RAW MILK QUALITY: THE PROCESSOR'S POINT OF VIEW

K. A. Schmidt

Summary

Raw milk quality is important to the processor for many reasons, this quality can be assessed by several different tests. Quality tests are used to ensure that the raw milk meets legal USDA standards as well as some of the individual requirements of the processor. Although some quality tests can be done in a matter of minutes, others require up to several days to complete. Because milk quality deteriorates relatively quickly, it is important to concentrate on those tests that provide the greatest amount of information in the shortest time. This information then is extrapolated to assess the "actual raw milk quality". After all, the quality of milk does not improve with time; thus, if the starting materials are substandard, the final products will be less than substandard. Generally, raw milk quality is assessed by type and number of microbes, milk composition, presence of contaminants, and current (and perhaps previous) temperature.

(Key Words: Raw Milk, Quality, Incoming Tests.)

Microorganisms

In raw milk, the assumption is that pathogenic microbes (those that cause disease) will be present. However, in the U.S., most processors do not assess the type and number of a specific pathogen(s) in raw milk. Testing for specific microorganisms can be both time-consuming and inefficient. However, the type and number of microbes will affect the quality of the product. Microbes differ in their temperature and nutrient requirements for growth. For many years, lactic acid bacteria (LAB) were of great concern to producers and processors. As LAB grow in milk, they utilize lactose, subsequently producing lactic acid, which causes a decrease in pH. The milk then sours and as a final result, it is unfit for fluid, cultured, or fermented products.

Over time, refrigeration has been mandated at producer, in-transit, and processor locations, because maintaining low temperatures (<45°F) minimizes the growth of LAB. Psychrotrophic bacteria, which can grow at low temperatures, have become the predominant microbes in raw milk today. These bacteria may not grow quickly at refrigeration temperatures, but they can utilize the milk components as nutrients and produce enzymes that further degrade fat, lactose, and proteins. Degradation of these milk components leads to off-flavors and odors that may cause the raw milk to be unfit for processing or consumption as fluid milk. Depending on the reactions, this raw milk also may not be suitable for other dairy products. For instance, if the casein protein has been degraded, cheese yields can be reduced drastically and the off-flavors in the milk may be carried through to the final product. In addition, rancid or oxidized milk (the result of fat degradation) is unsuitable for ice cream or butter, because the fat-derived off-flavors carry through to the final product. Another issue is that as milk components are degraded, their functionality changes and the ability to manufacture some products may be compromised.

Pasteurization generally reduces the total number of microbes in raw milk. A higher number of bacteria implies that more reactions have occurred and more enzymes (which may not be inactivated during pasteurization) will be present in the pasteurized milk. This presence of more bacteria decreases the shelf life of the product as well as its quality. Shelf life usually depends on the number of spoilage microorganisms present in the milk. Once the number of bacteria reaches a certain level, the milk is considered "unsaleable".

Typical microbial testing done at the processing plant on raw milk includes coliform, preliminary incubation (PI), and standard plate count (SPC) tests. These three tests measure different aspects of the microbial quality and require 24 to 72 hr to perform. The coliform test indicates the degree of cleanliness of the raw milk. Greater coliform counts are interpreted as potential fecal contamination of the raw milk. Although no standard exists for maximum allowable coliform counts in raw milk, milk processors want raw milk with the lowest possible number of coliforms. The SPC enumerates the number of aerobic bacteria in the sample. Legally, maximum limits for the bacteria counts are allowed in fluid milk, and these limits vary depending upon whether the milk is from a single source or is commingled. The PI testing is used as an indication of the keeping quality of the milk. Often, individual plants set their own guidelines and test conditions to define acceptable limits for the PI test.

Composition

Legally, according to the Pasteurized Milk Ordinance, milk is defined by its fat and solids-not-fat contents. The public buys and consumes fluid milk (and other dairy products) based on fat content; thus, the fat and total solids contents of the incoming raw milk play key roles in dairy foods marketing.

