CHEMICAL COMPOSITION OF MILK OF CROSSBRED GOATS

BY

B. BAIJU

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 "CHEMICAL COMPOSITION OF MILK 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

B. BAIJU.

CERTIFICATE

Certified that this thesis entitled "CHEMICAL COMPOSITION OF MILK OF CROSSBRED GOATS" is a record of research work done independently by Sri. B. Baiju 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.

M. Subrahmanyam

Mannuthy,
24-9-1981

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

ACKNOWLEDGEMENTS

I wish to express my deep sense of gratitude to :

Dr. M. Subrahmanyam, B.V.Sc., 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, Dr. B.R. Krishnan Nair, Associate Professor of Animal Breeding and Genetics, Dr. N. Kunjikutty, Associate Professor of Nutrition, tho members of the Advisory Committee for their constructive criticism and valuable suggestions given from time to time.

Dr. C.P. Anantakrishnan, Professor Emeritus, N.D.R.I., Bangalore and Dairy Adviser to the Kerala Agricultural University for his valuable advices at various stages of the study.

The Dean, Faculty of Veterinary and Animal Sciences and the Geneticist, A.I.C.R.P. on Goats for Milk, Mannuthy for providing all the facilities for the Research work.

my colleagues for their sincere co-operation and help.

the staff members of the Department of Dairy Science for their help and assistance.

Sri. V.S. Skandakumar, for the elegant typing of the manuscript.

the Kerala Agricultural University for the award of the fellowship.

BAIJU

C O N T E N T S

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INTRODUCTION

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Goats were among the first domesticated animals. They are believed to have descended from a species of wild goats found in Asia minor, Persia and nearby countries. There are a dozen of biblical reference to goats. A bas-relief on an ancient pharaoh's tomb shows goats feeding on the tops of trees. Hard and disease resistant, goats are natural browsers and thrive on rough pasture whereas the dairy cow would virtually starve.

The goats are not only very useful to man in providing milk and meat, but are also wonderful pets and enjoyable companions for children. Goat milk is used in the manufacture of many dairy products, especially cheese. It is not commonly used for butter making. Goats also provide man with high quality wool, meat and skin. In India the total contribution of goats to the gross national income is about Rs.350/- crores (Bhat et al. 1981).

The goat ranks next to the cow and buffalo as an important contributor to the country's total milk production. India has a goat population of 71 million which is the largest in the world (Mittal and Ghosh, 1981). The milk production is 675 thousand tonnes constituting about three per cent of the total milk produced in 1971-72 (National

Commission Report, 1976). In 1977 the goat population of Kerala State was 16,85,000 (Statistical Hand Book of Kerala, 1979).

As a milk producer goat holds advantage over other species of livestock. The better milch goats are extremely efficient convertors of feed to milk, while adaptability of the more rustic type, under extreme conditions permit them to contribute much to human requirements in difficult environment and under poor soil and water conditions, where cattle or buffalo would not be able to survive.

Goat as suppliers of milk and meat serve the most useful function in providing animal proteins especially to the rural community in which majority of people are unable to either buy these products or get these by rearing cattle or buffaloes.

Eventhough the country has some good milch breed of goats the average productivity does not compare with their counterparts in some advanced goat rearing countries. Hence, to realise the untapped production potential existing in our goat population and to improve Indian goats through crossbreeding with exotic bucks of well known breeds such as Saanen and Alpine, the All India Co-ordinated Research Project on Goats for Milk was launched at Karnal (Haryana) and Mannuthy (Kerala).

The present investigation was undertaken with the object of studying the normal variations in the chemical composition of milk produced by different crossbreds (Saanen x Malabari and Alpine x Malabari) that are maintained at the All India Co-ordinated Research Project on Goats for Milk, Mannuthy, and some of the factors that cause variations with a view to device a set of standards suitable for acceptance or rejection of goats milk collected locally. The composition of milk will also help to understand the dietary significance of goat milk in human nutrition and for preparing special dietary formulations with goat milk and milk products.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Several problems of lactational physiology and biosynthesis have been studied with goats and valuable information on the composition and characteristics of goats' milk has been obtained. Milk contains water, fat, proteins, lactose and minerals in varying proportions. These variations are caused by interplay of a number of factors that affect the physiology of the animal. In the present review the gross composition of the goats' milk and the various factors that influence it are discussed in detail.

a) Milk fat.

One of the most important constituents of milk is the fat. Milk fat has an important bearing on the economics of milk and milk products. Milk lipids are of diverse practical importance. Moreover, the contributions of these materials in dairy products are inter-related. The fine flavour and the physical properties which milk fat imparts to dairy products and to food products in general, are important factors in the economics of milk. The fat also enhances the consumer acceptability of foods.

In their review on the composition and characteristics of goats' milk, Parkash and Jenness (1968) have shown that

the milk fat content varied from 3.00 per cent to 5.50 per cent. They also reported that the frequency distribution of the fat content of milk from individual goats was similar to that for cows of the common dairy breed, a range of 2-8 per cent being observed in both species and that the differences are due to the genetic composition and physiological state of the animal, the sampling procedure or the analytical methods employed.

Baker (1958) reported a value of 3.36 per cent fat in Black Mediterranean goats' milk. An average fat content of 2.97 per cent was obtained by Leonhard (1963). A higher value of 3.90 per cent was obtained by Uusi-Rauvi et al. (1970). According to Graf et al. (1970) the milk of German Improved Fawn goats contained 3.92 per cent fat. A very high fat percentage of 5.65 was reported by Ueckermann et al. (1974) in goats milk.

Devendra (1972) studied the fat content of milk from British Alpine and Anglo-Nubian goats and the value were 3.42 and 4.46 per cent respectively. Composite goats milk samples taken from various districts in Yugoslavia were found to contain on an average 3.07 per cent fat (Dozet, 1973).

The milk fat percentage of the West African dwarf, Red Sokoto and Saanen goats at mid-lactation were 3.34,

7.78 and 5.32 respectively (Mba et al. 1975). On the basis of the analyses of 39 milk samples produced in Sardinia Pusino and Vodret (1975) reported an average fat per cent of 5.00 whereas Marques (1977) got a value of 4.71 per cent only for the milk from Murcian-Granada goats.

According to Akinsoyinu et al. (1977) the milk of African dwarf goats contained 6.9 per cent fat while Ketelhodt (1977) obtained a lower value of 5.55 per cent for the same breed. Gono (1979) reported a value of 4.45 per cent. In their study Malta and Shkolnik (1979) could obtain a fat content of 3.68 per cent in goat milk. The fat content of Pygmy goats' milk was estimated to be as high as 7.76 per cent (Jenness, 1980).

A fat content of 2.81 per cent was reported by French (1970) in the milk of Saanen goats. Ranawana and Kellaway (1977a, 1977b) reported values of 4.61 per cent and 4.01 per cent in the milk from Saanen goats in Australia while in Korea, Chang and Kim (1978) could obtain only 3.27 per cent fat.

The average fat per cent of milk was 4.26 for Saanen, 4.13 for French Alpine and 4.38 for Nubian goats (Mena and Escamilla H, 1977).

In their studies regarding the yield and composition of milk in Black Bengal, Barbari and Black Bengal x Barbari nannies, Agrawal and Bhattacharyya (1978) obtained the fat content as 3.83, 4.66 and 4.92 per cent respectively.

The milk fat content of Barbari and Jamnapari goats were studied by Mittal and Pandey (1971) who reported values of 4.67 and 5.12 per cent respectively. Sachdeva et al. (1974) determined the milk fat of Barbari and Jamnapari goats and obtained values of 4.11 and 4.31 per cent respectively.

Qureshi et al. (1981) in their studies on the lactation of Jamnapari goats reported an average milk fat content of 4.70 per cent in individual samples and 4.71 per cent in herd sample. The Parbatsar goat of Rajastan desert produced milk containing 5.00 per cent fat (Mittal and Ghosh, 1981).

Nirmalan and Nair (1962) examined pooled samples of milk collected from Malabari goats and obtained a fat percentage of 4.95 whereas, Devendra (1979) got a value of 4.96 per cent for the same breed.

b) Milk proteins.

Proteins constitute an extremely important class of naturally occurring compounds that are essential for all

living processes. They perform a variety of functions ranging from structure to reproduction in living organisms. Milk, the natural food for young mammals, contains a number of proteins that serve their nutritive requirements. Milk proteins play an important role in meeting the dietary requirements of human beings. Since milk proteins are of such great importance and since some of them are unique products of the mammary gland, a great deal of studies have been made on their secretion, composition and properties. Parkash and Jenness (1968) and Jenness (1980) have reviewed the composition and properties of goat milk proteins.

Baker (1958) obtained a total protein content of 2.59 per cent for milk from Black Mediterranean goats. The values reported by Leonhard (1963) and Spedding (1969) were 3.18 and 3.38 per cent respectively.

Uusi-Rauvi et al. (1970) analysed 79 milk samples and showed that the protein content was 3.52 per cent. Graf et al. (1970) reported a value of 2.90 per cent. Results from Yugoslavia showed that the average total protein content was 3.51 per cent (Dozet, 1973).

Ueckermann et al. (1974) studied the protein content of Boer goats milk and obtained a value of 3.05 per cent. Pusino and Vodret (1975) reported the protein content of

goats milk in Sardinia as 3.90 per cent whereas Murcian-Granada goats produced milk containing 3.62 per cent protein (Marques, 1977).

The milk of African dwarf goats contained 3.90 per cent protein (Akinsoyinu et al. 1977). A higher value of 5.36 per cent was reported for the same breed by Ketelhodt (1977). The total protein content at mid-lactation of the West African dwarf, Red Sokoto and Saanen goats were found to be 3.04, 5.30 and 4.73 per cent respectively (Mba et al. 1975).

Malts and Shkolnik (1979) got a low protein content of 2.79 per cent in the milk of Black Bedouin goats. Gone (1979) reported an average total protein content of 3.39 per cent after analysing milk obtained from German Improved White goats. Jenness (1980) estimated the protein content of Pygmy goats milk and obtained a value of 5.06 per cent.

French (1970) could obtain only a protein content of 2.17 per cent for Saanen goats milk. Chang and Kim (1978) reported a value of 3.65 per cent in the milk of Saanen goats. Ranawana and Kellaway (1977a, 1977b) worked on the milk protein content of Australian Saanen goats and obtained values ranging from 4.01 to 4.61 per cent.

The analysis of milk of British Alpine and Anglo-Nubian revealed total nitrogen contents of 0.46 (protein = 2.89) and 0.530 (protein = 3.38) per cent respectively (Devendra, 1972).

Mena and Escamilla H (1977) gave the average protein content of goats milk as 3.14 for Saanen, 3.34 for French Alpine and 3.70 for Nubian.

The gross protein composition of the milk of Black Bengal, Barbari and their crosses were studied by Agrawal and Bhattacharyya (1978) and found that the values were 4.13, 5.83 and 5.07 per cent respectively.

A total protein content of 3.74 per cent for Barbari and 3.58 per cent for Jamnapari goats were reported by Mittal and Pandey (1971). Protein content of 3.76 and 3.74 per cent respectively for the milk from Barbari and Jamnapari goats were reported by Sachdeva et al. (1974).

Qureshi et al. (1979) obtained a protein content of 3.31 per cent for individual milk samples and 3.32 per cent for herd milk samples in a flock of Jamnapari goats. A value of 3.31 per cent protein was reported in the milk of Parbatsar goat (Mittal and Ghosh, 1981).

In Malabari goats, Nirmalan and Nair (1962) obtained a total protein content of 4.04 per cent while Devendra (1979) found that as 3.89 per cent.

c) Lactose.

Lactose, milk sugar, is the carbohydrate of milk. Although, trace amounts of glucose, galactose and other sugars are present, lactose is the only sugar present in milk in significant quantities. Lactose has many aspects of significance in milk and milk products. It is a controlling factor in fermented and ripened dairy products, it contributes to the nutritive values of milk and milk products, it is related to the texture and solubility of certain stored dairy products and it plays an essential role in the colour and flavour of highly heated (caramelised) dairy products. The lactose content in goats milk have been determined by many workers and the information available is given below.

In the review on the composition and characteristics of goats' milk (Parkash and Jenness, 1968 ; Jenness, 1980) exhaustive information on the composition of goats' milk from different countries and breeds are given.

The lactose content of Black Mediterranean breed of goats' was studied by Baker (1958). He reported a value

of 3.29 per cent. Leonhard (1963) obtained a value of 4.75 per cent for the milk of Improved White goats.

Uusi-Rauvi et al. (1970) estimated the lactose content of Finnish goats milk and gave a value of 4.48 per cent. Graf et al. (1970) reported a value of 4.01 per cent lactose in the milk of German Improved Fawn goats. Ueckermann et al. (1974) obtained a lactose content of 6.12 per cent in the milk from Boer goats.

Akinsoyinu et al. (1977) obtained a lactose content of 6.30 per cent while Ketelhodt (1977) got a very low value of 1.39 per cent for the milk of African dwarf goats. Maltz and Shkolnik (1979) obtained a value of 3.74 per cent in the milk of Black Bedouin goats. Gonc (1979) reported a value of 4.20 per cent and for Pygmy goats Jenness (1980) reported a lactose content of 5.36 per cent.

The composition of the milk of West African dwarf goats, Red Sokoto and Saanen goats were studied by Mba et al. (1975) and the results revealed a lactose content of 4.56, 5.19 and 4.77 per cent respectively.

Ramawana and Kellaway (1977a, 1977b) reported that the lactose content of Australian Saanen goats milk ranged from 4.85 to 4.93 per cent. Swiss Saanen goats produced milk containing 3.50 per cent lactose (French, 1970). Chang and

Kim (1978) obtained a lactose content of 3.91 per cent for Saanen goats.

The milk of British Alpine and Anglo-Nubian goats was found to contain 4.83 and 4.05 per cent lactose respectively (Devendra, 1972).

The lactose content of the milk of Barbari and Jamnapari goats were estimated by Mittal and Pandey (1971) and the values were found to be 4.12 and 4.15 per cent respectively.

Sachdeva et al. (1974) could obtain a value of 4.80 and 4.72 per cent lactose in the milk of Barbari and Jamnapari goats respectively. Qureshi et al. (1981) reported a value of 4.05 per cent lactose in the milk of Jamnapari goats.

The milk of Malabari goats contained 5.10 per cent lactose (Nirmalan and Nair, 1962) and Devendra (1979) reported 4.11 per cent lactose only in the milk of Malabari goats.

d) Ash.

The ash content gives a rough idea about the mineral content of milk. The milk ash is known to contain potassium, sodium, magnesium, chlorine, phosphorus and sulphur in relatively large amounts. Small amounts of iron, copper, zinc, aluminium, manganese, cobalt and iodine and traces of

silicon, boron, titanium, vanadium, rubidium, lithium and strontium are also present. From the stand point of nutrition it is one of the most important constituents of milk for supplying minerals in human diet. They are extremely important in the relation to heat stability of milk, towards alcohol coagulation, the age thickenning of sweetened condensed milk, the coagulation of milk by rennin and clumping of fat globules in homogenization. The ash content of goats' milk have been studied by many workers and their findings are given below.

The ash content of goats milk was reviewed by Parkash and Jenness (1968) and Jenness (1980). Uusi-Rauvi et al. (1970) reported a value of 0.84 per cent for the milk from Finnish goats. Dozet (1973) obtained an ash content of 0.88 per cent. An ash content of 0.71 per cent was given by Pusino and Vodret (1975) for goats milk produced in Sardinia. The ash content of milk from Boer goats was found to be 0.89 per cent (Ueckermann et al. 1974).

Akinsoyinu et al. (1977) determined the ash content of West African dwarf goats' milk and obtained a value of 0.81 per cent whereas Zetelhodt (1972) obtained a higher value of 1.15 per cent for the same breed. The milk of German Improved White goats contained 0.83 per cent ash

(Gonc, 1979). Jenness (1980) obtained a value of 0.84 per cent for Pygmy goats milk.

Devendra (1972) analysed the milk of British Alpine and Anglo-Nubian goats and found an ash content of 0.78 and 0.79 per cent respectively. Chang and Kim (1978) could obtain a value of 0.78 per cent in the milk of Saanen goats.

An ash content of 0.82 per cent was reported for the milk of both Barbari and Jamnapari goats by Sachdeva et al. (1974). Qureshi et al. (1981) got an ash content of 0.81 per cent for the milk from Jamnapari goats. Nirmalan and Nair (1962) worked on the ash content of Malabari goats milk and obtained a value of 0.76 per cent.

Factors affecting the composition of milk

Breed.

a) Fat content.

The breed differences in the fat and SNF contents of goats milk have been well established by analysis of milk from animals kept under common conditions (Parkash and Jenness, 1968).

Many workers have reported the fat content of Nubian goats (Knowles and Watkin, 1938 ; Mythgoe, 1940 ; Trout, 1941 ; Holmes et al. 1945 ; Devendra, 1972 and Mena and

Escamilla H, 1977). The fat content was found to range from 4.10 per cent (Devendra, 1972) to 6.63 per cent (Lythgoe, 1940).

The milk of Toggenberg breed of goats was analysed for the fat content (Knowles and Watkin, 1938 ; Lythgoe, 1940 ; Trout, 1941 and Holmes et al. 1945). The lowest value was 3.54 per cent (Trout, 1941). The highest value was 4.97 per cent (Lythgoe, 1940).

Mba et al. (1975) reported the fat content of West African dwarf goats as 7.10 per cent whereas Akinsoyinu et al. (1977) reported a value of 6.90 per cent and Ketelhodt (1977) obtained a value of 5.55 per cent for the same breed of goats.

The Finnish goats produced milk containing 3.90 per cent fat (Uusi-Rauvi et al. 1970). The milk of Red Sokoto goats contained 4.86 per cent fat (Mba et al. 1975). Pusino and Vodret (1975) studied the fat content of Sardinian goats milk and reported a value of 3.40 per cent. Marques (1977) estimated the fat content in the milk of Murcian-Granada goats and obtained a fat content of 4.71 per cent.

Ueckermann et al. (1974) stated that the milk of Boer goats contained 5.65 per cent fat. The Black Mediterranean

breed of goats produced milk having 3.36 per cent fat (Baker, 1958) and the Black Bedouin breed 3.68 per cent fat in milk (Maltz and Shkolnik, 1979). Jenness (1980) found the milk of Pygmy goats to contain 7.76 per cent fat. The German Improved Fawn goats produced milk containing 3.92 per cent fat (Graf et al. 1970).

The fat content of Saanen goats milk have been studied by many workers (Knowles and Watkin, 1938 ; Gamble et al. 1938 ; Lythgoe, 1940 ; Trout, 1941 ; Holmes et al. 1945 ; French, 1970 ; Mba et al. 1975 ; Ramawana and Kellaway, 1977a, 1977b ; Mena and Escamilla H, 1977 and Chang and Kim, (1978). The lowest value of 2.81 per cent was reported by French (1970) and the highest value of 4.95 per cent by Lythgoe (1940).

The milk fat content of the British Alpine was found to be 3.40 per cent (Devendra, 1972). For French Alpine the value obtained was 4.13 per cent (Mena and Escamilla H, 1977).

