Special Report 29 - 1973

Dairy Plant FIELDMAN HAULER GRADER and TESTER'S Manual

V. S. Packard
Dairy Products Extension

AGRICULTURAL EXTENSION SERVICE
UNIVERSITY OF MINNESOTA
ST. PAUL, MINNESOTA

Dairy Plant FIELDMAN HAULER GRADER and TESTER'S Manual

CONTENTS

PURPOSE

This publication is designed as a reference manual for eldmen, haulers, graders, and testers. Knowledge of the oblems encountered in the various areas of work may help omote cooperation in carrying out the important function rved by each.

COMPOSITION OF MILK

To understand the problems which confront the fieldman, ader, and tester it is necessary to know the composition of ilk. Below is a gross breakdown of major constituents and ie approximate percentage in which they are found in milk:

Constituent	Percent
Water	87.0
Butterfat	4.0
Casein	2.8
Whey proteins	0.7
Milk sugar (lactose)	4.8
Ash*	0.7
Total	100.0

Ash is the mineral matter which remains after charring.

TOTAL SOLIDS include everything except water. *Total otein* includes casein and whey proteins. The *solids not fat* e the constituents other than butterfat and water.

Butterfat normally shows the greatest variation, protein ntent varies somewhat less, and lactose and minerals vary e least of all milk constituents. Changes in lactose content ually are compensated by changes in mineral content i.e. creases in lactose will be followed by decreases in minerals id vice versa.

LAWS AND REGULATIONS

Grade A raw and pasteurized milk products are usually gulated under the Grade A Pasteurized Milk Ordinance Rec-mendations of the U.S. Public Health Service. Commonly, ites adopt the grade "A" pasteurized milk ordinance verbatim d administer the program as such.

Manufactured milk and manufactured dairy products, such butter, various cheeses, and nonfat dry milk are regulated rough standards and grades promulgated and adopted by the mmissioner of Agriculture. In Minnesota, both grade A and anufacturing milk regulations come under the jurisdiction of e Minnesota Department of Agriculture.

Any person wishing to haul milk in bulk, or grade, sample, test milk for purchase purposes, is required, by law, to ob-in a license to perform this work. The maximum penalty for erating without a state license or misgrading milk or cream, misreading a butterfat test is a fine not to exceed $300. ice obtained, milk grading and sampling, or grading and sting licenses are permanently valid. No retest or reapplica-n for license is currently required.

The U.S. Department of Agriculture has published in the deral Register recommendations for production and pro-ssing of milk for manufacturing purposes. The recommenda-ns, similar to grade A recommendations of the U.S. Public Health Service, cover grades and standards for manufacturing milk and milk products. Until these standards are adopted by the state, they remain recommendations only. If adopted, 24 months are allowed for initiating the program requirements. These requirements are similar, though not identical to grade A requirements.

All private, municipal, and industrial laboratory work done in compliance with grade A raw milk standards must be performed in laboratories certified by the regulatory authority (Minnesota Department of Agriculture). These laboratories are certified biannually by the State Laboratory Certification Officer.

BACTERIOLOGY

Definition

Bacteria are small, one-celled plants. They range in size from 1/75,000 to 1/10,000 of an inch in diameter, from 1/25,000 to 1/10,000 of an inch in length. Each cell is capable of reproduction within itself.

Useful Action

Certain bacteria are used in manufacture of cultured dairy products and cheeses. They form desirable flavor compounds and change milk consistency.

Undesirable Action

Many bacteria cause spoilage of foods creating serious economic losses. Other bacteria, some of which may be carried in milk, cause illness in man.

Appearance Under the Microscope

Most bacteria encountered in the dairy industry will be rod-shaped or round. Round bacteria are referred to as coccus (plural cocci). They are found singly or grouped characteristically:

1. Micrococcus – occur singly or in irregular groups
2. Staphylococcus – irregular, grape-like clusters
3. Streptococcus – found in chains
4. Sarcina – occur as cubical packets of eight

Requirements of Bacterial Growth

Most conditions under which bacteria grow and multiply are similar to those needed for human survival. Bacteria must have:

WATER. Therefore, if milk handling and storage equipment is stored drained and dry, bacteria levels do not increase between milkings.

