DISCUSSION
DISCUSSION

In spite of the remarkable developments in Indian milk industry there are still great difficulties with regard to quality as well as quantity of milk served to the consumer. The universal practice of allowing the calf to suckle a little milk before milking, the practice of milking the animals on streets for door to door delivery, the dirty udder and unwashed flanks, filthy condition of byres, polluted water supply, unclean utensils, the unwashed and contaminated hands of milkers, defective transport arrangements, the warm climate of the country, the unhygienic conditions of milk shops, the lack of suitable technical and educational facilities, widespread adulteration, the ignorance and indifference of persons generally engaged in the milk trade are only a few of the many causes for inferior quality milk as compared to other countries.

The quantity of milk being processed in the organized sector is hardly ten percent of the total production. The rest of the milk is either retained by milk producers or is sold through middlemen. In villages and big cities, a large volume of milk is being supplied by middlemen and vendors for human consumption. The bacteriological analysis of raw milk in India is poor resulting in an enormous loss through souring and spoilage and also greatly imperiling the health of consumers with such milk. The time lag between production and consumption of milk particularly in rural areas being 4-5 hours results in significant bacteriological growth in the raw milk and ultimately affects the quality of milk. Thus, the milk reaching the last consumers particularly during hot and humid season, will be on the verge of spoilage. Due to such conditions clean milk production assumes special significance. The quality
standards for market milk in India covers mostly chemical aspects and aims at checking its adulteration whereas the quantum of work done throughout the country in bacteriological grading of milk has formed no dent in enforcing the bacteriological grading of milk. High bacterial count of raw milk is a health hazard for consumers. The present study is an attempt to estimate and analyse the biochemical parameters and various groups of bacteria and in general the quality of milk and milk products produced and distributed in and around Courtallam.

**BIOCHEMICAL EVALUATION OF MILK SOLD IN AND AROUND COURTALLAM**

**pH**

The pH is defined as negative logarithm of hydrogen ion concentration. This is a measure of the amount of active hydrogen (H⁺) or hydroxyl (OH⁻) ions present in a solution. For a perishable food product of exceptional nutritive value like milk, its hydrogen-ion concentration is an important property governing stability and behaviour under various conditions. The pH determination is therefore, used in the dairy industry for various purposes beginning from the production of milk till its disposal either for liquid consumption or in the manufacture of products of long keeping quality (Rao and Dastur, 1955-a).

The pH of milk plays an important role indicating the healthy state of the mammary gland, keeping quality of milk, stability of milk to heat, stability of milk as a medium for the growth and nature of bacteria, in the manufacture of products like dahi, butter, cheese of various kinds, food casein, evaporated milk and also in determining the keeping quality of milk products. Besides, pH measurements find other uses like checking the strength of detergents, efficient
disposal of dairy effluents and quality of brine used for refrigeration (Rao and Dastur 1955-a).

In the present study the pH range of milk obtained from different sources and places was 6.38 to 6.89. Normal fresh milk has slightly acidic pH, the average being 6.6 (Parkash and Puri, 1960; Jayant and Singh, 2001). The pH of milk decreases during storage under ordinary conditions as a result of bacterial action on some of the milk constituents particularly lactose (Rao and Dastur, 1955-b). Rao and Dastur (1955-b) reported the lowest pH value as 6.00±0.00. Similar study was carried out by Balasubramanyam et al. (1985) and Raniya and Kumaresan (1996) and the respective values were 6.53 and 6.54. All these values were in the acidic range showing the freshness of milk. However, Adesiyun et al. (1997) indicated slightly elevated pH and the values were 6.73 and 6.76 for bulk and composite milk. Similarly Boghra and Mathur (2000) studied pH of cow's milk and buffalo-milk and reported the values as 6.78 and 6.71 respectively. The pH value of Melagaram sample was 6.89 ± 0.01. This was slightly higher than the values quoted by the above authors. The pH values of most milk samples of present study conclusively showed that the range was less than the reported values except Melagaram samples.

**MOISTURE AND TOTAL SOLIDS**

Milk is a natural liquid food containing a high percentage of water. Milk is actually a concentrated food designed to produce rapid growth in young mammals and contains more solid material than many of our other common foods. Water is the medium in which all the other components of milk are dissolved. A small percentage of water in milk is hydrated to lactose, salts and some bound in the proteins. Water present in milk is not different
from ordinary water and serves to hold the soluble constituents of milk in solution. Any variation in the amount of other constituents is also reflected upon the water percentage. The fluid nature and the high water percentages, often lead to an erroneous conception of the food value of milk.

In the present study minimum and maximum moisture were recorded in the home sample of Melagaram and in vendor's sample of Tenkasi respectively (Table 2). This difference was also reflected in the total solid contents of the milk samples studied (Table 3). Boghra and Mathur (1996), Boghra and Mathur (2000), Mathur et al. (2000) and Jayant and Singh (2001) studied the moisture contents of cow's milk and buffalo milk and provided the respective values as 86.68 and 85.16, 86.79 and 85.88, 87.50 and 83.1 and 86.1 percent. In the present study, the analysis carried out on cow's milk, the moisture content and total solids were comparable to the values of above authors. Krishnamurti et al. (1977) Yadav and Saraswat (1982) showed higher total solids (14.11 percent and 15.64 percent) and Ernest and Venkateswami (1980) recorded a wider range of total solids (12.50 to 15.00 percent). Patwardhan et al. (1986) studied the total solids of milk in different seasons and reported a range of cow milk 13.67 to 14.4 percent. There was perfect negative correlation between moisture and total solids ($r = -1.0$) and positive correlation between total solids and lactose ($r=0.99$) (Table-24). Whenever the moisture content of milk was increased, automatically the total solids would be decreased. This was true in the present study. Higher moisture contents with the simultaneous reduction in the total solids in any milk sample might be attributed to the adulteration by the unscrupulous vendors. Values of moisture and total solid contents of the present study were comparable to the established values for cow's milk.
ACIDITY

The acidity of fresh milk is due to certain constituents of milk like phosphates, proteins and to a slight degree by the presence of carbon dioxide and citrates. Generally the acidity of milk is first detected by taste when pH drops to about 6.0. When milk is freshly drawn from the cow, it shows an amphoteric reaction. As fresh milk contains no lactic acid, this acidity is apparent and is a measure of the amounts of alkali combines with the protein and mineral salts in the milk. When bacterial fermentation takes place, lactic acid is formed and the acidity of milk is increased (Matta et al. 1991)

The acidity determination is valuable to use as a guide in manufacturing operations and measuring the quality of dairy products. When fresh milk is titrated with a standard solution of alkali, its acidity is equivalent to 0.13 to 0.18 percent of lactic acid.

Acidity of milk samples of the present study showed the values of 0.12 and 0.19 percent as minimum and maximum. The maximum value was recorded from the milk samples of Viswanathapuram which was higher than the values recorded by Ernest and Venkateswami (1980), Balasubramanyam et al. (1985), Lakhani et al. (1990) and Jayant and Singh (2001). However, Salam and Shibiny (1966) recorded higher values and were 0.21 and 0.21 percent for individual and bulk samples. On the contrary Rao and Dastur (1955-a) recorded a minimum acidity value of 0.13 ± 0.02 percent which was comparable to the lowest value of the present study. Hence, the values of milk acidities of the present study did not deviate much from the values available in the literature.

MILK FAT

Lipids are essential constituents of all living tissues. They are vital components of brain and nerve cells and are essential to many physiological processes. They play an important role in both
human diet and nutrition since it serves as a potential source of energy.

