced. The concentrate feed given to the animals was 'GODREJ E.M.R. Pellets' containing 70 per cent TDN and 20 per cent CP. As roughage, during summer months, the various locally available tree leaves such as leaves of Jack tree (_Artocarpus heterophyllus_), Poovam (_Schleichera trijuga_) and Venga (_Pterocarpus marsupium, Roxb_) were fed. During rainy season different varieties of grass cultivated locally such as Napier and Para were fed. Clean and fresh water was made available to the animals at all times. Details regarding the experimental goats are given in Table 16.

The samples were brought to the laboratory as immediately as possible for further analysis. The total number of samples collected for the study was 183 from the twelve experimental animals.

Fat globule size

A representative sample of milk was taken for determining the size of the fat globule. The fat globule size was determined by the method described in Roadhouse and Henderson (1950). An amount of 0.1 ml milk sample was diluted with 10 ml of 40 per cent glycerin solution and the slide prepared was examined under a microscope whose eye piece micrometer was standardized against a stage micrometer. A total number of 100 fat globules from various microscopic fields were counted and the average size of one fat globule was calculated.

Preparation of ghee sample

The samples of milk collected were subjected to a process of centrifugal separation in a power operated cream separator. The cream thus obtained was heated over a low and controlled flame to 110°C using a shallow pan till a good quantity of ghee was produced. The ghee was filtered through a filter paper to remove the curd particles and stored in closed glass containers for the determination of various physical and chemical constituents.

Melting point

A small quantity of melted milk fat was drawn in a capillary tube, then hardened under refrigeration. It was then placed in the melting point apparatus (Viswo) and the temperature raised until the opaque solidified fat became transparent. The temperature at which the ghee became transparent was noted by use of the thermometer fitted in the melting point apparatus.

Refractive index

The refractive index was determined by butyro-refractometer (Andhra Scientific Co. Ltd.) at a temperature of 40°C. The reading obtained in the instrument was converted to refractive index by using a table (Hart and Fisher, 1971).

Iodine value

The iodine value was determined by Hanus method described in Hart and Fisher (1971). In this method atleast 100 per cent excess of halogenating agent (Hanus reagent - iodine monobromide is used in preference to iodine solutions, because they are more active and give more nearly correct results) was allowed to react for a fixed time with the fat in chloroform. The excess reagent was then allowed to react with aqueous potassium iodide (KI) in acid solution and the liberated iodine was titrated against standard (0.12 N) thiosulphate solution. The amount of Hanus reagent absorbed by the double bonds in the fat gives a measure of degree of unsaturation. The iodine value was calculated as per the formula given hereunder.

$$\text{Iodine value} = \frac{(B-S) \times N \times 12.69}{\text{Weight of sample}}$$

where B = titre of the blank

S = titre of the sample

N = the normality of the thiosulphate solution

Saponification number

The saponification number was determined by AOAC method (Hart and Fisher, 1971). It was determined by hydrolysis of fat in excess of standard alcoholic alkali solution (0.5 N) for 30 minutes and titrimetric determination of the excess alkali with standard acid (0.5 N).

$$\text{Saponification value} = \frac{(B-S) \times 28.05}{\text{Weight (in g) of sample}}$$

where S = the titre of the sample

B = the titre of the blank

Reichert-Meissl and Polenske values

Reichert-Meissl and Polenske values were determined by the method described in Pearson (1976). Reichert-Meissl number was obtained by determining the amount of (in ml) 0.1 N alkali solution required to neutrialise the water soluble volatile fatty acids obtained from 5 g of fat which has been saponified, acidified to liberate the fatty acids and then steam distilled. The Reichert-Meissl value was calculated by the formula given below:

Reichert-Meissl value = 1.1 x (S-B)

where S = titration of the sample in ml of 0.1 N NaOH

B = titration of the blank in ml of 0.1 N NaOH

Polenske value was determined by determining the amount of 0.1 N alkali solution (in ml) required to neutralize the water insoluble volatile acids obtained from 5 g of fat which has been saponified, acidified to liberate the fatty acids and then steam distilled. It was calculated by using the formula given hereunder

Polenske value = ml of 0.1 N NaOH required,
after correction for the blank.

Statistical analyses

The statistical analyses of the data on various physical and chemical constituents of milk fat were done according to standard methods (Snedecor and Cochran, 1956).

RESULTS

RESULTS

A total of 183 milk samples were collected from the twelve crossbred goats of the experiment for the determination of the various physical and chemical constants of milk fat. Out of this 65 samples were used for studying the size of the fat globules. The results obtained in the course of study are presented in tables 1 to 14.

Size of the fat globule

The size of the milk fat globule obtained from the milk samples of Alpine X Malabari group of animals is presented in table 1. The mean value for the size of the milk fat globule during the early, middle and late stages of lactation was 2.971 ± 0.192, 2.407 ± 0.086 and 2.204 ± 0.059 microns respectively. The range obtained for the size of the fat globule was 2.043 to 3.435 ± 0.165. The average value obtained for the size of the milk fat globule during the lactation was 2.556 ± 0.110 microns for Alpine X Malabari goats.

The values obtained for the size of the milk fat globule of Saanen X Malabari goats are given in table 2. The values ranged from 1.975 ± 0.115 to 3.581 microns. The average size obtained during the early middle and late stages of lactation was 3.317 ± 0.097, 2.545 ± 0.086 and 2.166 ± 0.072 microns respectively. The average size of the fat globule was 2.702 ± 0.038 microns for this group of animals.

On statistical analysis of the values obtained for the size of the milk fat globules of the two groups of crossbred goats the difference was found to be not significant as the calculated 'Z' value (Z = 1.158) was lower than the critical value ($P \angle 0.01$). The calculated 'Z' values are shown in table 15.

Melting point

The melting point of Alpine X Malabari goat milk fat is given in table 3. The Alpine X Malabari goat milk fat showed a melting point 31.07 ± 0.16°C and it ranged during the lactation from 29.23 ± 0.23 to 32.24 ± 0.29°C. The melting point obtained during the early, middle and late stages of lactation was 30.38 ± 0.30, 31.30 ± 0.30 and 31.85 ± 0.18°C respectively for the Alpine X Malabari crossbred goats.

Table 4 shows the melting point of the milk fat of Saanen X Malabari goats. The mean value for the melting point during the early, middle and late stages of lactation was 30.81 ± 0.29, 31.32 ± 0.06 and 32.18 ± 0.16°C respectively. The melting point during the lactation ranged from 29.94 ± 0.11 to 32.60 ± 0.29°C and the average melting point obtained for the milk fat of Saanen X Malabari goat was 31.36 ± 0.13°C.

There was no significant difference in the melting point of the milk fat of Alpine X Malabari and Saanen X Malabari crosses since the calculated 'Z' value (1.674) was less than the critical value ($P < 0.01$) (Table 15).

Refractive index

The refractive index obtained for the milk fat of Alpine X Malabari goat was 1.4568 ± 0.0001 and is shown in table 5. The refractive index at the various stages such as early, middle and late lactation was 1.4558 ± 0.0001, 1.4571 ± 0.0001 and 1.4575 ± 0.0001 respectively. The value ranged from 1.4553 ± 0.0002 to 1.4579 ± 0.0002.

The Saanen X Malabari goat milk fat showed a refractive index of 1.4569 ± 0.0001 and it showed a range from 1.4556 ± 0.0003 to 1.4586 ± 0.0001 during the lactation. The values obtained for the refractive index are shown in table 6. The refractive index obtained was 1.4561 ± 0.0001, 1.4575 ± 0.0002 and 1.4579 ± 0.0002 during the early, middle and late stages of lactation respectively for the Saanen X Malabari goats.

Statistical analysis indicated that the difference in refractive index between the two groups was not significant as the 'Z' value calculated (0.707) was lower than the critical value ($P < 0.01$) (Table 15).

Iodine value

The iodine value determined at the early, middle and late stages of lactation was 23.51 ± 0.50, 25.26 ± 0.07 and 26.65 ± 0.50 respectively for the Alpine X Malabari goat milk fat and is shown in table 7. The mean iodine value for this group was 24.95 ± 0.28 with a range of 21.40 ± 0.94 to 26.94 ± 0.36 during the lactation.

The iodine values for the Saanen X Malabari goat milk fat are presented in table 8. An iodine value of 25.09 ± 0.35 was obtained for this group of goats with a range of 22.62 ± 0.95 to 28.03 ± 0.29. The iodine value during the early, middle and late stages of lactation was 24.08 ± 0.34, 25.27 ± 0.28 and 26.42 ± 0.56 respectively.

No significant difference was noticed between the iodine values of the milk fat of two different crossbred goats since the calculated 'Z' value (0.366) was lower than the critical value ($P < 0.01$) (Table 15).

Reichert-Meissl value

The Reichert-Meissl (RM) values obtained for the milk fat of Alpine X Malabari and Saanen X Malabari goats are presented in tables 9 and 10 respectively. The early, middle and late stages of lactation gave the RM value as 27.46 ± 0.28, 28.01 ± 0.22 and 29.04 ± 0.21 respectively for the Alpine X Malabari goats. The corresponding values were 27.87 ± 0.23, 28.14 ± 0.29 and 30.00 ± 0.33 respectively for the Saanen crossbred goats. The RM value ranged from 26.59 ± 0.38 to 29.78 ± 0.22 for Alpine X Malabari goats, whereas it varied from 27.21 ± 0.68 to 30.86 ± 0.21 for Saanen X Malabari goats. The average RM value obtained was 28.14 ± 0.18 for the Alpine X Malabari as against the value of 28.61 ± 0.13 got for Saanen X Malabari goats.

On statistical analysis the difference in RM value of milk fat between the two crossbreds was not significant since the calculated 'Z' value (1.735) was less than the critical value ($P < 0.01$) (Table 15).

Polenske value

The Polenske values of the milk fat of Alpine X Malabari goats are presented in table 11. The value ranged from 1.95 ± 0.11 to 5.50 ± 0.11 with an average value of 3.52 ± 0.15 during the lactation. The Polenske value at the early, middle and late stages of lactation was 2.29 ± 0.09, 3.62 ± 0.18 and 4.99 ± 0.32 respectively.

The Polenske value of the milk fat of Saanen X Malabari goats are found in table 12 and the average value was 3.64 ± 0.12. During the early, middle and late stages of lactation the milk fat gave the values of 2.44 ± 0.03, 3.86 ± 0.23 and 4.83 ± 0.15 respectively. The Polenske value showed a range of 2.38 ± 0.20 to 5.30 ± 0.17 during the lactation.

