Churning

Churning of cream consists of agitation at suitable temperatures until the fat globules adhere, forming larger and larger masses and until a relatively complete separation of fat and serum occurs. The object of churning is to produce butter from cream. The fat exists in the formof emulsion i.e. a continuous phase. This emulsion is fairly stable. As long as itremains intact, there is no formation of butter. The factors contributing towards the stability of this fat in skim milk emulsion are:

- Force of surface tension: this causes the fat globules in milk/ cream to retain their individuality and prevent butter formation.
- Phenomenon of adsorption: the surface layer of the fat globules contains an adsorbed, phospholipid protein complex, which resists deemulsion.
- Electric charge: the fat globules have negative charge and repel each other. The charge decreases as the cream acidity increases.
- Viscosity: increased viscosity retards churning.
- A greater concentration of fat globules in cream promotes amore profuse and rapid coalescence and aggregation than milk.
- Preparation of churn: a new churn requires careful pre-treatment before use. An old churn requires proper sanitation and cooling, to render it clean.
- Filling the cream into the churn: the amount of cream filled should be slightly below the rated capacity.
- Addition of butter colour: this is done to maintain the uniformity of yellow colour in butter throughout the year for consumer satisfaction. The amount of standard color added varies from 0 to 250 ml ormore per 100 kg of butterfat. The butter colour should preferably be added to the cream in the churn.
- Butter colour should have the following properties: it should be harmless, free from off flavours, concentrated, permanent, and oil soluble. Butter colours are of following types:
    - Vegetable origin: annatto and carotene. Annatto isobtained from the seeds of the annato plant (Bixa orellana) carotene isextracted from carrots and other carotene rich vegetable matter. Its use growing for it increases vitamin A potency.
    - Mineralorigin: harmless oil soluble coal tar dyes. Examples: yellow AB (benzene Azo b - naphthyl-amine),Yellow OB(ortho toluene Azo- b - naphthylamine).

Churning of cream

- Good churnability refers to clear breaking stage churninguntil the grains of butter are of the correct size. Exhaustiveness of churning - refers to fatlosses in buttermilk, satisfactory washing and optimum churning period.

Factors influencing churnability of cream and body of fat

- Chemical composition of fat: an increase in the proportion of soft fat shortens the churning period, diminishes the firmness of butter and increases the fat lossesin butter milk and vice versa. Fresh green succulent feeds increase the proportion of soft fat and dry hard feeds increase the proportion of hard fat.
- Size of the fat globes; the higher the proportion of the small –sized fat globules, the longer the churning time and the greater the fat loss in buttermilk and viceversa.
- Viscosity ofcream: the greater the viscosity of cream, the greater the churning period andvice versa.
- Temperatureof cream at churning: Under Indian conditions the optimum churning temperature ranges from 9-11 ° C. A higher churning temperature causes a shorter churning time, higher fat loss and a weak body in butter, which is difficult to wash and from which it is difficult toremove curd particles properly. A lower churning temperature prolongs the churning period.
- Fatpercentage of cream. The higher thepercentage of cream, the lower the churning period. The fat percentage under Indian conditionswill be 40 for cow milk and 35 for buffalo milk.
- Acidity ofcream: according to Hunziker, acid cream churns more rapidly and exhaustivelythan sweet cream. However Mc Dowel believes that the reverse is the case.
- Load offchurn: the butter churn should be filled with one-half to one –third of its total capacity with cream. Overloading prolongs churning time, while under loading reduces total capacity of thechurn.
- Nature ofagitation: this is influenced by he size, type, and RPM of the churn, and affects the churning period.
- Pre-churning ageing period. Refers to cooling and ageing of cream.

Operating the churn

- Afterinitially rotating the churn for 5 –10 min., the liberated gas is removed once or twice by opening the churn vent. Thenthe cream sample is drawn for the fat test. During the churning process there is invariably a rise in temperaturefrom 1-3 ° C. Churning is accompanied by foaming. Then comesthe “breaking stage”. When the creambreaks away from the spyglass, which becomes clear. At this stage the fat in the skim milk emulsion breaks and very small butter granules of the size of pin heads maketheir appearance, it is sometimes necessary especially in the tropics, to add break water at this stage to reduce the temperature of churn contents, and there by control the body of the butter. The amount and temperature ofbreakwater depends on the temperate reduction required. After the breaking the churning is continued until the butter grains are of the desired size (viz., ‘ pea size’ in largechurns). In the tropics, addition ofbreakwater can be avoided by providing an air-conditioned butter making room and /or chill water spray over the butter churn.

Factors affecting fat loss in buttermilk

- Fatpercentage of cream: Lower the fat percentage of cream, the lower the fat percentage in butter milk,but the greater is the percent total fat loss in buttermilk, vice versa
- Size of fatglobules. the greater the proportion ofsmall sized fat globules, the greater the fat loss ,and vice versa
- Acidity ofcream at churning. According toHunziker, sour cream causes a lower fat loss than sweet cream; but according toMc Dowell, the reverse is true.
- Physical properties of fat: the softer the fat, the more the fat loss and vice versa.
- Condition ofcooling and ageing: insufficient cooling and ageing i.e. improper crystallization causes more fatloss and vice versa
- Conditions ofchurn: overloading, gross under loadingand under churning all a cause a greater fat loss in butter milk.