Mittal and Pandey (1971) studied the milk composition of Barbari goats and reported a value of 4.67 per cent fat. Sachdeva et al. (1974) found the value to be 4.11 per cent whereas Agrawal and Bhattacharyya (1978) obtained a fat content of 4.66 per cent in the milk of the same breed.

According to Agrawal and Bhattacharyya (1978) the milk of Black Bengal goats contained a fat percentage of 3.85 and the Black Bengal x Barbari nannies produced milk having 4.92 per cent fat. Spedding (1969) analysed the milk of Beetal goats and obtained a fat content of 4.43 per cent.

Sachdeva et al. (1974) determined the fat content of Jamnapari goats milk and obtained a value of 4.30 per cent. Qureshi et al. (1981) gave an average value of 4.70 per cent for individual milk samples and 4.71 per cent for the herd milk samples for the Jamnapari breed of goats. Mittal and Pandey (1971) obtained a value of 5.12 per cent in the milk of Jamnapari goats.

The milk of Malabari goats was analysed by Nirmalan and Nair (1962) and found to contain 4.90 per cent fat. Devendra (1979) reported a value of 4.96 per cent for the same breed.

b) Milk proteins.

According to Mba et al. (1975) the protein content of milk of West African dwarf goat was 3.04 per cent. Akinsoyinu et al. (1977) reported the value to be 3.90 per cent whereas, in his work, Ketelhodt (1977) obtained a protein content of 5.36 per cent in the milk of African dwarf goats.

Devendra (1972) worked out the nitrogen content of Anglo-Nubian goats milk to be 0.53 (protein = 3.38) per cent. For Nubian goats milk the protein content was estimated to be 3.70 per cent (Mena and Escamilla H, 1977).

Graf et al. (1970) reported that the milk of German Improved Fawn goats contained 2.90 per cent protein. Ueokermann et al. (1974) found that the milk of Boer goats contained 3.05 per cent protein. Uusi-Rauvi et al. (1970) working on the milk of Finnish goats reported a protein content of 3.52 per cent. The Red Sokoto goats were found to produce milk having 5.30 per cent protein (Mba et al. 1975).

In their studies regarding the protein content of Sardinian goats milk, Pusino and Vodret (1975) were able to obtain a value of 3.97 per cent. Marques (1977) reported a value of 3.62 per cent for Murcian-Granada goats milk. The Black Mediterranean produced milk having 2.59 per cent protein (Baker, 1958). The protein content of Black Bedouin was 2.79 per cent (Maltz and Shkolnik, 1979). Jenness (1980) found that the Pygmy goats milk contained 5.06 per cent protein.

Numerous workers have studied the protein content in the milk of Saanen goats (French, 1970 ; Mba et al. 1975 ;

Ramavana and Kellaway, 1977a, 1977b ; Mena and Escamillah, 1977 and Chang and Kim, 1978). The protein content varied from 2.17 per cent (French, 1970) to 3.65 per cent (Chang and Kim, 1978).

The total nitrogen content in the milk of British Alpine goats was given as 0.46 (protein = 2.93) per cent (Devendra, 1972). Mena and Escamilla H (1977) obtained a value of 3.36 per cent for the milk of French Alpine. Spedding (1969) obtained a protein content of 3.38 per cent for the milk of Beetal goats.

Agrawal and Bhattacharyya (1978) found that the Black Bengal x Barbari goats produced milk containing 5.07 per cent protein. Mittal and Pandey (1971) and Sachdeva et al. (1974) studied the protein content in the milk of Barbari goats and obtained values of 3.74 and 3.76 per cent respectively.

Mittal and Pandey (1971) studied the protein content in the milk of Jamnapari goats and got a value of 3.85 per cent while Sachdeva et al. (1974) obtained a value of 3.74 per cent. Qureshi et al. (1981) estimated the protein content in the milk of Jamnapari goats and reported 3.31 per cent for individual samples and 3.32 per cent for herd samples.

The milk of Malabari goats was found to contain 4.04 per cent protein (Nirmalan and Nair, 1962). Devendra (1979) reported the protein content to be 3.89 per cent in the milk of the same breed.

c) Lactose.

Mba et al. (1975) reported that the West African dwarf goats produced milk containing 4.56 per cent lactose. Akinsoyinu et al. (1977) obtained a value of 6.30 per cent and Ketelhodt (1977) reported a value of 1.39 per cent in the milk of African dwarf goats.

Uusi-Rauvi et al. (1970) estimated the lactose content of Finnish goats milk and reported a value of 4.48 per cent. Graf et al. (1970) obtained a lactose content of 4.01 per cent for the milk of German Improved Fawn goats. The Red Sokoto goats produced milk containing 4.72 per cent lactose (Mba et al. 1975).

Maltz and Shkolnik (1979) found that the milk of Black Bedouin goats contained 3.74 per cent lactose. Ueckermann et al. (1974) gave a value of 6.12 per cent lactose for Boer goats milk. The Black Mediterranean goats had a lactose content of 3.29 per cent in their milk (Baker, 1958).

The lactose content of the milk of Saanen goats was found to be 3.50 per cent (French, 1970), 4.54 per cent (Mba et al. 1975), 4.85 and 4.93 per cent (Ranawana and Kellaway, 1977a, 1977b), 3.91 per cent (Chang and Kim, 1978).

The milk of Barbari goats had a lactose content of 4.12 per cent (Mittal and Pandey, 1971). Sachdeva et al. (1974) reported a lactose content of 4.80 per cent in the milk of Barbari goats.

Mittal and Pandey (1971) worked on the lactose content of Jamnapari goats milk and obtained a value of 4.15 per cent. Investigation on the same breed by Sachdeva et al. (1974) revealed a lactose content of 4.72 per cent. Recently, Qureshi et al. (1981) reported a value of 4.05 per cent lactose in the milk of Jamnapari goats.

Malabari goats produced milk containing 5.10 per cent lactose (Nirmalan and Nair, 1962). Devendra (1979) reported a value of 4.11 per cent only for the same breed.

d) Ash content.

Akinsoyinu et al. (1977) reported the ash content of the African dwarf goats as 0.80 per cent whereas Ketelhodt (1977) got a higher value of 1.15 per cent. Pusino and Vodret (1979) obtained a value of 0.71 per cent for Sardinian

goats milk. Uusi-Rauvi et al. (1970) after analysing milk of Finnish goats reported a value of 0.84 per cent ash.

Ueckermann et al. (1974) found the ash content of milk of Boer goats to be 0.89 per cent. Jenness (1980) showed that the milk of Pygmy goats had an ash content of 0.84 per cent.

The milk produced by Saanen goats had an ash content of 0.78 per cent (Chang and Kim, 1978). The milk of British Alpine had an ash content of 0.78 per cent while the ash content of Anglo-Nubian was 0.79 per cent (Devendra, 1978).

The ash content of Jamnapari goats was found to be 0.82 per cent (Sachdeva et al. 1974). Qureshi et al. (1981) obtained a value of 0.81 per cent for individual milk samples and 0.79 per cent for herd milk samples in Jamnapari goats. The milk of Barbari goats was reported to contain 0.82 per cent ash (Sachdeva et al. 1974).

Nirmalan and Nair (1962) reported a value of 0.76 per cent for the milk of Malabari goats and Devendra (1979) found that the milk of Malabari goats had an ash content of 0.83 per cent.

Effect of Feed on the composition of milk

Considerable variation in the gross composition of milk due to differences in feeding have been reported by several workers.

The exclusive feeding of fresh lemon pulp decreased milk yield and lowered the lactose content but increased butter fat content of milk (Biondo, 1957), while feeding of pulp once daily with other foods had no significant effect.

Gomez-Guillamon et al. (1961) fed dried prickly pear flour to goats and noticed that it increased the milk yield and butter fat per cent by an average of 4 and 2 per cent respectively.

Sodium-bi-carbonate when added to ration increased the fat content of milk (Cappa et al. 1970).

Park et al. (1970) noticed no difference in the milk yield, fat per cent or solids-not-fat per cent in the milk of goats which were fed rations with varying roughage concentrate ratio (on TDN basis) of 75:25, 60:40 and 40:60.

The milk fat decreased by about 2 g/kg of milk and nitrogenous matter by 1.5 g/kg of milk when pelleted lucerne was fed to goats instead of normal lucerne hay (Fehr, 1971).

The milk yield and butter fat content were found to decrease when urea was fed to goats and the decrease depended upon the amount of urea fed (Varela et al. 1961).

Schellner (1972/1973) observed that the fat per cent, total solids and ash contents of milk were not affected by feeding different levels of zinc and manganese. The same workers noticed that the supplementation of sodium reduced milk fat per cent while total solids and ash contents were unaltered.

An experimental ration with supplements of cassava flour only or with either urea or ground nut cake was fed to goats (Mba et al. 1975). Goats fed on the ration containing ground nut cake showed a marked depression in milk yield and fat content while the yield of total solids, protein and lactose were not significantly affected.

Goto et al. (1976) found no significant difference in the fat, lactose and total protein contents when goats were fed on a protein free diet containing 1,1 - diuredionsobutane.

Variations in energy and protein (from 75% to 125% of the recommended standards) fed to Barbari and Jamnapari goats had little influence on milk composition but did affect yield considerably (Sachdeva et al. 1974).

Intra-abomasal infusion of glucose had little effect on the milk composition of Saanen goats, whereas casein infusion resulted in increased milk non protein nitrogen and potassium contents and decreased the fat content (Farhan and Thomas, 1977).

Ranawana and Kellaway (1977a, 1977b) found that post ruminal infusions of glucose or casein in lactating Saanens, affected yield but not composition except that milk fat was decreased (from 4.6 per cent to 3.6 per cent) by infusion of glucose at 4.5 g per day.

Sauvant and Fehr (1977) fed goats with lucerne hay ad lib and 100 g dried beet pulp plus high or low level of concentrates. Daily milk yields on the two rations respectively averaged 3.45 and 2.91 kg with 2.7 and 4.8 per cent fat, 3.0 and 2.8 per cent protein and 3.79 and 3.66 per cent lactose in the milk.

Supplementation of control diet with protected cholesterol caused a drop in milk fat content equivalent to 20-30 per cent drop in milk fat secretion and neither protected cholesterol or unprotected cholesterol had any effect on milk protein or solids-not-fat content (Gulati et al. 1978).

After 24 hours fasting, the yield of milk decreased

drastically, sodium, chloride, fat and protein and citrate contents increased and lactose and potassium decreased (Linzell, 1967).

Effect of hormones on composition of milk

Oxytocin treatment of goats and to a lesser extent frequent milking without oxytocin caused an increase in sodium, chloride and non-casein protein and a decrease in potassium and lactose content (Linzell, 1967 ; Linzell and Peaker, 1972).

Adrenaline injection at a dose of 2.5 mg/kg body weight markedly depressed milk yield of goats but increased fat and total protein concentration whereas chlorpromazine had little effect (Protasov, 1968).

Prolactin injection to goats increased the fat and protein per cent in the first half of lactation and casein per cent in the second half of lactation and thyroxine injection increased the fat and lactose per cent in the second half. When insulin was injected to goats the percentage of fat increased in the first half of lactation and lactose and protein contents increased in both halves (Golovan, 1968).

Thyroxine administration to goats was found to increase

the fat per cent whereas thyrotrophic hormone did not affect fat content. In the case of protein content it was vice-versa (Arepev et al. 1971).

Gelbert and Novgorodova (1972) in their experiments with goats showed that thyrotrophin had greater effects on milk yield than thyroxine which had more effect on the casein and non protein nitrogen.

Chowdry and Forbes (1972) reported that low level of 17-B-oestradiol infusion and injection resulted in a non significant increase in the milk yield of goats accompanied by a slight decrease in fat and in protein content. With higher levels of administration, the milk yield decreased progressively and fat and protein content increased. Variable changes in lactose and decrease in potassium concentrations were noted.

Variations during lactation

Gamble et al. (1938) ; Knowles (1939) and Ronningen (1964) have found pronounced tendency for both fat and solids-not-fat of milk to decline to a minimum at about the fourth month of lactation.

The total solids, fat and total nitrogen content of

goats milk decreased as lactation progressed (Barnabas and Mawal, 1959).

Mba et al. (1979) found that the butter fat, protein and lactose values of West African dwarf, Red Sokoto and Saanen goats were significantly affected by stage of lactation ($P<0.05$) and tended to rise with advancing lactation particularly in West African dwarf goats. The percentage of protein, lactose, fat and total solids were found to decline slightly with advance in lactation, in West African dwarf goat. There was a steady fall in milk yield that was reported to be statistically significant (Akinsoyinu et al. 1977).

Gone (1979) observed that the total solids, fat, protein, lactose and mineral contents of German Improved White goats tended to decrease towards the end of each lactation.

Sauvant and Fehr (1977) studied the changes in the composition of milk of goats during the first ten weeks of lactation. Milk fat and protein content decreased rapidly at first. Ash content decreased steadily while the lactose increased.

Rakes et al. (1980) analysed about 1100 records during

one year and found that the yield of milk fat and protein are significantly affected by stage of lactation.

Seasonal variation

Pronounced seasonal variations occurred in the fat and solids-not-fat content of goats' milk at least in temperate regions. Data of Gamble et al. (1939) and Lythgoe (1940) indicated that in Maryland and in Massachusetts both fat and solids-not-fat declined to a maximum in late summer and increased thereafter. The fat varied as much as two per cent and the solids-not-fat by nearly one per cent.

The chloride content of milk tended to be higher in summer and protein higher in winter. No seasonal variation in fat and lactose, sodium or potassium contents of milk was observed (Linzell, 1973).

Effect of teat stimulation on milk composition

The duration of teat receptor stimulation during milking was reported to have no change in the composition of the milk of goats (Marchenko, 1972).

Denamur and Martinet (1959) observed that denervation of the mammary glands produced milk which was richer in total N, casein N, butter fat and lactose contents.

Effect of temperature on composition

A five minute thermal stimulation at 45.51°C before each milking enhanced milk ejection and increased butter fat yield in goats (Valdma, 1959).

Clarke et al (1976) exposed goats to cold for two days and observed that the crude protein and fat yield of milk were reduced. The reduction was more on the first day than on the second day.

Frequency of milking

Moe Quot and Arun (1974) studied the effects of milking (i) once daily, (ii) twice daily and (iii) thrice daily at the start of lactation and then once daily. The average figures for i to iii respectively(coefficient of variation in parenthesis) were as follows : lactation milk yield - 3237 (0.402), 589.6 (0.747), 479.6 (0.250) kg ; milk fat per cent 2.86 (0.126), 2.84 (0.116), 2.81 (0.109) ; milk protein - 3.47 (0.069), 3.37 (0.062), 3.36 (0.062).

Goats maintained in continuously lighted conditions were milked at 13 hour intervals. In goats milked at 13 hour intervals there was a slight ($P<0.05$) decrease in fat per cent of 0.16 per cent per milking. No di-urnal variation in the milk composition was observed (Caruolo, 1974).

Conditions of the Udder

In healthy goats the milk yield and milk composition (Na, K, Cl and lactose) of individual glands varied randomly from day to day but were always parallel (Linzell and Peaker, 1972).

Infection of the udder of goats caused an increase in cell count, fat per cent and concentration of albumin and immunoglobulin, but a decrease in milk volume and whey protein concentration (Caruolo, 1974).

Effect of Oestrus on the composition of milk

It has been reported by Peaker and Linzell (1974) that considerable changes in the composition of the aqueous phase of milk preceded oestrus by one to four days in goats. The lactose content decreased from 127-110 mM. The composition was found to return to normal by the onset of oestrus. The fat, protein and immunoglobulin concentrations showed no change preceding the oestrus. Administration of exogenous oestrogen to an oestrus goat caused an increase in sodium and a fall in potassium content in milk but lactose and chloride were not affected.

Effect of chemicals and alkaloids on milk composition

Patton (1976a, 1976b) and Patton et al. (1977) found that infusion of the plant alkaloids, colchicine, vincristine and vinblastine or the plant lecithin concanavalin A into the udder of lactating goats suppressed secretion temporarily. As the glands recovered from the suppressing effect, fat and protein content of milk and size of milk fat globules increased. The fat and protein contents of the goats milk was found to increase as much as two per cent (3-5%). Patton (1976a) speculated that the consumption of plant alkaloids by grazing goats may at times alter the yield and composition of milk.

Basmacil and Clapperton (1980) found out that chloroform introduced into the rumen of the lactating goats significantly decreased the milk fat and solids-not-fat contents and that the milk protein per cent was slightly increased.

Correlation between the various milk constituents

Meyer (1963) calculated the correlation coefficients (r^2) between milk constituents and between constituents and yield. The values for solids-not-fat content with milk yield, fat, protein and lactose contents were r^2 = 0.16, 0.23, 0.53 and 0.46 respectively.

Correlation coefficients were calculated between constituents of goats milk. It was found that r = 0.864 between total solids and fat, r = 0.526 between calcium and acidity and r = 0.18 between fat and protein. The variations were least between total solids and lactose contents and the highest in daily milk yields and calcium content (Leonhard, 1963).

Ronningen (1964) found the correlation between milk yield and fat percentage as r = -0.25 and that between milk yield and kg butter fat as r = 0.719. There was a correlation of 0.297 between fat percentage and kg butter fat.

MATERIALS AND METHODS

MATERIALS AND METHODS

Animals and their management.

For the study of the gross composition of the milk of crossbred goats six each of Saanen x Malabari and Alpine x Malabari goats maintained under stall-fed conditions at the All India Co-ordinated Research Project on Goats for Milk, Mannuthy, were selected. The selection of animals was at random. Details regarding the selected goats are presented in table 1.

Feeding.

The milking goats were given a maintenance ration of 3 kg roughage and 400 g concentrate. Additional 400 g concentrate was given for every one litre of milk produced. The concentrate fed was Godrej MMR Pellets. The roughage included Napier grass, Para grass and Guinea grass during rainy months and various tree leaves like Jack fruit leaves (*Artocarpus heterophyllus*), Kirni (*Manilkhra hexandra*), Poovam (*Schelichera trijuga*) and Venga (*Pterocarpus Marsupium*, Roxb).during the summer months. Fresh clean water was always provided *ad lib*.

Collection of milk samples.

The milk samples from the experimental animals were collected from the seventh day of kidding to the end of lactation. The samples were collected by complete hand milking both in the morning and evening, at weekly intervals. The milk samples were immediately brought to the laboratory and were analysed for the fat, protein, lactose and ash contents. A total of 471 samples from twelve goats were collected and analysed during the period of study.

Analytical Procedures

1. Determination of fat in milk samples.

The fat content of the samples of milk was estimated using the Gerber's method as described in Indian Standards, I.S. 1224 (1958). The principle involves mixing of milk with concentrated sulphuric acid in correct proportions to hydrolyse the protein of milk and breaking the emulsion, setting free the fat and melting of the fat by the heat, generated during the reaction, and thereby allowing it to rise to the surface. The amyl alcohol added helped to prevent charring.