The statistical analysis of the data pertaining to the Polenske value of the milk fat of Alpine X Malabari and Saanen X Malabari goats did not show any significant difference. The 'Z' value calculated (0.591) was less than the critical value ($P \angle 0.01$) (Table 15).

Saponification value

The saponification values for the milk fat of Alpine X Malabari and Saanen X Malabari goats are presented in tables 13 and 14 respectively. During the early, middle and late stages of lactation for the Alpine X Malabari groups was 235.4 ± 0.9, 237.1 ± 0.7 and 232.7 ± 1.3

respectively. The average saponification value for this group was 235.1 ± 0.7 with a range from 228.3 ± 2.2 to 239.2 ± 1.1.

The milk fat of Saanen X Malabari goats showed a saponification value of 236.9 ± 1.2, 236.1 ± 1.1 and 230.0 ± 1.5 during the early, middle and late stages of lactation. The mean saponification value for this group was 234.6 ± 1.1 with a range from 224.4 ± 1.5 to 240.5 ± 1.4.

No significant difference was noticed between the saponification values of the two groups on statistical analysis of the data since the calculated 'Z' value (0.273) was less than the critical value (Table 15).

TABLES

Table 1. Fat globule size (Alpine X Malabari)

Stage of lactation	Animal number						Mean
	6284 (6)	6297 (6)	6477 (6)	6526 (5)	6376 (5)	6288 (5)	
Early	3.435 ±0.165	3.375 ± 0.095	3.361 ± 0.151	2.415 ± 0.145	2.745 ± 0.075	2.495 ± 0.275	2.971 ± 0.192
Middle	2.600	2.433 ± 0.276	2.445 ± 0.225	2.310	2.615 ± 0.025	2.043	2.407 ± 0.086
Late	2.270	2.145 ± 0.125	2.250 ± 0.020	2.070 ± 0.140	2.440	2.050 ± 0.030	2.240 ± 0.059
Mean	2.935 ± 0.303	2.651 ± 0.248	2.641 ± 0.198	2.256 ± 0.100	2.632 ± 0.061	2.226 ± 0.140	2.556 ± 0.110

Figures in parenthesis indicate the number of samples

Table 2. Fat globule size (Saanen X Malabari)

Stage of lactation	Animal number						Mean
	F2S 50 (6)	595 (6)	704 (5)	561 (5)	604 (5)	855 (5)	
Early	3.225 ± 0.045	3.575 ± 0.395	3.581	3.280 ± 0.033	2.947 ± 0.223	3.296 ± 0.345	3.317 ± 0.097
Middle	2.800 ± 0.006	2.285 ± 0.035	2.697 ± 0.027	2.674 ± 0.050	2.497	2.320 ± 0.050	2.545 ± 0.066
Late	2.105 ± 0.175	2.330 ± 0.110	1.975 ± 0.115	2.421	2.005 ± 0.782	2.160	2.166 ± 0.072
Mean	2.710 ± 0.212	2.730 ± 0.287	2.584 ± 0.298	2.865 ± 0.204	2.648 ± 0.141	2.678 ± 0.276	2.702 ± 0.038

Figures in parenthesis indicate the number of samples

Table 3. Melting point (Alpine X Malabari)

State of lactation	Animal number						Mean
	6284 (11)	6297 (19)	6477 (17)	6526 (14)	6376 (14)	6288 (14)	
Early	30.43 ± 0.38	30.97 ± 0.25	31.31 ± 0.26	29.91 ± 0.17	30.42 ±0.31	29.23 ± 0.23	30.38 ± 0.30
Middle	30.50 ± 0.51	31.20 ± 0.19	31.60 ± 0.15	31.38 ± 0.34	31.58 ± 0.05	31.58 ± 0.26	31.30 ± 0.30
Late	30.98 ± 0.41	32.24 ± 0.29	32.06 ± 0.24	31.90 ± 0.11	31.95 ± 0.06	32.00 ± 0.34	31.85 ± 0.18
Mean	30.65 ± 0.23	31.39 ± 0.18	31.62 ± 0.15	30.90 ± 0.27	31.19 ± 0.23	30.69 ± 0.38	31.07 ± 0.16

Figures in parenthesis indicate the number of samples

Table 4. Melting point of milk fat (Saanen X Malabari)

Stage of lactation	Animal number						Mean
	F2S 50 (17)	595 (17)	704 (14)	561 (13)	604 (13)	855 (13)	
Early	31.24 ± 0.23	30.68 ± 0.37	31.22 ± 0.32	31.73 ± 0.19	30.04 ± 0.29	29.94 ± 0.11	30.81 ± 0.29
Middle	31.34 ± 0.14	31.10 ± 0.22	31.55 ± 0.15	31.35 ± 0.24	31.20 ± 0.13	31.38 ± 0.34	31.32 ± 0.06
Late	32.60 ± 0.29	31.73 ± 0.31	31.73 ± 0.31	32.40 ± 0.12	32.05 ± 0.06	32.58 ± 0.31	32.18 ± 0.16
Mean	31.67 ± 0.20	31.05 ± 0.22	31.46 ± 0.17	31.77 ± 0.15	31.02 ± 0.27	31.19 ± 0.34	31.36 ± 0.13

Figures in parenthesis indicate the number of samples

Table 5. Refractive index of milk fat (Alpine X Malabari)

Stage of lactation	Animal number						Mean
	6284 (11)	6297 (19)	6477 (17)	6526 (13)	6376 (14)	6288 (14)	
Early	1.4559 ± 0.0002	1.4555 ± 0.0002	1.4553 ± 0.0002	1.4561 ± 0.0002	1.4565 ± 0.0002	1.4560 ± 0.0004	1.4558 ± 0.0001
Middle	1.4570 ± 0.0003	1.4568 ± 0.0001	1.4568 ± 0.0002	1.4574 ± 0.0002	1.4578 ± 0.0001	1.4572 ± 0.0001	1.4571 ± 0.0001
Late	1.4569 ± 0.0002	1.4578 ± 0.0001	1.4573 ± 0.0003	1.4579 ± 0.0002	1.4578 ± 0.0001	1.4573 ± 0.0001	1.4575 ± 0.0001
Mean	1.4565 ± 0.0002	1.4566 ± 0.0001	1.4570 ± 0.000	1.4569 ± 0.0002	1.4572 ± 0.0002	1.4567 ± 0.0002	1.4568 ± 0.0001

Figures in parenthesis indicate the number of samples

Table 6. Refractive index of milk fat (Saanen X Malabari)

Stage of lactation	Animal number						Mean
	F2S 50 (17)	595 (17)	704 (14)	561 (14)	604 (14)	855 (13)	
Early	1.4558 ± 0.0004	1.4556 ± 0.0003	1.4563 ± 0.0001	1.4564 ± 0.0002	1.4562 ± 0.0005	1.4567 ± 0.0001	1.4561 ± 0.0001
Middle	1.4575 ± 0.0003	1.4566 ± 0.0003	1.4576 ± 0.0002	1.4574 ± 0.0002	1.4577 ± 0.0001	1.4582 ± 0.0002	1.4575 ± 0.0002
Late	1.4584 ± 0.0001	1.4569 ± 0.0001	1.4579 ± 0.0001	1.4579 ± 0.0002	1.4579 ± 0.0001	1.4586 ± 0.0001	1.4579 ± 0.0002
Mean	1.4571 ± 0.0003	1.4562 ± 0.0002	1.4571 ± 0.0002	1.4571 ± 0.0002	1.4572 ± 0.0002	1.4577 ± 0.0002	1.4569 ± 0.0001

Figures in parenthesis indicate the number of samples

Table 7. Iodine value of milk fat (Alpine X Malabari)

Stage of lactation	Animal number						Mean
	6284 (11)	6297 (19)	6477 (17)	6526 (14)	6376 (14)	6288 (15)	
Early	21.40 ± 0.94	24.22 ± 0.94	24.70 ± 0.23	24.23 ± 0.46	23.72 ± 1.01	22.79 ± 0.76	23.51 ± 0.50
Middle	25.33 ± 0.28	25.06 ± 0.43	25.49 ± 0.41	25.06 ± 0.70	25.36 ± 0.56	25.28 ± 0.65	25.26 ± 0.07
Late	24.77 ± 0.56	25.65 ± 0.14	26.18 ± 0.56	26.76 ± 0.10	26.94 ± 0.36	26.65 ± 0.85	26.65 ± 0.50
Mean	23.70 ± 0.66	25.68 ± 0.62	25.37 ± 0.54	25.19 ± 0.39	25.10 ± 0.58	24.65 ± 0.59	24.95 ± 0.28

Figures in parenthesis indicate the number of samples

Table 8. Iodine value of milk fat (Saanen X Malabari)

Stage of lactation	Animal number						Mean
	F2[illegible] 50 (17)	595 (16)	704 (14)	561 (15)	604 (14)	855 (13)	
Early	24.54 ± 0.55	22.62 ± 0.95	24.04 ± 0.33	25.09 ± 0.48	24.17 ± 0.89	24.00 ± 0.90	24.08 ± 0.34
Middle	26.21 ± 0.16	24.64 ± 0.90	24.48 ± 1.07	25.87 ± 0.55	24.99 ± 0.66	25.40 ± 0.54	25.27 ± 0.28
Late	26.31 ± 0.23	25.54 ± 0.54	24.48 ± 0.85	28.03 ± 0.29	26.25 ± 0.32	27.91 ± 0.49	26.42 ± 0.56
Mean	25.55 ± 0.21	23.88 ± 0.57	24.29 ± 0.38	26.13 ± 0.41	25.06 ± 0.44	25.63 ± 0.49	25.09 ± 0.35

Figures in parenthesis indicate the number of samples

Table 9. Reichert-Meissl value of milk fat (Alpine X Malabari)

State of lactation	Animal number						Mean
	6284 (10)	6297 (18)	6477 (15)	6526 (13)	6376 (14)	6288 (15)	
Early	26.59 ± 0.38	27.25 ± 0.35	27.67 ± 0.37	26.85 ± 0.38	28.38 ± 0.32	28.00 ± 0.57	27.46 ± 0.28
Middle	28.05 ± 0.57	28.60 ± 0.28	28.58 ± 0.75	27.16 ± 0.43	27.86 ± 0.28	27.81 ± 0.57	28.01 ± 0.22
Late	28.22 ± 0.35	29.32 ± 0.87	29.06 ± 0.37	28.79 ± 0.66	29.78 ± 0.22	29.04 ± 0.31	29.04 ± 0.21
Mean	27.68 ± 0.32	28.35 ± 0.34	28.44 ± 0.32	27.52 ± 0.36	28.63 ± 0.26	28.21 ± 0.32	28.14 ± 0.18