Milk fat is the most valuable of all milk components. Milk lipids rate high for their pleasing flavour which is not duplicated in other types of food. They help to improve palatability by contributing to the texture and flavour. They also add to the satiety value since fat stay in the stomach longer than carbohydrates and proteins do.

Milk lipids are carriers of fat soluble vitamins and are precursors of vitamins A and D. They carry a small amount of the essential fatty acids like linoleic and arachidonic acids. In addition, certain phospholipids and sterols are also present in milk lipids (Mathur et al. 2000).

The range of fat percentage in the present study was 1.9 to 3.1, which was much lower to the values given for cow's milk (Mathur et al. 2000). The lowest fat percentage was recorded in Viswanathapuram vendor's sample (Table 6). Milk fat recorded in cow's milk and the milk of buffalo by Boghra and Mathur (1996), Boghra and Mathur (2000), Mathur et al. (2000) and Jayant and Singh (2001) were 4.15 and 5.12, 3.97 and 4.30, 4.10 (cow milk alone) and 7.40 and 5.40 percent respectively. Balasubramanyam et al. (1985) reported a fat percentage of 3.88 for cow’s milk. In a similar study conducted by Ernest and Venkateswami (1980) showed a range of 3.5 to 6.0 percent and Ontsouka et al. (2003) recorded the value of 5.76 percent. Pruthi et al. (1987) reported the average fat content in four farms located at Lucknow, Jabalpur, Pimpri and Bangalore were 3.98, 3.97, 4.12 and 3.96 percent respectively. Petit (2003) reported the mean fat percent of 4.23 and 4.44 in cow milk fed with flaxseed and sunflower seed. In the present study the percentage of fat in all sources of milk was inferior to the levels
indicated by the above authors. Hence, the milk sold in Courtallam area is not complying with the prescribed standards.

**LACTOSE**

Lactose is the major carbohydrate present in milk. It forms the main source of carbohydrate in the diet of young ones. On hydrolysis it yields one molecule each of glucose and galactose, both of which are convertible into glycogen in the human body. Galactose is essential for the synthesis of galactosidasases of brain and medullary sheaths of nerve tissues and the myelin formation of cerebrosides in infants. The presence of lactose in the intestine stimulates the growth of beneficial microorganisms that produce organic acids and synthesise many B-vitamins (Mathur *et al.* 2000).

Lactose in milk exists in true solution. It occurs in two forms both of which occur either as hydrate or anhydrate. It is fermented by bacteria to yield lactic acid and other organic acids and is important in the production of cultured milk products by souring. (Matta *et al.* 1991). The lactose content of milk is increased slightly by feeding with fodder rich in carbohydrates, especially soluble carbohydrates. The amount tends to decline gradually with the progress of lactation and mastitis infection of udder.

Minimum and maximum lactose content were noted in milk obtained from vendors of Courtallam and home samples of Tenkasi respectively and the range was 4.49 to 5.85 percent. Boghra and Mathur (1996), Boghra and Mathur (2000), Mathur *et al.* (2000), Jayant and Singh (2001) and Ontsouka *et al.* (2003) reported the lactose contents as 5.09, 5.19, 4.40, 4.90 and 4.99 percent respectively. In an earlier study carried out by Praphulla and Anandakrishanan (1958) and (1960) recorded lower lactose percentages and the respective values were 4.71 and 4.66. Petit (2003) analysed the cow’s milk fed with flax seed and sunflower seed
and reported the lactose percentage as 4.36 and 4.46. Hence, the lactose content of the present study was comparable to the values of different breeds of cows.

**MILK PROTEINS**

Proteins are most abundant intracellular macromolecules and constitute over half the dry weight of most organisms. Protein occupies a central position in the architecture and functioning of living matters. They are intimately associated with all phases of chemical and physical activity that constitute the life of the cell. Some proteins serve as important structural elements of the body; other proteins may be enzymes, hormones or oxygen carriers. Still other proteins participate in muscular contraction and some are associated with the genes, the hereditary factors (Smith et al. 1983).

Milk proteins are synthesised in the mammary gland and biologically it is graded next to egg protein. Its biological value has been reported to be 85 percent showing that the utilization of milk proteins in the body is approximately thorough. The most important milk protein is casein, which is not found in any other source except milk. It supplies almost all the essential amino acids required for growth (Mathur et al. 2000).

In the present study the protein content of milk samples ranged from 2.77 to 3.36 percent (Table-8). This value agrees well with the range given by Parkash and Puri (1960) and Ernest and Venkateswami, (1980) However, these values were inferior to the protein content shown by Boghra and Mathur (1996), Boghra and Mathur (2000), Ontsouka et al. (2003) and Petit (2003). Jayant and Singh (2001) reported the protein content as 3.8 and 3.2 percent in cow's milk and buffalo's milk respectively. Even the maximum value of the present study did not coincide with the value of Jayant and
Singh (2001). In general the milk protein values of the samples studied were much less than the values quoted by the other authors. Therefore, the milk sold in our area may be considered as poor in terms of its protein content.

**MILK MINERALS**

Our body contains about twenty four minerals; all of them must be provided by the diet. It has been known for many years that calcium, phosphorus, potassium, sodium, chlorine, magnesium, iron, iodine, manganese, copper and sulphur are essential to the animal body for its normal function. In addition to many specific functions, the macrominerals are involved in some rather generalized functions in maintaining physiological conditions suitable for life. These would include such things as osmotic pressure, buffering activity which stabilizes tissue pH, and effects on irritability of muscle and nerves (Church *et al.* 1971).

Milk contains minerals mainly as inorganic salts, although some of them are in organic combination. Though minerals form a very minor part of the total nutrients present in milk, they are very important in human nutrition. A slight variation of these minerals in milk greatly affects the quality of milk products like cheese and evaporated milk.

**CALCIUM AND PHOSPHORUS**

Calcium and phosphorus are important constituents of all body cells. Quantitatively more calcium is found in animal body than any other mineral element chiefly due to the fact that calcium is the major element in bone, representing about 9 percent of the bone, on a wet basis. In the bone calcium is found in a rather constant ratio of 2 : 1 to phosphorus. Of the total body supply of
Calcium, about 99 percent is said to be found in bone and teeth with the other 1 percent distributed in various soft tissues.

Calcium is essential for clotting of blood, contraction of cardiac and skeletal muscle, regulates excitability of nerve fibres. Phosphorus plays an important role in carbohydrates metabolism and storage of energy in the form of ATP (Prapulla and Anantakrishnan, 1959).

In the present study the calcium content of milk was higher in Courtallam samples in all the three sources than any other place. Salam et al. (1983), Srivastava et al. (1978), Florence et al. (1985) and Akinsoyinu (1981) gave the values as 147, 126-130, 111-132 and 125.2 milligrams per 100 milliliter of milk respectively. Calcium values of the present study was much lower than the values recorded by the above authors. In addition, Indian standard Institute reported the milk calcium level as 124.35 mg per 100 milliliter for cow's milk. Increased amount of calcium was reported by Boghra and Mathur (1996) and Boghra and Mathur (2000) for buffalo's milk and the respective values were 178 and 181.5 milligram per 100 milliliter.

Similar to calcium, the phosphorus content was higher in Courtallam samples than in any other source of milk studied. Akinsoyinu (1981), Salam et al. (1983), Florence et al. (1985) and Srivastava et al. (1978) reported the phosphorus content of cow's milk as 91.7, 132.0, 89-100 and 91.7-95.0 milligrams per 100 ml respectively. These values were more elevated than the values of present study except Courtallam samples. Milk phosphorus levels observed by Jayant and Singh (2001) were also superior to most of the values of the present study. A critical study was taken by Mistry and Patel (1961) on the calcium and phosphorus contents in the milk of Kankrej cows. Results of their study indicated that the calcium content of milk of an individual cow would not be uniform at
all throughout and the variation would be different for different animals. Another important factor to be considered in Courtallam area is the adulteration of milk by unscrupulous milk vendors.

