CHAPTER 2

REVIEW OF LITERATURE
2.1 **SOYBEAN**

The soybean (*Glycine max*) ranks high among the leguminous crops of the world, both in its content of protein and its nutritional quality, when properly processed. Soyprotein contains, in nearly optimum proportions, all the essential amino acids (except sulphur-containing ones) required in the diet of man and animals. Two kg of soyflour contains as much protein as 14 litres of milk. The soyprotein acts as moisture retainer, emulsifier, stabilizer and binder, and improves the product appearance. It helps food
processors to produce generally high quality food at comparatively low production cost (Anon, 1970).

The high nutritional value of soybean has attracted many scientists and technologists to utilize it for the manufacture of soymilk and various products which include imitation dairy products. Soybean grown in this country contains 42.1 percent protein, 31.5 percent carbohydrate, 21.2 percent fat and 5.2 percent ash (Chander Mohan, 1977).

2.1.1 PROCESSING OF SOYBEAN

Like any other legume, soybean has to be properly processed before being used as a food. While processing may involve several types of treatment of soybean, heat treatment is of utmost importance. Because of the presence of some anti-nutritional factors such as trypsin inhibitor and haemagglutinin, soybean is of little value in human nutrition when consumed raw. In fact, if the soybean is used without any treatment that would destroy or minimise such factors, it is bound to prove very harmful to the health. Adequate heat treatment is the most practical way of eliminating the substances responsible for body disorders resulting from their ingestion through soybean.
Heat treatment is also aimed at improving the flavour and thereby making it more palatable. Unless people are used traditionally to the raw-soybean (beany) flavour, the product having such flavour would not be acceptable to the consumers. Soybean therefore, has to be so processed as to make its flavour least objectionable. The treatment to render it bland is of particular significance in its utilization for the production of dairy-product analogs.

Soybean processing may involve, in addition to heat treatment, certain other steps such as presoaking and dehulling for purposes like increasing the protein content and reducing certain compounds like oligosaccharides responsible for flatulence. Soaking whenever adopted, is the first of a series of processing steps for whole soybean. Dehulling may be carried out either with dry soybean before heat treatment or wet beans after heat treatment.

The so-called Illinois Process (Nelson et al., 1976) for the preparation of soymilk is believed to give the best product with respect to its flavour and nutritional quality. It consists in soaking soybean in 0.5 percent sodium bicarbonate
solution overnight, draining off the soak water, blanching the soybean in boiling water containing 0.5 percent sodium bicarbonate for 30 min, cooling the blanched soybean and dehulling them before grinding in water. The resulting product is free from trypsin inhibitor, has low soluble carbohydrate content and fairly bland flavour.

2.1.2 SOYBEAN IN ICE CREAM

As will be seen in the following review, attempts to make ice cream using soybean were made as early as in the early forties, yet not much work has been done in this regard. Some time during World War II soybean ice cream was sold for the first time as reported by Altschul (1958). He mentioned that all the usual milk ingredients of ice cream were replaced by soy ingredients. Ice cream made from soyprotein and soyfat or modified fat had no great texture problem.

The use of 'Gelsoy', a water soluble proteinaceous product with excellent water binding properties isolated from defatted soybean flour was described by Globe et al. (1956). They claimed that spray dried milk consisting of dried skim milk, sugar, vegetable fat, vegetable gum and modified starch with Gelsoy could be reconstituted and frozen without homogenization to yield good quality low-fat ice cream.
Lenderink (1972) patented a process for soft ice containing 0.2 to 0.8 percent (in DM) partially hydrolysed protein obtained by alkaline, acid or enzymic hydrolysis of casein, soyprotein or wheat protein. The mixture was adjusted to pH of less than 7, preferably less than or equal to 5 by adding an edible acid.

Soft serve ice cream making by the use of soy flour was reported by Crowhurst (1974). An acceptable ice cream could also be obtained by using 7.5 percent milk solids-not-fat (SNF) + 2.2 percent demineralized dried whey + 1.5 percent soy flour in place of 11.2 percent milk SNF as reported by Rothwell (1976).

