Paper No.: 07

Paper Title: TECHNOLOGY OF MILK AND MILK PRODUCTS

Module – 31: Defects in condensed and dried milks

INTRODUCTION

It is absolutely essential to maintain the quality of good grade concentrated milk during storage until it reaches the intended customer. Condensed milk and evaporated milk are the products suitable for prolonged storage. They have typical properties after production by which they are identified. Condensed milk should have a clean, pleasant aroma, a pronounced sweet taste, smooth and uniform body and texture and uniform light colour, which should be yellow for cow milk and light greenish white for buffalo milk. Evaporated milk should have mild pleasant flavour, a relatively viscous body, uniformly smooth in texture and uniform colour. These properties must be such that the product is fit for sale immediately after production and does not alter during reasonable period of storage. If certain defects are noticed in the product the reasons for the same and the preventive steps to be taken to eliminate defects should also be known to the manufacturer.

DEFECTS IN SWEETENED CONDENSED MILK

The major defects that are characteristics of unmarketable sweetened condensed milk are discussed hereunder:

Sandiness

The relative smoothness of texture of sweetened condensed milk is determined mainly by the size of the lactose crystals it contains. Sandiness is due to the presence of relatively large, coarse crystals. For a product of the desired smoothness, the crystal should average $\leq 10\mu$ in length.

Super saturation state of sucrose is also sometimes responsible for sandiness defect. When the sucrose ratio of finished product exceeds 64.5 %, it approaches the status of a saturated solution of sucrose. When such condensed milk is subjected to low temperature such as in cold storage or otherwise on its journey from factory to consumer, some of the sucrose that is present in excess of saturation will crystallize. They give the condensed milk a coarse, sandy texture. Incomplete solution in the pan has also been found to be a contributing factor of sandiness.

Cooling of condensed milk must be carried out in such a manner that smooth texture is obtained by the formation of large number of minute sugar crystals. High viscosity also delays the crystal formation. It is, therefore, necessary to rapidly cool the condensed milk in the initial stages. Correct cooling and induced rapid crystallization with correct amount of seed lactose will help to avoid this defect. Optimum storage temperature is also essential to avoid this defect.

Age Thickening

It is a common defect of sweetened condensed milk. It may be due to: Bacterial Activity or Physico - chemical reactions. Bacterial thickening is caused by extremely heavy bacterial contamination with the causative species of microorganisms, which results from lack of efficient sanitary supervision in manufacture. It can be prevented by proper sanitation and efficiently controlled forewarming temperature. In the presence of causative organism; it can be controlled by increasing the sucrose in water ratio to nearly 64.5 %. The exact reactions involved in Sweetened condensed milk age thickening due to physico-chemical causes have not yet been fully explained but it may be due to:

1. Hydration of proteins mainly the casein which adsorbs water and thicken.
2. The influence of season on age-thickening is very marked.

In order to avoid early thickening of condensed milk, optimum pre heating temperature should be maintained. Sugar should only be added at the end of condensing of milk. The product should preferably be stored at temperature below 15°C with the addition of proper type of stabilizers age thickening may be decreased to a great extent.

Flavour Defects

Rancid Flavour: It is not a frequently occurring defect of sweetened condensed milk. It can be controlled by taking following precaution:

(1) Fore warming the fresh milk at temperature above 76°C.

(2) Avoid leaks of raw milk in to the batch during fore warming and between the forewarmer and vacuum pan.

(3) Do not add sugar during fore-warming process.

(4) Use unpolluted water and keep all the equipments in sanitary condition.

Metallic Flavour: It may be caused due to the use of copper equipment. It may give pickery coppery taste of copper salts. Use stainless steel equipments to avoid this flavour defect.

Tallowy Flavour: It is due to the autoxidation of milk fat. Now-a-days it does not occur, but it may occur if the finished product is exposed for a considerable period of time to air and light and in plants that are still using copper vacuum pans and copper forewarming units.

Fat Separation

It is the result of abnormally low viscosity and thin body. In such milk at rest, there is definite tendency of some of the fat to rise to the surface forming a layer that has deeper yellow colour than fresh milk. This defect can be controlled by proper processing and proper concentration of total solids.