**MAGNESIUM**

Magnesium is required to activate many enzyme system by forming a metallo–enzyme complex. This element plays a significant role in intracellular metabolism by the way of enzyme activation. The metal seems to activate all enzyme system which catalyze the transfer of phosphate from ATP to a substrate or form a phosphorylated compound to ADP. Since ATP is involved in activation of acetate, formate, sulphate, in oxidative phosphorylation, in muscular contraction, in group transfers and active transport of nutrients across cellular membranes, the important role of magnesium is implicit in all these functions. In enzyme reactions involving ATP, the actual substrate is assumed to be ATP – Mg complex.

Milk magnesium of the present study showed a very wide range of 1.10 to 23.05 milligrams per 100 milliliter (Table-11). Similar to the values of calcium and phosphorus, magnesium was also higher in the samples of Courtallam. The lowest magnesium content were recorded in Tenkasi and Melagaram samples of three sources studied. Akinsoyinu (1981), Salam et al. (1983), Florence et al. (1985), Mathur et al. (2000), Boghra and Mathur (2000) and Jayant and Singh (2001) showed the values as 14.9, 21.0, 11-13, 12.0, 12.85 and 11-14 milligrams per 100 milliliter of milk respectively. Some of the magnesium contents of Shencottah and Viswanathapuram were comparable to the values of above authors. It is very pertinent to indicate that the minerals in milk entirely depended upon the dietary supply of these minerals. High concentration of calcium, phosphorus and magnesium were observed
in the milk of Shahabadi cows when the animals were in the lactation period of 15-60 days (Singh et al. 1984). Low minerals present in the milk definitely will have impact on the consumer.

**IRON**

A tremendous amount of research has been carried out on the nutrition and metabolism of iron. Iron is found in enzymes such as the catalase and peroxidase which are heme enzymes which liberate oxygen from peroxides. Other iron containing enzymes include non-heme metallo-flavoproteins such as xanthine oxidase, succinic dehydrogenase and cytochrome reductase. With the sole exception of lactic acid bacteria, all living organisms require iron as an element for growth and multiplication (Underwood, 1977; Kumaresan and Aliu, 1983).

Generally the iron content of milk is very low. In the current study, the milk was found to contain much higher amount than the value reported in the literature (Kumaresan and Anooja, 1999). Iron content of milk reported by Anita, (1989) was 0.1 milligram per 100 milliliter. Similar value was also given by Lampert (1974). Its usual range shown by Webb et al. (1987) was 100 to 900 μg per liter of milk. Since the milk is transported in iron utensils than other type of vessels in this area, the iron contents estimated were much superior to the values available in the literature (Mathur and Roy, 1976; Mathur et al. 2000; Boghra and Mathur, 2000 and Jayant and Singh, 2001). It is very important to note that the trace - element contamination in samples like milk could not be completely prevented because of usage of iron utensils for the transport of milk (Mills and Williams, 1971). Hence, higher iron contents were also possible with the milk samples of this area.
SODIUM, POTASSIUM AND CHLORIDE

Sodium is generally said to be primarily confined to the extracellular fluids, however, an appreciable amount of the body store is found in bone and cartilage. Sodium apparently makes a greater contribution to pH, buffering systems and maintenance of physiologically desirable osmotic pressure than do many of the other inorganic nutrients. Sodium is certainly considered to have a very important influence in the regulation of body fluid volume. The transmission of nerve impulses is related to the electrical potential resulting from the separation of sodium and potassium across the cell wall since the upstroke of nerve action potential is associated with a sudden inflow of sodium which precedes the subsequent outflow of potassium. Although most sodium exists in solution in body fluids, sodium is known to be found in a number of organic molecules.

Sodium concentration of milk samples of the present study ranged from 37.67 to 103.17 milligrams per 100 milliliter of milk which was much elevated to the values given by Jayant and Singh (2001). However, sodium content of some samples of the present study was slightly higher than the value shown by Sindhu and Roy (1982), Mathur et al. (2000), Praphulla and Anantakrishnan (1958 and 1960), Ashokumar et al. (1985) and Sbodio et al. (1985). An overview of sodium concentration of the present study clearly indicated that the values were superior to the values compared to those found in the literature. This might be due to excess of sodium concentration present in ruminant’s ration. Feeding such high level of sodium might result hypertonicity of extracellular fluid and intracellular dehydration.

Majority of potassium present in the body is found in the cells and very little fraction of it in the extracellular fluids. Potassium is known to be one of the several elements concerned with
nerve irritability and along with sodium is believed to be directly involved in the development of electrical potentials in nerve impulses. Nerve fibers are rich in potassium which rapidly diffuses out and is replenished in the nerve cells during the rest period. A number of the enzymes of carbohydrate metabolism and electron transport have been found to be potassium dependent.

Minimal and maximal concentration milk potassium recorded were 52.67 and 110.0 milligrams per 100 milliliters in the vendor's samples of Viswanathapuram and Melagaram. These values were far less than the literature values available. The values quoted by Praphulla and Anantakrishnan (1958 and 1960) Mathur et al. (2000) and Jayant and Singh (2001), Sbodio et al. (1985) were much elevated than our potassium concentration. The lower potassium concentration of milk sample may be directly related to the potassium content of the diet. Under normal circumstances the potassium content of most grains and forages in this area are greater than 1 percent of the dry matter. Hence, such a situation was not contributed by the dietary factors.

Chloride and bicarbonate are the principal anions found in the body fluids and are believed to be primarily concerned with the regulation of osmotic pressure and in the maintenance of physiological pH in the tissues. In gastric juice, the chloride ion is associated with hydrogen ion, but in most other tissues it tends to be indirectly related to the bicarbonate concentration and the sum of the two ions is relatively constant (Smith et al. 1983).

The chloride content of the body is most probably present as chloride ions, rather than in combination with sodium and other minerals. The average chloride content of a normal cow's milk is about 140 milligrams per 100 milliliters (Mitra, 1956). Milk from cows with diseased udder usually has a high content of salt and tastes salty. In the present study the chloride content of milk
ranged from 78.3 to 100.02 milligrams. Values of the present study coincided with the observation of Praphulla and Ananatakrishnan (1958; 1960) and Jayant and Singh (2001). Boghra and Mathur (2000) described an increased chloride content compared to the values of present study. The chloride content of milk from cows with mastitis may be as high as 0.3 percent. Raniya and Kumaresan (1996) also gave 0.12 and 0.42 percent of chloride per 100 milliliter for normal and mastitis milk. In such circumstances the lactose content may be decreased. In order to compensate for the decrease of lactose and maintain the normal osmotic pressure of the milk there is an increase in its chloride content (Raniya and Kumaresan, 1996). Hence, the chloride content of milk sold in this area is comparable to the values given for normal milk.

MICROBIOLOGICAL QUALITY OF MILK SOLD IN AND AROUND COURTALLAM

BACTERIAL POPULATION

There is a need for a better understanding of the current prevalence of bacterial pathogens in raw milk. This information could be used to assess the public health value of regulations banning the sale of raw milk and to educate the public concerning the probability of exposure to bacterial pathogens when consuming raw milk (Steel et al. 1997).