The effect of soy protein isolate substitute on the quality and acceptability of ice cream was studied by Kim and Byun (1977). Ice cream containing 25 to 50 percent substitution of milk SNF with soy protein isolate showed the same textural quality as the control but had a significant 'beany' off-flavour.

2.2 BUTTERMILK

Buttermilk derives from the churning of cream into butter. It is an important byproduct of dairy industry having valuable 9 percent solids.
(consisting of 4.5 percent lactose, 3.4 percent nitrogenous matter, 0.7 percent ash and 0.4 percent fat). The striking difference in composition of dry skim milk and dry buttermilk is of the fat content (0.8 vs 5.3 percent). In addition to casein and other proteins characteristic of skim milk, buttermilk contains large proportion of protein mixture sloughed off from fat globule-milk serum interface by churning (King, 1955). Garten (1963) stated that the amount of this membrane protein is not large in proportion to the total buttermilk protein, however, the membrane also constitutes a complex mixture of glycerophospholipids, which include more or less equal proportions of lecithin, sphingomyelin and cephalin, with considerable amount of cerebrosides.

2.2.1 BUTTERMILK IN ICE CREAM

The high phospholipid content of dry buttermilk gives the material unique emulsifying properties along with those beneficial attributes associated with non-fat dry milk and dry whey. Buttermilk used in the manufacture of frozen desserts results in improvement of whipping properties and flavour. According to Webb and Whittier (1972), whether fresh, condensed, or dried, buttermilk will usually improve whipping when it replaces most of the skim solids in milk, because of lecithin content. It also imparts strong emulsifying
properties which develop a smooth body and texture and helps to retard the growth of large ice crystals during hardening of ice cream.

Buttermilk has been utilized with considerable success as an ice cream ingredient, as is evident from the early report of Spochor (1938). Its use has, however, been limited to a small quantity because of the requirement of high-grade sweet-cream buttermilk. Neutralized sour-cream buttermilk carries objectionable flavours and it is not suitable for ice cream. It is believed that satisfactory buttermilk can be obtained from cream having less than 0.25 percent acidity. While buttermilk can be used in its fluid form in place of whole milk or skim milk, it has largely been used in condensed and dried form.

The structure and dietetic aspects of buttermilk soft ice have been outlined by Sorenson (1971). Smirnov et al. (1977) made an ice cream of improved nutritive value; it comprised of 10 to 15 percent dried whole milk, 3.2 - 3.8 percent dried skim milk, 2.0 - 5.7 percent animal fat, 6.97 percent confectionary fat, 8.4 - 10.6 percent sugar, 1.48 - 1.50 percent stabilizer, 0.008 - 0.01 percent vanilla, 3.0 - 19.5 percent water and the remainder buttermilk (65 to 37 percent).
2.2.2 CONDENSED BUTTERMILK IN ICE CREAM

Williams et al. (1950) suggested the use of sweetened condensed sweet-cream buttermilk, which could be stored for 90 days at 15°C or lower without developing age thickening, as a suitable substitute for sweetened condensed skim milk in ice cream mixes to provide up to 80 percent of milk SNF. Buttermilk ice cream had better whipping properties and a richer and creamier flavour than skim milk ice cream. This product could be stored for 4 mo at 10°C.

2.2.3 DRIED BUTTERMILK IN ICE CREAM

Roller dried sweet-cream buttermilk powder (SCBMP) resulted in a greater rate of whipping as compared to skim milk powder (SMP) as a source of SNF in ice cream (Thomas and Combs, 1944). Usually 1-2 min less time was required to obtain a normal overrun at lower temperature. These workers also observed that when SCBMP was used in place of SMP neither the true nor the apparent and basic viscosities of the aged mix were significantly affected. It resulted in frozen product which was drier in appearance and better in consistency than when SMP was used. Sweet-cream BMP tended to impart richer flavour to ice cream as compared to SMP. There was less tendency towards a cooked flavour
in ice cream containing roller dried SCBMP than when SMP was used. The ice cream made from SCBMP was finer in structure and more stable.