2. Estimation of protein content of milk samples.

The protein content was estimated by the dye binding

method, using Amido Black, which has been recommended by Dolby (Pearson, 1976). The method is based on the ability of the dye to combine with the polar groups of protein of opposite ionic charge. The insoluble complex was then removed by centrifugation and the concentration of unbound dye was assessed from a photometric curve with optical density (determined using Erma Photo electric colorimeter AE 11) and protein content. The estimation of the protein for this purpose was carried out by Kjeldhal method.

3. Estimation of lactose content of milk samples.

Lactose was estimated according to the Micro method, the modified procedure of Folin and Wu method (Oser, 1965). The protein free milk filtrate obtained after the treatment with sodium tungstate (10%) and sulphuric acid (2/3 N) was allowed to react with alkaline copper solution in a special tube to prevent reoxidation. The cuprous oxide formed was treated with phosphomolybdic acid solution to form a blue colour and the blue colour was compared with that of a standard. The photometric readings of the unknown (determined using Erma photoelectric colorimeter AE 11) were utilized for the calculation using the formula

$$\frac{\text{optical density of unknown}}{\text{optical density of standard}} \times 0.6 \times \frac{100}{0.01} \times \frac{1}{1000}$$

= % of lactose.

4. **Estimation of ash content of milk samples.**

The ash content of the milk samples was determined by igniting a 5 g sample of the milk in a muffle furnace as described in Indian Standards, I.S. 1479 Part II (1960).

Statistical Analyses

The statistical analyses of the data on milk were done according to standard methods (Snedecor and Cochran, 1967).

RESULTS

RESULTS

A total of 471 samples of milk were collected from the twelve crossbred goats of the AICRP on Goats for Milk, Mannuthy for studying the gross composition of milk. The samples were analysed for the percentage of fat, protein, lactose and ash contents and the data obtained are presented in Tables 2 to 9.

Milk fat.

The milk fat content obtained by the analysis of the milk of Alpine x Malabari goats is presented in table 2. The milk fat content of the samples of milk collected in the morning during the early, middle and late lactation was 4.62 ± 0.17, 4.78 ± 0.13 and 5.75 ± 0.16 per cent respectively. The milk fat content ranged from 3.28 to 6.33 per cent. The average milk fat content for the morning samples collected during the lactation was 5.00 ± 0.10 per cent. In the evening samples, the fat content ranged from 5.68 to 9.69 per cent with an average value of 7.57 ± 0.12 per cent. The average fat content obtained during the early, middle and late lactation was 6.89 ± 0.24, 7.79 ± 0.19 and 8.19 ± 0.16 per cent respectively.

The analysis of variance of the data obtained (Table 10) revealed that there was significant difference between

morning and evening milk samples in the percentage of fat. Significant difference was also noticed between the stages of lactation with regard to fat per cent ($P<0.01$). There was significant difference between the first and second, first and third and second and third stages of lactation.

The milk fat content of the milk of Saanen x Malabari goats is given in table 6. The average fat content during the early, middle and late lactation was 4.26 ± 0.12, 4.60 ± 0.08 and 5.01 ± 0.11 per cent respectively for the morning milk samples. The percentage of fat ranged from 3.73 to 5.37 per cent. The average milk fat percentage of the morning sample was 4.61 ± 0.07. The milk fat content of the samples of milk collected in the evening milking ranged from 5.24 to 8.04 per cent with an average values of 6.69 ± 0.13. The milk fat content during the early, middle and late lactation averaged 6.39 ± 0.17, 6.66 ± 0.15 and 7.01 ± 0.18 respectively.

The analysis of variance for the milk fat content of Saanen x Malabari goats is presented in table 11. There was a significant difference between the morning and evening samplesof milk ($P<0.01$) but no significant difference between the stages of lactation. The critical difference presented in table 12 indicated no significant difference between the first and second stages but the

differences between the first and third stage and second and third stage of lactation were significant.

Statistical analysis of the data obtained showed that there was no significant difference between the fat content of the morning samples of milk obtained from the two cross-bred goats. But there was significant difference between the evening samples and also between the total fat content of milk of both breeds.

Protein content.

The protein content of the milk of Alpine x Malabari goats is presented in table 3. In the morning samples the protein content was found to vary from 3.62 to 4.67 with an average of 4.31 ± 0.05 per cent. The protein content during the early, middle and late lactation was 4.05 ± 0.06, 4.31 ± 0.06 and 4.50 ± 0.05 per cent respectively. In the samples of milk collected during the evening milking the protein content varied from 3.83 to 5.12 with an average of 4.53 ± 0.05 per cent. The protein content during the early, middle and late lactation was found to be 4.38 ± 0.07, 4.47 ± 0.16 and 4.79 ± 0.09 per cent respectively.

The analysis of variance table (Table 12) for the milk protein content of Alpine x Malabari goats showed significant differences between the morning and evening samples and also

between the three stages of lactation ($P<0.01$). The critical difference calculated indicated significant difference between the first and second, first and third and second and third stages of lactation with regard to protein per cent in milk.

The protein content of the milk of Saanen x Malabari goats is given in table 7. The morning samples contained an average of 4.29 ± 0.03 per cent protein with a range of 3.87 to 4.79. The protein content during the early, middle and late lactation was 4.10 ± 0.04, 4.18 ± 0.04 and 4.59 ± 0.04 per cent respectively. The corresponding values of the evening samples of milk was 4.28 ± 0.04, 4.38 ± 0.03 and 4.84 ± 0.04 per cent respectively with an average value of 4.50 ± 0.03 per cent.

The analysis of variance of the data presented in table 13 revealed significant differences between the morning and evening samples of milk and also between the various stage of lactation ($P< 0.01$).

The comparison of the protein content of the samples of milk from Alpine x Malabari and Saanen x Malabari showed that there was no significant difference between the two crossbreds.

Lactose content.

Table 4 presents the lactose content of the milk of Alpine x Malabari goats. The lactose contents of the samples of milk collected in the morning during the early, middle and late lactation were 4.10 ± 0.04, 4.15 ± 0.13 and 3.94 ± 0.07 per cent respectively. The lactose content ranged from 3.88 to 4.27 with an average value of 4.06 ± 0.03 per cent. The lactose content of the samples of milk collected in the evening was found to range from 3.85 to 4.30 with an average of 4.06 ± 0.03. The average lactose content of the evening samples during the early, middle and late lactation was 4.10 ± 0.04, 4.15 ± 0.03 and 3.94 ± 0.07 per cent respectively. The overall lactose content of the milk of Alpine x Malabari goats was found to be 4.06 ± 0.02 per cent.

The analysis of variance table (Table 14) showed no significant difference between the lactose content of the morning and evening samples of milk but there was significant difference due to the stages of lactation. The critical difference (Table 18) showed that the lactose content of the first and second, first and third and second and third stages of lactation differed significantly.

Table 5 presents the lactose content of the milk of Saanen x Malabari goats. The samples of milk obtained

in the morning contained lactose in the range of 3.83 to 4.28 per cent with an average value of 4.06 ± 0.03 per cent. The lactose content at the early, middle and late lactation was 4.08 ± 0.03, 4.23 ± 0.02 and 3.87 ± 0.06 per cent respectively.

The percentage of lactose in the evening samples of milk ranged from 3.73 to 4.32 with an average of 4.06 ± 0.03 per cent. The lactose content during the early, middle and late lactation averaged 4.09 ± 0.03, 4.24 ± 0.02 and 3.85 ± 0.05. The overall lactose content of the milk of Saanen x Malabari goats was found to be 4.06 ± 0.02 per cent.

The analysis of variance table (Table 15) showed that there was no significant difference in the lactose content between the morning and evening samples of milk. But significant difference was noticed between the stages of lactation ($P<0.01$) for the lactose content and the critical difference table (Table 16) revealed significant difference between the first and second, first and third and second and third stages of lactation with respect to the lactose content.

The statistical analysis of the data on lactose content revealed no significant difference between the lactose content of the milk of Alpine x Malabari and Saanen x Malabari goats.

Ash content.

The ash content of the milk of Alpine x Malabari goats is presented in table 5. During the early, middle and late lactation the ash content in the morning samples of milk was 0.773 ± 0.006, 0.772 ± 0.003 and 0.783 ± 0.004 respectively with a range of 0.762 to 0.795 per cent. The average ash content of the morning samples was 0.776 ± 0.003 per cent.

The ash content of the evening samples varied from 0.756 to 0.793 with an average value of 0.775 ± 0.003 per cent. The percentage of ash in the samples of milk collected in the evening during the early, middle and late lactation was found to be 0.772 ± 0.006, 0.771 ± 0.003 and 0.784 ± 0.005 respectively. The overall ash content of the milk of Alpine x Malabari goats was found to be 0.776 ± 0.001 per cent.

The analysis of variance table (Table 16) showed that there was no significant difference between the ash content in the samples of milk collected in the morning and evening. But there was significant difference ($P<0.05$) for the various stages of lactation. There was no difference between the first and second stages of lactation but between the first and third and second and third stage of lactation significant difference as shown by the critical difference (Table 18) was noticed.

The ash content of the milk of Saanen x Malabari goats is presented in table 9. The ash content was found to range from 0.760 to 0.801 with an average value of 0.779 ± 0.002 per cent. The ash content during the early, middle and late lactation was 0.774 ± 0.003, 0.777 ± 0.003 and 0.789 ± 0.003 per cent respectively.

In the milk of Saanen x Malabari goats the percentage of ash in the sample of milk collected in the evening during the early, middle and late lactation was found to be 0.777 ± 0.003, 0.782 ± 0.003 and 0.793 ± 0.004 respectively. The ash content ranged from 0.760 to 0.804 with an average of 0.784 ± 0.002 per cent. The overall ash content of the milk of Saanen x Malabari goats was found to be 0.782 ± 0.001 per cent.

The analysis of variance of data obtained (Table 17) showed no significant difference between the ash content of the morning and evening samples of milk and also between the various stages of lactation.

Moreover, no significant difference was noticed between the ash content of the Alpine x Malabari and Saanen x Malabari goats on statistical analysis of the data.

TABLES

Table 1. Details of the experimental goats.

	Alpine x Malabari					
Animal Number	6163	6133	6474	6252	6297	6314
Date of birth	27.11.77	29.10.77	2.2.79	28.2.78	8.5.78	30.8.78
Date of kidding	11.12.80	9.12.80	11.12.80	13.12.80	7.12.80	8.12.80
Order of lactation	Second	Second	First	Second	Second	Second
Duration of lactation (in days)	105	113	115	121	220	219

	Saanen x Malabari					
Animal Number	F_2S 43	F_2S 49	F_2S 50	F_2S 57	595	764
Date of birth	16.1.79	2.3.79	2.3.79	28.3.79	9.2.75	29.3.76
Date of kidding	26.2.81	5.2.81	26.12.80	10.1.81	10.1.81	6.2.81
Order of lactation	Second	First	First	First	Fourth	Third
Duration of lactation (in days)	170	183	170	184	185	144

Table 2. Percentage of fat in the milk of Alpine x Malabari goats.

Stage of lactation		Animal Number						Mean	Total Mean
		6163	6133	6474	6252	6297	6314		
Early	Morning	3.40 ±0.16	5.84 ±0.22	4.98 ±0.34	3.28 ±0.37	4.49 ±0.27	4.95 ±0.27	4.62 ±0.17	5.76 ±0.2
	Evening	5.68 ±0.16	8.38 ±0.26	7.20 ±0.57	5.76 ±0.39	7.63 ±0.56	6.32 ±0.42	6.89 ±0.24	
Middle	Morning	4.16 ±0.32	5.26 ±0.20	5.02 ±0.29	4.26 ±0.34	4.19 ±0.17	5.66 ±0.16	4.78 ±0.13	6.27 ±0.20
	Evening	7.32 ±0.54	8.24 ±0.43	7.72 ±0.39	7.26 ±0.43	8.09 ±0.30	7.64 ±0.23	7.75 ±0.15	
Late	Morning	5.33 ±0.53	6.20 ±0.12	6.33 ±0.18	5.42 ±0.10	5.01 ±0.46	6.30 ±0.25	5.75 ±0.16	6.99 ±0.19
	Evening	8.15 ±0.45	9.26 ±0.34	8.93 ±0.10	8.04 ±0.16	9.69 ±0.31	8.10 ±0.43	8.19 ±0.16	
Total	Morning	4.29 ±0.2	5.76 ±0.16	5.38 ±0.20	4.32 ±0.2	4.59 ±0.17	5.56 ±0.16	5.00 ±0.10	6.29 ±0.18
	Evening	7.07 ±0.37	8.44 ±0.21	7.88 ±0.30	7.01 ±0.31	7.82 ±0.24	7.26 ±0.26	7.57 ±0.12	

Table 3. Percentage of protein in the milk of Alpine x Malabari goats.

Stage of lactation		Animal Number						Mean	Total Mean
		6163	6133	6474	6252	6297	6314		
Early	Morning	3.62 ±0.03	4.21 ±0.16	4.12 ±0.13	3.79 ±0.13	4.03 ±0.14	4.22 ±0.10	4.05 ±0.06	4.21 ±0.05
	Evening	3.83 ±0.14	4.20 ±0.21	4.25 ±0.16	4.10 ±0.12	4.49 ±0.09	4.75 ±0.14	4.38 ±0.07	
Middle	Morning	4.25 ±0.07	4.41 ±0.04	4.52 ±0.14	3.90 ±0.15	4.26 ±0.03	4.46 ±0.18	4.31 ±0.06	4.39 ±0.04
	Evening	4.06 ±0.09	4.36 ±0.03	4.52 ±0.16	4.30 ±0.19	4.59 ±0.09	4.67 ±0.18	4.47 ±0.16	
Late	Morning	4.36 ±0.06	4.43 ±0.07	4.49 ±0.22	4.16 ±0.11	4.58 ±0.14	4.67 ±0.09	4.50 ±0.05	4.65 ±0.09
	Evening	4.38 ±0.06	4.52 ±0.14	5.12 ±0.19	4.57 ±0.09	4.98 ±0.24	5.07 ±0.22	4.79 ±0.09	
Total	Morning	4.13 ±0.09	4.35 ±0.06	4.37 ±0.10	4.01 ±0.10	4.26 ±0.07	4.43 ±0.09	4.31 ±0.05	4.40 ±0.03
	Evening	4.11 ±0.08	4.31 ±0.08	4.59 ±0.13	4.32 ±0.09	4.64 ±0.09	4.81 ±0.10	4.53 ±0.05	

Table 4. Percentage of lactose in the milk of Alpine x Malabari goats.

Stage of lactation		Animal Number 6163	6133	6474	6252	6297	6314	Mean	Total Mean
Early	Morning	3.97 ±0.10	4.04 ±0.12	4.17 ±0.13	4.11 ±0.13	4.12 ±0.09	4.11 ±0.07	4.10 ±0.04	4.10 ±0.06
	Evening	4.06 ±0.15	4.11 ±0.10	4.13 ±0.12	4.08 ±0.08	4.08 ±0.08	4.14 ±0.06	4.10 ±0.04	
Middle	Morning	4.00 ±0.09	4.09 ±0.08	4.26 ±0.05	4.16 ±0.10	4.27 ±0.05	4.05 ±0.08	4.15 ±0.13	4.15 ±0.02
	Evening	3.91 ±0.05	4.15 ±0.06	4.30 ±0.08	4.18 ±0.00	4.24 ±0.04	4.09 ±0.07	4.15 ±0.03	
Late	Morning	3.94 ±0.15	3.89 ±0.08	4.01 ±0.08	3.88 ±0.04	4.02 ±0.20	3.88 ±0.08	3.94 ±0.07	3.93 ±0.11
	Evening	3.95 ±0.10	3.85 ±0.05	4.01 ±0.07	3.90 ±0.04	4.01 ±0.08	3.92 ±0.08	3.94 ±0.07	
Total	Morning	3.97 ±0.05	4.02 ±0.06	4.16 ±0.06	4.05 ±0.06	4.14 ±0.09	4.03 ±0.04	4.06 ±0.03	4.06 ±0.08
	Evening	3.97 ±0.06	4.05 ±0.05	4.14 ±0.06	4.05 ±0.05	4.11 ±0.03	4.06 ±0.04	4.06 ±0.03	

Table 5. Percentage of fat in the milk of Alpine x Malabari goats.

Stage of lactation		Animal Number 6163	6133	6474	6252	6297	6314	Mean	Total Mean
Early	Morning	0.770 ±0.007	0.778 ±0.026	0.772 ±0.019	0.775 ±0.009	0.778 ±0.017	0.780 ±0.010	0.773 ±0.005	0.772 ±0.004
	Evening	0.765 ±0.006	0.770 ±0.007	0.780 ±0.022	0.756 ±0.016	0.770 ±0.007	0.780 ±0.015	0.772 ±0.006	
Middle	Morning	0.782 ±0.008	0.776 ±0.009	0.776 ±0.002	0.770 ±0.030	0.770 ±0.007	0.779 ±0.005	0.772 ±0.003	0.772 ±0.002
	Evening	0.768 ± 0.006	0.770 ±0.008	0.774 ±0.010	0.766 ±0.009	0.774 ±0.005	0.771 ±0.008	0.771 ±0.003	
Late	Morning	0.795 ±0.008	0.790 ±0.008	0.790 ±0.004	0.762 ±0.010	0.781 ±0.009	0.789 ±0.008	0.783 ±0.004	0.784 ±0.003
	Evening	0.793 ±0.006	0.785 ±0.009	0.773 ±0.013	0.772 ±0.009	0.786 ±0.017	0.791 ±0.012	0.784 ±0.005	
Total	Morning	0.781 ±0.045	0.781 ±0.009	0.779 ±0.006	0.764 ±0.012	0.775 ±0.004	0.785 ±0.005	0.776 ±0.003	0.776 ±0.001
	Evening	0.775 ±0.005	0.774 ±0.005	0.776 ±0.009	0.765 ±0.006	0.776 ±0.006	0.780 ±0.006	0.775 ±0.003	

Table 6. Percentage of fat in the milk of Saanen x Malabari goats.

Stage of lactation		Animal Number						Mean	Total Mean
		F_2S 43	F_2S49	F_2S 57	F_2S 50	595	764		
Early	Morning	4.19 ±0.14	5.31 ±0.26	3.83 ±0.24	4.40 ±0.31	3.73 ±0.18	4.00 ±0.10	4.26 ±0.12	5.30 ±0.14
	Evening	5.89 ±0.30	7.23 ±0.15	6.16 ±0.53	7.18 ±0.41	5.24 ±0.22	6.63 ±0.23	6.39 ±0.17	
Middle	Morning	4.25 ±0.13	4.83 ±0.14	4.25 ±0.08	5.35 ±0.10	4.26 ±0.08	4.77 ±0.16	4.60 ±0.08	5.65 ±0.14
	Evening	6.51 ±0.16	6.74 ±0.30	7.03 ±0.11	8.11 ±0.16	5.37 ±0.09	5.87 ±0.43	6.66 ±0.15	
Late	Morning	4.50 ±0.20	4.76 ±0.13	5.26 ±0.30	5.37 ±0.46	5.06 ±0.17	5.18 ±0.23	5.01 ±0.11	5.99 ±0.16
	Evening	6.75 ±0.46	6.51 ±0.16	7.74 ±0.25	9.04 ±0.22	5.71 ±0.11	6.60 ±0.15	7.01 ±0.18	
Total	Morning	4.31 ±0.09	4.98 ±0.12	4.45 ±0.18	5.01 ±0.19	4.32 ±0.15	4.63 ±0.16	4.61 ±0.07	5.64 ±0.09
	Evening	6.40 ±0.18	6.85 ±0.13	6.98 ±0.23	7.98 ±0.23	5.43 ±0.10	6.37 ±0.13	6.69 ±0.13	

Table 7. Percentage of protein in the milk of Saanen x Malabari goats.