Figures in parenthesis indicate the number of samples

Table 10. Reichert-Meissl value of milk fat (Saanen X Malabari)

Stage of lactation	Animal number						Mean
	F28 50 (14)	595 (16)	704 (12)	561 (14)	604 (14)	855 (13)	
Early	27.49 ± 0.26	27.72 ± 0.50	28.22 ± 0.50	28.70 ± 0.36	27.21 ± 0.68	27.81 ± 0.24	27.87 ± 0.23
Middle	28.30 ± 0.45	28.09 ± 0.37	27.68 ±0.68	27.08 ± 0.19	29.09 ± 0.65	28.61 ± 0.53	28.14 ± 0.29
Late	28.71 ± 0.29	30.18 ± 0.47	29.76 ±0.22	29.65 ± 0.33	30.86 ± 0.21	30.83 ± 0.46	30.00 ± 0.33
Mean	28.16 ± 0.23	28.61 ± 0.37	28.60 ±0.36	28.39 ± 0.33	28.92 ± 0.51	28.98 ± 0.42	28.61 ± 0.13

Figures in parenthesis indicate the number of samples

Table 11. Polenske values of milk fat (Alpine X Malabari)

Stage of lactation	Animal number						Mean
	6284 (10)	6297 (18)	6477 (15)	6526 (13)	6376 (14)	6288 (15)	
Early	2.07 ± 0.17	1.95 ± 0.11	2.48 ± 0.23	2.30 ± 0.19	2.48 ± 0.17	2.43 ± 0.17	2.29 ± 0.09
Middle	2.83 ± 0.03	3.47 ± 0.19	3.88 ± 0.35	3.90 ± 0.10	4.05 ± 0.10	3.60 ± 0.09	3.62 ± 0.18
Late	3.43 ± 0.20	5.46 ± 0.23	5.50 ± 0.11	5.38 ± 0.24	5.28 ± 0.09	4.93 ± 0.11	4.99 ± 0.32
Mean	2.84 ± 0.21	3.52 ± 0.36	3.95 ± 0.36	3.62 ± 0.40	3.73 ± 0.33	3.49 ± 0.28	3.52 ± 0.15

Figures in parenthesis indicate the number of samples

Table 12. Polenske values of milk fat (Saanen X Malabari)

Stage of lactation	Animal number						Mean
	F28 50 (15)	595 (16)	704 (12)	561 (14)	604 (14)	855 (13)	
Early	2.40 ± 0.24	2.38 ± 0.20	2.40 ± 0.19	2.60 ± 0.20	2.44 ± 0.15	2.42 ± 0.16	2.44 ± 0.03
Middle	3.86 ± 0.42	3.80 ± 0.27	4.00 ± 0.06	4.84 ± 0.20	3.30 ± 0.30	3.38 ± 0.23	3.86 ± 0.23
Late	4.90 ± 0.05	4.82 ± 0.10	4.78 ± 0.15	5.30 ± 0.17	5.02 ± 0.12	4.18 ± 0.17	4.83 ± 0.15
Mean	3.72 ± 0.31	3.59 ± 0.28	3.52 ± 0.33	4.17 ± 0.34	3.61 ± 0.32	3.25 ± 0.23	3.64 ± 0.12

Figures in parenthesis indicate the number of samples

Table 13. Saponification value of milk fat (Alpine X Malabari)

Stage of lactation	Animal number 6284 (11)	6297 (18)	6477 (15)	6526 (13)	6376 (14)	6288 (15)	Mean
Early	235.9 ± 0.8	235.0 ± 1.1	231.8 ± 2.4	237.0 ± 0.8	234.5 ± 1.0	238.3 ± 0.7	235.4 ± 0.9
Middle	236.1 ± 0.2	235.6 ± 1.0	238.8 ± 0.7	239.2 ± 1.1	235.1 ± 1.3	237.9 ± 2.0	237.1 ± 0.7
Late	237.0 ± 1.0	231.7 ± 3.4	231.8 ± 1.8	235.3 ± 1.8	228.3 ± 2.2	232.4 ± 2.3	232.7 ± 1.3
Mean	236.3 ± 0.6	234.3 ± 1.1	233.7 ± 1.4	237.0 ± 0.8	232.9 ± 1.1	236.7 ± 1.1	235.1 ± 0.7

Figures in parenthesis indicate the number of samples

Table 14. Saponification value of milk fat (Saanen X Malabari)

Stage of lactation	Animal number						Mean
	F2S 50 (16)	595 (18)	704 (14)	561 (15)	504 (15)	355 (13)	
Early	240.4 ± 0.8	239.5 ± 0.7	232.3 ± 0.7	237.2 ± 1.2	236.3 ± 1.5	236.0 ± 1.2	236.9 ± 1.2
Middle	240.5 ± 1.4	237.9 ± 0.7	234.2 ± 1.5	235.4 ± 1.9	235.6 ± 0.6	233.2 ± 0.9	236.1 ± 1.1
Late	235.1 ± 1.0	231.1 ± 1.0	232.4 ± 1.6	228.3 ± 6.1	228.9 ± 3.3	224.4 ± 1.5	230.0 ± 1.5
Mean	238.8 ± 0.8	236.7 ± 1.0	232.9 ± 0.7	234.2 ± 1.9	233.6 ± 1.4	231.6 ± 1.6	234.6 ± 1.1

Figures in parenthesis indicate the number of samples

Table 15. 'Z' value calculated for different characteristics of milk fat

Sl.No.	Characteristics studied	'Z' value calculated	Critical value
1.	Fat globule size	1.158	
2.	Melting point	1.674	
3.	Refractive index	0.707	
4.	Iodine value	0.366	1.960
5.	Reichert-Meissl value	1.735	
6.	Polenske value	0.591	
7.	Saponification value	0.273	

Table 16. Details of the experimental goats

	Alpine X Malabari					
Animal number	6284	6297	6477	6526	6376	6288
Date of birth	16-4-'78	8-5-'78	5-2-'79	21-3-'79	26-11-'78	20-4-'78
Order of lactation	Second	Second	First	First	First	Second
Date of kidding	31-12-80	7-12-80	30-12-80	4--2--81	9--2--'81	5--2-'81
Duration of lactation (in days)	90	164	158	142	149	149

	Saanen X Malabari					
Animal number	F2S 50	595	704	561	604	855
Date of birth	2--3--79	9-2-'75	23-12-75	30-12-74	20-2-'75	30-11-'76
Order of lactation	First	Fourth	Sixth	Third	Fifth	Third
Date of kidding	26-12-80	10-1-81	31-1--81	3--2--81	18-2-'81	17--2-'81
Duration of lactation (in days)	153	166	148	144	149	149