The use of less than 25 percent dried whey or less than 50 percent dried buttermilk as a substitute for dried skim milk in the manufacture of ice cream was considered possible, in combination with an efficient stabilizer (Rothwell, 1974).

Mahran et al. (1976) used buttermilk solids in ice cream and reported that viscosity values of ice cream mixes, either before or after ageing, were not significantly affected when some of the serum solids were replaced with 2 - 4 percent sweet-buttermilk solids. Specific gravity and acidity of mix containing sweet-buttermilk solids were same as the control. Overrun as well as body and texture of the resulting ice cream were improved by the use of the buttermilk solids. Melting resistance of ice cream containing buttermilk solids was nearly the same as the control, but flavour scores were slightly less. It was suggested that sweet buttermilk solids could supply 20 percent but not more than 25 percent serum solids of ice cream.

### 2.3 BUTTERFAT SUBSTITUTES IN ICE CREAM

Fat is an important component of ice cream. It contributes not only to the flavour but also
to the body and texture of the product. Vegetable fat has successfully replaced butterfat in frozen desserts, like "Mellorine", because of its low cost as compared to milk fat. The replacement of butterfat, partial or complete, seems to have caused practically no change in the quality of ice cream.

2.3.1 VEGETABLE OILS IN ICE CREAM

Miekle et al. (1955) studied milk fat and other fats and found that there was little or no difference between the physical and chemical characteristics of ice cream made from the different fats.

Soft serve ice cream containing 15 percent fat, 18 percent sugar and 42 percent dry matter with or without dried egg was made using 20 percent synthetic cream by Kozin and Rebrina (1976). The cream was prepared by homogenization at 40 - 50 atm of 12.37 percent fat base consisting of hydrogenated sunflower or coconut oil or margarine (having a melting point of 33°C or less), 3 percent dried skim milk, 0.45 percent disodium phosphate and 0.3 percent sodium citrate. They reported data on fat globule dispersion before and after homogenization, overrun (37.7 - 50.6 percent), bulk density (0.682 - 0.807 g cm⁻²), air-fat ratio (272-347 percent) and viscosity (17.4 - 27.8 cp). Out of 7 variants, the one with 100 percent hydrogenated vegetable fat base, was particularly recommended for wholesale production and
distribution. The base was also considered suitable for hardened ice cream.

Garlib and Chedey (1976) used randomized blend of palm oil (Iodine value 50) with 20 percent of softening fat consisting entirely of lauric-acid fat (palm kernel oil, coconut oil, or their fractions). The composition was used at 10 percent by weight in the manufacture of vanilla ice cream containing 11 percent dried skim milk, 14.5 percent sucrose, 2 percent corn syrup and locust-bean gum as stabilizer and emulsifier.

Purefiz (1976) prescribed a procedure using 9.8 percent vegetable fat with 3.2 percent-fat milk, spray dried skim milk, 82 percent fat butter, crystalline sucrose, "Cremodan" stabilizing and emulsifying agent and vanillin for commercial-scale manufacture of ice cream.

Ramanna (1975) studied the costing of ice cream and found that the cost of non-dairy ice cream was reduced considerably with the use of non-milk fat. No major problem in manufacture was encountered and large scale trials in industrial units gave quite acceptable ice cream.

2.3.2 MARGARINE IN ICE CREAM

Butterfat in ice cream mixes was partially substituted by margarine (Elhanne et al., 1977).
They stated that it was possible to substitute 50 percent margarine for butterfat in chocolate ice cream.