Milk fat imparts desired and unique functionality to products such as milk, ice cream, butter, and certain cheeses. Not only is the quantity of fat important for these products, but the integrity of the fat (little to no chemical reactions such as oxidation or lipolysis) must be high, so that the final products have acceptable flavors, odors, and textures. Milk protein, in particular the quantity and integrity of casein, influences cheese yields. Lactose contributes sweetness and imparts viscosity to fluid milk and other fluid dairy foods. Physically, lactose and minerals depress the freezing point of milk; thus, as their concentrations decrease, the freezing point increases. Many processors and governmental agencies use this relationship to determine if water has been added to the raw or fluid milk product.

In most large plants today, the compositional analyses can be done relatively quickly with the use of infrared technology. This technology provides rapid results for composition of protein, lactose, and total solids, depending on the sophistication of the instrumentation. To determine if water was added to the milk, the freezing point is measured. This also is a rapid test that is fairly accurate. Both types of instrumentation can produce results within 5 to 10 min depending on the instrumentation itself, operator experience, and calibration status.

Titrable acidity (TA) and pH are two other chemical measurements that may be utilized to monitor the raw milk quality. In both cases, the acidity of the milk is measured. Generally a "high acid" milk sample indicates that microbial activity is high. These two methods measure different chemical compounds within the milk, so their interpretations are different. Both methods are easy and relatively inexpensive to perform, provided the equipment is available. In the U.S., high-quality raw milk will fall within a narrow range of pH and TA levels. Thus, deviations from these narrow limits indicate that raw milk quality has been compromised.

Contaminants

In recent years, the main raw milk contaminants of concern are antibiotics, toxins, and pesticide residues. All U.S. processors must test for the presence of antibiotic residue in raw milk prior to receiving the milk into the plant. When antibiotic-contaminated milk is in the general milk supply, those individuals who are allergic to a specific antibiotic may have an allergic reaction if they consume the milk. To date, pasteurization does not inactivate antibiotics; thus, they pass from the raw milk into the final product. Over the years, reports of serious illness and several deaths have been associated with consumption of milk that contained antibiotic residues. Federal law mandates that all incoming raw milk is tested for the presence of antibiotics. Most facilities have an approved "quick" test procedure and equipment for detection of a certain type of antibiotics. These tests can take from 10 to 40 min depending on the equipment model and operator's experience.

Alfatoxin is a concern for all milk processors and producers. When a cow consumes tainted feed, aflatoxin may be transferred into her milk. Aflatoxin is a powerful neurotoxin that can harm humans. Recently, reports of other contaminants in dairy products, such as dioxin, have surfaced. Residues from pesticide and other treatments used for crop, land, or water management can be ingested by cows and eventually can transfer into the milk. All of these unwanted compounds can be dangerous for the consuming public.

Most processing plants do not have the capability to test for specific toxins in the raw milk supply. This testing may be done at the main headquarters' laboratory, or the dairy processing company may contract an outside, independent, testing laboratory to do these analyses. Testing for most contaminants requires expensive equipment and time-consuming procedures for the isolation, identification, and quantification of the specific contaminant. In addition, test procedures, equipment, and necessary reagents differ depending on the specific toxin in question. Generally, this testing is not done routinely, but rather as an audit or if a load of milk is suspect.

Temperature

Temperature is critical, and most plants will not accept a shipment of raw milk, if it exceeds a specific temperature. As temperatures increase, microbial growth increases. Microbial growth decreases the quality of the milk, as discussed above. Most plants rely on calibrated thermometers or temperature-sensing devices to verify raw milk temperature. If raw milk temperature is above a critical level, usually 45°F as defined in the Pasteurized Milk Ordinance, it will be rejected. Generally, a lower limit is not set for milk temperature. However, a frozen load of raw milk would be difficult to unload and probably be unsuitable for processing.

Conclusions

All processors of raw milk are concerned about the quality of the incoming product. They will use a variety of tests to assess the quality of the microbial activity; fat, protein, and total solids contents; presence of antibiotics; and temperature to decide whether to accept the load of milk. Processors continue to monitor the quality of the processed milk and relate it to the raw milk quality. It is not unusual for a processor to have set standards for the incoming ingredients as a means to ensure the acceptability, quality, and safety of the final product.