Bacterial population of milk sample obtained from various sources and places ranged from $56.28 \times 10^3$ to $230.17 \times 10^4$ cfu per milliliter of sample in this study. A similar value recorded by Vijayarao and Gopalarao (1983) and the value was $10^7$ cfu per gram of sample. Maximum bacterial population recorded in raw milk samples obtained from various sources like organized dairy farm, vendors and dairy plants were $25 \times 10^5$, $17 \times 10^6$ and $1000 \times 10^5$ cfu
per milliliter respectively (Misra and Kuila, 1989). According to Kumawat et al. (1972), Thomas and Laxminarayana (1972), Sharma et al. (1972) and Con et al. (1996), the bacterial population of raw milk were $130 \times 10^3 - 110 \times 10^7$, $225-4550 \times 10^3$, $48 \times 10^5$ and $9.8 \times 10^6$ cfu per gram. Mean bacterial population of raw milk sold in Kanpur city were $295 \times 10^4$, $33 \times 10^4$, $1142 \times 10^4$ and $429.12 \times 10^4$ cfu per gram of sample in four different sources respectively (Rai et al. 1990). These values were slightly higher than the values recorded in the present study (Table 17).

When the microbial population was correlated with pH, there was negative correlation in the milk sample of Shencottah (Table-27). Normally, pH of milk would drop due to acid production by the increased microbial activity. This phenomenon was observed in the present study too.

The bacteriological quality assessed in milk collected from three societies namely A, B, and C were $205 \times 10^5$, $441 \times 10^5$ and $92 \times 10^5$ cfu per milliliter respectively (Desai and Natarajan, 1981). These values were higher than the values of the present investigation. Bacteriological quality of market milk sold in Rewa city was studied by Dwivedi (1976) and inferred that the quality of milk was very poor. Similarly microbiological quality of market milk in Hisar city was assessed by Gahlot et al. (1975) and found that the total bacterial population was maximum in the milk of Government. Livestock farms showing the poor type of sanitary conditions of milking and utensils cleaning prevailed. Raw milk is regarded as very good, good, fair and poor when it showed the bacteriological population not exceeding 2,00,000, 2,00,000 to 10,00,000, 10,00,000 to 50,00,000 and above 50,00,000 per gram (ISI, 1962). Considering this assessment, milk sold in this area may be graded as fair. In addition, the bacterial population of these samples were higher than the values given by Balasubramanyam et al. (1985).
Microbial population of raw milk stated by Patricia et al. (1996) was $4 \times 10^3$ and $2 \times 10^5$ cfu per millilitre which was much less than the values recorded in this area. Hence, the bacterial load of raw milk sold in this area is high showing poor hygienic conditions.

**METHYLENE BLUE REDUCTION TEST**

Methylene blue reduction test (MBR) is used to assess the quality of milk and indirectly show the microbial load. Milk of poor quality would have lower MBR value indicating a high growth rate of microorganisms causing quick acidity and prominent flavour development in milk. The range of MBR was 32.0 to 115.0 minutes for the milk samples of this area (Table-16). The milk would be satisfactory if it had more than 240 minutes (Igumbor et al. 2002). Negative correlation was recorded with MBR and microbial population (Table-28). As the bacterial population of milk sample increased there was simultaneous reduction in MBR. Hence, the milk sold in Courtallam area was unsatisfactory in terms of microbial population and MBR.

**COLIFORM COUNT**

The presence of coliform organism in milk and milk products is an indicative of these materials being contaminated with fecal matter. Pathogenic bacteria are difficult to detect but are often intestinal associates of *Escherichia coli* (Coliform bacteria) which can be detected by a fairly simple technique. It is used as an indirect assessment of the presence of pathogenic bacteria. The operating assumption is that as long as *E. coli* is present, there is a chance that some pathogenic bacteria are also present.

Microbiological quality of indigenous milk products is usually far from satisfactory. Coliforms play a major role in determining microbiological quality of these milk products. The
coli forms are killed at pasteurization temperature so their presence in milk products such as paneer, khoa and Gulabjamun is an indication of post-preparation, unhygienic handling. Very scanty information is available with regards to the incidence of coliforms in indigenous milk products (Vijaykumar and Sinha, 1989)

Maximum coliform count recorded in raw milk was $93.25 \times 10^4$ cfu per milliliter in Shencottah sample with the minimum value of $0.99 \times 10^4$ cfu per milliliter in Melagaram home sample (Table 18). Since there was wide difference in the values of different places, they were significant. Coliform count of fresh milk recorded by Vijayarao and Gopalarao (1983) were $10^3$ to $10^5$ cfu per milliliter. The values obtained in this area fell in the range given by the above authors. Misra and Kuila (1989) estimated the coliform count in organized dairy farm, vendors and dairy plants and the respective values were $90 \times 10^2$, $18.5 \times 10^3$ and $40 \times 10^1$ cfu per milliliter which were much inferior to the values observed in Courtallam area. Desai and Natarajan (1981) recorded the coliform count in three societies (A, B and C) and the respective values were $1040 \times 10$, $80 \times 10^3$ and $282 \times 10^3$ cfu per milliliter where society A showed higher coliform count than the present values. In raw milk sold at Kanpur city recorded the coliform count as $24.375 \times 10^2$, $5.125 \times 10^2$, $213.375 \times 10^2$ and $64.125 \times 10^2$ cfu per gram of sample obtained from four different sources (Rai et al. 1990). Thomas and Laxminarayana (1972) reported the total coliform range of $0.04 -1.1 \times 10^3$ cfu per milliliter in cow's milk. According to Indian Standard Institution, the raw milk would be satisfactory if it contains no coliform in 1/100 dilution which was not found with raw milk sold in this area. On overall evaluation with regard to coliform count, the milk samples of this area were inferior in quality due to poor sanitary practices. Hence, hygienic handling of milk must be taught to milk vendors to minimize the coliform count in raw milk.
Mold growth in potatoes dextrose agar medium

Seven brands of ice cream evaluated in the present study
Presence of dark, red centred colonies showing the presence of coliform (voilet red bile agar medium)

Bromothymol blue lactose agar plate illustrating golden yellow colonies of *S. aureus*. 
Bacillus cereus

This organism gains entry into milk mainly by contamination with particles of dust, soil and manure. When milking is done without proper washing of the cow, it is not uncommon to find their increase in numbers in raw milk. Bulk of milk production of India is from villages where individual farmers maintain small number of animals. These animals are not maintained in satisfactory hygienic conditions. The milk collected are transported to cities or nearby chilling centre. The spores present in raw milk do not multiply in large numbers due to competition from other fast growing bacteria but grow subsequently under favourable conditions. Davies and Wilkinson (1973) found that B. cereus contamination appears to originate from straw bedding and soil and enter milk mainly from inadequately washed teats. Some strains of B. cereus have been implicated in the production of heat stable enterotoxin thus poisoning the health of the public.

Concentration of B. cereus was minimum in samples from Melagaram and maximum in Viswanathapuram milk samples and the respective values recorded were 0.17 to 20.65 x 10^4 cfu per milliliter. Joseph (1997) observed a range of 10^3 to 10^6 cfu per milliliter.

Staphylococcus aureus

Staphylococci are of importance regarding public health in that strains of Staphylococcus aureus elaborate thermostable enterotoxins in various kinds of foods. Consumption of foods containing these enterotoxins are incriminated in several food poisoning outbreaks. The disease condition is generally referred to “gastroenteritis”. Several earlier reviews have covered the nature of
enterotoxins and the effect of food processing conditions on the stability of enterotoxins as well as the purification of enterotoxins.

The *S. aureus* is an important human pathogen causing both community and hospital associated infections (Yuki et al. 2003). Concentration of *S. aureus* in milk in this area had a very wide range of 0.05 to 30.45 x 10^4 cfu per milliliter and the maximum value was recorded in the samples collected from Viswanathapuram.