2.4 PHYSICO CHEMICAL PROPERTIES OF MIX AND ICE CREAM

2.4.1 OVERRUN

As explained by Sommer and Horrall (1928), viscosity and surface tension, besides certain other factors, play an important role in whipping of ice cream mix. According to the theory advanced by these investigators, there is continuous air incorporation and continuous air escape during whipping of the mix, the former being greater than the latter. When the mix has attained the maximum overrun, the rates of these two opposite processes are equal. The escape of air being dependent upon the strength of the walls of the air cells or the lamellae, both the rate of whipping and maximum overrun are governed by the strength of the lamellae. The strength of the lamellae in turn, depends on the surface tension, viscosity and cohesion. These properties of the mix are obviously controlled by its composition.

2.4.1.1 Effect of viscosity and surface tension.

Early investigations (Washburn, 1910; Brown, 1913 and Baer, 1916) indicated that high viscosity was conducive to good whipping quality of ice cream mix. However, subsequent findings (Davis, 1916; and Lucas and Roberts, 1927) conclusively proved that the differences
in whipping ability could not be explained on the basis of viscosity. Lucas (1927) observed that increasing the fat content (which is known to increase the viscosity), actually decreased the overrun. Sugar and gelatin, besides fat, all of which increase the viscosity were earlier found to be detrimental to overrun (Williams, 1922). Further observations made by Hening and Dahlberg (1929) and Dahle (1930) established that whipping ability is not dependent on viscosity.

It appeared that an increase in viscosity retards the rate of whipping without necessarily decreasing the maximum overrun that can finally be attained (Dahle, 1926). However, this does not hold true for aged mix which has increased viscosity and better whipping characteristics (Washburn, 1910).

The surface tension of ice cream mixes were studied by Reid and Moseley (1926), Gebhardt (1928), and Tumbow and Nelson (1928). The results failed to show any definite relationship of surface tension with the whipping ability of the mix. Addition of fat to a skim milk-sugar-gelatin mix was found to considerably reduce the surface tension as well as whipping ability.

2.4.1.2 **Effect of the mix constituents.**

Fat in the mix had a retarding effect on both the rate of increase in overrun and the maximum overrun attained (Williams, 1922, and Gregory and Manhart,
Lucas et al. (1930) showed that increasing the fat content decreased the maximum overrun and increased the time required to reach an overrun of 90 percent.

The serum solids content of mixes has been observed to show variable influence on the whipping ability. Lucas and Roberts (1927) obtained maximum overrun of 73.7, 79.1, 81.8 and 80.0 percent for mixes containing 6, 8, 10 and 12 percent serum solids respectively. Sommer (1927) reported that within the range of 5.25 to 11.50 percent, the serum solids content had little effect on the time required to reach 95 percent overrun while Dahle and Caulfield (1928) reported that up to 10 percent, the serum solids had only a slight effect on the overrun and beyond that the time required to reach the desired overrun increased. Sommer (1951) concluded that the serum solid levels usually encountered in commercial mixes (8 to 12 percent) had no pronounced effect on the whipping ability.

While gelatin contributes whipping ability to simple fat-free mixes, it acts as a deterrent to overrun in normal mixes. Baer (1916) and Mortenson (1918) showed that gelatin did not increase the whipping ability of mix. Williams (1922) and Sommer (1951) noted that the whipping ability decreased as the gelatin content increased. Although other stabilizers also have a limiting effect on the whipping ability, sodium alginate
was found to improve it due to the decrease in calcium-ion concentration of the mix through the formation of calcium alginate (Stebnitz and Sommer, 1938).

Emulsifiers as such or incorporated in stabilizer blends have been generally acknowledged for their enhancing influence on the whipping ability of the mix (Defew and Dyer, 1925; Sommer, 1927 and Leighton, 1941).

Sheurin and Rossi (1952) studied the effects of butterfat, SNF, stabilizer and emulsifier and of the substitution of half of the sucrose by glucose or maize-syrup solids on the overrun, dryness, texture, flavour and firmness of soft serve ice cream. They reported a drop in overrun with the increase in the fat content but the product was richer as compared to that containing higher solids. The addition of stabilizer and emulsifiers improved the body and texture and the product was firmer as compared to lower levels of stabilizer. Glucose and maize syrup improved the flavour of the product.