ILLUSTRATIONS

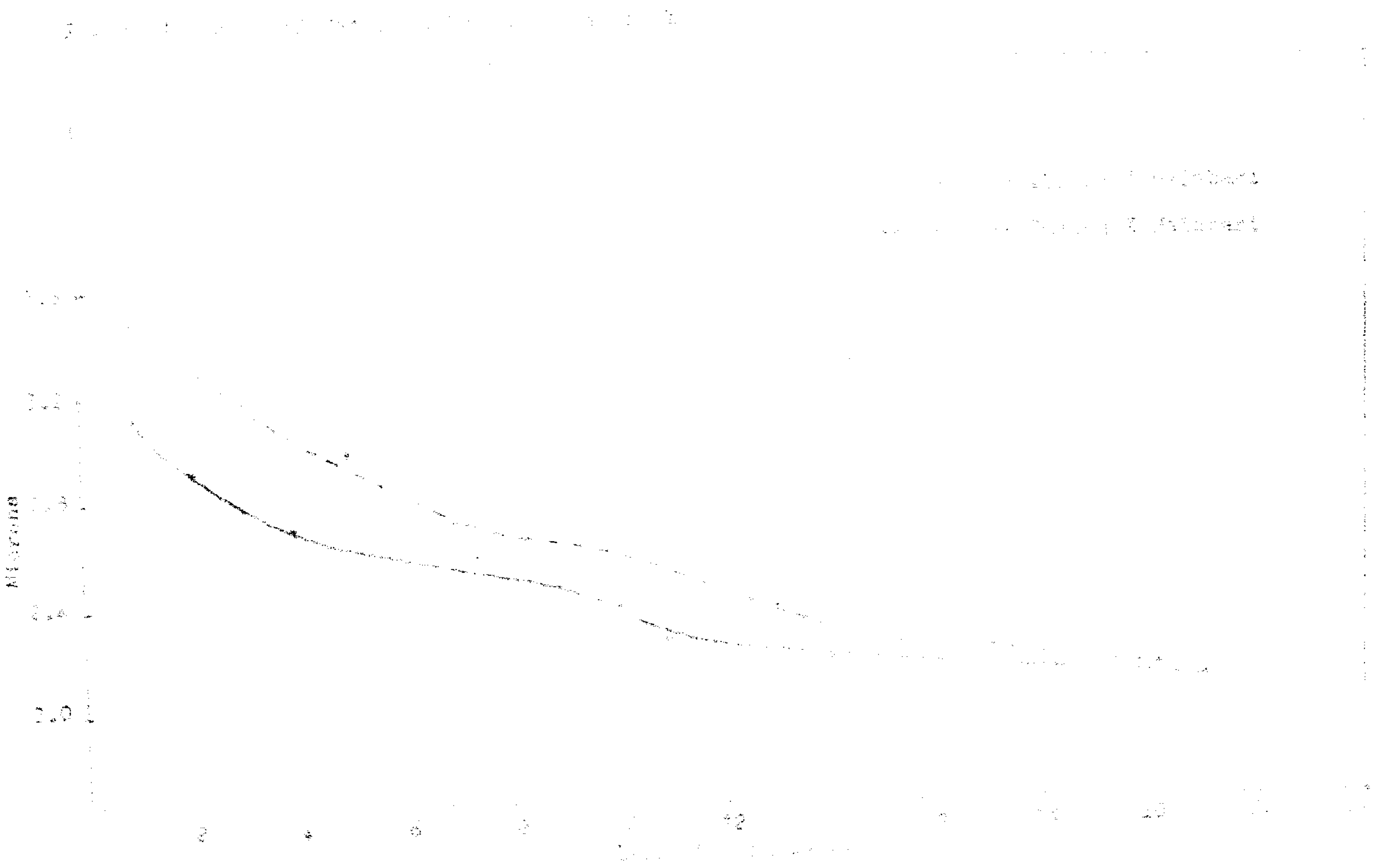


Figure [illegible]. Melting point of milk fat of goats

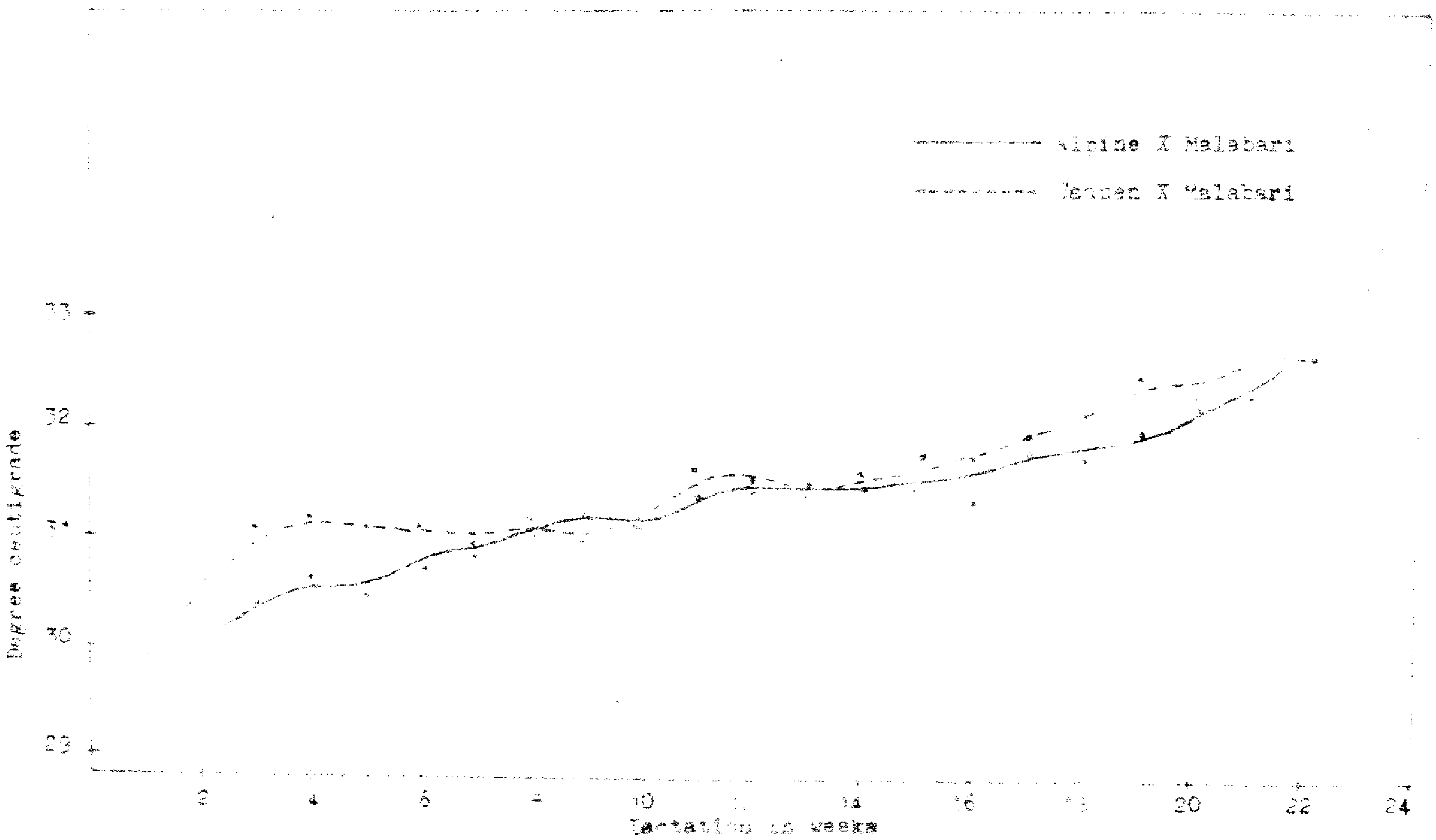


Figure 3. Refractive index of milk fat of goats

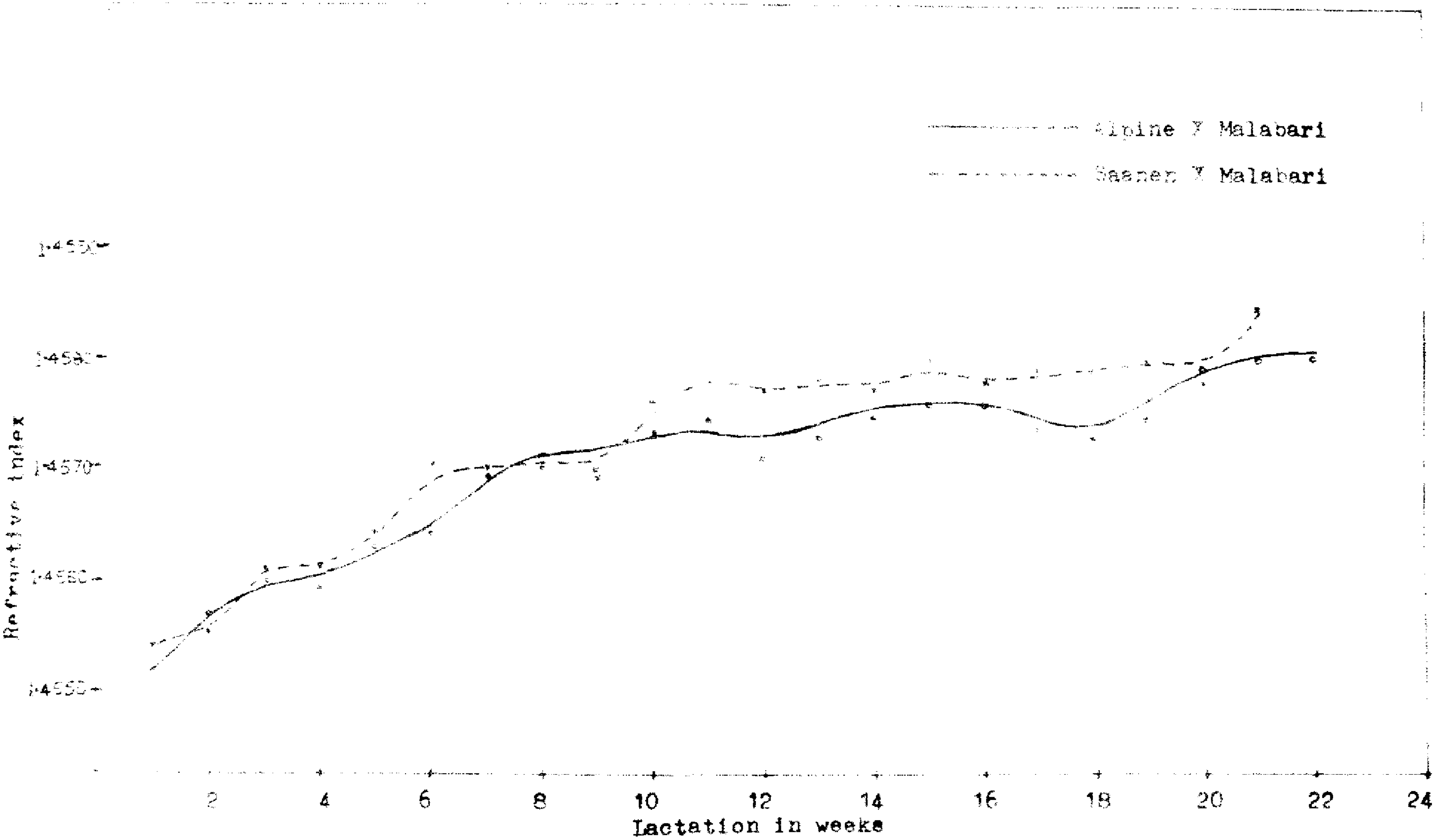


Figure 4. Iodine number of milk fat of goats