According to Clark and Nelson (1961) the *S. aureus* recorded was 2 x 10^3 to 3 x 10^7 cfu per milliliter. In the present study, *S. aureus* value fell in the range provided by the above authors. Rajmany et al. (1989) reported the presence of coagulase positive staphlococci and the count in raw milk as 3.15 x 10^4 cfu per milliliter which was less than the values of the present investigation.

In a similar study conducted by Khan and Malik (2002) reported *S. aureus* value in raw milk as 4.70 x 10^6 cfu per milliliter which was much higher than the values of present study. However, the bacteriological quality of raw milk sold in this area in terms of *S. aureus* count was not satisfactory.

**YEAST AND MOLD**

The ability of yeast and molds to grow even under unfavourable conditions like low water activity and reduced pH are the main reasons for their importance in milk and milk products. As these organisms are intensively lipolytic and cause spoilage due to rancidity, the incidence and distribution of these organisms in milk and milk products are considered to be necessary to adopt effective sanitary practices.

Values of yeast and mold count recorded in the milk sample of Melagaram was minimum and maximum in the sample from Viswanathapuram and the respective values recorded were 0.06
to $20.03 \times 10^4$ cfu per milliliter. Con et al. (1996) reported the yeast and mold count of $1.9 \times 10^3$ cfu per gram in raw milk sample which was much lower than the values recorded in the present investigation. The range of yeast and mold count in milk reported by Dhand et al. (2001) varied from $23 \times 10^2$ to $26 \times 10^5$ cfu per milliliter. This clearly showed the insanitary condition prevailing during the handling and sale of raw milk in this area.

**CO-OPERATIVE MILK PRODUCER’S SOCIETY MILK SAMPLES**

Two co-operative milk producer's societies are functioning well in our area. They are located at Tenkasi and Shencottah villages. Milk samples from these societies were taken and analysed for its biochemical and microbiological qualities. No much variation was recorded regarding the pH, moisture, total solids, fat, lactose, acidity and protein. However, there was some difference in the volatile solid content of these two societies. Similarly wide variation was also noted in the macro element concentration of milk samples of these two societies (Table-22). Among the biochemical parameters studied with society milk, it was superior quality to other sources of milk sold in this area.

The microbial population of milk of these two societies were 150.17 and $119.33 \times 10^4$ cfu per milliliter respectively. This was much higher than the values recorded by Patrica et al. (1996) and lower than Desai and Natarajan (1981). Wide variation was also observed with coliforms, *B. cereus* and *S. aureus* but this difference was not reflected in the case of yeast and mold. These values were comparable to the values of Thomas and Laxminarayana (1972), Joseph (1997), Yuki et al. (2003) and Dhand et al. (2001).
BIOCHEMICAL AND MICROBIOLOGICAL QUALITIES OF PACKAGED MILK

In Tamilnadu 100 million liters of milk is processed and distributed by private dairies and local vendors. It is very essential to assess the biochemical and microbial qualities of milk supplied by these private dairies. Biochemical constituents would indicate the nutritive value of milk. The microorganisms present not only affect the shelf-life of milk but have implication in public health as these may also include potential pathogens.

Seven commercial brands of standardized and pasteurized milk sold by private dairies were studied for its biochemical and microbiological qualities. The names of these brands were kept secret and alphabet A, B, C, D, E, F and G were assigned to identify them. The biochemical parameters studied were pH, moisture, total solids, volatile solids, fat, acidity, lactose, protein, calcium, phosphorus, magnesium, iron, sodium, potassium, and chloride. The microorganism studied included bacterial population, coliform, B. cereus, S. aureus and yeast and mold.

The biochemical profile of these seven brands of milk is presented in Table-29. All the seven brands of milk samples were slightly acidic and the value ranged from 6.53 to 6.66. There was no significant difference in the moisture, total solids, volatile solids, acidity, lactose and protein of the milk samples. However, significant difference was observed in the fat content of these samples. When the fat content was estimated highest amount was recorded in brand G and lowest in brand D. Macroelement concentrations of these seven brands of milk sample are shown in Table-30. Among the minerals studied, there was no significant difference in calcium, phosphorus, sodium, potassium, and chloride. However, there was significant difference (P<0.01) regarding
magnesium and iron content among various brands of milk samples. Based on the biochemical profile of milk brand G was much superior to other brands of milk studied.

Bacterial population, coliform, *B. cereus* and *S. aureus* and yeast and mold counts of these brands of milk sample are presented in Table-31. The highest bacterial population was recorded in brand G compared to other milk brands of milk investigated. Gopi *et al.* (2001) reported the average bacterial population of various brands of milk and the values varied from 5.5 to 175.17x10^4 cfu per milliliter. In the present study the bacterial population of different brands of milk fell in the range provided by the above authors (21.81 to 67.83 x 10^4 cfu per milliliter). However, this was much superior to the values given by Katre and Prasad (2000). According to Indian standard Institution, the raw milk would be satisfactory if it contains no coliform in 1/100 dilution and 1/10 dilution which was not found with the commercial brands of packaged milk sold in this area. The values obtained in the present study were higher than the values of Misra and Kuila (1989) (zero to 1000 cfu per milliliter) and Siva *et al.* (1993) (1 to 80 cfu per milliliter). Much variation was also recorded in the counts of *B. cereus*, *S. aureus* and yeast and mold counts of packaged milk sold in our environment. Though brand G was very good in its biochemical quality, it was inferior in terms of its microbiological quality. Hence, buying of such milk by the public must be discouraged and consumer awareness must be created regarding microbiological quality of milk. Punitive measures must be advocated on the milk companies who are not complying with ISI specifications.
BUTTER

Butter consists primarily of milk fat and is an important dairy product in India. It is made from sweet or sour cream and the largest percentage of butter is made from sour cream. About 6.1 percentage of total milk produced in India is converted into butter. The colour of butter varies from yellowish - white to deep yellow. The fat content of butter is generally about 80 percent and farm butter in this country contains only 60 - 65 percent fat (Manay and Sharaswamy, 1998; PFA, 1955). The acidity of dahi determines the yield, quality, and storage properties of butter. Salt is added to the butter to bring it into a compact mass.

The fat content of butter was minimum in Shencottah retail shop and maximum in Shencottah home sample and the range was 55.33 to 75.83 percent respectively. Hence, even the maximum value of present study was not comparable to the values of Rangappa and Achaya (1971), Karwasra et al. (1997), PFA and Agmark grading for butter samples. The fat content of butter samples decreased with simultaneous increase in moisture after storage at 4 ± 1°C for 30 days. Moisture content of butter samples of Courtallam area varied from 16.22 to 22.94 percent. According to Agmark grading (1987), the moisture content should be less than 16 percent. But the moisture content of these samples were much higher which might cause deterioration of butter in a rapid manner. The acidity of butter samples varied from 0.069 to 0.156 percent which coincided with the Agmark grading and fell in the range given by Subramanyam (1981) and less than values of Karwasra et al. (1997). The chloride content of butter samples varied from 0.19 to 1.68 which was less than the values of PFA and Karwasra et al. (1997) but more than the values specified by De (1982).