Dark Colour / Brown Discolouration

The immediate causes of the discolouration are the intense heat treatment during fore warming and high storage temperature. At low temperature, the colour is not noticeably affected by aging.

DEFECTS IN EVAPORATED MILK

The major defects that are characteristics of unmarketable evaporated milk are discussed hereunder:

Curdiness Due to Heat Coagulation

For the dependable prevention of curdiness and other physical defects that dissipate the marketable properties of the finished product, it is necessary to efficiently control the viscosity of the evaporated milk. The causes and prevention of curdiness due to heat coagulation are briefly summarized as follows:

Curdy evaporated milk is due to too low heat stability in the presence of heat treatment used for sterilization. When the cooking time (minutes held at full sterilizing temperature) approaches the heat stability time, there is danger of permanent curdiness in the finished product. If the heat stability of the evaporated milk is too low to ensure freedom from curdiness, it may be increased and curdiness prevented by use of higher forewarming temperature or by the proper use of casein stabilizer. Higher homogenizing pressure such as pressure between 211 & 281 kg/cm^2 or higher lowers the heat stability and increases the tendency to curdiness.

Age thinning/low viscosity

Milk like consistency of evaporated milk indicates its low viscosity. This defect may be due to insufficient concentration of milk and inadequate or no homogenization of milk or improper sterilization. This defect is eliminated by following correct/adequate processing conditions and storing the product at low temperature.

Fat Separation in Storage

Adoption of homogenization as an integral function of manufacturing of evaporated milk eliminates the defect of fat separation as a serious problem. Yet even in the homogenized product, the distribution of fat globules is not permanently uniform, on progressive storage of homogenized product, it becomes higher and richer on top layer.

The reasons for this defect to appear are in adequate homogenization high storage temperature, long storage period and improper handling during storage. Proper homogenization, low temperature storage and correct handling of the product will eliminate this defect.

Mineral Deposit

Under certain conditions, there is a tendency for a whitish gritty deposit to form near the bottom of the container. This deposit consists chiefly of tri calcium citrate. This gritty sediment formation takes place during prolonged storage of evaporated milk. The rapidity with which the sediments are formed is influenced by the nature of the milk, conditions of manufacture and temperature of storage. Selection of good quality milk, correct processing conditions and low temperature storage will help to eliminate this defect. Higher viscosity product is less prone for this defect.

Browning of Evaporated Milk

The reasons for browning or darkening of colour is due to reaction in the presence of sterilizing heat, between the sugar of milk and certain amino acid. The colour of evaporated milk darkens with age. The rate of darkening increases with storage temperature. At $5^{\circ}C$ or below there is no change of colour during storage. The brown colour defect in evaporated milk is eliminated by employing proper preheating temperature, correct sterilization process and low temperature for storage of the product.

COMMON DEFECTS OF DRIED MILKS

Milk powders possess various organoleptic, physico-chemical and reconstitutional properties, which are important to both industrial and consumer use. These properties are the basic elements of quality specifications for milk powders. These properties of the powder are affected by the milk quality, the design of the evaporator and dryer, and by the process conditions. During drying process, care is taken to conserve as much as possible the natural properties of the original raw milk. Quality of dried products should be such that when reconstituted with water, give little or no evidence of detrimental change compared to the original liquid products.

Some of the common defects that may develop in dried milk products due to various reasons are described below:

Off Flavours

Oxidised/ tallowy flavour: Whole milk powder undergo lipid oxidative deterioration. Higher storage temperature, higher acidity, sunlight and ultra violet irradiation, presence of copper and iron promote faster development of oxidative deterioration.

Rancidity flavour: Rancidity is due to hydrolysis of fat through lipase enzyme leading to production of free fatty acids, like butyric acid.

Stale flavour: Carbonyl compounds formed during Maillard reaction is responsible for stale flavour. Oxidation by products also contribute to a stale, cardboard flavour. The defect is accelerated by high moisture content and high temperature of storage.