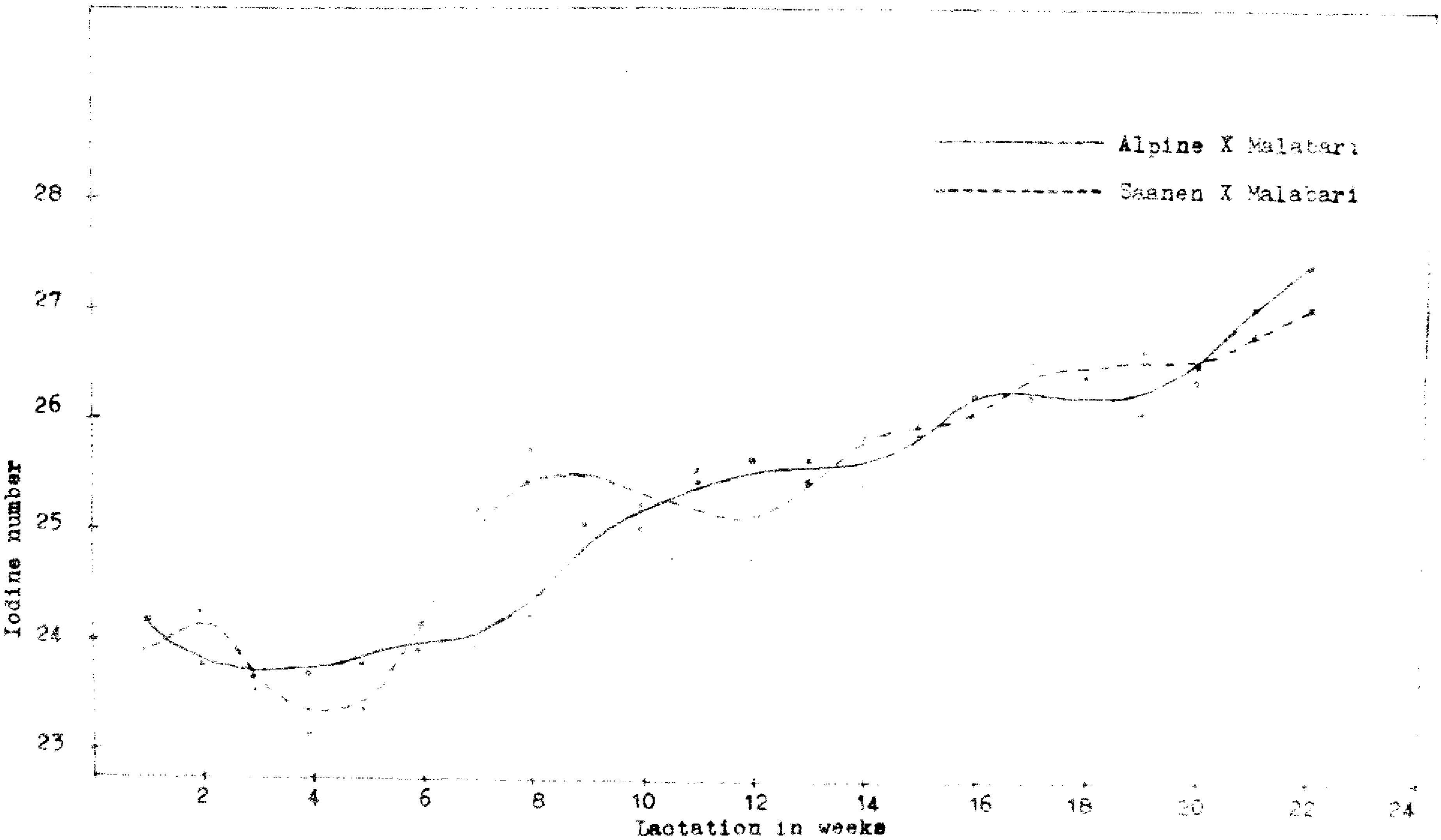


Figure [illegible]. Reichert-Meissl number of milk fat of goats

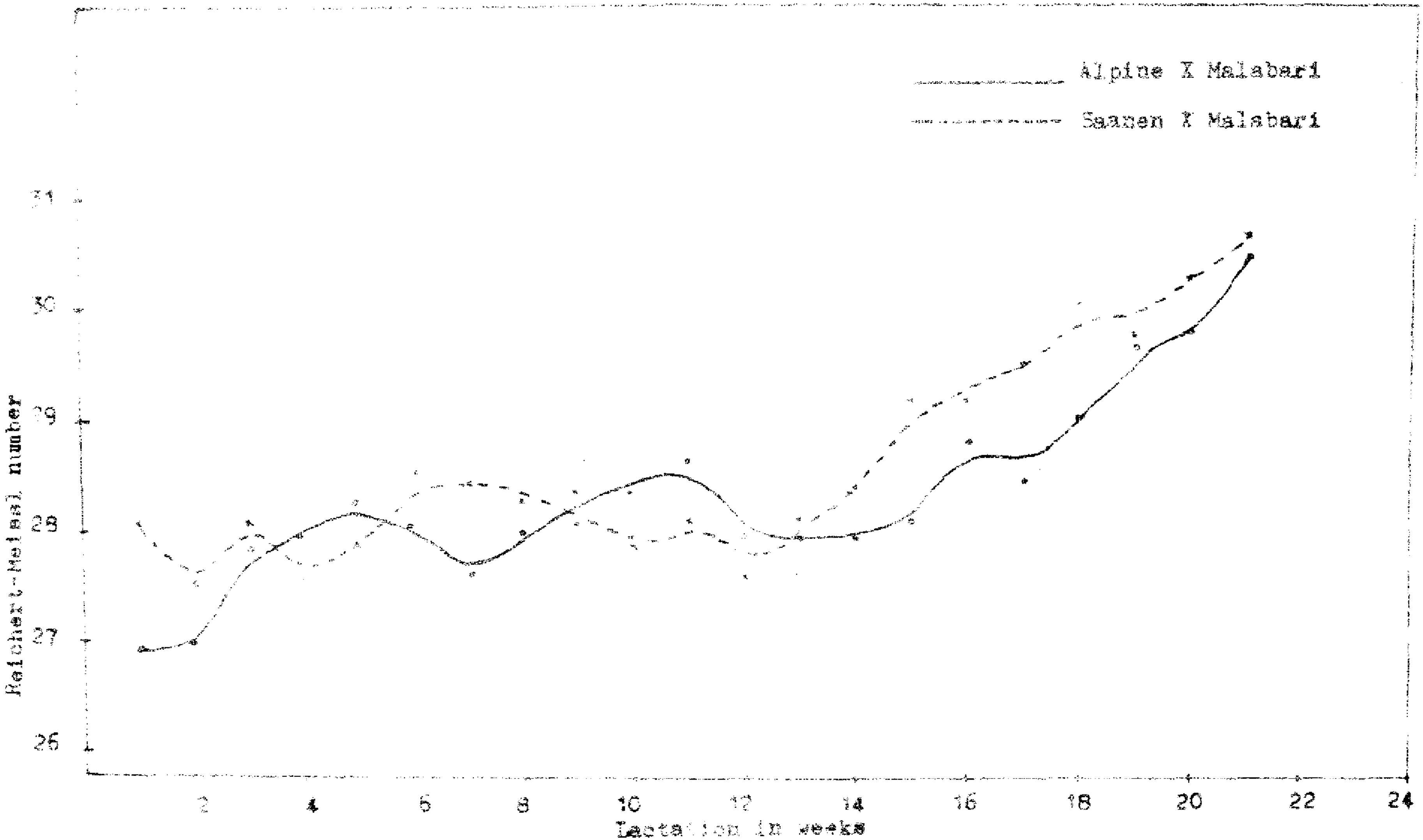


Figure 5. Polenske value of milk fat of goats

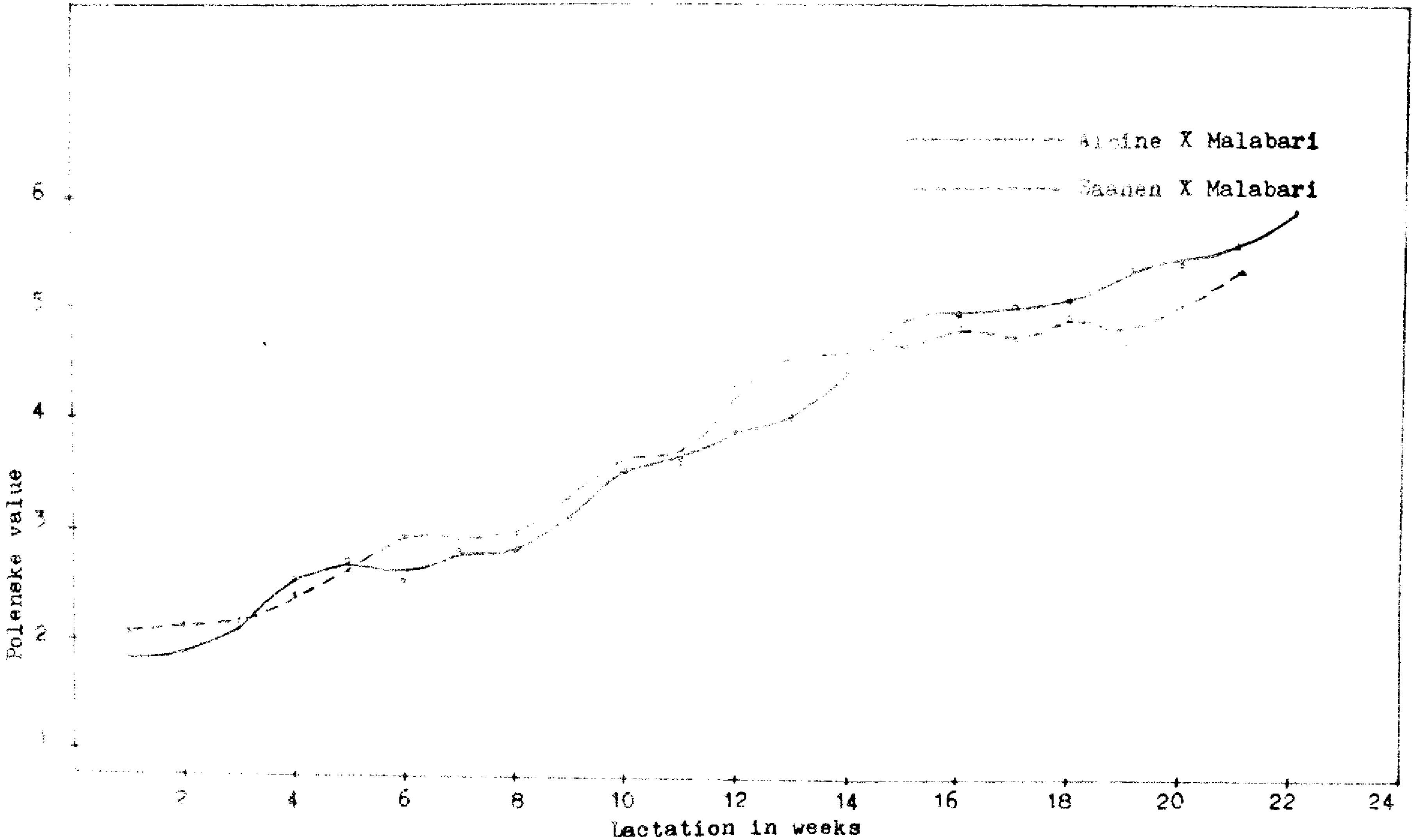
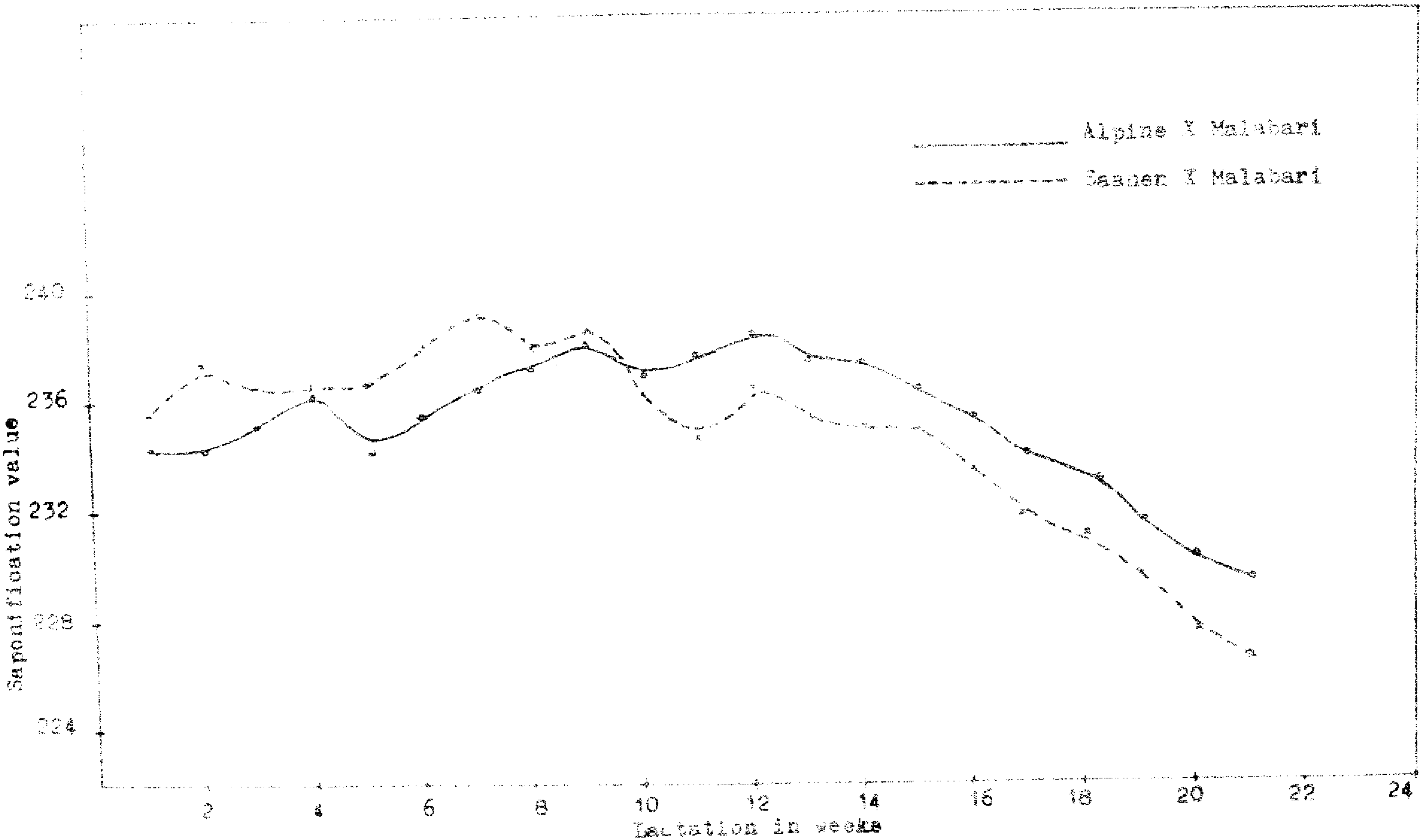


