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Review Article

New Trends for Low Moisture Part Skim Mozzarella (Pizza Cheese)

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Abstract

Low moisture part-skim (LMPS) mozzarella cheese is a healthy, functional food ingredient and mainly used as pizza toppings around the world. This article aims at discussing the functional attributes and overall cheese making process of LPMS Mozzarella in general. Further an in depth analysis of the newer trends in cheese making to shorten overall process time and improve cheese yields like use of ultra-filtered milk for protein standardization, pre-acidification of milk with acidulants or carbon dioxide, use of direct vat cultures, waterless stretching/scalding process to eliminate fat and protein loss and standardization of lactose in cheese milk were also covered.

Keywords: *Low Moisture Part-Skim (LMPS); Mozzarella Cheese; Cheese Milk*

Introduction

In recent years the global production of low moisture part-skim (LMPS) mozzarella cheese; often referred as pizza cheese; has shown an unprecedented growth. The popularity is enhanced by its healthy and positive image and its suitability for use as pizza topping and the growing popularity of pizza restaurants around the world.

LMPS mozzarella cheese is obtained from the acid and rennet coagulation of partially skimmed milk. It usually contains 46 - 52% moisture and the fat content depending on the preferences for cheese performance by different pizzerias. Higher fat tends to withstand severe baking conditions because of its ease in melting and release of fat when heated. While lower fat cheese gives limited shred, melt and fusion, resulting in a pizza with atypical burnt and dry appearance.

Since the production of LMPS Mozzarella is coupled so strongly with sales of pizza, it is manufactured to meet functionality requirements set by individual pizza company and type of oven used for baking pizza like conventional, convection or conveyor belt. The cheese must melt, flow and brown under conditions specified by each pizza company.

Large scale manufacture of mozzarella requires precise control of production operations. It requires better understanding of functionality of ingredients, its influence on cheese composition, texture, structure, functionality of cheese under different temperatures (hot/cold) and yield.

Overview of manufacturing technology

The initial manufacturing process and equipment lines for making LMPS Mozzarella are similar to cheddar or other similar cheeses. Cheese milk is normally standardised to high protein to fat ratio by either skimming or addition of solids such as ultrafiltered milk or condensed skim milk or SMP or MPC powder. The standardized milk is pasteurized and then pumped into horizontal or vertical enclosed vats containing up to 40,000 L of milk. Usually milk is set at a temp of 35°C.

A very important parameter for the production of Mozzarella cheese is the acidity. Generally thermophilic cultures are used for the production of LMPS mozzarella. Fast acidification is required, for faster turnaround of the equipments, on a large scale production unit using millions of liters of milk per day. The rate and extent of acidification influence many important cheese attributes like moisture content, flavour development, yield and functionality. When the pH goes down, it triggers the solubilisation of calcium phosphate; thus demineralize caseins and provide the ability of cheese curd to undergo pasta filata process. The acidity must be kept under control during entire process, from culture addition to stretching. Should the curd not reach the right pH during the incubation phase, it may then not be possible to stretch it.

Rennet is added to coagulate the milk. During cheese making, the enzyme chymosin specifically cleaves the protective layer of K-casein from the surface of the casein micelles; this reaction results in the loss of steric stabilisation leaving hydrophobic and calcium sensitive patches on the surface of the casein particles. When more than 90% of the caseinomacropeptide has been removed, the secondary phase of rennet aggregation occurs, moderated by free Ca^{2+}. The modification of the surface of the micelle is particularly critical to the secondary phase of rennet aggregation.

During this acid-rennet induced coagulation, liquid milk transforms to the gel state and it is then cut to drain the whey out. Once the cutting is finished part of the whey is pre-drawn to enable faster heat distribution; rest of the mix (curd and whey) is cooked to 39 - 41°C in 30 minutes with constant stirring. Acidity is continued to develop during cooking stage and when sufficient acidity is developed (pH 6.2 - 6.3), cheese curd is ready to drain. The pH at the time of draining is critical to the retention of calcium in the curd as calcium is a principal determinant of curd strength. For a stronger curd, drain the whey at higher pH to retain more calcium.

The curd along with whey is then pumped to draining belt or cheddaring belt system for draining, washing and matting. By the time the curd reaches the end of the belt, it should have attained sufficient pH for stretching (pH 5.3). It is then immediately milled and partially salted to inhibit the pH development. This is then sent over to hot water cooker/stretching unit and mechanically worked to produce a plastic consistency with desired melting and stretching properties characteristics for pasta filata cheeses. The hot mass of cheese is filled under pressure into moulds of desired size and shape. This hot cheese is then conveyed to saturated brine tanks to cool and absorb more salt.

It is very important to monitor the overall cheese make time. Faster make enables the cheese to retain higher moisture content in the finished product and thus improved yield. The overall make time averaging about 2.25 - 2.50h from coagulant addition to the ready to stretch.

Cheese intended for use on pizza or similar application should be aged for at least two weeks to improve melting properties. This effect is possibly due to proteolysis or perhaps due to equilibration reactions among casein and minerals.

Recent developments

Use of membrane filtration for cheese making

Membrane separation processes have been used as unit operations to standardize milk and change its composition for further processing. The physico-chemical properties of the milk and its serum can be carefully controlled by choosing appropriate selectivity for the membranes. The functional properties of concentrated milk obtained by membrane processing have been widely studied, in particular for cheese making applications. UF can concentrate protein up to 70% on dry matter basis (DM); while higher protein on DM can be achieved by using diafiltration (DF) along with UF. During DF, water is added to the retentate (UF concentrate) before further concentration, thereby drastically changes the serum composition of the concentrated milk. However, in most industrial applications, ultrafiltration (UF) is often combined with diafiltration (DF) which is then added back to whole milk before cheese making. The advantages of this type of protein standardisation are uniformity in milk composition, better protein retention, firmer coagulum and higher yield. This in turn affects the overall cheese plant efficiency in terms of faster turnaround of equipments with minimal capital investment.