Stage of lactation		Animal Number						Mean	Total Mean
		F_2S 43	F_2S 49	F_2S 57	F_2S 50	595	764		
Early	Morning	4.16 ±0.11	4.04 ±0.09	4.19 ±0.11	4.15 ±0.10	4.12 ±0.10	3.87 ±0.06	4.10 ±0.04	4.18 ±0.03
	Evening	4.32 ±0.10	4.27 ±0.08	4.43 ±0.10	4.23 ±0.10	4.27 ±0.04	4.00 ±0.06	4.28 ±0.04	
Middle	Morning	4.06 ±0.11	4.27 ±0.10	4.23 ±0.10	4.15 ±0.08	4.26 ±0.05	4.10 ±0.07	4.18 ±0.04	4.28 ±0.08
	Evening	4.33 ±0.07	4.32 ±0.16	4.44 ±0.07	4.33 ±0.07	4.43 ±0.04	4.44 ±0.06	4.38 ±0.03	
Late	Morning	4.68 ±0.07	4.66 ±0.07	4.49 ±0.12	4.79 ±0.09	4.54 ±0.10	4.40 ±0.10	4.59 ±0.04	4.72 ±0.03
	Evening	4.79 ±0.13	4.93 ±0.12	4.81 ±0.14	5.01 ±0.17	4.88 ±0.08	4.79 ±0.13	4.84 ±0.04	
Total	Morning	4.31 ±0.08	4.33 ±0.78	4.30 ±0.08	4.36 ±0.08	4.31 ±0.07	4.12 ±0.07	4.29 ±0.03	4.40 ±0.02
	Evening	4.49 ±0.07	4.52 ±0.09	4.50 ±0.05	4.53 ±0.09	4.55 ±0.07	4.41 ±0.10	4.50 ±0.03	

Table 8. Percentage of lactose in the milk of Saanen x Malabari goats.

Stage of lactation		Animal Number						Mean	Total Mean
		F_2S 43	F_2S 49	F_2S 57	F_2S 50	595	764		
Early	Morning	4.09 ±0.06	4.05 ±0.08	4.07 ±0.06	4.13 ±0.07	4.09 ±0.09	4.05 ±0.07	4.08 ±0.03	4.08 ±0.02
	Evening	4.04 ±0.08	4.16 ±0.09	4.08 ±0.04	4.14 ±0.07	4.10 ±0.08	4.03 ±0.09	4.09 ±0.03	
Middle	Morning	4.24 ±0.04	4.30 ±0.04	4.08 ±0.06	4.28 ±0.06	4.24 ±0.05	4.24 ±0.06	4.23 ±0.02	4.23 ±0.02
	Evening	4.28 ±0.04	4.32 ±0.05	4.09 ±0.05	4.27 ±0.06	4.23 ±0.04	4.23 ±0.06	4.24 ±0.02	
Late	Morning	3.92 ±0.05	3.85 ±0.06	3.88 ±0.04	3.83 ±0.03	3.86 ±0.05	3.90 ±0.09	3.87 ± 0.06	3.86 ±0.04
	Evening	3.88 ±0.03	3.82 ±0.03	3.91 ±0.10	3.73 ±0.02	3.88 ±0.06	3.85 ±0.12	3.85 ±0.05	
Total	Morning	4.08 ±0.04	4.07 ±0.05	4.01 ±0.04	4.08 ±0.1[illegible]	4.06 ±0.05	4.06 ±0.05	4.06 ±0.03	4.06 ±0.02
	Evening	4.07 ±0.05	4.10 ±0.06	4.03 ±0.04	4.05 ±0.[illegible]	4.07 ±0.05	4.04 ±0.06	4.06 ±0.03	

Table 9. Percentage of ash in the milk of Saanen x Malabari goats.

Stage of lactation		Animal Number						Mean	Total Mean
		F_2S 43	F_2S 49	F_2S 57	F_2S 50	595	764		
Early	Morning	0.770 ±0.010	0.768 ±0.007	0.796 ±0.006	0.784 ±0.025	0.780 ±0.006	0.760 ±0.006	0.774 ±0.003	0.776 ±0.001
	Evening	0.762 ±0.006	0.782 ±0.006	0.790 ±0.005	0.777 ±0.012	0.785 ±0.007	0.760 ±0.006	0.777 ±0.003	
Middle	Morning	0.775 ±0.003	0.767 ±0.009	0.790 ±0.004	0.776 ±0.007	0.786 ±0.009	0.766 ±0.007	0.777 ±0.003	0.779 ±0.002
	Evening	0.770 ±0.010	0.784 ±0.007	0.796 ±0.006	0.771 ±0.011	0.790 ±0.020	0.774 ±0.006	0.782 ±0.003	
Late	Morning	0.788 ±0.013	0.774 ±0.006	0.801 ±0.007	0.793 ±0.018	0.794 ±0.006	0.780 ±0.007	0.789 ±0.003	0.791 ±0.002
	Evening	0.786 ±0.018	0.780 ±0.007	0.802 ±0.14	0.793 ±0.033	0.804 ±0.008	0.788 ±0.009	0.793 ±0.004	
Total	Morning	0.777 ±0.003	0.76[illegible] ±0.005	0.793 ±0.003	0.781 ±0.003	0.786 ±0.004	0.770 ±0.004	0.779 ±0.002	0.782 ±0.001
	Evening	0.773 ±0.006	0.782 ±0.004	0.795 ±0.003	0.781 ±0.005	0.791 ±0.003	0.775 ±0.005	0.784 ±0.002	

Table 10. Analysis of variance table for fat percentage in milk of Alpine x Malabari goats.

Source	df	SS	MSS	F
Between periods within group	1	62.278	62.278	111.470**
Between stages within group	2	11.958	5.979	10.702**
Error	32	17.877	0.559	
Total	35	92.114		

** Significant at 1% level.

Table 11. Analysis of variance table for fat percentage in milk of Saanen x Malabari goats.

Source	df	SS	MSS	F
Between periods within groups	1	38.098	38.098	69.281**
Between stages within group	2	3.197	1.599	2.907 NS
Error	32	17.597	0.550	
Total	35	58.892		

** Significant at 1% level.

NS- Not significant.

Table 12. Analysis of variance table for protein percentage in milk of Alpine x Malabari goats.

Source	df	SS	MSS	F
Between periods within group	1	0.838	0.838	25.177**
Between stages within group	2	1.520	0.760	22.823**
Error	32	1.067	0.033	
Total	35	3.425		

** Significant at 1% level.

Table 13. Analysis of variance table for protein percentage in milk of Saanen x Malabari goats.

Source	df	SS	MSS	F
Between periods within group	1	0.459	0.459	40.602**
Between stages within group	2	2.029	1.014	89.770**
Error	32	0.362	0.011	
Total	35	2.850		

** Significant at 1% level.

Table 14. Analysis of variance table for lactose content (percentage) in milk of Alpine x Malabari goats.

Source	df	SS	MSS	F
Between periods within group	1	0.00039	0.00039	0.056 NS
Between stages within group	2	0.26907	0.13454	18.962**
Error	32	0.22704	0.00710	
Total	35	0.49651		

NS - Not Significant.

** Significant at 1% level.

Table 15. Analysis of variance table for lactose content (percentage) in milk of Saanen x Malabari goats.

Source	df	SS	MSS	F
Between periods within group	1	0.000001	0.000001	0.000077NS
Between stages within group	2	1.0898	0.5449	42.2010**
Error	32	0.413199	0.12912	
Total	35	1.503000		

NS - Not Significant.

** Significant at 1% level.

Table 16. Analysis of variance table for the ash percentage in milk of Alpine x Malabari goats.

Source	df	SS	MSS	F
Between periods within group	1	0.0001	0.0001	1.00 NS
Between stages within group	2	0.0010	0.0050	5.00*
Error	32	0.0034	0.0010	
Total	35	0.0045		

NS - Not Significant.

* Significant at 5% level.

Table 17. Analysis of variance table for the ash percentage in milk of Saanen x Malabari goats.

Source	df	SS	MSS	F
Between periods within group	1	0.000038	0.000038	0.0568 NS
Between stages within group	2	0.001421	0.007110	1.0620 NS
Error	32	0.021390	0.000668	
Total	35	0.022849		

NS - Not Significant.

Table 18. Critical difference between stages of lactation of Alpine x Malabari and Saanen x Malabari goats.

Stage of lactation	Alpine x Malabari			
	Fat	Protein	Lactose	Ash
Early	5.76 a	4.21 a	4.10 a	0.772 a
Middle	6.27 b	4.39 b	4.15 b	0.772 b
Late	6.99 c	4.65 c	3.93 c	0.784 c
Critical difference	0.305	0.075	0.023	0.006

Stage of lactation	Saanen x Malabari			
	Fat	Protein	Lactose	Ash
Early	5.30 a	4.18 a	4.08 a	0.776 a
Middle	5.65 a	4.28 b	4.23 b	0.779 b
Late	5.99 b	4.72 c	3.86 c	0.791 c
Critical difference	0.303	0.043	0.046	---

Identical numbers indicate no difference within the group.

Unidentical numbers indicate significant difference within the group.

Table 19. Comparison of the composition of the milk of Alpine x Malabari and Saanen x Malabari goats.

Constituents	Breed	Average of the morning samples	Average of the evening samples	Grand Mean	Error
Fat	Alpine x Malabari	5.00	7.57a	6.29 c	0.554
	Saanen x Malabari	4.61	6.69b	5.64 d	
Protein	Alpine x Malabari	4.31	4.53	4.40	0.223
	Saanen x Malabari	4.29	4.50	4.40	
Lactose	Alpine x Malabari	4.06	4.06	4.06	0.008
	Saanen x Malabari	4.06	4.06	4.06	
Ash	Alpine x Malabari	0.776	0.775	0.776	0.0004
	Saanen x Malabari	0.779	0.784	0.782	

Unidentical numbers indicate significant difference within the group.

ILLUSTRATIONS

Fig. 1. Percentage of fat in the morning milk of Alpine x Malabari and Saanen x Malabari goats.

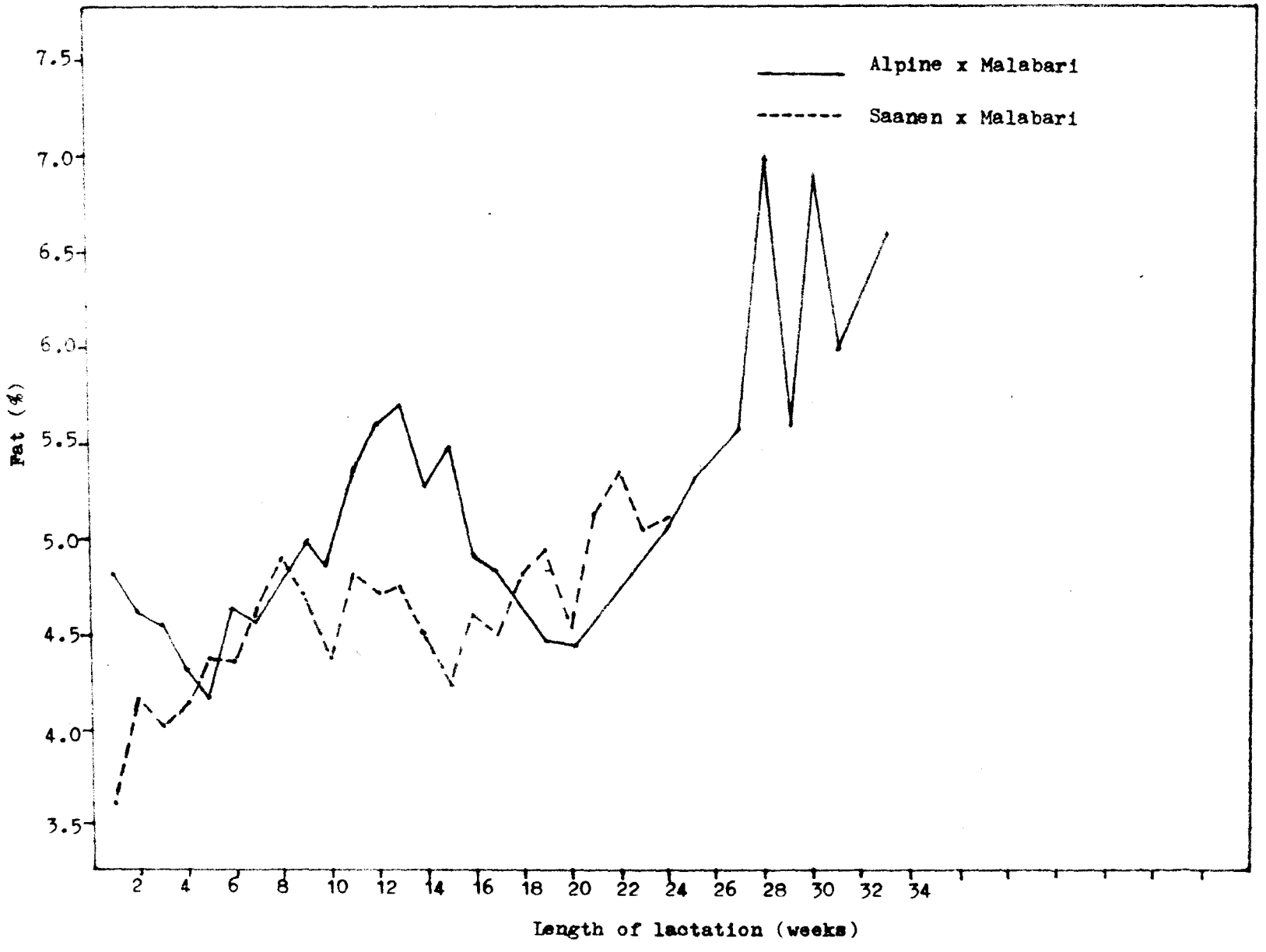


Fig. 2. Percentage of fat in the evening milk of Alpine x Malabari and Saanen x Malabari goats.

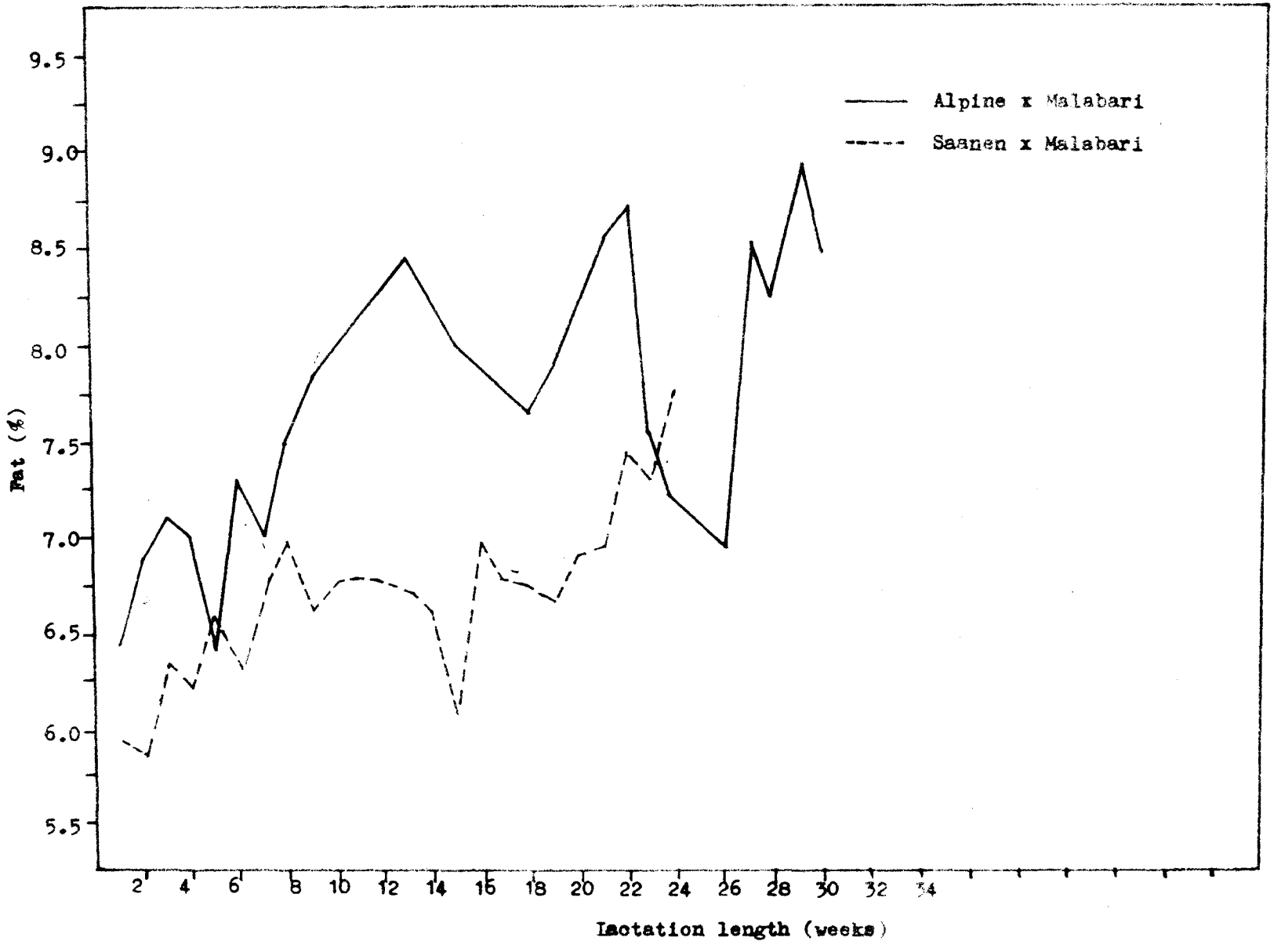


Fig. 3. Percentage of protein in the morning milk of Alpine x Malabari and Saanen x Malabari goats.