Nickerson and Pangborn (1961) studied the changes in physical properties of ice cream as influenced by variations in the sugar and SNF contents. Keeping the butter level constant at 12 percent and increasing the sugar content from 10 to 13 percent or SNF content from 10 to 12 percent increased the viscosity
slightly. Addition of a stabilizer markedly increased the viscosity. There was no significant effect on the melting rate by the addition of stabilizer. Firmness was most affected by the storage temperature. An increase of sugar content or of overrun, had a softening effect, and seeding to crystallize lactose increased the firmness. Stabilizers tended to maintain a more uniform firmness within the range of overrun in the commercial product.

2.4.2 COMPOSITION AND CHARACTERISTICS OF MIX

The properties of mix are markedly affected by its composition i.e. the relative proportion of its constituents viz. fat, SNF and stabilizer-emulsifier. These consequently determine the eating quality or sensory characteristics of the ice cream.

Lambard (1965) reported stiff body, smooth texture and a slightly glossy appearance of the ice cream obtained from a mix of optimum composition of 32 percent total solids, 5 percent fat, 12.1 percent milk SNF, 10 percent sugar, 4 percent maize syrup solids, 0.9 percent stabilizer-emulsifier and 0.05 percent calcium sulphate at a drawing temperature of -7.2° to -6.6°C and overrun of 50 to 60 percent.

Jain and Verma (1974) used buffalo and cow milk ingredients to make ice cream mixes containing 8%, 10%, 12 and 15 percent fat, 10%, 11 and 12 percent milk SNF,
14 and 15 percent sugar and 0.5 percent gelatin. They observed that buffalo milk ice cream mix had higher viscosity and greater freezing-point depression. The cow-milk ice cream mix had better whipping ability, but buffalo-milk ice cream gave better body and texture scores.

2.4.3 MIX PROPERTIES AS INFLUENCED BY PROCESSING

Homogenization and ageing of the ice cream mix are integral parts of the processing involved in ice cream making. Homogenization has been cited in the earliest literature on ice cream (Brown, 1913; Baer, 1916, and Davis, 1916) and its usefulness in ice cream making has been confirmed by a number of later investigators. In general homogenization modified the mix properties so that the resulting ice cream had improved body, texture and appearance (Sommer, 1951).

Nielsen (1973) observed that correct homogenization was the key to the production of a satisfactory ice cream structure. During homogenization new fat surfaces are exposed and secondary membranes are formed from milk proteins and added emulsifier. During ageing the proteins and stabilizing agents absorb water until hydration is complete, while super-cooled fat crystallizes.
It was found desirable to use 300 to 500 psi more pressure during homogenization of vegetable fat mix (Mellorine) than for ice cream mix of the same composition (Willingham, 1967).

Kapoor and Gupta (1980) reported a decrease in solubility index and free-fat content of the soy-whey weaning food with vegetable fat when it was homogenized at 3000 psi in the first stage and 500 psi in the second as compared to 2000 or 2500 psi in the first stage and 500 psi in the second.

2.4.4 EFFECT OF STABILIZERS AND EMULSIFIERS

Most of the stabilizers that are satisfactory for use in ice cream can be used in "Mellorine" and similar frozen desserts. If a drier dessert is desired, it is better to use some emulsifier in combination with a stabilizer. Willingham (1967) suggested that extreme care should be taken in using stabilizers and emulsifiers to assure proper use.

To determine the reaction (in terms of flavour and texture) of consumers to varying emulsifier-stabilizer level in vanilla ice cream, Finnegan and Sheuring (1962) studied five levels (0.14, 0.19, 0.24, 0.29 and 0.34 percent). Consumer preference for flavour was for the three highest emulsifier-stabilizer levels viz. 0.24, 0.29 and 0.34 percent and texture preference for 0.14 percent and above levels.
Rothwell and Palmer (1965) compared the properties of gelatin, sodium alginate, locust bean gum, guar gum, carrageenan and sodium carboxymethyl cellulose (CMC). Very satisfactory texture was obtained using 0.17 percent CMC and 0.03 percent carrageenan. In soft serve ice cream optimum results were obtained with 0.085 percent CMC and 0.04 percent carrageenan.