FOOD. Milk is an excellent source of many nutrients needed by bacteria. Removal of milk solids during cleaning helps starve them out.

OXYGEN. Some bacteria require oxygen (aerobes); others grow only in its absence (anaerobes). Still others are capable of living with or without oxygen (facultative).

FAVORABLE TEMPERATURE. All bacteria grow best at certain specific temperatures. However, these optimum temperatures differ among species. But no bacteria multiply at a maximum rate at temperatures below 40° F. So cooling is an effective method for controlling growth.

FAVORABLE pH (acid or alkaline reaction). Bacteria grow best in solutions neither highly acid nor highly alkaline. Milk is slightly acid and favorable for their development.

Types of Bacteria in Milk

One way to classify bacteria is by temperature response. From this knowledge, insight can be obtained about their source and control.

1. THERMOPHILES are heat loving. They can grow even at pasteurization temperatures and readily multiply at 131° F. Their growth range is 113° to 158° F. You might find thermophilic bacteria in hot water lines or hot water storage tanks. Other sources are soil, bedding, and feeds. Thermophiles may be found in milk following pasteurization, thus contributing to "lab-pasteurized" counts.

2. THERMODURIC bacteria are literally durable to heat, thus thermo(heat)-durics. They survive pasteurization and are reported to producers in pasteurized counts, but do not grow at high temperatures. They cause milk to sour and decrease its shelf life. They are not associated with disease.

Thermodurics can grow at temperatures between 45° and 104° F. Their primary source is dirty equipment. Old, cracked inflations and milkstone deposits are common sources. During advanced lactation they may be found in the cow's udder.

Most thermodurics are cocci. Thermodurics are usually a summer problem when warm temperatures permit rapid multiplication. They do not grow at cold temperatures. Clean equipment and cold storage conditions are necessary to control them.

3. MESOPHILES grow best at temperatures between 68° and 104° F.

4. PSYCHROPHILES can grow at relatively cold temperatures – even refrigeration temperatures. But they grow much slower at temperatures below 40° F. than at those above. Their best growth rate occurs between 68° and 86° F.

Off-flavors caused by psychrophiles are bitter, fruity, rancid, stale, and putrid. They also cause a physical defect – ropiness in milk.

Psychrophiles have become more significant with the advent of bulk handling because milk is held on the farm longer. When contaminated with psychrophiles, opportunity for growth is present.

Most milk quality tests do not detect psychrophiles because they grow slowly at incubation temperatures normally used for quality evaluation.

Psychrophiles are found in water supplies. Their numbers increase in water storage tanks, recirculated cooling water, and in tank-type can coolers.

Rinse water, when used on dairy equipment, should always be sanitized. Add 5 to 10 parts per million of chlorine. Or use an acid rinse. Keep equipment clean and milkrooms *ventilated* and *dry*.

Psychrophiles are usually a raw milk problem. Pasteurization destroys psychrophiles and they get into finished products through post-pasteurization contamination.

Classification of Bacteria According to Reactions Produced

1. ACID PRODUCERS. Many bacteria ferment milk sugar (lactose) to form lactic acid. Most common of these is *Streptococcus lactis. S. lactis* is often used as a culture in the manufacture of various dairy products. It is found naturally occurring in raw milk.

Lactobacillus species are used in some fermentation processes, but usually are not associated with raw milk quality problems.

Many other rods and cocci produce acid.

2. ACID AND GAS PRODUCERS. Most notable among bacteria that produce both acid and gas from lactose are coliform group (Aerobacter and Escherichia).

Coliform bacteria have special significance to the industry.