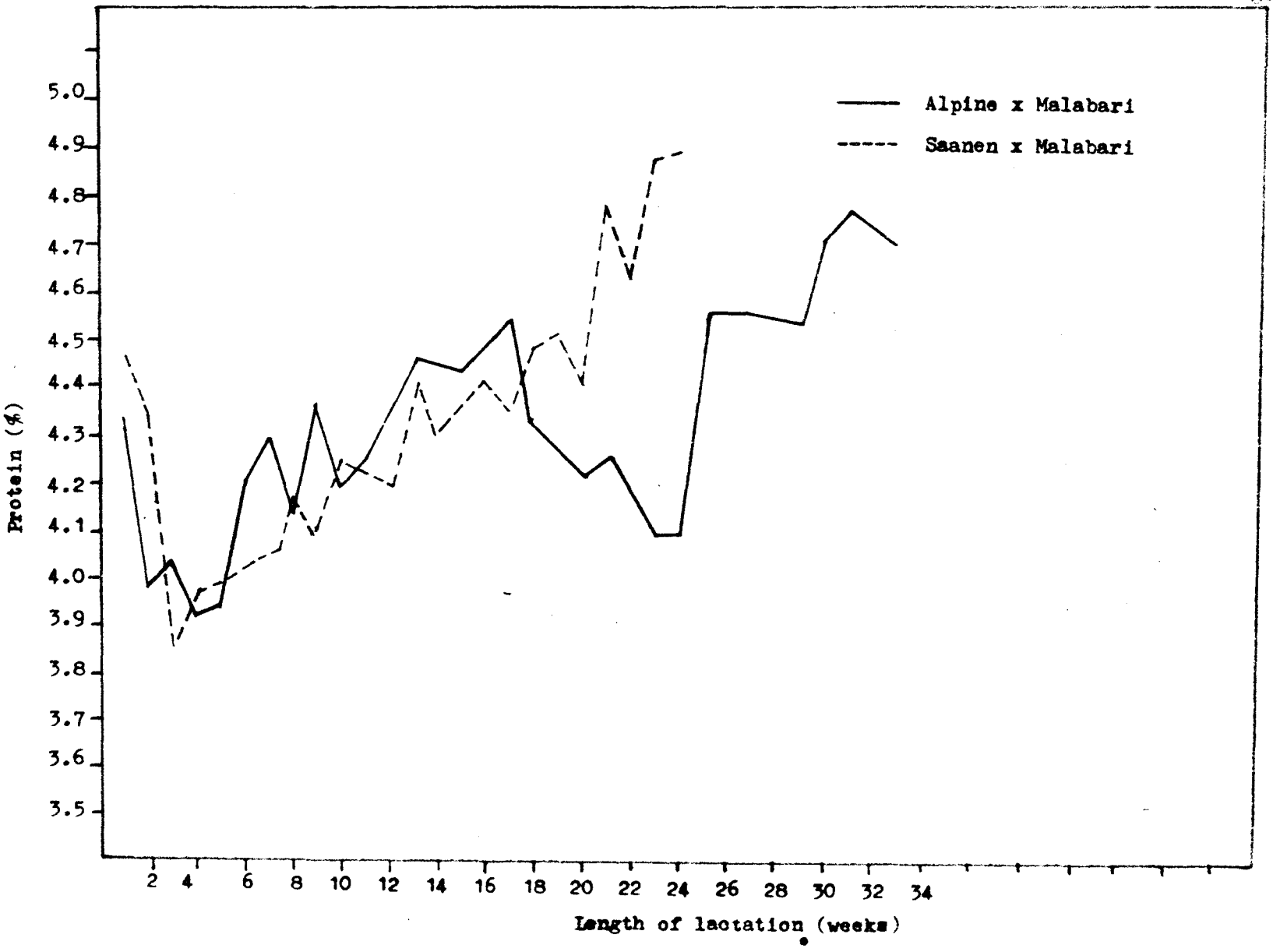


Fig. 4. Percentage of protein in the evening milk of Alpine x Malabari and Saanen x Malabari goats.

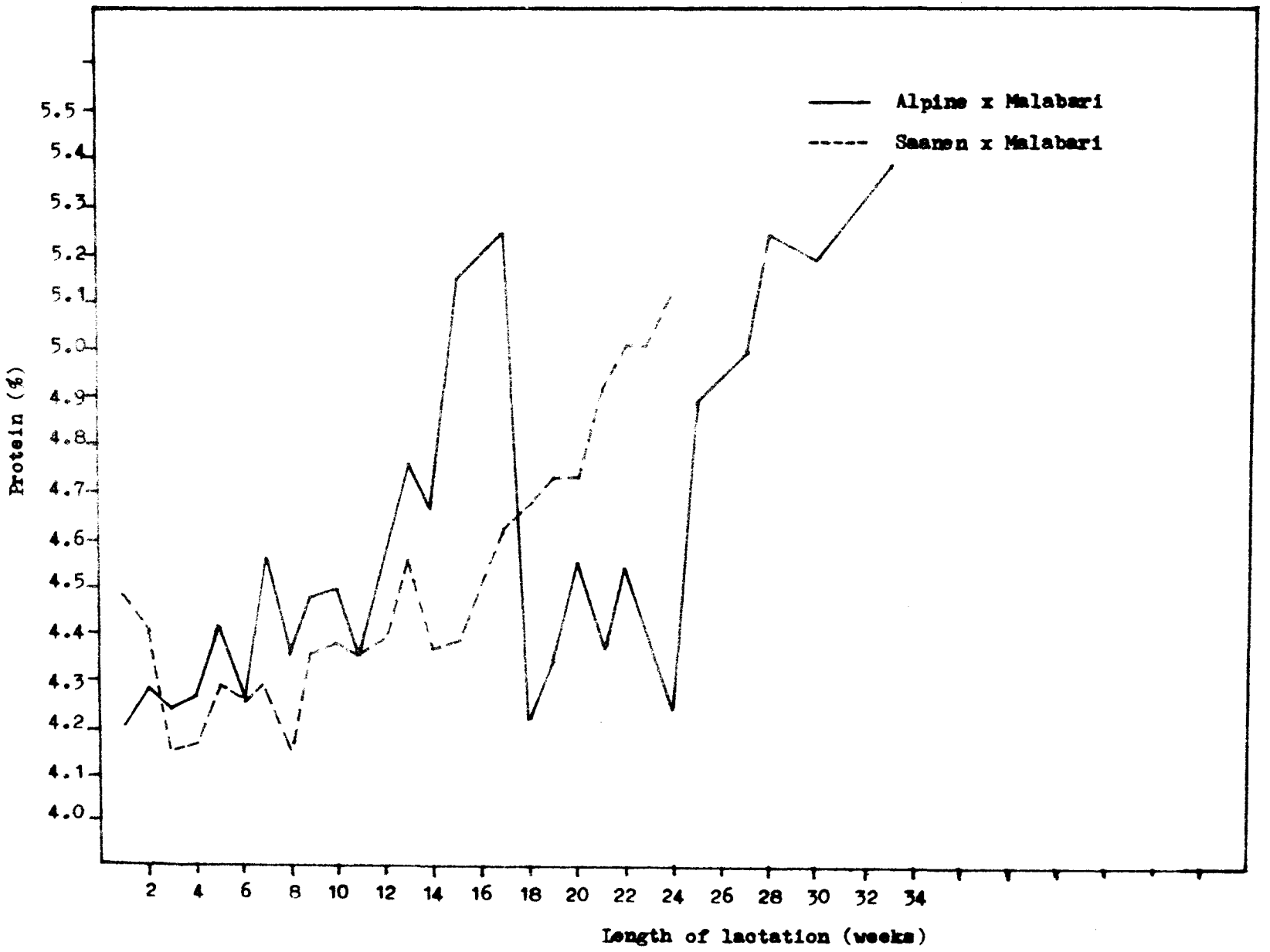


Fig. 5. Percentage of lactose in the morning milk of Alpine x Malabari and Saanen x Malabari goats.

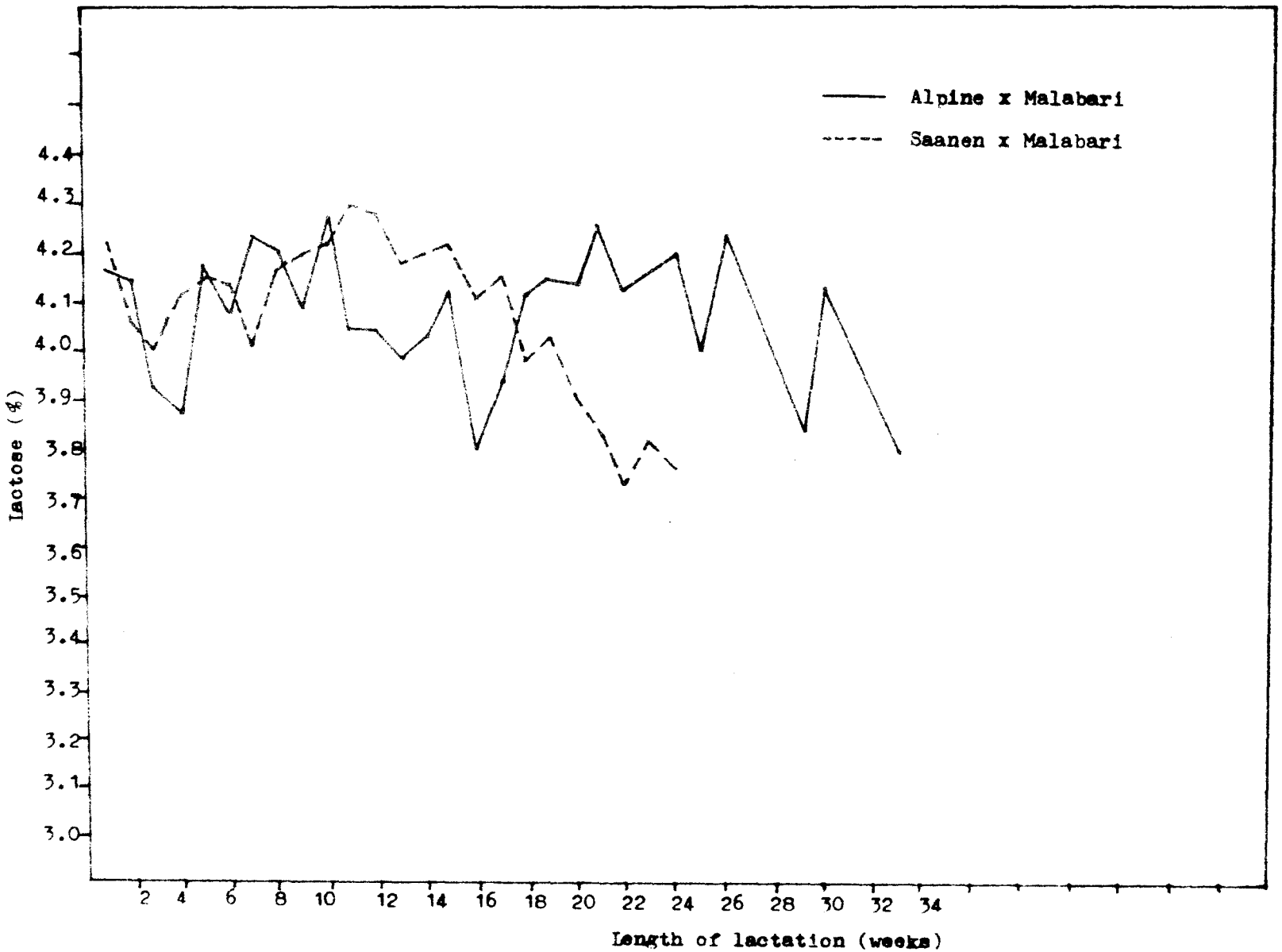


Fig. 6. Percentage of lactoee in the evening milk of Alpine x Malabari and Saanen x Malabari goats.

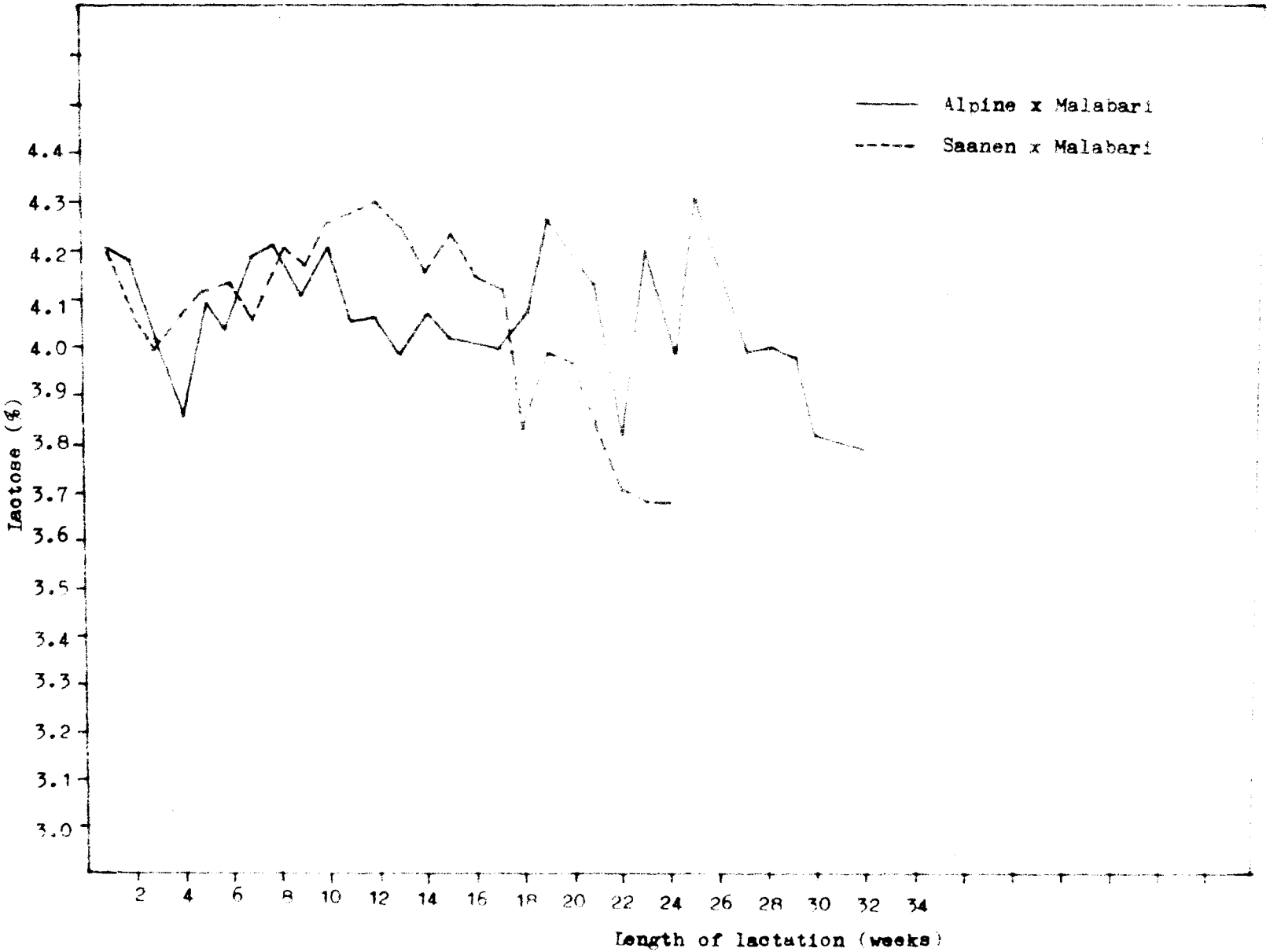


Fig. 7. Percentage of ash in the morning milk of Alpine x Malabari and Saanen x Malabari goats.

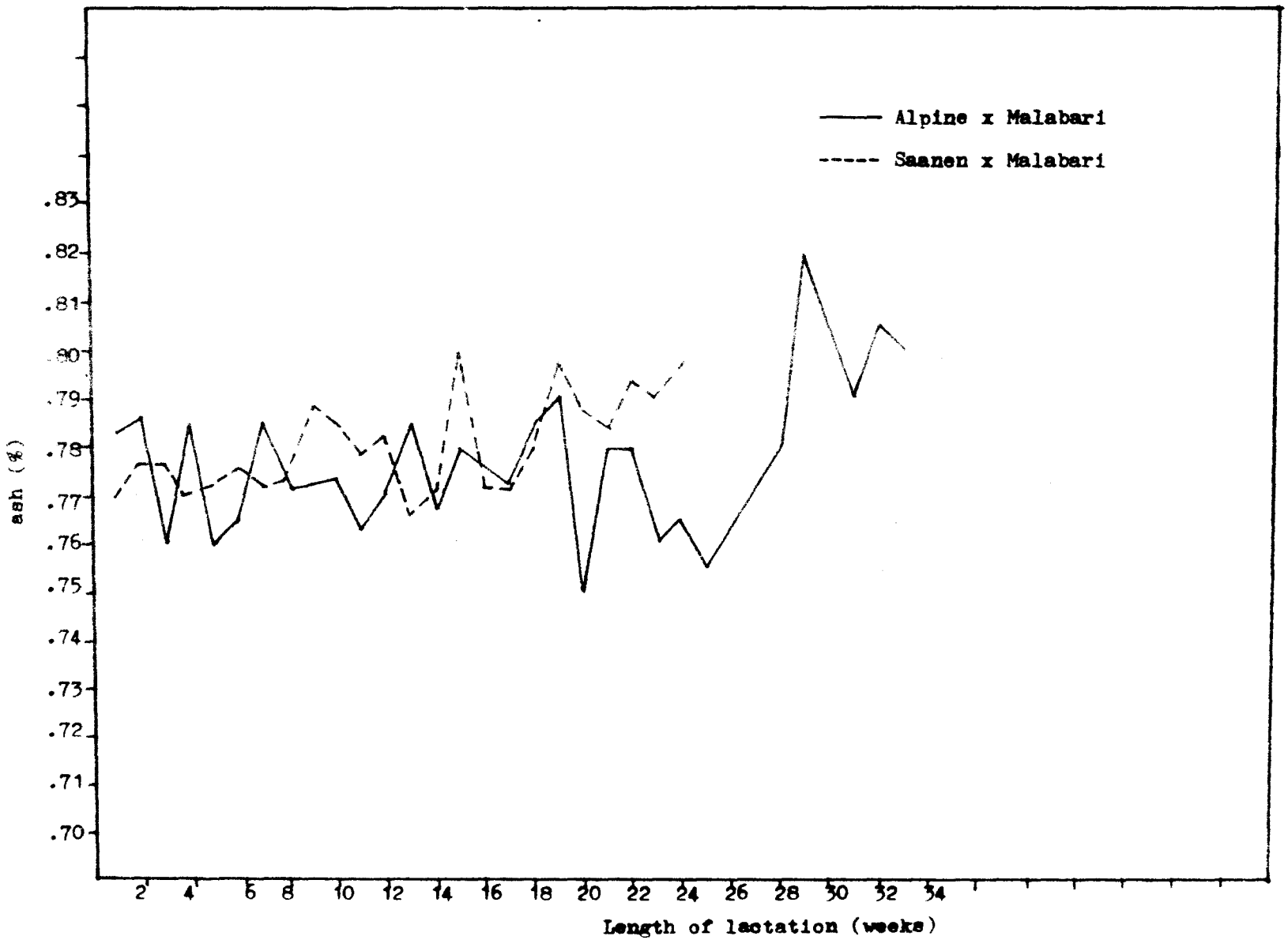


Fig. 8. Percentage of ash in the evening samples of milk of Alpine x Malabari and Saanen x Malabari goats.