Figure 7. Saponification value of milk fat of goats



DISCUSSION

DISCUSSION

One of the most important constituents of milk is the lipide material and it plays significant roles in milk and milk products. In order to have an understanding about the ways in which these roles are being carried out in the milk products it is desirable to have a knowledge of the physical and chemical properties of milk fat. In our country goat milk is getting more and more attention particularly on its utilization for milk product manufacture either alone or in combination with cow or buffalo milk (Jailkhani and Sukumar De, 1979).

Many factors like species, breed, diet, plane of nutrition, stage of lactation, season, stall versus pasture feeding, climate and freedom of movement are considered to be influencing the fatty acid composition of milk fat (Webb and Johnson, 1965). The size of the fat globule and the physical and chemical constants obtained on the study of milk fat of the two crossbred goats (Alpine X Malabari and Saanen X Malabari) are discussed with reference to the differences due to breed and stage of lactation.

Size of the fat globule

The average size of the fat globule of the milk of Alpine X Malabari goat was 2.556 ± 0.110 microns and that of Saanen X Malabari goat was 2.702 ± 0.038 microns. Fahmi (1956) reported a range 1 to 10 microns diameter for the size of fat globules in goats' and cows' milk respectively. He also reported that the content of smaller globules was more in goats' milk. As the lactation advanced, it has been found that the diameter of the fat globule decreased from the average value of 3.122 to 2.160 microns and 3.540 to 2.170 microns from the first to the twentieth week of lactation for the Alpine and Saanen crossbred goats respectively. In both the crossbreds the rate of decrease in the size of the fat globule was rapid from the first to the eleventh week of lactation (3.122 to 2.240 microns and 3.540 to 2.580 microns) and from the eleventh week to the end of lactation (twentieth week) the rate of decrease in size was not much appreciable (2.240 to 2.160 microns and 2.580 to 2.170 microns) for Alpine X Malabari and Saanen X Malabari goats respectively (Fig. 1). A decrease in the size of the milk fat globules of Sahiwal cows as lactation advanced was reported by Katiyar _et al_. (1973) and similar observations have been reported in Murrah buffaloes by Upadhyaya _et al_. (1973). The observations made in the present study were found to be in agreement with reports mentioned above.

From figure 1 seems that the Saanen crossbreds have a larger size for the milk fat globule during the entire lactation. However the statistical analysis of the data obtained for the size of the milk fat globule of both the crossbreds indicated no significant difference between the groups (Table 15).

Melting point

The melting points of the milk fat of Alpine X Malabari and Saanen X Malabari goats are presented in tables 3 and 4 respectively. The Alpine X Malabari goat milk fat showed a melting point 31.07 ± 0.16°C as against the value of 31.39 ± 0.13°C obtained for the Saanen X Malabari goat milk fat. Both the group of animals showed an increase in the melting point of milk fat with the advancement of lactation.(Fig.2). The Alpine X Malabari group showed an increase from 29.98 to 32.95°C from the beginning to the end of lactation. In the Saanen X Malabari group this increase was from 29.92 to 32.60°C. Basu (1962) reported an increase in melting point by 1 to 4°F towards the end of lactation period. As the milk fat consisted mainly of glycerides of fatty acids of saturated or acetic series an increase in melting point would indicate an increase in the mean molecular weight of mixed acids (Goodman, 1941). Statistically no significant difference was noticed between the melting points of the milk fat of the Alpine X Malabari and Saanen X Malabari goats (Table 15).

Refractive index

The refractive index at 40°C obtained for the milk fat of Alpine X Malabari and Saanen X Malabari goats was 1.4568 ± 0.0001 and 1.4569 ± 0.0001 respectively (Tables 5 and 6). The refractive index was found to increase as the lactation advanced in both the Alpine and Saanen crossbreds (Fig. 3). For the Alpine crossbred group of animals the refractive index at the beginning of the lactation was 1.4551 and it increased to 1.4580 at the end of the lactation. For the Saanen group this increase was from 1.4554 to 1.4586. Fahmi and Fahmy (1972) also noticed that the refractive index tended to increase with the advancement of the stage of lactation in the case of cow and buffalo samna. The refractive indices obtained for the two crossbred goat milk fats were slightly higher than the values reported for goat milk fat by Basu (1962) and Colmenar et al. (1965). On statistical analysis no significant difference between the refractive index obtained for the milk fat of

Alpine X Malabari goat and Saanen X Malabari goat was noticed (Table 15).

Iodine value

The iodine value of the milk fat of the Alpine X Malabari goat was 24.95 ± 0.28 as against the value of 25.09 ± 0.35 obtained for Saanen X Malabari goat (Tables 7 and 8). Basu (1962) reported that the iodine value for ghee from goats and different breeds of cows varied from 32.8 to 33.9. He reported a lower value of 29.4 for buffalo ghee. As the iodine value indicates the degree of unsaturation a lower iodine value for milk fat from goat milk is justifiable in the light of the report of Jenness and Parkash (1968) who have stated that the goat milk fat had a higher content of saturated fatty acids than those of cows or buffaloes. The iodine value at the beginning of the lactation was 24.19 and 23.92 for the Alpine and Saanen crossbred goat milk fat respectively; the corresponding values were 27.55 and 27.02 at the end of the lactation. As the stage of lactation advanced the iodine value was found to be on the increase thereby indicating an increase in the degree of unsaturation as the lactation advanced. It has been reported by Muzaffar <u>et al.</u> (1970) that at the end of the lactation the oleic, linoleic and linolenic acids increased as these acids constitute the major unsaturated acids present in the goat milk fat. Basu (1962) and Fahmi and Fahmy (1972) also noticed an increase in iodine value with the advancement in the stage of lactation. Therefore the findings in the present study are in agreement with the reports made earlier. No significant difference between the iodine values of the milk fat of the two breeds of crossbred goats was noticed on statistical analysis (Table 15).

Reichert-Meissl value

The Reichert-Meissl (RM) value obtained for the milk fats of Alpine X Malabari and Saanen X Malabari goats was 28.14 ± 0.18 and 28.61 ± 0.13 respectively (Tables 9 and 10). At the beginning of the lactation the RM value was 26.93 and 27.50 for Alpine and Saanen crossbred groups and at the end of lactation the values were 30.52 and 30.71 respectively. Basu (1962) reported a value of 32.54 and Colmenar _et al._ (1965) obtained a value of 20.33. The RM values obtained in the study for the milk fat of the two groups of crossbred goats were found close to the value reported by Basu (1962). The increase in RM value was not much appreciable from the first to the fourteenth week of the lactation

(26.93 to 27.87 for Alpine crossbred and 27.50 to 28.36 for Saanen crossbred). But from the fourteenth week to the end of lactation the increase was more appreciable (27.87 to 30.52 and 28.36 to 30.71 for Alpine and Saanen crossbreds respectively) (Fig. 5). The RM fraction of milk fat contains butyric, caproic and caprylic acids (Arun Sengupta et al.,1958 and Hyghebaert and Hendrickx, 1970). The higher RM value obtained towards the end of lactation therefore indicates a higher content of soluble fatty acids such as butyric, caproic and caprylic acids. Between the RM values of the milk fat of Alpine and Saanen crossbreds goats no significant difference was noticed on the analysis of the data by statistical method (Table 15).