When protein content of the cheese milk is increased it can exert higher buffering capacity because of the increased concentration of casein and colloidal calcium phosphate that is concentrated to the same extent as that of casein micelles. Increased buffering may adversely affect the rate and extent of pH development, texture, rheological properties and subsequent proteolysis during ripening. DF enables to lower the mineral content of the retentates and UF coupled with DF is preferred by cheese makers around the world.

Pre acidification of milk

Rapid acidification shortens the total manufacturing time of the cheese make, which in reduces the total amount of whey syneresis and enables the cheese to retain more moisture content. The pre-acidification not only decrease the lag time requires for direct vat (DV) cultures but also solubilizes colloidal calcium, thus eliminating the necessity of adding external $CaCl_2$ in the cheese milk. This solubilized calcium will act as a catalyst for the secondary stage of rennet coagulation.

It is possible to use chemical acidification instead of starter cultures. Various acidifying agents like lactic acid, citric acid and CO_2 has been used for acidifying the milk. Now a day's addition of citric acid to cheese milk is widely used for making traditional high moisture (e.g. 55% to 60%) Mozzarella cheese like Bocconcini that is consumed fresh and added in salads, however it is not used extensively for making LMPS Mozzarella. Lactic acid has been widely used but both lactic acid and citric acid requires ingredient declaration on the label. CO_2 appears to be a good source of pre-acidification of cheese milk. CO_2 creates carbonic acid which stays with the casein portion of the milk, thus no effect on whey processing.

Use of DV cultures

Traditionally mesophilic strains of rods and cocci were used for making Mozzarella-type cheeses. Recently a mixture thermophilic strains like *S. thermophilus* and *L. helveticus* has been used to replace the mesophilic strains. *S. thermophilus* enables the conversion of lactose to lactic acid while *L. helveticus* metabolise residual galactose; a byproduct of LAB metabolism; thereby eliminating the Maillard browning reaction on subsequent baking of the cheese over pizza.

Traditionally bulk starter cultures were used for inoculating the cheese milk. Propagating bulk cultures is a tedious process that involves sterilizing the medium (reconstituted skim milk powder or in a milk or whey-based phage inhibitory medium) containing ingredients for culture growth, pH control and to inhibit bacteriophages. pH can be controlled by internally buffering the media or by external control units like injecting ammonia. This enables to achieve active cultures with high cell count; however, it requires extensive labour, energy and constant surveillance.

The recent trend is towards Direct Vat cultures; which is highly concentrated, are produced in either freeze-dried powder or frozen pellet formats and are added directly into the vat. The main advantages are it is effective in reducing the risk of phage attack, multiple strains available, no lethargic processing facility required and easy to use. However, it requires a slightly longer pre-ripening period as it requires time to adapt to the new environment.

Direct steam technology for stretching

Traditionally Pasta filata cheese is stretched using single- or twin-screw hot water cookers. The cooker is filled with hot water (65 - 70°C) where curd is heated, mixed and stretched while pushed to the other end of the cooker by rotating screws. This process of kneading and working releases lot of fat from the cheese matrix and this fatty water is continuously discharged into the plant effluent stream. This in turn results in high BOD counts and expensive effluent treatment options.

Recent years direct steam technology gaining more and more popularity because of improved texture of the finished product and better control of final cheese composition. Here curd comes in contact with direct steam in a closed chamber and this process does not discharge fatty water from cheese curd during kneading and working. This is a discontinuous process and fine tuning of the cheese composition is possible as it allows the re-absorption of added ingredients from the process chamber (water, butter oil, spices and gum).

Standardising cheese milk for lactose content

Burning cheese on the top of pizza is one of the biggest problems faced by cheese manufacturers. Many steps such as washing curd twice with chilled water, galactose metabolizing cultures were used to remove reducing sugars from cheese.

In addition, controlling the pH of the finished cheese can be difficult in pasta filata cheeses. The rate of acid development is too fast that it is difficult to stretch the entire whitemass in a short period of time. The first batch going through the stretcher must be at the ideal pH for stretching while the last batch from the same vat will be stretched at a very low pH (close to pH 4.9). The functionality of these two batches from the same vat will be markedly different. By adjusting lactose content of cheese milk without changing protein to fat ratio has been proven successful in controlling cheese pH that in turn affected the texture, organoleptic properties and functionality of LMPS Mozzarella cheese. A combination of ultrafiltration and diafiltration for adjusting the protein to fat ratio can enable cheese makers to adjust the lactose content of the cheese milk [1-8].

Conclusion

Cheese making is an indulging technology and evolving over time. Numerous variations of LMPS Mozzarella is available in the market like cheese curd by itself, leaving pasta filata process, resulting in pizza cheese with same chemical specification and functionality except the microstructure of pasta filata cheese. Similarly, traditional brining process can be shortened or eliminated by pre-salting curd before cooker stretcher process or by cooking/stretching in hot brine solution or adding salt to the hot product when it exits the cooker stretcher.

Nontraditional aspects of cheese making like adding components within the cooker stretcher, waterless stretching, shredding and freezing are the new trends in market. In future we may even encounter replacing the overall curd make process with milk protein concentrate rather micellar casein concentrate and butter oil. Another emerging trend is “make pizza cheese in the morning and eat pizza by evening” by eliminating the entire ripening aspect of cheese making.

Functionality or stringiness of the LMPS Mozzarella cheese can be manipulated by adding gums, starches, emulsifying agents, chelating agents, surfactants into the curd before heating the mix. Spices or flavouring agents can be added into the cheese curd before stretching to obtain novel snack products.

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