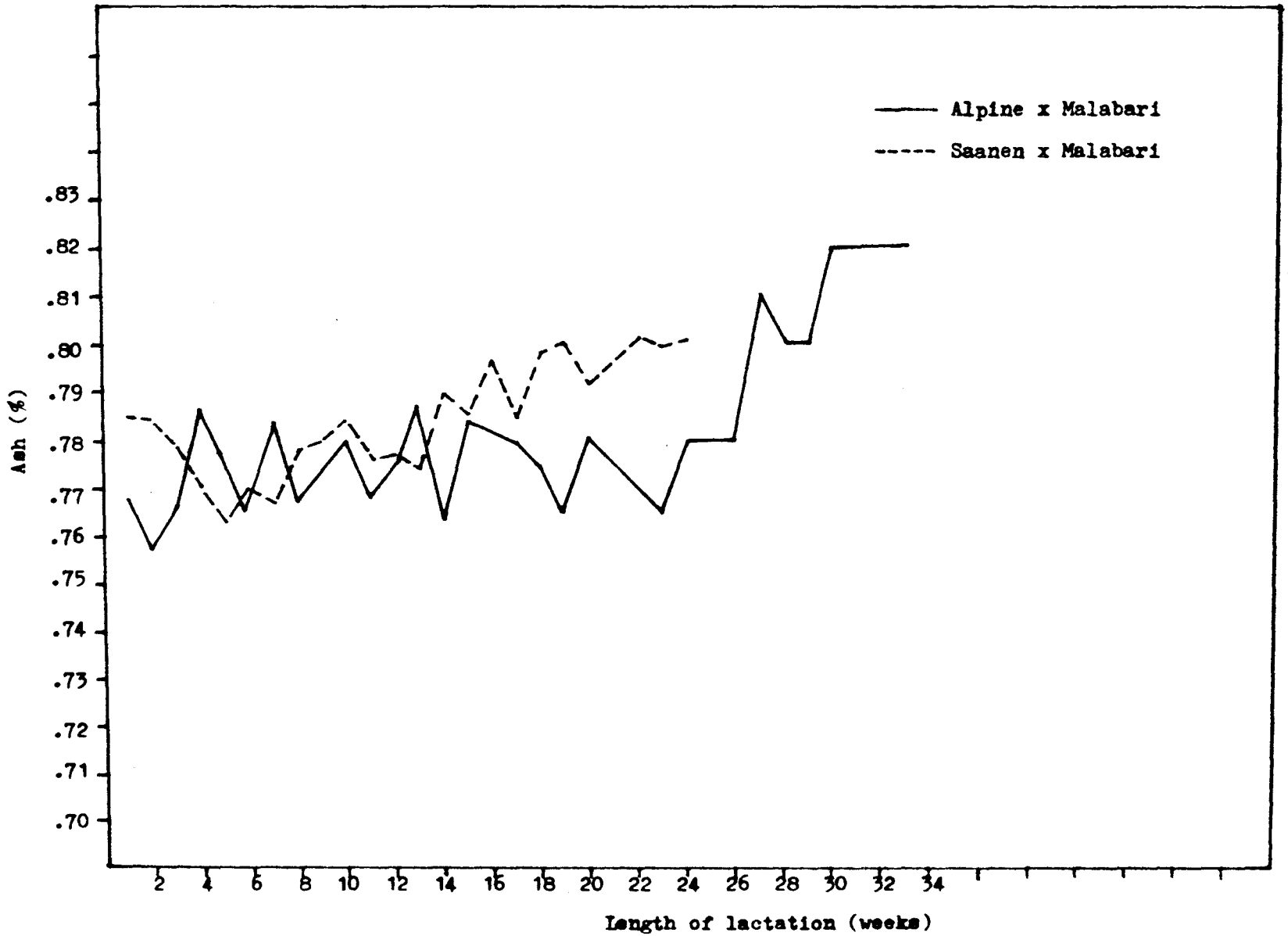


Fig. 4. Composition of the morning milk of Alpine x Malabari and Saanen x Malabari goats.

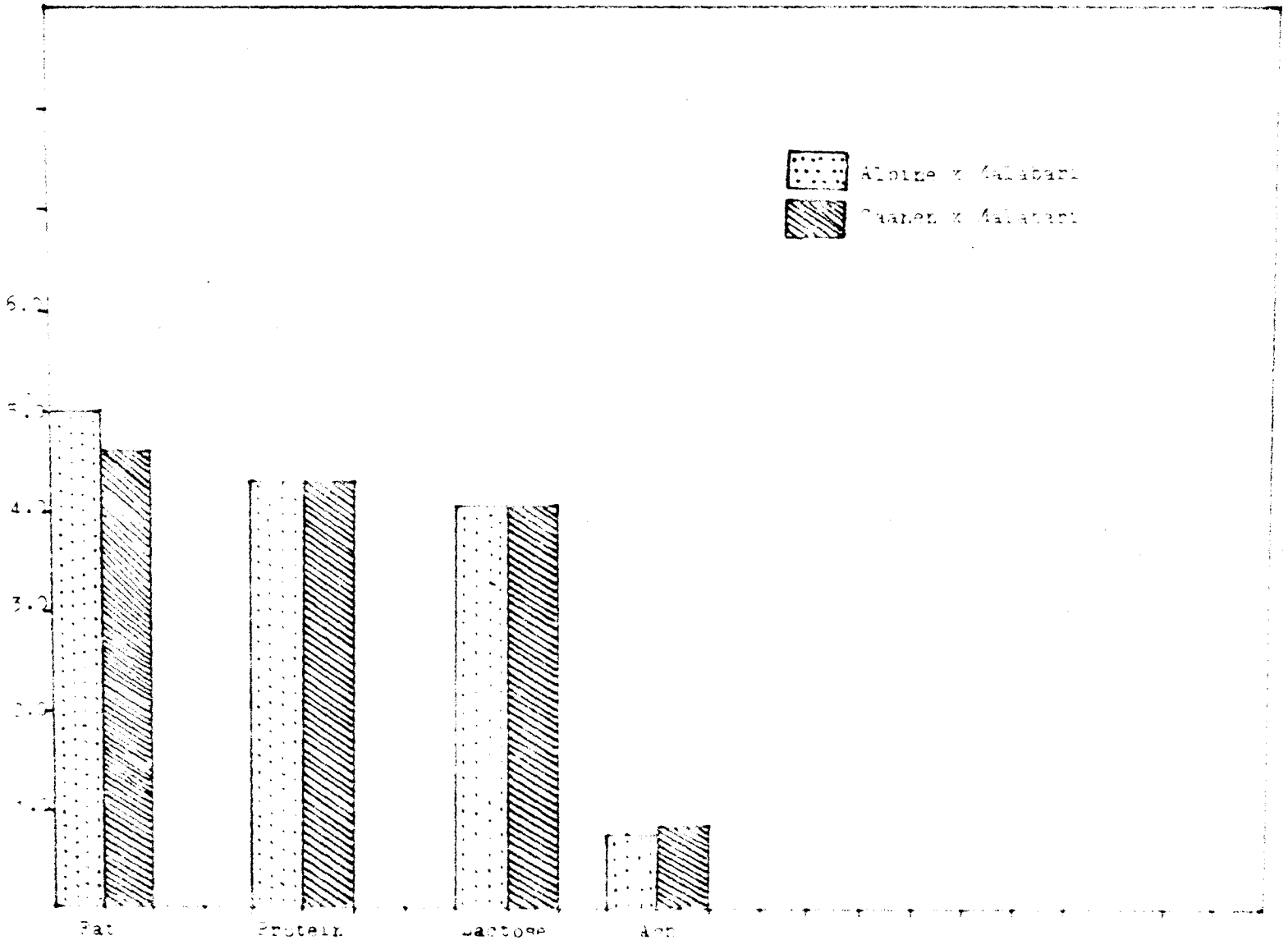
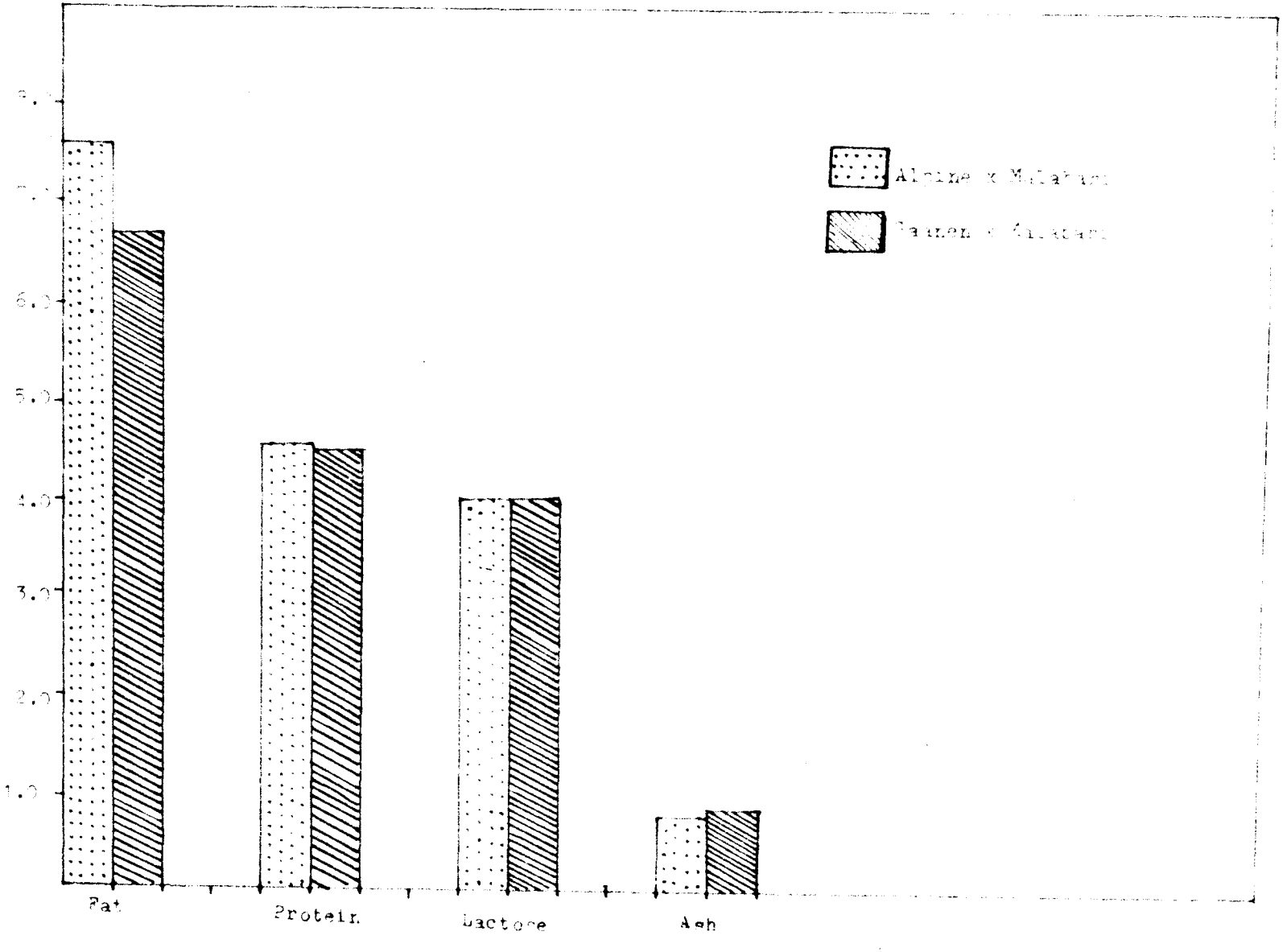


Fig. 10. Composition of the evening milk of Alpine x Malabari and Saanen x Malabari goats.



DISCUSSION

DISCUSSION

In order to increase the milk production potentialities of Indian breeds of goats crossbreeding with exotic breeds such as Alpine and Saanen is being resorted to. The chemical composition of the milk of crossbred goats, Alpine x Malabari and Saanen x Malabari, maintained at the All India Co-ordinated Research Project on Goats for Milk, Mannuthy, was studied. The fat, protein, lactose and ash contents of the milk of the two crossbreds are discussed with referenceto the difference between breeds, stage of lactation and time of milking.

Fat content.

The average fat content of the milk of Alpine x Malabari goats in the morning sample was 5.00 ± 0.10 and that of the evening sample 7.57 ± 0.12 with an overall mean of 6.29 ± 0.18 per cent (Table 2).

The average milk fat content of the Saanen x Malabari goats in the morning sample of milk was found to be 4.61 ± 0.07 while the evening milk sample contained 6.69 ± 0.13 with an average of 5.64 ± 0.09 per cent (Table 6).

The above mentioned values fall within the range of milk fat reported by Parkash and Jenness (1968). They have

stated that the frequency distribution of the fat content of milk from individual goats was rather similar to that of the milk of cows of common dairy breeds, the range being 2 to 8 per cent. Almost similar values as obtained in this study were reported for the milk of Saanen goats by Mba et al. (1975) and for West African dwarf goats by Ketelhodt (1977) and Akinsoyinu et al. (1977). The values obtained in the present study were higher than the fat percentages reported by Mittal and Pandey (1971) ; Sachdeva et al. (1974) ; Qureshi et al. (1981) ; Nirmalan and Nair (1962) and Devendra (1972).

Saanen x Korean native first generation crossbreds were found to produce milk containing 5.37 per cent fat and Korean native goats had 5.72 per cent fat in the milk (Lee et al. 1975).

The percentage of fat in milk obtained in the present study was lower than the values reported for Red Sokoto goats by Mba et al. (1975) and Pygmy goats by Jenness (1980).

The fat content of the milk of goats was almost similar to that of fine wool sheep which produced 5.79 per cent fat in its milk (Georgiev, 1962), whereas Volohenko (1959) and Kubis (1965) have reported a higher fat content in the milk of ewes.

The average fat percentage of the six Alpine x Malabari goats decreased from 4.80 per cent at the first week of lactation to 4.12 per cent during the fifth week of lactation (Fig. 1) and thereafter the fat content steadily increased upto 5.50 per cent at the end of the lactation period (15th week). From the 16th week of lactation only two animals in the Alpine x Malabari group continued to lactate and the average fat percentage in the milk of the two goats are presented in Fig. 1. The fat percentage decreased from 5.50 per cent at the 16th week of lactation to 4.40 per cent at the 21st week of lactation and the fat content again increased upto 6.51 per cent at the end of the lactation (33rd week).

In the case of the Saanen x Malabari goats, the fat content of the morning sample of milk (Fig. 1) increased from 3.50 per cent at the second week of lactation 4.50 per cent at the seventh week of lactation. Thereafter the fat content was found to remain almost constant with slight variation upto the 17th week of lactation and then increased upto 5.40 per cent at the end of the lactation period (24th week).

Figure 2 represents the fat content of the evening samples of milk of Alpine x Malabari goats. The average

fat content of the milk of the six animals was found to increase from 6.48 per cent at the beginning of the lactation (1st week) to 8.00 per cent at the end of the lactation (15th week). The average fat content of the milk of the two animals which continued to lactate after the 16th week of lactation increased to 8.72 per cent at the 22nd week of lactation and thereafter declined to 6.80 per cent by the 20th week of lactation and again increased gradually upto 8.50 per cent at the end of the lactation (30th week).

Figure 2 also represents the milk fat content of the evening milk samples of the Saanen x Malabari goats. In this case the fat content of the evening milk samples was found to increase from 5.80 per cent during the first week of lactation to 6.75 per cent by the 7th week of lactation and thereafter the fat content was found to remain steady with slight fluctuations upto the 18th week of lactation. Towards the end of lactation the fat content was found to increase steadily and reached 7.70 per cent at the end of the lactation (24th week).

The increase in the fat percentage of goats' milk with advance in lactation noticed in this study is in agreement with the findings of Mba et al. (1975) and contrary to Barnabas and Mawal (1959) and Gonc (1979) who stated that

the fat content of the goats milk decreased as lactation advanced.

The present observations are similar to those reported by Georgiev (1962) and Kubis (1963) for ewes milk. In the milk of Indian cows and buffaloes also the fat content was found to increase as the lactation progressed (Ghosh and Anantakrishnan, 1964).

The analysis of variance for the fat content of milk of Alpine x Malabari goats (Table 10) showed significant difference between the fat percentage of the morning and evening samples and also between the stages of lactation ($P<0.01$). The critical difference calculated from table 18 showed that there was significant difference between the first and second, first and third and second and third stages of lactation. The analysis of variance for the fat content of milk of Saanen x Malabari goats (Table 11) also showed significant difference between the morning and evening samples of milk ($P<0.01$) but not between the stages of lactation. However, the critical difference table (Table 18) showed that eventhough there was no significant difference between the first and second stage of lactation, there was significant difference between the first and third and second and third stages of lactation.

The variation in the fat content of the milk between

the morning and evening samples of milk was in agreement with the findings of Urquhart (1930) indicating that the fat of the evening samples of milk of goats (1.90 to 9.09 per cent) was higher than that of the morning samples (1.60 to 8.85 per cent). Marques (1977) also reported that milking goats twice a day gave higher percentage of fat in the evening sample. In the case of cows, similar findings have been reported by Nicholson et al. (1957) and Ling et al. (1961).

The statistical analysis of the fat content of Alpine x Malabari and Saanen x Malabari goats (Table 19) revealed no significant difference between the morning milk samples of both the crossbreds. However, the fat content of the evening milk samples and the total fat percentage (evening and morning) were significantly different for both the crossbred genetic groups.

The difference in the milk fat percentage of the two crossbreds observed in this study was similar to the findings of Parkash and Jenness (1968). They have reported breed differences in the fat content in the milk of goats kept under common conditions. The findings are similar to those of Devendra (1972) regarding the composition of milk of British Alpine and Anglo-Nubian goats.

Protein content.

The protein content of the milk of Alpine x Malabari goats is presented in table 3. The average protein content of the morning sample of milk was 4.31 ± 0.05 as against 4.53 ± 0.05 for the evening sample with an overall average of 4.40 ± 0.03 per cent.

The protein content of the milk of Saanen x Malabari goats is presented in table 7. The average protein content in the morning sample was 4.29 ± 0.03. The average protein content of the milk collected in the evening was 4.50 ± 0.03 with a total mean of 4.40 ± 0.02 per cent.

The protein content of the milk of the Alpine x Malabari and Saanen x Malabari crossbreds obtained in the present study was within the range of 3.38 to 5.62 per cent (average of 4.11 per cent) reported for goats milk by Rythgoe (1940). Similar observations were made by Ranawana and Kellaway (1977a, 1977b) who stated that the protein content varied from 4.01 to 4.61 per cent in the milk of Saanen goats. Mba et al. (1975) obtained a protein content of 4.73 per cent in Saanen goats. Agrawal and Bhattacharyya (1978) reported a protein content of 5.07 per cent in the milk of Black Bengal x Barbari goats. In the milk of Malabari goats a protein content of 4.04 per cent has been reported by Nirmalan and Nair (1962).

The values of protein obtained in the present study was less as compared to the value of 5.30 per cent reported for Red Sokoto goats by Mba *et al.* (1975) and 5.83 per cent reported in the milk of Barbari goats by Agrawal and Bhattacharyya (1978). Lower values in the protein content in the milk of goats have been reported by French (1970). French (1970) and Chang and Kim (1978) reported a protein percentage of 2.17 and 3.65 respectively in the milk of Saanen goats whereas in the French Alpine goats milk a value of 3.14 per cent has been reported by Mena and Escamilla H (1977).