In water, coliform imply potential contamination sources known to carry disease. Coliform are present intestinal tract of humans and animals and their prese water indicates possible contamination with fecal m Disease bacteria originate from the same sources.

In raw milk the presence of coliform means eith potential contamination from fecal material or (2) tremely damaging case of mastitis.

Major sources of coliform are dirty equipment a cow's coat. They are present also in barn dust, on cerea and hay, and in polluted water.

In pasteurized milk the presence of coliform ind post-pasteurization contamination. Some heat resistant have been isolated but their contribution to the co count in pasteurized products likely is negligible.

3. PROTEOLYTIC bacteria utilize protein in their gr Off-flavors that result are bitter or putrid. Some proteo are psychrophilic (grow at cold temperatures) and origin sources known to harbor psychrophiles.

When equipment is scratched, cleaning and sanitation surface is difficult if not impossible. Scratches beco constant source of proteolytics.

Some bacillus species (anaerobic spore-forming rod cause protein breakdown. Usually bacilli are not invol spoilage problems because they do not grow at refrige temperatures. They may contribute to the proteolytic however. This means that mere presence of a proteolytic is not conclusive evidence of a proteolytic problem.

Clostridium species (anaerobic spore-forming rods) als digest protein. These bacteria, too, are not usually impli in off-flavor problems.

4. LIPOLYTIC bacteria can break down butterfat produce rancid off-flavors (bitter with pungent odor). Mo breakdown likely occurs as a result of naturally occurring in milk (to be discussed later). In products stored for s days or longer, bacteria may contribute to rancid development.

Some lipolytics can grow at cold temperatures and therefore, particularly undesirable contaminants.

SPORES. Some bacteria can form special structures w make them highly resistant to adverse conditions. bacterial cell forms one spore. Spores resist the killing effe heat, chemicals, light, and drying.

Spores are often found in dust. Barns should not be s just prior to milking.

DISEASES THAT MAY SPREAD BY M

Cow Diseases That Can Be Spread To Man

1. BRUCELLOSIS (Bang's disease). This disease c abortion in cows. The illness in man is called undulant

In Minnesota all milk for pasteurization must be pro on farms supervised for control of brucellosis as a cer herd in a modified-certified brucellosis-free area or certified brucellosis-free area as defined by the U.S. D ment of Agriculture.

2. BOVINE TUBERCULOSIS. All milk for pasteurization must be produced on farms located in a modified-accredited tuberculosis area as determined by the U.S. Department of Agriculture.

3. Q FEVER. This is a Rickettsia (Coxiella burnetii). The disease infects cows and is transmitted to man through raw milk.

4. OTHER INFECTIOUS AGENTS. Many organisms capable of producing abscesses can be spread from cow to man.

Diseases of Man That May Be Spread by Cows

Several disease agents common to man can be transmitted through contaminated milk. They are:

1. TYPHOID AND PARATYPHOID FEVERS (caused by Salmonella). Milk must be contaminated with fecal material of an infected man or rodent.

2. SALMONELLA "FOOD POISON" DISEASES. Salmonellae produce a toxin when growing in man. They may be carried in milk. Typical food poisoning symptoms result about 0 hours after intake. This type of illness, though producing similar symptoms, differs from food poisoning caused by *staphylococcus aureus.* With the latter, a toxin is produced while the organism is growing in a food environment outside man. Eating contaminated food then causes illness much faster.

In recent years the salmonella problem has become more serious with more cases reported. Both raw milk and finished products can become contaminated with salmonellae; however, pasteurization kills all salmonellae.

Salmonellae are commonly spread through contaminated feeds. Fowl, cattle, hogs, rodents, insects, humans, domestic pets, wild birds, and animals can serve as carriers. Eggs and egg products are also common sources of contamination, and salmonellae may be present in polluted water.