The factors contributing to the dryness of ice cream were studied by Ludwig and Gakenheimer (1967). Apart from the stirring intensity in the freezer, a proper selection of emulsifier-stabilizer was one of the main factors contributing to the agglomeration of finely dispersed fat globules which determine the "dryness" of the ice cream. The glossiness was found to be an adequate indicator for estimating the dryness; a glossiness degree of 20 - 25 showing a very moist product and a degree of 5 - 9 a very dry product. Good results were obtained with polyoxyethylene sorbitan fatty acid esters (at a concentration of 0.1 percent). Mixtures of these emulsifiers with mono- and diglycerides were also efficient.

The effect of four different emulsifiers (glycerol monostearate, glycerol monooleate, Tween 65 and Tween 80A) on the fat destabilization during freezing was studied on soft serve ice cream mix containing 10 percent fat, 11 percent milk SNF, 13 percent cane sugar
and 0.3 percent vegetable gum stabilizer (Mann, 1968). The level of 0.01 percent Tween 80A was found to be equivalent to 0.2 percent glycerol monostearate in causing fat destabilization. The quantity of destabilized fat decreased with increasing homogenization pressure.

Burg and Newby (1970) obtained a 140 percent volume increase of soft serve ice cream mix by the use of an expanding agent, an edible monochlorine perfluorine hydrocarbon.

2.5 **STUDY ON THE STRUCTURE OF ICE CREAM**

Some 70 - 80 percent of the water in ice cream is frozen to form ice crystals, whose size and shape influences the structure. The remainder is present as bound water and in liquid form in concentrated syrup. The distribution of air also influences the texture, a uniform distribution of small air cells giving a smooth texture (Nielsen, 1973).

Mohar and Peters (1955) described a microscopic technique for determining the size and distribution of the air cells. Arbuckle (1960) conducted microscopic examination of texture and structure of ice cream as affected by composition and homogenization. Further, Valaer and Arbuckle (1952) observed that individual fat globules were 6 - 8 microns in diameter. When homogenization pressure increased,
the size reduced to less than 2 microns. King (1962) made valuable studies on the physical structure of ice cream and discussed the effect of mix composition, homogenization, freezing, whipping and hardening on the physical structure of ice cream. Walker (1963) studied the factors influencing the structure of ice cream as affected by milk fat, milk protein, emulsifier and air content. Air had its maximum effect at 110 - 120 percent overrun, and gave a palatable product when the air cells were fine and well distributed.

Savenovskii (1956) observed that the consistency and structure of ice cream was satisfactory and its removal from the freezer was comparatively easy when the product temperature was -6.0 to -6.3°C. Thermal stability of soft serve ice cream with 27 - 40 percent overrun was significantly better than that of regular ice cream. (King (1962) observed the air-cell size ranged from 5 to 10 microns in diameter.

2.6 DRYING OF MIX AND ITS EFFECT ON THE QUALITY OF ICE CREAM

Converting liquid mix into a powder needs only minor modification such as reducing its sugar content before drying, so as to avoid defective flavour and appearance. However, drying of mix is to be given special attention since the quality of the ice cream made
after reconstitution of the dried mix is likely to be influenced by the drying treatment.

Tracy and Pyenson (1944) conducted extensive studies to determine the effect of drying, temperature of reconstitution of the dry mix and ageing on the whippability and body characteristics of ice cream. The differences observed were not significantly affected by temperature of drying, but slight preference existed for mix reconstituted at 60°C and aged overnight at 4.4°C before freezing.