Washing

When thecream has been churned the churn is stopped in the proper position, adrain-plug fixed and the buttermilk removed thorough sieve.

The purpose of washing is

- Remove allloose buttermilk adhering to butter grains so as to reduce the curd content ofbutter, thereby improving its keeping quality.
- To correctd efects in the firmness of butter by proper adjustment of wash watertemperatures, and
- To deceasethe intensity of certain off flavours

After buttermilk has been drained chilled water is added to the butter grains in thechurn. The temperature of water isusually1-2 ° C lower than the churning temperature of cream and an amount equal to the quantity of buttermilk removed. Normally one wash isenough for good quality butter. The quality of water should be physically clean and bacteriologically and chemically safe. It is better to use freshly pasteurized and cooled water.

Salting

- Refers to addition of salt to butter.
- To improve keeping quality
- To enhance the taste.
- To increase overrun. Salt is usually added at therate of 2.0-2.5 % of the butterfat. Excessive salt damages the quality of butter.
- The calculated amount of salt may be added to butter eitherby sprinkling the powder salt over the butter surface during working or it may be wetted in the least amount of potable water and then sprinkled over the butter during working. The salt is added in the form of a saturated solution of brine.

Specifications of butter salt

- The saltshould be a coarse grained and free from lump. It should pass completely through and IS sieve-85 (aperture 842 microns).99.5 –99.85 % sodium chloride on dry matter. Bacterial counts less than 10/kg.Completely soluble. High rate of solution. Negligible sediment.

Working

This refers to the kneading of butter

Objectives

- To completely dissolve, uniformly distribute and properly incorporate the salt.
- To expel buttermilk and to control the moisture content of butter,
- To fully incorporate the added makeup water in butter.
- To bring the butter grains together into a compact mass for convenient handling andpackaging.
- During working, the moisture in butter is reduced todroplets of microscopic size, which are mostly sterile.
- The working should be continued until the butter has acompact body, closely-knit grain, a tough waxy texture, and an even distribution of salt and moisture. Indicator paper develops a coloured spot if free moisture is present.Both over working and under working should be avoided; the over working damages the body and texture of butter and under working produces leaky butter. Working increases the air content ofbutter. Normally worked butter has anair-content of 0.5-10ml/100 g. The air content of butter is important because it affects I) the density of butter ii) its microbial spoilage; and iii) itsoxidative spoilage.

Keeping quality of butter

The factors affecting the keeping quality are

- Temperature of storage
- Copper and iron content the higher the content the lower the salt content of butter keeping quality.
- Acidity content of butter
- Curd content of butter
- Air contentof butter.
- Raw orpasteurized cream: pasteurization of cream increases the keeping quality.
- The method ofpackaging: sanitized high quality packaging materials and sanitary methods ofpackaging increase the keeping quality and vice versa
- Exposure tolight lowers the keeping quality
- Sweet cream/unsalted butter has the maximum and acid cream /salted butter the minimum keeping quality under commercial cold storage

Theories of churning

They are three main theories on the churning of cream in tobutter. Viz.

- Fisher and Hooker’s phase reversal theory
- Rahn’s foam theory
- King’s modern theory.

Fisher and Hookers Phase Reversal Theory

- According tothis theory, churning is a process of phase reversal, i.e. changing anoil-in-water type emulsion to a water-in-oil type emulsion such as butter. Agitation of cream in the churning processcauses coalescence and clumping of fat globules until eventually the ratio ofthe surface area to the volume of fat units becomes so small that it can nolonger contain all the buttermilk in stable form. The fat-in-water emulsion then suddenlybreaks, yielding butter grains and free buttermilk.

Drawback

- Butter is not true water in fat emulsion. Microscopicstudies reveal that a proportion of fat globules in butte is still intact inthe worked butter.

Rahn’s Foam Theory

- According tothis theory, the presence of foam/froth is essential for churning. It also postulates that there is a foam producing substance present in cream, which gradually solidifies as the cream,or milk is agitated. Foam is created during the churning period. The fat globules due to surface tension effect tend to concentrate and clump on thefoam bubbles. The foam producing substance assumes a solid character and the foam collapses. The fat globules then coalesce and butter isformed.

Drawbacks

- Foamformation is not required in some continuous butter making processes.

King’s Modern Theory

According tothis theory,

- In cooledcream at churning temperature, the fat is present as clusters of fat globules;and within each globule it is present partly in liquid and partly in solidform.
- Churningbreaks up the cluster and cause foam/ froth formation. The globules become concentrated to some extent in the film around the air bubbles in the foam and are thus brought intoclose contact with each other.
- The movementof the globules over one another in the foam film and the direct concussion between them causes a gradual wearing away of the emulsion protecting surfacelayer of the phospholipid protein complex. The globules then adhere together to form larger and largerparticles. Eventually these particlesbecome visible as butter grains. As the granules form , they enclose some of the air from the foam. The fat in thegranules is still mainly in globular form.

- The working of butter grains cause the globules to move overone another, under the effect of friction and pressure, some of them yield up aportion of liquid fat. Others are broken up during working. Finally there is enoughfree liquid fat present to enclose all the water droplets, air bubbles andintact fat globules.