Bacterial population of butter sold in Courtallam area was 1.59 to 42.50 x 10^4 and 3.29 to 106.50 x 10^4 cfu per milliliter for
initial and 30 days after storage at 4 ±1°C. These counts were less than the values of Hankin and Hanna (1985) and Juffs (1970) and more than the values of Vijayalakshmi and Murugesan (2001). Coliform counts of butter samples were 0.24 to 14.83 x 10^4 and 1.23 to 20.07 x 10^4 cfu per milliliter initially and 30 days after storage at 4±1°C. The coliform count exceeding 10 per milliliter would indicate ineffective pasteurization of cream or contamination of the product from wash water, equipment and other sources during manufacture and packaging (Sud, 1985). Hence, the butter samples obtained in our area were contaminated with coliform.

Proteolytic bacterial count in butter sample ranged from 0.25 x 10^4 to 8.67 x 10^4 cfu and 1.42 x 10^4 to 19.80 x 10^4 cfu per milliliter for initial and 30 days of storage at 4±1°C. Malik and Mathur (1983) estimated the proteolytic count in butter sample and gave a range of 2.0 x 10^4 to 8.0 x 10^6 cfu per milliliter. The butter sample of this area fell in the range of Malik and Mathur (1983). However, there was an increase in the proteolytic count of butter after 30 days of storage at 4 ±1°C. Due to enormous proteolytic count and subsequent changes in the butter samples, it would not be advisable for human consumption.

The lipolytic counts of butter samples of this area ranged from 0.22 x 10^4 to 5.83 x 10^4 and 0.55 x 10^4 to 16.67 x 10^4 cfu an initial and 30 days after storage at 4 ± 1°C (Mikawa and Hoshino, 1974).

The ranges of psychrotrophs observed in butter sample initially and 30 days of storage at 4 ±1°C were 0.16 x 10^4 to 13.75 x 10^4 and 0.98 x 10^4 to 36.67 x 10^4 cfu per milliliter respectively.

Yeast and mold counts of butter sold in this area ranged from 0.30 to 11.33 x 10^4 and 2.00 to 26.92 x 10^4 on initial and 30 days after storage at 4±1°C. These counts were much superior to the

Correlation matrix of butter samples between sources and parameters studied indicated a positive correlation between microbial population and coliform \((r = 1.0)\) (Table-43). There was a perfect positive correlation \((r = 1.0)\) between acidity and yeast and mold counts of butter (Table-44) showing poor microbiological quality of butter sold in this area.

**DAHI OR CURD**

Dahi is the popular fermented milk product in northern part of the country and is referred as Curd. It is easily digested, has high nutritional value, and is a rich source of carbohydrate, protein, fat, vitamins, calcium and phosphorus. Because milk protein, fat and lactose components undergo partial hydrolysis during fermentation it has the ability to protect and maintain the natural flora of the intestine and it has anti-tumor and anti-cholesterol attributes (Sinha and Sinha, 2000). Since it has high nutritional qualities researchers are continually experimenting with production and consumption of dahi. Due to the rise in population, the demand for milk products like dahi has escalated. It takes about 10-15 hours for the preparation of dahi and during this period undesirable microorganisms such as coliforms, spore formers, yeast, mold and certain pathogenic microorganisms, if present may grow and bring about large changes in physical, chemical as well as organoleptic quality of the end product (Jayaram and Gandhi, 1987). Pathogenic microorganisms present due to the unhygienic way of preparation of the dahi may serve as a source of infection to human
beings. Hence, biochemical and microbiological assessment of market dahi is very important.

The biochemical parameters evaluated in dahi samples of various places and sources are pH, acidity, fat and protein. According to Sinha and Sinha (2000), the acidity, fat and protein in dahi were 0.52-1.1, 5.8 and 3.3-3.4 percent. These values were much elevated in the sweetened market dahi and the respective values 1.34, 5.24 and 8.84 percent (Gupta et al. 2000). The fat and protein reported by Boghra and Mathur (2000) were 4.09 and 3.77 percent. When the present values were compared with the values of the above authors, the acidity, fat and protein were much less in the samples of Courtallam area. However, the pH, titrable acidity values were comparable to the chemical characteristics of Laban, a cultured milk product common in Sultanate of Oman. This product showed higher protein and lower fat contents than the dahi sample of present study (Guizani et al. 2001)

Bacterial population of dahi samples recorded by Lakshminarayana et al. (1951), Sheikhet et al. (1970) and Mohanan et al. (1983) were $13 \times 10^6$ to $6.27 \times 10^7$ cfu per gram, $22 \times 10^6$ to $365 \times 10^6$ per milliliter and $47 \times 10^5$ to $88 \times 10^6$ cfu per gram respectively. Jayaram and Gandhi (1987) analysed the dahi samples of hotels, houses and dairy and reported the bacterial population as $20 \times 10^5$ to $22 \times 10^6$, $41 \times 10^5$ to $88 \times 10^6$ and $6 \times 10^5$ cfu per gram of sample respectively. Dave et al. (1991) analysed market and house dahi samples and gave the bacterial population range as $49 \times 10^7$ to $37.0 \times 10^8$ cfu per gram. The range of bacterial population in dahi sample of this area was 11.42 to 132.50 $\times 10^4$ per milliliter. The upper limit value of our study was much elevated than the values shown by Lakshminarayana et al. (1951) and Mohanan et al. (1983) and lower than the values of Sheikhet et al. (1970) Rajmany et al.
(1989) reported the bacterial population range of $2.5 \times 10^6$ to $19.6 \times 10^6$ with the mean value of $9.5 \times 10^6$ cfu per gram in dahi samples obtained from the market. Similarly Misra et al. (1993) reported the bacterial population range of $6 \times 10^6$ to $19 \times 10^6$ with the average count of $9.5 \times 10^6$ cfu per gram of dahi sample. It is very obvious that the bacterial population of this area samples were much inferior to the values reported by Rajmany et al. (1989) and Misra et al. (1993).

As already indicated, the presence of coliform is the indication of fecal contamination. Minimum and maximum coliform counts were recorded in Courtallam and Shencottah dahi samples respectively. These values were much higher than the colony forming units shown by Jayaram and Gandhi (1987) and Gupta et al. (2000) for the market dahi sample sold in Calcutta. However, Bhagirathi et al. (1993) reported much higher coliform counts in dahi samples while carrying out research on the production of dehydrated convenience foods. In the present study the values of coliform were much higher than the values prescribed in ISI (1964) for dahi sample.

The microbiological quality of dahi sample showed the $B.\text{cereus}$ and $S.\text{arueus}$ counts were in the range of $2.5 \times 10^4$ to $11.67 \times 10^4$ and $0.33 \times 10^4$ to $16.67 \times 10^4$ cfu per gram respectively. These values were much higher than the values of Rajmany et al. (1989) but less than the counts observed by Dobbertin and Siems (1976) and Ghodekar (1989).

Yeast and mold counts of the present study showed a range of $0.92 \times 10^4$ to $10.42 \times 10^4$ cfu per gram in house samples and restaurant samples respectively from Courtallam. Sreenivasan and Ranganathan (1972) observed an average yeast count of $8.85 \times 10^5$ per milliliter after 72 hours of preparation under simulated market.
condition. The values of present study fell in the range provided by the above authors. In a similar study, Natarajan and Ramasamy (1981) noted the yeast and mold count as $83.6 \times 10^3$ and $96 \times 10^3$ cfu per gram which also corresponded with the present values. Jayaram and Gandhi (1987) analysed the market dahi and recorded the range of yeast and mold count as $12 \times 10^3$ to $2 \times 10^5$ cfu per milliliter and the mean values were $106 \times 10^3$ and $35 \times 10^3$ for samples from hotels and houses respectively. Hence, it is very clear that the yeast and mold counts of hotel samples were higher than house samples. A similar trend was observed in the yeast and mold counts of the present study. Lower yeast and mold counts were recorded by Gosh and Rajorhia (1987) and Dave et al. (1991) and the respective ranges were $5 \times 10^3$ to $82 \times 10^3$ and $22 \times 10^3$ to $61 \times 10^3$ cfu per gram.