Control methods involve:

a. Strict sanitation.
b. Positive pasteurization.
c. Prevention of post-pasteurization contamination.
d. Separation of the milkhouse or milkroom from holding areas for farm animals, poultry, and from feed storage rooms.
e. Cold storage of milk. Salmonellae can grow at temperatures between 50° and 120°F.
f. Good insect and rodent control.
g. Salmonella-free cows and milk handlers.
h. Clean, properly sanitized water supplies.

3. SCARLET FEVER. Streptococcal infections cause scarlet fever.

4. SEPTIC SORE THROAT. This is a streptococcal infection.

5. DIPHTHERIA, HUMAN TUBERCULOSIS, POLIOMYELITIS, and possibly other diseases. These may be spread through infected milk.

6. STAPHYLOCOCCAL FOOD POISONING. *Staphylococcus aureus,* a bacteria that can cause mastitis, may produce a toxin (poison), if allowed to grow in milk. Although the bacteria are killed by pasteurization, the toxin remains stable and can cause illness.

a. Conditions favoring growth of *S. aureus:* This organism grows at temperatures between 50° and 120° F and multiplies slowly up to 60° F.

Unlike many bacteria, *S. aureus* can grow in high concentrations of sugar or salt (45 percent solids, condensed milk, or up to 10 percent salt).

b. Controlling growth of *S. aureus:* Staphylococcal mastitis is more prevalent since other competing mastitis organisms (streptococci) have been controlled by antibiotic treatment and because of the ability of staphylococci to develop antibiotic resistance. Therefore, to control staphylococcal infection on farms:

(1) Use mastitis control procedures.
(2) Sanitize udders before milking.
(3) Use strip cups, mastitis tests, and/or veterinary service.
(4) Keep equipment clean to prevent spread of the organism and stop growth of those that are present.
(5) Do not sell milk from cows having mastitis.
(6) Keep milk cold!

Controlling Spread of All Milk Borne Diseases

1. Keep herds healthy. Segregate sick cows and discard their milk.
2. Allow only healthy individuals to work in dairy operations.
3. Keep premises and equipment clean.
4. Cool milk promptly and keep it cold.
5. Pasteurize milk quickly and prevent recontamination after pasteurization.

Killing Bacteria

Bacteria are killed by heat in the form of hot air, hot water, or steam. Effectiveness of kill depends upon time-temperature relationships. At higher temperatures, shorter periods of time are required to kill a given bacteria population.

Sterilization (total kill of all bacteria) requires a temperature of 250° F for 20 minutes by steam heat. Pressure is required to get steam temperatures this high. This is a wet form of heat. Using dry heat, a temperature of 338° F for at least one hour is necessary to bring about sterility.

Hot water treatment can be used. For immersion purposes a two-minute exposure at 170° F is recommended; for flow-through sanitizing, 5 minutes at 170° F. These are sanitizing treatments which may not necessarily bring about sterility.

Chemical sanitizers are effective bactericides. Sanitizers common to the dairy industry are chlorine, iodine, quaternary ammonium compounds, and acids.

Characteristics of sanitizers vary greatly depending upon their formulation. In general, chlorine sanitizers (hypochlorites) are inactivated by presence of organic matter. Whenever milk, dirt, or manure gets into a chlorine sanitizer, chlorine is tied up and prevented from working. Prepare a fresh solution when this happens.

A chlorine solution exposed to air dissipates quite rapidly, especially at warm solution temperatures. Sanitizers should not be saved from one milking to the next.

Hypochlorites are fairly effective in hard water.

Iodine sanitizers (iodophors) may be slower acting than hypochlorites. They are quite stable, relatively noncorrosive, and nonchapping to skin. They are often used as udder wash.

Quaternary ammonium sanitizers may be adversely influenced by presence of water hardness compounds, although formulations may be prepared with water hardness control agents. They are generally effective against thermodurics, but less effective than chlorine sanitizers against some psychrophilic and coliform bacteria.

Effectiveness of acid sanitizers may be reduced by water