Ewes produced milk having a higher protein content of 6.65 per cent (Volchenko, 1959) and 5.05 per cent (Georgiev, 1962). In Indian cows the protein content in milk varied from 2.99 to 3.79 per cent (Ghosh and Anantakrishnan, 1964) and the buffalo milk had an average protein content of 3.81 per cent (Anantakrishnan *et al.* 1943). These values were lower than those obtained in the study for the milk of crossbred goats.

The average protein content of the morning samples of milk in the six Alpine x Malabari goats declined from 4.33 per cent at the first week of lactation to 3.92 per cent at the fourth week of lactation and then gradually increased to 4.44 per cent at the 15th week of lactation

with minor fluctuation (Fig. 3). In the case of the two animals which continued to lactate thereafter the protein content declined to 4.10 per cent at the 22nd week of lactation. By the 25th week the protein content increased to 4.55 per cent and this level was maintained upto the 29th week of lactation after which the protein content again increased to 4.79 per cent at the endof the lactation period (33rd week). With regard to the protein content in the morning samples of milk of the Saanen x Malabari crossbred goats (Fig. 3) there was a decrease from 4.46 per cent to 3.85 per cent at the second week of lactation and thereafter the protein content steadily increased to 4.90 per cent at the end of the lactation (24th week).

In the evening samples of milk the protein content of the milk of the six Alpine x Malabari goats (Fig. 4) increased from 4.20 per cent at the first week of lactation to 5.13 per cent at the end of the lactation (16th week). The protein content of the milk of the two animals in the group which had a longer lactation length was found to decline to 4.20 per cent at the 18th week of lactation. This level was maintained with minor fluctuations upto the 24th week of lactation and thereafter the protein content increased to 5.38 per cent at the end of the lactation (33rd week). In the Saanen x

Malabari crossbred goats, the protein content of the evening samples of milk (Fig. 4) declined from 4.48 per cent at the first week of lactation to 4.15 per cent during the third week of lactation. This level was maintained with slight fluctuations upto the eighth week of lactation when the protein content slightly increased to 4.40 per cent and remained steady till the 15th week of lactation. The protein content steadily increased to 5.12 per cent at the 24th week of lactation.

The values obtained on the protein content of the milk of two crossbred goats were found to increase as the lactation advanced. Similar findings have been reported by Mba et al. (1975) for goats milk and also in ewes milk by Kubie (1963) and Georgiev (1962). In cows and buffaloes milk a similar trend has been observed by Ghosh and Anantakrishnan (1964). However, Akinsoyinu et al. (1976), Gonc (1979) and Barnabas and Mawal (1959) have stated that the protein content in goats milk declined when lactation advanced.

The analysis of variance table (Table 12) for the protein in milk of Alpine x Malabari goats and that for the Saanen x Malabari goats (Table 13) showed significant difference between the protein content of the morning and evening samples and also between the stages of lactation ($P<0.01$). In goats which have been milked twice

Marques (1977) indicated that the protein content in the evening samples was slightly more than that in the morning samples of milk.

Statistical analysis of the protein content of the milk of Alpine x Malabari and Saanen x Malabari goats (Table 19) showed no significant difference between the two crossbred groups.

Lactose content.

The lactose content of the milk of the Alpine x Malabari goats in the morning samples was 4.06 ± 0.03 and that of the evening samples 4.06 ± 0.03 with an average of 4.06 ± 0.08 per cent (Table 4).

The morning samples of milk of Saanen x Malabari goats contained 4.06 ± 0.03 per cent lactose whereas the evening samples had 4.07 ± 0.02 per cent with an average of 4.06 ± 0.02 per cent lactose (Table 8).

The lactose content in goats milk obtained during the present study was in agreement with the values reported by Qureshi et al. (1981), Mittal and Pandey (1971), Devendra (1972), Devendra (1979) and Chang and Kim (1978). Lower lactose contents have been reported by Maltz and Shkolnik (1971), Baker (1958) and French (1970). However, Mba et al.

(1975), Ramawana and Kellaway (1977a, 1977b), Sachdeva et al. (1974) and Nirmalan and Nair (1962) have reported higher values.

The lactose content of the goats milk (Alpine x Malabari and Saanen x Malabari) was similar to the lactose content in ewes milk (4.15 per cent) reported by Volchenko (1959). The cows milk on the other hand had a higher lactose content of 4.40 to 5.20 per cent with an average of 4.80 per cent anhydrous lactose (Nickerson, 1965).

The changes during the lactation in the lactose content of the Alpine x Malabari goats milk is shown in Fig. 5. The average lactose content of all the six animals in the group was found to decrease from 4.27 per cent at the first week of lactation to 3.88 per cent at the fourth week of lactation. It again increased to 4.16 per cent during the fifth week of lactation and this level was maintained upto the twelfth week of lactation with minor fluctuation and then decreased gradually to 3.80 per cent at the end of the lactation (16th week). Two animals in the group continued to be in lactation after the 16th week and the lactose content of their milk increased to 4.15 per cent during the 18th week of lactation and the level was maintained upto the 24th week with slight variations and thereafter the lactose content decreased

to 3.80 per cent at the end of the lactation (33rd week).

Figure 5 shows the lactose content of the morning samples of milk of Saanen x Malabari goats. The lactose content was found to decrease from 4.22 to 4.00 per cent at the third week of lactation, increased to 4.10 per cent at the fourth week of lactation and remained steady upto the eighth week of lactation. Thereafter the lactose content in the milk increased to 4.30 per cent by the eleventh week of lactation and remained almost steady with a slight reduction upto the 17th week of lactation. It gradually declined to 3.70 per cent at the 24th week of lactation.

The lactose content of the evening samples of milk of Alpine x Malabari and Saanen x Malabari crossbreds is shown in Fig. 6. The lactose content of the evening samples followed the same trend as that of the morning samples.

The lactose content of milk of goats decreased as the lactation advanced and similar findings have been reported by Akinsoyinu et al. (1977) and Gone (1979). But Mba et al. (1975) stated that the lactose per cent of goats milk increased at the end of the lactation period.

The results of the present study are also similar to those reported by Georgiev (1962) and Kubis (1963) for ewes milk. In cows milk also lactoee content was found to decrease slightly at the end of the lactation period (Rook and Campling, 1965).

The analysis of variance of the data obtained on the lactose content of the milk of Alpine x Malabari and Saanen x Malabari goats (Tables 14 & 15) showed no significant difference between the morning and evening samples of milk but significant difference was noticed between the stages of lactation (P 0.01). The critical difference calculated from table 18 revealed that there was significant difference between the first and second, first and third and second and third stages of lactation with regard to the lactose content of the milk.

Statistical analysis of the data (Table 19) revealed no difference between the two groups of crossbreds in the lactose content of milk.

Ash content.

The ash content of the Alpine x Malabari goats milk is presented in table 5. The ash content in the morning samples of milk was 0.776 ± 0.003 and that of the evening sample 0.775 ± 0.003 with an average of 0.776 ± 0.001.

Table 9 presents the ash content of the milk of Saanen x Malabari goats. The ash content of the morning samples of milk was 0.779 ± 0.002 and the evening samples 0.784 ± 0.002 with an average of 0.782 ± 0.001 per cent.

Lythgoe (1940) found that the ash content of goats milk varied from 0.75 per cent to 1.04 per cent with an average of 0.89 per cent. The ash content of the goats milk generally ranged from 0.70 to 0.85 per cent and was usually slightly higher than that of cows or buffaloes milk (Parkash and Jenness, 1968). Devendra (1972) reported that the ash content of the British Alpine goats milk to be 0.78 per cent and that of the Anglo-Nubian goats to be 0.79 per cent. While Nirmalan and Nair (1962) obtained an ash content of 0.76 per cent for the milk of Malabari goats, Chang and Kim (1978) reported an ash content of 0.78 per cent in the milk of Saanen goats.

The ash content of the goats milk obtained in the present study has been lower than those reported by several workers (Devendra, 1979; Akinsoyinu et al. 1977; Jenness, 1980; Sachdeva et al. 1974 and Qureshi et al. 1981).

Ewes milk was found to contain a higher ash content of 0.88 (Kubis, 1963) and 1.02 per cent (Volchenko, 1959). The reported values on the ash content of ewes milk were higher

than that of the ash content of the goats milk obtained in the present study.

The amount of ash in the morning samples of milk of Alpine x Malabari goats is indicated in Fig. 7. The average amount of the ash of the six goats in the group remained almost constant within the range of 0.760 to 0.786 per cent from the beginning to the end of the lactation (1st to 16th week). After the 16th week of lactation only two goats continued to lactate and the percentage of ash in the milk increased to 0.79 at the 19th week of lactation, decreased at the 20th week of lactation and remained between 0.76 and 0.78 per cent upto the 28th week. The ash content gradually increased upto 0.81 per cent at the end of the lactation (33rd week).

The ash content of the morning milk samples of Saanen x Malabari goats (Fig. 7) remained constant at the level of 0.77 per cent until the eighth week of lactation and then increased upto 0.785 per cent. This level was maintained upto the 12th week, decreased to 0.765 per cent at the 13th week and gradually increased to 0.795 per cent at the end of the lactation (24th week).

In the evening samples of the Alpine x Malabari goats (Fig. 8) the average ash per cent in the milk of the six

goats varied from 0.765 to 0.780 and remained almost constant upto the end of the lactation period (16th week). In the two animals which remained in lactation thereafter, the trend in the content of ash in milk remained the same upto the 24th week of lactation, increased to 0.82 per cent by the 30th week and was constant till the end of the lactation (33rd week).

The ash content of the evening samples of milk (Fig.8) was 0.785 per cent at the beginning of the lactation and 0.763 per cent at the fifth week of lactation for the Saanen x Malabari goats. The milk contained 0.80 per cent ash at the 18th week of lactation and remained constant throughout the rest of the lactation period (24th week).

In the present study the ash content of the goats milk was found to increase towards the end of lactation. Similar trend has been reported in cows milk by Whittier and Corbin (1965). They observed that the total ash content of the milk of cows was high at the end of the lactation.

The analysis of variance for the ash content of the Alpine x Malabari goats (Table 16) revealed no significant difference between the morning and evening samples of milk. Significant difference was noticed between the stages of

lactation ($P < 0.05$). The critical difference table (Table 18) indicated significant difference between the first and third and second and third stages of lactation. No significant difference was found between the first and second stages of lactation.

The analysis of variance table for the ash content of the milk of Saanen x Malabari goats (Table 17) showed no significant difference between the morning and evening samples as well as between the different stages of lactation.

The statistical analysis of the data for the ash content of the milk of Alpine x Malabari and Saanen x Malabari goats (Table 19) showed no significant difference between the two crossbreds.

SUMMARY

SUMMARY

An investigation was undertaken to study the chemical composition of the milk of crossbred goats, utilising six each of Alpine x Malabari and Saanen x Malabari crossbreds maintained at the All India Co-ordinated Research Project on Goats for Milk, Mannuthy.

The samples of milk were collected both in the morning and evening and at weekly intervals. A total of 471 milk samples, so collected, were analysed for the major constituents such as fat, protein, lactose and ash. The possible influence of factors such as breed, stage of lactation and time of milking on the composition of milk has also been studied.

In Alpine x Malabari goats, the fat content of the samples of morning milk ranged from 3.28 to 6.33 per cent with an average of 5.00 $\pm$ 0.10 per cent. In the samples of evening milk the fat content ranged from 5.68 to 9.69 with an average of 7.57 $\pm$ 0.12 per cent. The overall fat percentage was found to be 6.29 $\pm$ 0.18.

For the Saanen x Malabari goats the fat content of the samples of mroning milk was found to vary from 3.73 to 5.37 per cent with an average of 4.61 $\pm$ 0.07 per cent while that of the samples of evening milk varied from 5.24 to 9.04 with

an average of 6.69 ± 0.13 per cent. The overall fat content of the milk of Saanen x Malabari goats was found to be 5.64 ± 0.09 per cent.

Statistical analysis of the data revealed significant difference ($P<0.01$) between the samples of morning milk and evening milk on the fat content in both the crossbreds. But no significant difference was noticed between the two crossbreds in the overall fat percentage and the fat content of the samples of evening milk. The fat content of the milk was found to increase as the lactation advanced.

The protein content of the samples of morning milk of the Alpine x Malabari goats was found to range from 3.62 to 4.67 with an average of 4.31 ± 0.05 per cent. In the samples of evening milk the protein content varied from 3.83 to 5.12 with an average of 4.53 ± 0.05 per cent. The overall protein content of the milk of Alpine x Malabari goats was found to be 4.40 ± 0.03 per cent.

The protein content of the samples of morning milk of the Saanen x Malabari goats averaged 4.29 ± 0.03 per cent with a range of 3.87 to 4.79 per cent. In the samples of evening milk the protein content varied from 4.00 to 5.01 with an average of 4.50 ± 0.03 per cent. The overall protein content of the milk of Saanen x Malabari goats was found to be 4.40 ± 0.02 per cent.

In both the crossbreds, significant difference ($P<0.01$) was found between the morning and evening samples of milk in the protein content. But no significant difference could be noticed between the protein content of the milk of the two different crossbred goats. The protein content was found to increase with the advancement in lactation.

The lactose content of the milk samples collected in the morning from Alpine x Malabari goats varied from 3.88 to 4.27 with an average of 4.06 ± 0.03 per cent. The lactose content of the samples of milk collected in the evening was found to vary from 3.85 to 4.30 with an average of 4.06 ± 0.03 per cent. The overall lactose content of the milk of Alpine x Malabari goats was found to be 4.06 ± 0.02 per cent.

The morning milk of the Saanen x Malabari goats had a lactose content which varied from 3.83 to 4.28 with an average value of 4.06 ± 0.03 per cent. The percentage of lactose in the samples of evening milk varied from 3.73 to 4.32 with an average of 4.06 ± 0.03 per cent. The overall lactose content of the milk of Saanen x Malabari goats was found to be 4.06 ± 0.02 per cent.

In both the crossbreds no significant difference could be noticed between the morning and evening samples of milk with regard to lactose content. The lactose content of the

milk of the two crossbreds did not reveal any significant difference due to breed and it was found to decrease as the lactation advanced.

The ash content of the morning samples of milk of the Alpine x Malabari goats ranged from 0.762 to 0.795 per cent. The average ash content of the milk was 0.776 ± 0.003 per cent. In the evening samples, the ash content varied from 0.756 to 0.793 with an average of 0.775 ± 0.003 per cent. The overall ash content of the milk of Alpine x Malabari goats was 0.776 ± 0.001 per cent.

The ash content of the samples of morning milk of the Saanen x Malabari goats ranged from 0.760 to 0.801 with an average value of 0.779 ± 0.002 per cent. In the samples of evening milk the values ranged from 0.760 to 0.804 with an average ash content of 0.784 ± 0.002 per cent. The overall ash content of the milk of Saanen x Malabari goats was found to be 0.782 ± 0.001 per cent.

No significant difference in the ash content of the milk collected in the morning and evening was noticed in both the crossbreds. Also between the two crossbreds, no significant difference was found in the percentage of ash in milk. As lactation advanced a slight increase in the ash content of milk was noticed.

The milk from the crossbred goats appears to be richer in composition than that of Malabari goats.

REFERENCES

REFERENCES

Agrawal, K.P. and Bhattacharyya, N.K. (1978). Yield and composition of milk in Black Bengal, Barbari and Black Bengal x Barbari nannies. Indian J. Anim. Sci. 48 (12): 882-886.

Akinsoyinu, A.O., Mba, A.U. and Olubajo, F.O. (1977). Studies on milk yield and composition of the West African dwarf goat in Nigeria. J. Dairy Res. 44 (1): 57-62.

Anantakrishnan, C.P., Dastur, N.N. and Kothawala, Z.R. (1943). Effect of boiling milk on its composition. Indian J. Vet. Sci. 13:297.

Arepev, V.V., Molchanova, A.I. and Fedorov, P.D. (1971). Effect of hormones on fat and protein contents of goats' milk. Trudy Vsesoyuznogo Selskokhoz Yaistvennogo Instituta Zaochnogo Obrazovaniya. 44:110-133. (Cited in Dairy Sci. Abstr. 35 (12): 5203).

Basmaeil, S. and Clapperton, J.L. (1980). The effect of chloroform introduced into the rumen of lactating goat on the yield and composition of the milk. J. Dairy Res. 47 (1): 51-60.

Barnabas, T. and Mawal, R.B. (1959). The amino-acid content of goat's milk at different stages of lactation. Indian J. Dairy Sci. 12 (2): 63-67.

Beker, D. (1958). Sheep breeding. Israeli Sheep Breeders Assoc. Publ. Tel Aviv, Israel. (Cited by Jenness, R. (1980) in J. Dairy Sci. 63 (10): pp. 1751).

Bhat, P.N., Bhat, P.P., Khan, B.U., Goswami, O.B. and Singh, B. (1981). Animal Genetic Resources in India. National Dairy Research Institute, Karnal, Publication No. 192. pp.55.

Biondo, G. (1957). The influence of exclusive and mixed feeding with by-products of the citrus-fruit industry on the milk output of the goat. Note I: The influence upon the quantity of milk and its contents of fat, lactose and proteins. Atti Soc. ital. Sci. vet. 11 : 356-361. (Cited in Dairy Sci. Abstr. 21(5):1022).

Cappa, V., Bertoni, G. and Marini, C. (1970, Publ. 1972). Feeding of $NaHCO_3$ to ruminants. Annali Fac. Agr. S. Cuore, Milano. 10 (1/3): 491-502. (Cited in Dairy Sci. Abstr. 34 (8) : 3517).

Caruolo, E.V. (1974). Milk yield, composition and somatic cells as a function of time of day in goats under a continuous lighting regimen. Br. Vet. J. 130 (4): 380-387.

Chang, J.I. and Kim, Y.K. (1978). Physico-Chemical properties of Saanens' milk. Korean J. Anim. Sci. 20 (3): 207-212. (Cited in Dairy Sci. Abstr. 42 (2):1161).

Chowdry, M.S. and Forbes, J.M. (1972). Effects of 17 B-Oestradiol on milk secretion in goats. J. endocr. 54 (3): 521-522.

Clarke, P.L., Thomson, E.M. and Thompson, G.E. (1976). Acute cold exposure and milk secretion in the goat. J. Physiol. 263 (1): 176-177.

Denamur, R. and Martinet, J.C.R. (1959). Is the nervous stimulation of mammary gland necessary in the maintenance of lactation in the goat?. Acad. Sci. Paris. 248 (5): 743-746. (Cited in Dairy Sci. Abstr. 21 (5):1156).

Devendra, C. (1972). The composition of milk of British Alpine and Anglo-Nubian goats imported in to Trinidad. J. Dairy Res. 39 (3): 381-385.

Devendra, C. (1979). The potential of sheep and goats in world food production. J. Anim. Sci. (In press). (Cited by Jenness, R. (1980) in J. Dairy Sci. 63 (10): 1605-1630).