Polenske value

An average Polenske value of 3.52 ± 0.15 and 3.64 ± 0.12 was obtained for the milk fat of Alpine X Malabari and Saanen X Malabari goats respectively (Tables 11 and 12). Basu (1962) reported a Polenske value of 5.20 with a range of 2.81 to 7.81 whereas the value reported by Colmenar et al. (1965) was 9.29. The Polenske value reported by Hilditch (1956) for goat milk fat was in the range of 3.20 to 9.80. The

Polenske values for the milk fat of Alpine and Saanen cross-bred goats increased as the stage of lactation advanced. The value increased from 1.80 to 5.60 and 2.00 to 5.50 for the milk fat of Alpine and Saanen crossbred goats respectively (Fig. 6). The principal components of Polenske fraction are volatile insoluble acids-caprylic and capric acids (Arun Sengupta et al. 1958). An increase in the Polenske value is suggestive of an increase in the content of caprylic and capric acids during the course of lactation. It was found that there was no significant difference between the Polenske values of the milk fat of Alpine X Malabari and Saanen X Malabari goats (Table 15).

Saponification value

The saponification value obtained for the milk fat of Alpine X Malabari and Saanen X Malabari goats was 235.1 ± 0.7 and 234.6 ± 1.1 respectively (Tables 13 and 14). Basu (1962) reported a saponification value of 231.2 for goat ghee. The saponification values of the milk fat of the two crossbred goats were found to be decreasing towards the end of lactation. For the Alpine crossbred group the saponification value obtained was 234.3 and 228.6 at the beginning and end of the lactation and the corresponding values for Saanen crossbreds were 235.5 and 226.3 respectively. A decrease in saponification value at the end of the lactation period was also reported by Basu (1962), Webb and Johnson (1965) and Fahmi and Fahmy (1965). Since the saponification value is inversely proportional to the mean molecular weight of the fatty acid a low saponification number at the end of the lactation indicates a rise in the mean molecular weights of the fatty acids. The statistical analysis showed that there was no significant difference between the saponification values of the milk fat of Alpine X Malabari and Saanen X Malabari goats (Table 15).

The size of the milk fat globule was found to decrease as the stage of lactation advanced and no significant difference was noticed between the size of the milk fat globule of the two breeds of crossbred goats. Among the various physical and chemical constants studied for the milk fat of Alpine X Malabari and Saanen X Malabari goat, the melting point, refractive index, Reichert-Meissl value and Polenske value were found to be increased and the saponification value found to be decreased as the stage of lactation advanced. There was no significant difference between the physical and chemical constants of milk fat of the two breeds of crossbred goats.

SUMMARY

SUMMARY

Since the milk fat has been found to play an important part in the manufacture and keeping quality of milk and milk products the present study was undertaken to determine some of the physical and chemical properties of the milk fat of crossbred goats viz. Alpine X Malabari and Saanen X Malabari maintained at the All India Co-ordinated Research Project on Goats for Milk, Mannuthy. The study included the determinations of the size of the milk fat globule and the melting point, refractive index, iodine number, Reichert-Meissl number, Polenske value and saponification value of milk fat. The influence of factors such as breed and stage of lactation on the physical and chemical constants of the milk fat of crossbred goats have also been studied.

A total of 183 milk samples were collected from six each of the two different crossbred goats. Out of this 65 samples were used, after proper dilution, for the determination of the size of the milk fat globules. The various fat constants were determined by analysis of ghee samples prepared by heating the cream which was separated by a process of centrifugal separation in a power operated cream separator.

The average value for the size of the milk fat globule of Alpine X Malabari and Saanen X Malabari goats was 2.556 ± 0.110 and 2.702 ± 0.038 microns respectively. In Alpine crossbred goats the value was 3.435 ± 0.165 microns at the beginning and 2.043 microns at the end of the lactation, the corresponding values for the milk fat globule of Saanen X Malabari goats were 3.581 and 1.975 ± 0.115 microns respectively. The size of the fat globule in milk was found to decrease with the advancement of lactation in both the crossbred goats. On statistical analysis no significant difference was noticed between the size of the milk fat globule of the two crossbred goats.

The average melting point obtained for the milk fat of Alpine and Saanen crossbred goats was 31.07 ± 0.16°C and 31.36 ± 0.13°C respectively. For the milk fat of Alpine X Malabari goats, the value ranged from 29.23 ± 0.23 to 32.24 ± 0.29°C and the corresponding range for the milk fat of Saanen crossbred goat was from 29.94 ± 0.11 to 32.60 ± 0.29°C. Melting point was found to increase with the advancement of the lactation for the milk fat of both the crossbred goats. No significant difference was noticed between the melting points of the milk fat of the two crossbred goats.

The Alpine crossbred goats' milk fat showed a refractive index of 1.4568 ± 0.0001 with a range from 1.4553 ± 0.0002 to 1.4579 ± 0.0002, whereas the milk fat of Saanen crossbred goats showed an average refractive index of 1.4569 ± 0.0001 with a range from 1.4556 ± 0.0003 to 1.4586 ± 0.0001. The refractive index was found to increase with the advancement of the lactation in both the crossbred goats. There was no significant difference between the refractive index of the milk fat of Alpine and Saanen crossbred goats.

The average iodine number obtained for the milk fat of Alpine X Malabari and Saanen X Malabari goats was 24.95 ± 0.28 and 25.09 ± 0.35 respectively. It showed a range from 21.40 ± 0.94 to 26.94 ± 0.36 for the milk fat of Alpine crossbreds, whereas the corresponding range was from 22.62 ± 0.95 to 28.03 ± 0.29 in Saanen crossbred goats. The iodine number was found to increase with the advancement of the lactation in both the crossbreds. No significant difference was noticed between the iodine number of the milk fat of the two crossbred goats.

The Alpine X Malabari crossbred goat milk fat gave an average Reichert-Meissl (RM) number of 28.14 ± 0.18 whereas the value for the Saanen X Malabari crossbred goat milk fat was 28.61 ± 0.13. The RM number at the beginning and end of the lactation was 26.69 ± 0.38 and 29.78 ± 0.22 in Alpine X Malabari goats and the corresponding values for the milk fat of Saanen crossbreds were 27.21 ± 0.68 and 30.86 ± 0.21 respectively. In both the crossbreds the RM number showed an increase with the advancement of the lactation. No significant difference was noticed between the Reichert-Meissl number of the milk fat of Alpine and Saanen crossbred goats.

The average Polenske value obtained for the milk fat of Alpine X Malabari and Saanen X Malabari goats was 3.52 ± 0.15 and 3.64 ± 0.12 respectively. The milk fat of Alpine crossbred goats showed a range from 1.95 ± 0.11 to 5.50 ± 0.11 and in Saanen crossbred goats the range was from 2.38 ± 0.20 to 5.30 ± 0.17. The Polenske value for the milk fat of both the crossbred goats showed an increase with the advancement of the lactation. No significant difference was noticed between the Polenske value of the milk fat of the two crossbred goats.

The Alpine X Malabari goat milk fat gave a saponification value of 235.1 ± 0.7 and the milk fat of Saanen X Malabari goat analysed a value of 234.6 ± 1.1. The saponification value for the milk fat of Alpine crossbred goat showed a range from 228.3 ± 2.2 to 239.2 ± 1.1 and the corresponding range for the milk fat of Saanen crossbred goat was from 224.4 ± 1.5 to 240.5 ± 1.4. There was no significant difference between the saponification value of the milk fat of Alpine X Malabari and Saanen X Malabari goats.

It has been observed that towards the end of the lactation highly significant decrease was noticed in the size of the milk fat globule and saponification value, and an increase in the melting point, refractive index, iodine number, Reichert-Meissl number and Polenske value of the milk fat of both the Alpine X Malabari and Saanen X Malabari goats.

REFERENCES

REFERENCES

Arora, K.L., Bindal, M.P. and Jain, M.K. (1976). Variations in fat unsaponifiable matter and cholesterol contents of goat milk. Indian J. Dairy Sci. 29 (3) : 191-196.

Arun Sengupta, Shipe, W.F. and Dahlberg, A.C. (1958). Characterization of the volatile and nonvolatile fatty acids obtained by a Reichert-Meissl-Polenske distillation. J. Dairy Sci. 41 (2) : 703-704.

Basu, K.P. (1962). Composition of Milk and Ghee. I.C.A.R. Report series No. 8.

Bickerstraffe, R. and Johnson, A.R. (1972). The effect of intravenous infusions of sterculic acid on milk fat synthesis. Brit. J. Nutr. 27 : 561.

Cerbulis, J. and Zittle, Z.A. (1965). Identification of milk fat in other fats by means of thin layer chromatography. Fette Seifen Anstr Mittel. 67 (4) : 273-275. (Cited in Dairy Sci. Abstr. 27 (12):3922.)

Colmenar, M.L., Carballido, A. and Gracia-Olmedo, R. (1965). Spectrophotometric study of milk fat of cows, ewes and goats. An. Bromat. 17 (4) : 389-411. (Cited in Dairy Sci. Abstr. 29 (7): 2833)

Cook, L.J., Scott, T.W., Mills, S.C., Fogerty, A.C. and Johnson, A.R. (1976). Effects of protected cyclopropene fatty acids on the composition of ruminant milk fat. Lipids 11 (9) : 705-711.

(Cited in Jenness, R. (1980). Composition and characteristics of goat milk. J. Dairy Sci. 63 (10) :1605-1630.)

DeMan, J.M. (1964). Physical properties of milk fat. J. Dairy Sci. 47 (11) : 1194-1200.

Devendra, C. (1980). Milk production in goats compared to buffalo and cattle in humid tropics. J. Dairy Sci. 63 (10) : 1755-1767.

Eckles, C.H. and Palmer, L.S. (1916). Influence of plane of nutrition on the cow upon the composition and properties of milk and butterfat. Mo. Agr. Expt. St. Research Bull. 24. (Cited in Jack, E.L. and Smith, L.M. (1956). Chemistry of milk fat: A review. J. Dairy Sci. 39 (1) : 1 - 25.

Fahmi, A.H. and Fahmy, T.K. (1972). Studies on some chemical properties of samn. III. The degree of saturation present in Etyptian samn. Agricultural Research Review. 50 (3) 191-198. (Cited in Dairy Sci. Abstr. 35 (11) : 4821)

Fahmi, A.H. and Fahmy, T. K. (1972). Studies on some chemical properties of samn. IV. The inter-relations between the analytical values of samn. Agricultural Research Review. 50 (3) : 199-207. (Cited in Dairy Sci. Abstr. 35 (11) : 4822)

Fahmi, A.H., Sirry, I. and Safwat, A. (1956). The size of fat globules and creaming power of cow, buffalo, sheep and goat milk. Indian J. Dairy Sci. 9 : 124.