A perfect negative correlation existed between pH and acidity ($r=-0.81$ to $-0.97$) of dahi samples obtained from all sources (Table 57-61). Whenever the acidity of samples were increased there would be simultaneous reduction in the pH. The acidities of these samples increased due to the rise in the bacterial count which was evidenced from the present study (Table-57). On overall assessment of biochemical and microbiological quality of dahi samples sold in and around Courtallam area was relatively good compared to some of the values available in the literature. But these values were much higher than the counts indicated in ISI (1964) standards. Hence, such a situation must not be encouraged and proper monitoring system must be evolved to maintain the quality of the product.
KHOA

Khoa is an interesting indigenous milk product of considerable economic and dietary importance to people. It provides a good means of conserving and preserving surplus milk solids. It is crudely manufactured form of evaporated milk suitably dehydrated for the convenience of transportation, but at the same time it is sufficiently moist to permit the growth of microorganisms of which the molds, as a rule, give visible growth on its surface within a few days of storage at room temperature. When khoa is fresh, it has an agreeable flavour of hot (cooked) milk. In appearance it is a grainy mass with an open texture and creamy colour. It keeps well for 48 hours under ordinary storage conditions, but thereafter it changes in both its appearance and flavour. It takes a light brown tinge here and there, loses its grainy appearance and appears to be rather messy, especially on the exposed surface portions. Its flavour changes from agreeable to unpleasant and it is not very difficult to detect often a slight rancid odour emitting from it.

Khoa is used as the principal ingredient in the preparation of various sweets. Because of its nutritive value and moisture content, it serves as a favourable medium for the growth of microorganisms. Further, due to the unsatisfactory practices generally followed in its production, handling and storage, Khoa has a poor shelf-life. The main purpose of studying its biochemical and microbiological quality is to assess the cleanliness or the care taken in its production, handling and storage.

Acidity of khoa reported by Prajapati et al. (1986), Ghatak and Bandyopadhyay (1989), Goyal and Srinivasan (1989) and Rao et al. (1977) were 0.55, 0.58, 0.40 and 0.77 percent respectively. In the present study the acidity range was 0.51 to 1.28 percent. These values were much higher than the values noted by above authors as well as standard prescribed in ISI (1964).
Rudreshappa (1971) studied the acidity of khoa prepared from cow and buffalo milk and showed the value as 0.82 and 0.56 percent which was less than the upper limit values of the present study.

During storage, evaporative loss of moisture was most prominent in pure khoa (Prajapati et al. 1986). Moisture content of khoa samples observed by Ghatak and Bandyopadhyay (1989), Goyal and Srinivasan (1989), and Sharma et al. (1999) were 26.30, 27.20 and 32.15 percent respectively. Boghra and Mathur (1991) and Sharma and Lal (1999) showed elevated moisture content in khoa samples and the respective values were 41.14 and 36.40 percent respectively. In the present study a wide range of moisture was observed and the respective values were 20.93 to 35.49 percent. The upper limit of this study was nearing the lowest value given in Indian Standard Institution (1964).

The fat content of khoa noted by Dastur and Lakhani (1971), Ghatak and Bandyopadhyay (1989) Sharma et al. (1999), PFA (1955) and Sawhney et al. (2000) were 27.24, 24.30, 23.56, 18.00 and 24.90 percent respectively. In the present study the fat content had a range of 22.67 to 30.83 percent which was far less than the values given in Indian Standard Institution (1964). However, the present values did not deviate much from the values of the above authors.

Protein content of khoa samples shown by Boghra and Mathur (1991), Dastur and Lakhani (1971), PFA (1955) and Sawhney et al. (2000) were 14.29, 19.58, 20.0 and 15.40 percent respectively. These values were much lower than the minimum value (22.77 percent) of the present study. However, Sharma et al. (1999) and Boghra and Mathur (1996) reported slightly higher values (17.92 and 17.26 percent) than the above authors’. Ghatak and Bandyopadhyay (1989) recorded a value comparable to the minimum value of this
area. On overall assessment the protein content of these samples were much superior to the values available in the literature.

The bacterial population of khoa of the samples analysed were ranged from $15.58 \times 10^4$ to $100.62 \times 10^4$ cfu per gram. These values were much higher than the values observed by Thilagavathi et al. (1999), Rao et al. (1977) and Prajapati et al. (1986) and the respective values were $43.83 \times 10^3$, $3 \times 10^3$ and $11.70 \times 10^3$ cfu per gram of sample respectively. Varadaraj and Nambudripad (1982) and Rajmany et al. (1989) recorded the bacterial population as $95 \times 10^6$ and $235.9 \times 10^7$ cfu per gram of sample. Sharma et al. (1972) and Teufel et al. (1992) reported a value of $95 \times 10^5$ and $36 \times 10^7$ cfu per gram of sample. In a similar study Vijayalakshmi and Murugesan (2001) found no bacteria in their khoa sample. Saxena et al. (1994) analysed the khoa samples of Nagpur market and recorded an average total amount of $3.2 \times 10^8$ cfu per gram of sample.

Coliform counts were found to be highest in khoa collected from the vendor at Tenkasi and minimum in the samples from the shop of Viswanathapuram. The value ranged from $2.33 \times 10^4$ to $34.6 \times 10^4$ cfu per gram. This count was much higher than the value recorded by Sharma et al. (1972), Vijayakumar and Sinha (1989) and Thilagavathi et al. (1999) and the respective values given by them were $87 \times 10^2$, $980$ and $23.05 \times 10^2$ cfu per gram of khoa. The Indian Standard Institution indicated that the highest limit of coliform was 90 cfu per gram. In all observations the coliform count was much higher than the values available in the literature and ISI (1964). Therefore, khoa sample available in this area is unacceptable for consumption.

*B. cereus* and *S. aureus* are important organisms present in milk and milk products. Varadaraj and Nambudripad (1984) proved that there was no organism present in a freshly prepared
Eggyolk-tellurite-glycine-pyruvate agar plate illustrating black, shiny colonies of *S. aureus* in khoa sample.

Discolouration around *S. aureus* colonies indicating mannitol fermentation in khoa sample. *(Mannitol salt agar medium)*
khoa. However, in their earlier study they gave the mean value 400 \times 10^6 and 360 \times 10^6 cfu per gram of sample in Bangalore and Mysore cities (Varadaraj and Nambudripad, 1982). Rajmany et al. (1989) reported an average value of 45.6 \times 10^4 with a range of 22.5 \times 10^4 to 69 \times 10^4 cfu per gram. These values were much elevated compared to the present range of 4.17 \times 10^4 to 67 \times 10^4.

Yeast and mold range of khoa sample in the present study was 0.01 \times 10^4 to 0.21 \times 10^4. Yeast and mold count were recorded by Singh et al. (1975), Rao et al. (1977) and Ghodekar et al. (1980) and the respective values were 0.3 - 21 \times 10^3, 140 and 30-6500 cfu per gram of sample. Indian Standard Institution (1980) prescribed a value below 50 for good quality khoa. Even the minimum value recorded did not fulfill the quality indicated in ISI (1980) and PFA (1955). Therefore, the khoa sold in and around Courtallam area is unacceptable with respect to the coliform, \textit{B.\textit{cereus}}, \textit{S.\textit{aureus}} and yeast and mold counts. Hence, the microbiological quality of khoa is very poor.