Dozet, N. (1973). Composition and Nutritional value of goats' milk and goats' milk products. Mljekarstvo. 23 (1): 19-23. (Cited in Dairy Sci. Abstr. 35(8):3147).

Farhan, S.M.A. and Thomas, P.C. (1977). The effect of intra-abomasal infusions of glucose or casein on milk secretion in Saanen goats receiving a low-protein diet. Proceedings of the Nutrition society. 36 (2): 57A. (Cited in Dairy Sci. Abstr. 40 (4):1775).

Fehr, P.- M. (1971). Feeding pelleted forages to dairy goats. Annals zootech. 20 (3): 305-320. (Cited in Dairy Sci. Abstr. 34 (2) : 613).

French, M.H. (1970). Observations on the goats: Goat Milk. FAO Agric. Stud. 80 : 93. (Cited by Jenness, R. (1980). J. Dairy Sci. 63 (10):1605-1630).

Gamble, J.A., Ellis, N.R. and Beeley, A.K. (1938). Cited by Parkash, S. and Jenness, R. (1968). The composition and characteristics of goats' milk : A Review. Dairy Sci. Abstr. 30 (2): 67-87.

Gelbert, M.D. and Novgorodova, G.P. (1972). Effect of thyroid hormones on the yield and nitrogenous composition of goats' milk. Trudy Vsesoyusnogo Selskokhozyaistvennogo Instituta Zaochnogo Obrazo Vaniya. No. 51:15-21. (Cited in Dairy Sci. Abstr. 39(2):865).

Georgiev, I.V. (1962). Changes in the composition and properties of ewes' milk during lactation. Naushn. Trud. Visshselskoston. Inst. "G. Dimitrov" (Zootekh. Fak.) 11: 515-526. (Cited in Dairy Sci. Abstr. 24 (11): 5555).

Ghosh, S.N. and Anantakrishnan, C.P. (1964). Composition of milk. Part V. Effect of stage of lactation. Indian J. Dairy Sci. 17 (1): 17-28.

Golovan, V.T. (1968). Effect of prolactin, thyroxine and insulin on lactation. Fiziol. Zh. SSSR. 54 (5): 638-646. (Cited in Dairy Sci. Abstr. 31(1):163).

Gomez-Guillamon, L., Varela, G. and Bosa, J. (1961). Effect of feeding dried prickly pear on milk production in Granada goats. Zootechnia, Madrid. 10 (4): 190-197. (Cited in Dairy Sci. Abstr. 24 (5):1248).

Gonc, S. (1979). Yield and composition of milk from German Improved White goats kept by the agricultural faculty of the Aegean University, Izmir, Turkey. Ege Universitesi Ziraat Fakultesi Dergisi (Special Issue) pp. 91-101.(Dairy Sci. Abstr.42(10):6124).

Goto, M., Kasuga, M., Takahashi, T. and Takahashi, N. (1976). Milk secretion, casein content and amino acid pattern of milk protein produced in the goat fed on a protein-free diet containing 1,1-diureidoisobutane. Bulletin of the faculty of agriculture, Meiji University. No. 55: 1-7. (Cited in Dairy Sci. Abstr. 38 (10): 6047).

Graf, F., Osterkorn, K., Pautz, J., Farhm, K. and Gall,C. (1970). Caloriefic value of goats' milk. I. Relationship between fat and caloriefic value. Arb. Inst. Tierzucht. 8:45-52. (Cited in Dairy Sci. Abstr. 33 (10):5519).

Gulati, S.K., Cook, L.J., Ashes, J.R. and Scott, T.W. (1978). Effect of feeding protected cholesterol on ruminant milk fat secretion. Lipids. 13 (11):814-819.

Holmes, A.D., Lindquist, B.G. and Greenwood, E.K. (1945). Cited by Parkash, S. and Jenness, R. (1968). The composition and characteristics of goats' milk. A Review : Dairy Sci. Abstr. 30 (2):67-87.

Indian Standards:1224 (1958). Determination of fat in whole milk, evaporated (unsweetened) milk, seperated milk, skim milk, butter milk and cream by Gerber method. Indian Standards Institution, New Delhi. pp. 5.

Indian Standards: 1479 Part II. (1961). Indian Standards of test for dairy industry, chemical analysis of milk. Indian Standards Institution, New Delhi, pp. 6-9.

Jenness, R. (1979). Composition of milk of the Pygmy goats. (Unpublished). (Cited in J. Dairy Sci. 63 (10): 1605-1630.

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

Ketelhodt, H.F. Von.(1977). The composition of the milk of the African dwarf goat, Springbok and blue duiker. Zoologica Africana. 12 (1):232. (Cited in Dairy Sci. Abstr. 40 (6):4277).

Knowles, F. and Watkin, J.E. (1958). Cited by Parkash, S. and Jenness, R. (1980). The composition and characteristics of goats' milk : A Review. Dairy Sci. Abstr. 32(2):67-87.

Kubis, J. (1963). Study of the composition of ewes' milk during lactation. Prumysl Potravin. 14 (8):438-440. (Cited in Dairy Sci. Abstr. 25 (12):3592).

Lauer, D.H., Blood, D.A., Pearson, A.M. and Baker, B.E. (1969). Goat milk. I. Mountain goat (Oreamnos americanus). Gross composition and fatty acid constitution. Can. J. Zool. 47 (1):5-8. (Cited in Dairy Sci. Abstr. 31 (5):1906).

Lee, K.W., Choi, K.S., Tak, T.Y., Sul, D.S. and Lee, K.Y. (1975). Improvement of Korean native goats by grading-up with Saanen. II. Changes in milk performance of crossbreds between Korean native goats and Saanen. Korean J. Anim. Sci. 17 (1): 50-57. (Cited in Dairy Sci. Abstr. 38 (11): 6851).

Leonhard, Irena. (1963). Constituents of goats' milk in relation to their usefulness for estimating its value. I. Chemical composition of milk of Improved White Goats. Roczn. Nauk rol. (ser. Zootechniczna) 81 (3): 535-562. (Cited in Dairy Sci. Abstr. 26 (5): 1437).

Leonhard, Irena. (1963). Constituents of goats' milk in relation to their usefulness for estimating its value. II. Relation between and variation in the constituents studied. Roczn. Nauk rol. (ser. Zootechniczna) 82(1): 145-160. (Cited in Dairy Sci. Abstr. 26 (5):1438).

Ling, E.R., Kon, S.K. and Porter, J.W.G. (1961). "The composition of milk and nutritive value of its components", Milk: the mammary gland and its secretion. Ed. by Kon, S.K. and Cowie, A.T. Academic Press, New York. Vol. II. p. 237.

Linzell, J.L. (1967). The effect of very frequent milking and of oxytocin on the yield and composition of milk in fed and fasted goats. J. Physiol. 190 (2):333-346.

Linzell, J.L. (1967). The effect of infusions of glucose, acetate and amino acids on hourly milk yield in fed, fasted and insulin treated goats. J. Physiol. 190 (2): 347-357.

Linzell, J.L. (1971). The effects of oxytocin and milk removal on the milk secretion in the goat. J. Physiol. 216:717-734.

Linzell, J.L. and Peaker, M. (1972). Day-to-day variations in milk composition in the goat and cow as a guide to the detection of subclinical mastitis. Brit. Vet. J. 128:284.

Linzell, J.L. (1973). Innate seasonal oscillations in the rate of milk secretion in goats. J. Physiol. 230 (1): 225-233.

Lythgoe, (1940). Cited by Parkash and Jenness, R. (1968). The composition and characteristics of goats' milk: A Review. Dairy Sci. Abstr. 30 (2): 67-87.

Macy, I.G., Kelley, H.J. and Sloan, R.E. (1953). Cited by Parkash, S. and Jenness, R. (1968). The composition and characteristics of goats' milk: A Review. Dairy Sci. Abstr. 30 (2):67-87.

Maltz, E. and Shkolnik, A. (1979). Milk production in the desert : Lactation and water economy in the Bedouin goat. Zool. Soc., London (in press). (Cited by Jenness, R. (1980). J. Dairy Sci. 63 (10):1751).

Marchenko, G.M. (1972). Effect of duration of teat receptor stimulation during milking on milk secretion. Trudy Kishinevskii Selskokhozyaistvennyi Institut. No. 94. pp. 55-59, 73. (Cited in Dairy Sci. Abstr. 37 (9):5660).

Marques, F. (1977). Some dairy characters of Murcian-Granada goats. In symposium of goat breeding in Mediterranean countries, Madrid, Spain. pp.354-361. (Cited in Dairy Sci. Abstr. 42 (1):42[illegible]

Mba, A.U., Boyo, E.S. and Oyenuga, V.A. (1975). Studies on the milk composition of West African dwarf, Red Sokoto and Saanen goats at different stages of lactation. I. Total solids, butter fat, solids-not-fat, protein, lactose and energy content of milk. J. Dairy Res. 42 (2):217-226.

Mba, A.U., Bassey, E.A. and Oyenuga, V.A. (1975). Dietary effects on the relationship between metabolites and milk qualities in Red Sokoto goats'. Nigerian Journal of Animal Production. 21 (1):66. (Cited in Dairy Sci. Abstr. 39 (10):5395).

Mena, L.A. and Escamilla H, R.J. (1977). Adaptability and performance of three breeds of dairy goats under conditions of complete housing and identical feeding. In XV Informe de investigacion, 1975-1976, Division de Ciencias Agropecuarias Y Maritimas, Instituto Tecnologica de Monterrey. Monterrey, Mexico. pp. 130-131. (Cited in Dairy Sci. Abstr. 40 (10):5435).

Meyer, J. (1963). Correlations between yield, fat, S.N.F., protein and lactose in goats' milk. Ludwig-Maximilians-Univ. Munich: Inaug.-Diss. (Cited in Dairy Sci. Abstr. 26 (5):1436).

Mihal, L (1954). Study of the milk yield and milk composition of Pramenka and German Improved Land Sheep. Rad. Poljopriv. Fak. Univ. Sarajeva. 3 (4/5):41-56. (Cited in Dairy Sci. Abstr. 37 (6):1455).

Mittal, J.P. and Pandey, M.D. (1971). The yield and chemical composition of milk in Barbari and Jamnapari goats. Agra Univ. J. Res. 20 (3): 7-12. (Cited in Dairy Sci. Abstr. 37 (7):4447).

Mittal, J.P. and Ghosh, P.K. (1981). Parbatsar goat of Rajasthan desert. Indian Dairy man. 33 (6):347-350.

Moo Quot, J.C. and Arun, T. (1974). Effects of different milking frequencies on milk yield in goats. Annales de Genetique etde Selection Animale. 6 (4):463-475. (Cited in Dairy Sci. Abstr. 38 (10):6072).

National Commission Report, Govt. of India. (1976). Part VII, Animal husbandry. Ministry of Agriculture and Irrigation, New Delhi. pp. 211-222.

Nicholson, W.S., Jr., Willard, H.S., Thomas, W.A. and Brown, D.C. (1957). Cited by Kon, S.K. and Cowie, A.T. (Ed). Milk : The mammary gland and its secretion. Academic Press, New York. Vol. II. p. 237.

Nickerson, T.A. (1965). "Lactose", Fundamentals of Dairy Chemistry. Edited by Webb, B.H. and Johnson, A.H. The AVI Publishing Company, Inc. West port, Connecticut, U.S.A.

Nirmalan, G. and Nair, M.K. (1962). A study of the chemical composition of goats milk. Kerala Vet. 1(2):49-51.

Oser, B.L. (1965). Hawks Physiological Chemistry. Tata Mc Graw-Hill Publishing Company Ltd., Bombay. 14th ed. pp. 392-393.

Park, S.H., Gu, J.Y. and Han, I.K. (1970). Production and composition of milk of dairy goats consuming rations with various roughage/concentrate ratios. Korean J. Anim. Sci. 12 (3): 183-187. (Cited in Dairy Sci. Abstr. 36 (2):784.

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

Patton, S. (1976a). Reversible suppression of milk secretion by Concanavalin A. FEBS letters. 71 (1): 154-156. (Cited in Dairy Sci. Abstr. 39 (6):5133).

Patton, S. (1976b). Mechanism of secretion : Effects of Colchicine and Vincristine on composition and flow of milk in the goat. (Cited by Jenness, R. (1980). J. Dairy Sci. 63 (10): 1605-1630).

Patton, S., Stemberger, B.H. and Knudson, C.M. (1977). The suppression of milk fat globule secretion by colchine An effect coupled to inhibition of exocystosis. Biochem. Biophys. Acta. 499:400. (Cited by Jenness, R. (1980). J. Dairy Res. 63 (10):1605-1630).

Peaker, M. and Linzell, J.L. (1973). Changes in milk composition preceding oestrus in the goat : Comparison with the effects of exogenous oestrogens. J. endocr. 59 (2): 47.

Pearson, D. (1976). The chemical analysis of foods. Churchill Livingstone. Edinburg, London. 7th ed. pp.411.

Protasov, B.I. (1968). Effect of adrenaline and chlorpromazine on milk secretion. Fiziol. zh. SSSR. 54 (5): 631-637. (Cited in Dairy Sci. Abstr. 31 (1):164).

Pusino, A. and Vodret, A. (1975). Composition of goat's milk produced in Sardinia. Studisassaresi, III. 23. pp. 143-156. (Cited in Dairy Sci. Abstr. 41 (8): 4673).

Qureshi, H.A., Deshpande, K.S. and Bonde, K.S. (1981). Studies on the chemical composition of goat milk. Indian Vet. J. 58 (3):212-214.

Ranawana, S.S.E. and Kellaway, R.C. (1977a). Responses to post-ruminal infusion of graded levels of casein in lactating goats. Br. J. Nutr. 37 (1):67-79.

Ranawana, S.S.E. and Kellaway, R.C. (1977b). Responses to post-ruminal infusion of casein and glucose in lactating goats. Br. J. Nutr. 37:395.

Rakes, J.M.; Collins, J.; Johnson, Z.B.; Yasman, J.A. and Mannasmith, C.H. (1980). The effects of stage of lactation and breed on the production and composition of goat milk produced in Arkansas. J. Dairy Sci. 63 (1) : 112.

Ronningen, K. (1964). Relationships between milk yield, fat percentage and butter fat yield in goats. Sau og Geit. 17:9-10. (Cited in Dairy Sci. Abstr. 27(6):1640).

Rook, J.A.F. and Campling, R.C. (1965). Effect of stage and number of lactation on the yield and composition of cow's milk. J. Dairy Res. 32 (1):45.

Saohdeva, K.K. (1971). Influence of different levels of nutrition on feed utilisation and milk production by Indian goats. Agra Univ. J. Research Sci. 20 (3): 85-91. (Cited in Dairy Sci. Abstr. 37 (8): 4579).

Saohdeva, K.K., Sengar, O.P.S., Singh, S.N. and Lindahl, I.L. (1974). Studies on goats. II. Effect of plane of nutrition on milk production and composition. Milchwissenschaft. 29 (8):471-475. (Cited in J. Dairy Sci. 63 (10):1605-1630).

Sauvant, D. and Pehr, P.-M. (1977). Effect of concentrate intake in full lactation on performance of goats. In symposium on goat breeding in Mediterranean countries. Madrid, Spain. 174-183. (Cited in Dairy Sci. Abstr. 42 (1):58).

Schellner, G. (1972/1973). Effect of sodium deficiency and sodium feed supplements on growth, milk yield, milk fat content and yield and fertility in goats. Jahrbuch fur Tierernahrung und Fetterung. 8:246-259. (Cited in Dairy Sci. Abstr. 37 (8) : 3873).

Snedecor, G.W. and Cochran, W.G. (1967). Statistical Methods. The Iowa State College press, Iowa. 6th ed. pp. 489-525.

Spedding, C.R.W. (1969). The agricultural ecology of grassland. Agric. Progr. 44:7. (Cited by Jenness, R. (1980). J. Dairy Sci. 60 (3): 1760).

Statistical Hand Book of Kerala (1979). Bureau of Economics and Statistics. Trivandrum. p.47.

Trout, G.M. (1941). Cited by Parkash, S. and Jenness, R. (1968). The composition and characteristics of goats' milk: A Review. Dairy Sci. Abstr. 30 (2):67-87.

Uecokermann, L., Joubert, D.M. and Seyn, G.J. Van D. (1974). The milking capacity of Boer goat does. WldRev. Anim. Prod. 10 (4):78-83.

Urquhart, J.C. (1930). Cited by Davis, J.G. and Mac Donald, J.F. (Ed). Richmond's Dairy Chemistry. Charles Griffin and Company Limited. London. 5 th ed. pp. 88-106.

Uusi-Rauvi, E., Ali-Yrkko, S. and Antila, M. (1970). Composition of Finnish goats' milk. Suom. Kem. 43B (4):178-182. (Cited in Dairy Sci. Abstr. 32(8): 3525).

Valdma, M. (1959). Effect of thermal stimulation of the udder on milk yield, gas metabolism and minute heart volume. Sborn. Nauchm. Trud., Estonsk. Nauchno-issled. Inst. Zhivotn. vet. No. 3. pp.5-17. (Cited in Dairy Sci. Abstr. 25 (5):1412).

Varela, G., Lopez Granade, F. and Boza, J. (1961). Value of urea for milk production in Granada goats. Agrochimica. 6 (1):86-91. (Cited in Dairy Sci. Abstr. 25 (5):1295).

Volchenko, E.E. (1959). Chemical composition and properties of the milk of Karakul sheep. Trud. Alma-Atinsk. Zoovet. Inst. 11:197-202. (Cited in Dairy Sci. Abstr. 24 (1):252.

Whittier, E.O. and Corbin, E.A. (1965). "The composition milk", Fundamentals of Dairy Chemistry. Edited by Webb, B.H. and Johnson, A.H. The AVI Publishing Company, Inc. West port, Connecticut, U.S.A. p.18.

CHEMICAL COMPOSITION OF MILK OF CROSSBRED GOATS

BY

B. BAIJU

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 undertaken to study the chemical composition of the milk of Saanen x Malabari and Alpine x Malabari crossbred goats maintained at the All India Co-ordinated Research Project on Goats for Milk, Mannuthy.

A total of 471 milk samples collected both from the morning and evening at weekly intervals were analysed for the fat, protein, lactose and ash contents.

The results of the study indicated that there was no significant difference between the two breeds with regard to the fat content of the morning samples of milk, but significant difference was noticed between the fat content of the evening samples and also the total fat content of the milk. In both the crossbreds significant difference could be noticed between the fat contents of the morning and evening samples of milk.

No significant difference could be observed between the protein content of the milk of the two different crosses but significant difference was noticed between the protein content of the morning and evening samples of milk.

Between the two crossbreds no significant difference could be noticed in the lactose content of the milk. The

lactose content was found to be not influenced by either breed or the time of milking. A similar trend was observed in the ash content of milk also.

As lactation advanced there was a tendency for the fat, protein and ash content in milk to increase with a decline in the content of lactose.

The average composition of the milk of Alpine x Malabari goats was fat 6.29, protein 4.40, lactose 4.66 and ash 0.776 per cent and that of Saanen x Malabari 5.64, 4.40, 4.06 and 0.782 per cent respectively.