FAO World Production Statistics (1979). Monthly Bulletin of Statistics. 2 (11) : 44-56.

Glass R.L., Troolin, H. and Jenness, R. (1967). Comparative biochemical studies of milks - IV. Constituent fatty acids of milk fat. Comp. Biochem. Physiol. 22 : 415. (Cited in Devendra, (1980). Milk production in goats compared to buffalo and cattle in humid tropics. J. Dairy Sci. 63 (10) : 1755-1767)

Gono, S., Schmidt, R. and Renner, E. (1979). Fatty acid composition of buffaloes' milk and goats' milk. Milchwissenschaft 34 (11) : 684-686. (Cited in Dairy Sci. Abstr. 42 (5) 3047)

Hart, F.L. and Fisher, F.J. (1971). Modern Food Analysis. Springer - Verlag Inc. New York. pp. 285-290.

Hilditch, T.P. (1956). The Chemical Constitution of Natural Fats. 3rd ed. John Wiley & Sons. Inc. New York. (Cited in Webb, B.H. and Johnson, A.H. (1965). Fundamentals of Dairy Chemistry. The AVI Publishing Company, Inc. Connecticut. p. 131)

Hyghebaert, A. and Hendrickx, H. (1970). The relation between the fatty acid composition and the iodine value and refractive index of butterfat. Milchwissenschaft 25 (9) : 506-510. (Cited in Dairy Sci. Abstr. 33 (3) : 1602)

Hyghebaert, A. and Hendrickx, H. (1970). Analysis of Reichert-Meissl fraction of butterfat by gas chromatography. Meded. Fac. Landbwet Rijksuniv. Gent. 35 (1) : 83-95. (Cited in Dairy Sci. Abstr. 33 (8) : 4324)

Jack, E.L. and Smith, L.M. (1956). Chemistry of milk fat. J. Dairy Sci. 39 (1) : 1 - 25.

Jailkhani, V.K., and Sukumar De (1979). Utilization of goat milk for Khoa making. Indian J. Dairy Sci. 32 (4) : 428-433.

Jailkhani, V.K. and Sukumar De (1978). Utilization of goat milk for some indigenous milk products. Indian Dairym 30 (12) : 869-871.

Jenness, R. and Parkash, S. (1971). Lack of a fat globule clustering agent in goats milk. J. Dairy Sci. 54 (1) : 123-126.

Jenness, R. (1980). Composition and characteristics of goat milk. Review 1968-1979. J. Dairy Sci. 63 (10) 1605-1630.

Joshi, C.H. and Vyas, S.H. (1976). Studies on buffalo ghee. I. Seasonal variation in fatty acid composition and other properties of buffalo ghee. Indian J. Dairy Sci. 29 (1) : 7 - 12.

Katiyar, M.P., Srivastava, R.P. and Kushwaha, N.S. (1973). Studies on fat globules of milk. I. Factors affecting the size and distribution of fat globules in the milk of Sahiwal cows. Indian J. Farm Sci. 1 (1) : 90-95. (Cited in Dairy Sci. Abstr. 37 (4) : 2065)

Klobasa, F. and Senft, B. (1970). Studies on the fatty acid composition of goats' milk fat. Milchwissenschaft 25 (8) 453-456. (Cited in Dairy Sci. Abstr. 33 (2) : 1094)

Laruelle, L., Dijok, M.V. and Daenens, P. (1976). Fatty acid composition of Reichert-Meissl and Polenske fractions in butter fat. J. Dairy Res. 43 (1) : 137-140.

Lizuka, M., Shimbayashi, K. and Miyao, H. (1964). Volatile fatty acids as precursors of milk constituents in the lactating goat. Nat. Inst. Anim. Health. 4 (1) : 51-59. (Cited in Dairy Sci. Abstr. 27 (3) 791)

Morand-Fehr, P. (1978). Goat feeding and milk composition - Effect on cheese quality. Donees recentes sur l'alimentation de la chevre. 212-227. (Cited in Dairy Sci. Abstr. 42 (9) : 5501)

Muzaffar, T.Z., Ishaq, M., Ali, S.S. (1970). The effect of dietary changes on the fatty acid composition of goats' milk. Pakist. J. Scient. ind. Res. 12 (4) : 373-377. (Cited in Dairy Sci. Abstr. 33 (2) : 1095)

Parodi, P.W. (1973). Detection of synthetic and adulterated butterfat 4. GLC - triglyceride analysis. Aust. J. Dairy Technol. 28 : 38.

Parodi, P.W. and Dunstan, R.J. (1971). The relationship between the fatty acid composition, the softening point and the refractive index of milk fat. Aust. J. Dairy Technol. 26 (1) : 29-32. (Cited in Dairy Sci. Abstr. 33 (10) : 5313.

Pearson, D. (1976). The Chemical Analysis of Foods, 7th ed. Churchill - Livingstone, New York. pp. 456-462.

Parkash, S. and Jenness, R. (1968). The composition and characteristics of goats' milk : A review. Dairy Sci. Abstr. 30 (2) 67-87.

Reagan, W.M. and Richardson, C.A. (1938). Reactions of the dairy cow to changes in environmental temperature. J. Dairy Sci. 21:73. (Cited in Jack, E.L. and Smith, L.M. (1956). Chemistry of milk fat. J. Dairy Sci. 39 (1) : 1 - 25.)

Revollon, C., Morand-Fehr, P. and Sauvant, D. (1978). Effect of molecular weight of triglycerides and acetic and stearic acids in the diet on the structure of goats' milk triglycerides. In XX International Dairy Congress.270-271. (Cited in Dairy Sci. Abstr. 40 (9) 5170)

Roadhouse, C.L. and Henderson, J.L. (1950). The Market Milk Industry. 2nd ed. McGraw Hill Book Company Inc. New York. p. 658.

Shanmugasundaram (1980). Goat - The poorman's cow. Dairy Guide. 2 (4) : 35-38.

Sharp, P.F. and Krukovsky, V.N. (1939). Differences in absorption of solid and liquid fat globules as influenzing surface tension and creaming of milk. J. Dairy Sci. 22 : 743. (Cited in Jenness, R. and Parkash, S. (1971). Lack of a fat globule clustering agent in goat's milk. J. Dairy Sci. 54 (1) 123-126.

Singh, K.B., Ogra, J.L. and Rao Y.S. (1968). Studies on milk globules. I. Effect of heat treatment on the size and number of fat globules. J. Agric. Sci.Res. 7: 59-63. (Cited in Dairy Sci.Abstr. 31(2) : 716)

Skjevdal, T. (1979). Flavour of goat's milk. A review of studies on the sources of its variation. Livest. Prod. Sci. 6 (4) : 397-405.

Smith, G.H., McCarthy, S. and Rook, J.A.F. (1974). Synthesis of milk fat from beta-hydroxy butyrate and acetate in lactating goats. J. Dairy Res. 41 (2) : 175-191.

Snedecor, G.W. and Cocharan, W.G. (1956). Statistical Methods. 5th ed. The Iowa State College Press, Iowa. pp. 489-525.

Swaminathan, M. and Daniel, V.A. (1970). The chemical composition and nutritive value of goats' milk and its products. A review. Indian J. Nutr. Dietet. 7 (4) : 252-261.

Taneja, G.C. (1979). Goat development programme and policies in India. Indian Dairym. 31 (8) 539-546.

Upadhyaya, V.S., Katiyar, M.P. Srivastava, R.P. and Kushwaha, N.S. (1973). Studies on the fat globules of milk. II. Factors affecting the size and distribution of fat globules in the milk of Murrah buffalo. Indian J. Farm Sci. 1 (1) : 96-101.

Volohenko, E.E. (1959). Physical and chemical properties of milk fat of Karakul sheep. Trud. Alma-Atinsk. zoovet. Inst. 11 : 203-207. (Cited in Dairy Sci. Abstr. 24 (1) : 253)

Webb, B.H. and Johnson, A.H. (1965). Fundamentals of Dairy Chemistry. The AVI Publishing Company Inc. Connecticut. pp. 129-138, 161-165.

Woodman, A.G. (1941). Food Analysis. 4th ed. McGraw Hill Book Company Inc. New York. pp. 177-180.

PROPERTIES OF MILK FAT OF CROSSBRED GOATS

BY

BABY GEORGE

ABSTRACT OF A THESIS

Submitted in partial fulfilment of the requirement
for the degree

Master of Veterinary Science

Faculty of Veterinary and Animal Sciences
Kerala Agricultural University

Department of Dairy Science
COLLEGE OF VETERINARY AND ANIMAL SCIENCES
Mannuthy - Trichur

1981

ABSTRACT

An investigation was carried out to determine some of the physical and chemical properties of the milk fat of crossbred goats viz. Alpine X Malabari and Saanen X Malabari. A total of 125 milk samples were collected from six each of the two different crossbred goats and out of this 69 samples were used for determination of the size of the milk fat globules. The various fat constants were determined by analysis of ghee prepared by direct heating of cream seperated out from the collected milk samples.

The average size of the milk fat globule of Alpine X Malabari and Saanen X Malabari was 2.556 ± 0.110 and 2.702 ± 0.038 microns respectively. The average value obtained for the melting point of Alpine and Saanen cross-bred goats' milk fat was 31.07 ± 0.16°C and 31.36 ± 0.13°C respectively.

The Alpine crossbred goats' milk fat gave a refractive index of 1.4568 ± 0.0001 and an iodine number of 24.95 ± 0.28, whereas the corresponding values obtained for the milk fat of Saanen X Malabari goats were 1.4569 ± 0.0001 and 25.09 ± 0.35.

The Reichert-Meissl (RM) number and Polenske value obtained for the milk fat of Alpine X Malabari goats were

28.14 ± 0.18 and 3.52 ± 0.15 respectively. The corresponding values for the Saanen crossbred goats' milk fat were 28.61 ± 0.13 and 3.64 ± 0.12 respectively. The Alpine X Malabari and Saanen X Malabari goat milk fat gave an average saponification value of 235.1 ± 0.7 and 234.6 ± 1.1 respectively.

On statistical analysis of the data it has been found that there was no significant difference between the size of the fat globule and the various other physical and chemical constituents of milk fat of the two groups of crossbred goats.

Towards the end of the lactation highly significant increase was noticed in the melting point, refractive index, iodine number, Reichert-Meissl number and Polenske value and a decrease in the size of the milk fat globule and saponification value of the milk fat of both the Alpine X Malabari and Saanen X Malabari goats.