**ICE CREAM**

Ice cream is a popular, health-giving, highly nutritious and popular frozen dairy product. Its production and distribution constitute a major industry in Western Countries. In recent years, ice cream has been gaining great popularity in India particularly in the major metropolitan towns. The scientific progress in understanding physicochemical properties of various milk ingredients and their role in the preparation of ice cream coupled with technological innovations introduced in dairy industry have paved way for the rapid development of large size ice cream industry today. Although the untiring efforts of scientists and technologists that ice cream has received new forms from time to
time (Reddy et al. 1994; Moorthy and Balachandran, 1993). Despite the increase in production and utilization of ice cream, the chemical and bacteriological qualities of ice cream are far from satisfactory (Patel and Vyas, 1971).

Ice cream is a good medium for the growth of both pathogenic and non-pathogenic organisms. The increasing popularity of ice cream warrants the detailed chemical and microbiological study of this important dairy product since it has been incriminated frequently to be the cause of outbreaks of disease like typhoid, sore-throat etc. The presence of coliform in ice cream signifies the fecal contamination of the products and tends to reflect the sanitation of the production plant and the distribution agencies (Rao et al. 1977). There are studies which support the fact that ice creams sold in Indian market are of poor quality and the common contaminants encountered are coliform and psychrotropic group of organisms. Presence of these organisms in milk and milk products indicate not only insanitary conditions but also related to the keeping quality of the product as they cause organoleptic defect by elaborating heat resistant enzymes (Nareshkumar et al. 1989). Inspite of standards laid down for microbiological quality of ice cream, the quality of ice cream sold in market falls far below the stipulated microbiological standards (Patel and Vyas, 1971) Hence, great importance is given to ensure its safety for human consumption by regulating its manufacture, distribution and sales under strict hygienic conditions and by laying down bacterial standards of quality for the product (Sarada and Mushtari Begum, 1991). The present study was to assess the biochemical and microbiological qualities of seven brands of popular and commonly available ice cream sold in and around Courtallam.

The important biochemical constituents studied in the ice cream included acidity, fat, protein and total solids to determine
its quality. Hence, in the present study the amount of each of these ingredients was delineated in addition to its microbiological quality. These constituents present in the ice cream vary according to the type like plain, fruit, nut and chocolate. However, the Indian standard Institution laid down minimum values for some of these parameters. Regarding the acidity, minimum values given in ISI (1964) and Karwasra et al. (2000) were 0.25 and 0.21 percent respectively. In the present study the acidity of ice cream ranged from 0.184 and 0.220 percent in brand A and D respectively. These values may be acceptable since the range complied with minimum standard prescribed. The fat content of ice cream studied were slightly higher than 3 percent which was three times less than the minimum standard specified in ISI (1964) as well as the value provided by Karwasra et al. (2000). Protein levels of various brand of ice cream studied ranged from 4.97 to 7.04. These values were slightly superior to the range shown by Karwasra et al. (2000). Total solids of various ice creams studied were coincided with the minimum value indicated in ISI (1964) and the mean values provided by Karwasra et al. (2000). Considering the biochemical attributes brand G was superior followed by A, B, C and the poorest was brand D.

The hygienic quality of ice cream is chiefly assessed by total count of microorganisms and the coliform count per gram of food (Guha et al. 1979). Microbiological quality of seven brands of ice cream sold in Courtallam area was evaluated and the value ranged from $1.43 \times 10^4$ to $100.38 \times 10^4$. Krishnasamy Naidu and Vedanayakam (1969) monitored the average bacterial count of ice cream sold in Chennai from three sources namely manufacturers, small producers and push carts and the respective values were $3.7 \times 10^3$, $4.3 \times 10^6$ and $7.3 \times 10^6$ organisms per gram of sample. Luck
and Lategon (1976) obtained a total bacterial range of $1 \times 10^5$ to $5 \times 10^4$ cfu per gram. Aleksieva (1978) examined 85 samples of ice cream in which 87 percent of the sample had $5 \times 10^4$ cfu per milliliter of sample. In a similar study conducted by Singh et al. (1977) recorded a value of $1.51 \times 10^4$ organism per milliliter. Guha et al. (1979), Ramakrishnan et al. (1986), Kahlon and Grover (1984) observed the mean bacterial population as $0.46 \times 10^6$ cfu per milliliter, $2.5 \times 10^5$, $5 \times 10^5$ and $3 \times 10^5$ cfu per gram. Nareshkumar et al. (1989) studied the ice cream obtained from three sources and recorded $4.07 \times 10^4$, $3.63 \times 10^5$ and $3.61 \times 10^6$ cfu per gram of sample of organised dairies, private manufacturers and small vendors respectively. In the present investigation the value of bacterial population ranged from $1.43 \times 10^4$ to $100.38 \times 10^4$ per milliliter of ice cream. Minimum bacterial population was recorded in brand G and A and the respective values were $1.43 \times 10^4$ and $9.33 \times 10^4$ cfu per milliliter. The upper limit of the observed values were found in brand D and E ($100.38 \times 10^4$ and $76.83 \times 10^4$ cfu per milliliter respectively) which were higher than the values reported by the above authors. These values were much higher than the values specified ($250 \times 10^3$ cfu per milliliter) by ISI (1964).

The coliform count of the ice cream sold in Courtallam area was much higher than the standard prescribed (10 to 90 cfu per milliliter or gram) by ISI (1964) showing severe fecal contamination. The milk products containing more than the ISI prescribed standards are considered unsatisfactory or unwholesome for human consumption. Such increased coliform count was also reported in ice cream sold in different seasons of the year by Thatti et al. (1972) and with local vendors by Saradha and Mustaribegam (1991). Presence of *S. aureus* was reported by Rajmany et al. (1989) and the value was $5.6 \times 10^3$ cfu per milliliter. Reddy et al. (1994) and
Patwari and Chavan (1995) reported the *S. aureus* levels as $0-5.5 \times 10^2$ cfu and 1325 per milliliter respectively. Whereas the present value was $0.1 \times 10^4$ cfu per milliliter. Patwari and Chavan (1995) reported the yeast and mold counts as 235 per milliliter. The observed value of yeast and mold counts in the present study was a little higher than the value of the above author. However, Kumari et al. (1996) observed higher count when compared to the present values.

Considering microbiological quality of ice cream like bacterial population, coliform, *B. cereus*, *S. aureus*, psychrotrophics and yeast and molds of seven brands of ice cream sold in this area, brand G and A were superior followed by B and C and the poorest being brand D. Stringent action must be taken to those who produce and sell ice cream of poor quality since it would transmit the disease in a very rapid manner.

Psychrotrophic counts of various brands of ice cream sold in this area were recorded in which the minimum was in G ($0.017 \times 10^4$) and the maximum in brand D ($4.60 \times 10^4$). Singh et al. (1977) examined 80 samples of ice cream and gave the overall mean as $1060 \times 10^3$ which was much elevated than the values of present study. Similar study was carried out by Rajagopal (1978), who gave the range of $3.5 \times 10^2$ to $9.2 \times 10^5$ cfu per gram. Guha et al. (1979) tested 100 ice cream samples and found a mean value of $0.120 \times 10^6$. Bassiony et al. (1986) determined mean psychrotrophic count as 3.08 millions per gram. Nareshkumar et al. (1989) reported psychrotrophic count of ice cream collected from organized dairy, private manufacturer and small vendors an average of $3.9 \times 10^3$, $1.6 \times 10^4$ and $1.32 \times 10^5$ cfu per gram respectively. The psychrotrophic count of the present study was much higher than the values of Nareshkumar et al. (1989) but less than the mean value given by Guha et al. (1979) and Bassiony et al. (1986).