Cooked flavour: Milk powders often have cooked flavour, which results from components formed during preheating and evaporation. During drying, conditions are mostly not such that off-flavours are induced. On the contrary, a considerable part of the volatile sulphydryl compounds (especially H_2S) is removed. A cooked flavour in milk powder mainly results from methyl ketones and lactones formed by heating of the fat (not common in skim milk powder) and form Maillard reaction products.

Discolouration

Milk powder tends to darken during storage, turning to brown due to maillard reaction, which refers to the reaction between free amino group of protein and lactose. This is associated with old or stale off-flavour. High moisture content and high storage temperature enhance browning discolouration.

Free Fat

The amount of free fat in dried milks varies appreciably depending upon the manufacturing method and storage conditions. It is lowest in spray dried powders and highest in roller dried ones. The figures for free fat as % of the total fat have been reported in the literature ranging from 1-20% in spray dried powder and in roller dried powders 91.6 - 95.8%.

Free fat content of milk powders affect flowability, reconstitutability and stability of milk powder. The presence of larger quantities of free fat tend to increase the susceptibility of fat oxidation and thus to decrease in keeping quality of dried milk.

Poor Solubility

Powders with poor or low solubility cause sediment, which is unsightly. The sediment produced when milk powders are reconstituted is measured in terms of an insolubility index, so, in reality, the solubility of a powder is expressed as its degree of insolubility. Insolubility index is a measure of the extent of denaturation of the proteins in milk powder. It is determined as the volume of the insoluble sediment after dissolving and centrifuging according to a prescribed procedure. The analysis of insolubles shows these to be a protein/fat/mineral complex, the fat probably being held by relatively weak chemical bonds. The protein itself is casein and/or denatured whey proteins. The rate of insolubilization is dependent on both the moisture content and the storage temperature of the milk powders. The insolubilization can be inhibited for all practical conditions of storage by maintaining the moisture level below 3%.

Sludge Formation

Powders with poor dispersion properties can form sludges and can demand greater energy inputs to ensure complete solution. In an industrial or domestic context, the presence of a sludge following the reconstitution of a milk powder is regarded as a product defect.

Scum Formation

Scum is the layer formed on the surface of the reconstituted milk comprising of the foam (upper layer) and the undissolved/ slowly hydrated particles (flecks) (lower layer).

White Flecks

White flecks are slowly hydrated particles in lecithinated whole milk powder and are measured (in mm) as the lower layer of the scum (i.e. foam + flecks) after reconstitution under specified conditions. The occurrence of white flecks is of similar origin to insoluble sediment.

Scorched Particles

Scorched particles arise mainly from powder deposits which have been held for long periods in ducts or at other points in the drier or from drying chamber due to inadequate mixing and directional control of the milk and air streams. The moist powder sticks to the hot metal surfaces and eventually becomes brown or even black. Subsequently large pieces of discoloured material may become detached and mix with the powder bulk. Some drying chambers are provided with vibrators or internal rotating mechanical devices to prevent such accumulations.

Cakiness

Dried milk absorbs moisture very readily from atmosphere, and if packed in materials which are not impermeable to moisture such as plain paper sacks, cardboard cartons, etc., it may develop large hard lumps or severe caking during storage. Amorphous lactose is responsible for the tendency of milk powders to pick up moisture from surrounding air. Milk powder becomes sticky during the first phase of this moisture uptake and stoned-hard at the end of this process. Final caking is caused by the crystallization of lactose followed by the evaporation of excess moisture.

Feathering

Product intended for use as whiteners in hot beverages such as coffee and tea, must be reasonably thermostable. The lack of thermostability occurs as, so called feathering i.e. particles visible on the surface or throughout the beverage or sediment at the bottom. A temperature of 80-85°C coupled with the low pH of coffee, and often high levels of calcium and magnesium hardness in the water makes for an environment hostile to milk protein stability. Proper protein standardization, appropriate heat treatment of raw milk and incorporation of phosphates and citrates as pH regulators and protein stability enhancer are suggested to improve the stability of milk proteins.

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