Baur (1965) patented a process for the manufacture of dry frozen dessert mix, which required only mixing with water and/or milk before freezing. The product had good flavour, body and texture characteristics.

Bassett (1965) developed a process for a powdered mix to produce a liquid mix for converting into palatable cold lacteal confections such as ice cream, soft ice cream and milk shakes. The mix was complete following drying and could be easily reconstituted with tap water. The sweetening agent was included in ultimate concentration in the liquid mix formula.

Dry dessert mix with improved quality was manufactured by Fisher (1967). The method consisted in combining pasteurized cream and condensed skim milk with 1/3 of the sugar and other ingredients, heating the mix to 66°C and then subjecting it to vigorous agitation followed by spray drying and rapid cooling.
Fastova (1970) suggested inlet-air temperature of 150°C and a feed temperature of 60°C (before drying) when full sugar was used in the mix. Sood and Srinivasan (1975) reported on the manufacture and freezing characteristics of spray dried ice cream mix, containing 8, 10 and 14 percent sugar, dried to about 2 percent moisture content, at inlet-air temperature of 160°C and 200°C. The mix prior to drying contained only half of the total sugar necessary. Increased inlet-air temperature or sugar content gave considerable caramalization. Average free fat was 14.2 percent and solubility 94.2 percent. Reconstitution, which was difficult at room temperature, became progressively easier at higher temperature and the best quality ice cream was obtained with reconstitution at 50°C. Quality of ice cream was not as good as of the one made directly from liquid mix, but was still acceptable. The body, texture and melt-down characteristics were better than in the high-fat mixes.

2.7 EFFECT OF STORAGE ON ICE CREAM MIX POWDER

The shelf-life of the powder depends upon the condition and temperature of storage, and composition of the mix. The powder undergoes chemical and other changes, causing deterioration and reduction of shelf-life of the product.
Apart from the temperature of storage the moisture content is considered to be the principal factor influencing the rate of development of stale flavour in dried ice cream mixes, the rate being faster than that in whole milk powder (Coulter, 1946). Bassett (1965) recommended an inlet-air temperature of 150°C to avoid the stale flavour, which was undoubtedly due to chemical changes in the powder.

Kunkel et al. (1946) reported that increase in moisture content between 1 - 4.5 percent had much greater influence on the rate of deterioration of dried ice cream mix at 60°C.

Tarassuk and Jack (1948) hypothesized that the product of browning reaction inhibited the development of stale and oxidized flavours and noticed that stale and oxidized flavour preceded browning and may only be masked by caramalized flavour. Powder with less than 3 percent moisture kept well for two years at 30°C and 40°C when double gas-packed. They observed that high moisture, oxygen, metallic contamination and high storage temperature were responsible for flavour deterioration in dried ice cream mix.

Sood and Srinivasan (1975) observed, during storage studies of ice cream mix powder, that the moisture
content decreased when the fat level of the mix was raised. Packed bulk density averaged about 0.5 g/ml, and the loose density 0.3 g/ml. The free fat content increased at a greater rate under nitrogen than in air packed samples during storage. Solubility decreased faster under air than under nitrogen packing. Thiobarbituric acid value showed a faster increase under air packing than under nitrogen, the increase was slow and no flavour deterioration took place during first two months. Product could be kept in good condition for four mo under air packing. Although there was no difference in freezing after storage, but the product developed a coarse and icy texture due to low viscosity upon reconstitution. The melt-down was also foamy and watery in general.

Desai (1977) investigated the changes in the dried ice cream mix during storage and observed that the stored samples had acceptable color; the moisture content decreased during storage; the solubility decreased slightly; free fat content increased; the T.B.A. value dropped slightly; reconstituted mix required 8 to 12 hr ageing to remove chalky flavour and had acceptable freezing and whipping characteristics similar to control.

2.7.2 FREEZ DRIED MIX POWDER

In a report (Anon., 1964) it was claimed that freeze dried ice cream mix powder could be kept indefinitely when packed in polyethylene bags under nitrogen.