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DAIRY AND MILK INSPECTION.

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Dairy and Milk Inspection.

WHY INSPECT DAIRIES AND DAIRY PRODUCTS?

For the people in general, especially for invalids, infants and young children, the question of a pure milk supply is one of the foremost sanitary problems. The quantity of the staple dairy products (milk, cream, butter and cheese,) that are consumed annually make it all the more necessary that such foods should be pure and wholesome. Great Britain is said to consume annually 250,000,000 gallons of milk. The United States uses yearly 5,209,125,567 gallons.

The fact that man can contract tuberculosis, typhoid fever, Asiatic cholera, scarlet fever, diphtheria, infant intestinal diseases, and possibly malaria, yellow fever and anthrax, by consuming infected milk makes it of vital importance to the public that such a valuable food should be officially inspected, and every possible means should be used to keep dairy milk clean, pure and free of disease-producing germs. Numerous epidemics* of the above named infectious diseases have been traced to an infected milk supply.

It is also essential that the inspectors prevent the use of preservatives in dairy products, because such drugs are injurious to the human body. Commercial preservatives are used by ignorant or unscrupulous dairymen and milk dealers in order to keep the milk sweet for a longer time. There may be no intentional wrong on the part of the milk vendor. Ignorance and innocence may be excusable as long as human life is not at stake; but when human health is ruined and lives are sacrificed the law must come to the rescue and protect public health. The city, the state or the federal government performs no more important function than that of preventing disease and protecting the health of its citizens.

The question of cleanliness of milk is closely related to its

*See pages 248-252.

purity. When an eminent bacteriologist finds that a sample of market milk in his city contains more germs than an equal quantity of sewage in the same city, it suggests the need of thorough and practical milk inspection.

Milk, cream and butter may vary in their composition. Some milk may contain less than 3 per cent. of milk fat; also much less than 9 per cent. of solids not fat; consequently such milk would contain an excess of water. Some cows may produce such poor milk, but a cow that will pay for her feed will produce a richer and better milk. However, the unscrupulous milk dealer may abstract cream and add water and coloring matter until the milk looks yellow and rich. The average purchaser pays just as much for this poor milk as rich milk is worth. The law steps in and establishes a legal standard; then prices should be gauged according to the degree of richness of the milk, or according to the minimum legal standard.

Moreover, when milk is teeming with millions of germs that feed upon the nutritive materials of the milk its value as a food is partially or totally ruined. As a rule any germ that grows or multiplies in milk destroys partially or wholly one or more of its nutritive ingredients; hence its value is decreased.

What has been said of milk is in the main true of cream and butter. They may contain disease-producing and ferment-producing germs; they may vary in chemical composition, a result of defects in the mode of collecting the cream and in the manufacture of the butter. Cream or butter may be adulterated and may be greatly reduced in value by partial or complete decomposition.

Dairy and Milk Inspection should begin at the dairy with the tuberculin test. Every cow should be tested before she is permitted to go into the dairy barns or mingle with the herd. Every dairy owner will save time and trouble by keeping all newly purchased animals completely isolated from his herd until they have been thoroughly tested for tuberculosis and other infectious diseases. When tuberculosis once gains admission to a herd the expense of eliminating it from the

herd is always great. Losses from death and condemnation of infected animals will occur at intervals for a number of years.

When a herd becomes infected the cows that react with the tuberculin test should be quarantined or destroyed. The Danish method of quarantining tuberculous cows and sterilizing the milk from such cows can not be employed in this country without having an inspector conduct the process of sterilization. Some authorities believe that tuberculous milk may contain a sufficient quantity of the poison or toxine to injure the health of persons who consume such infected milk, especially if the persons are tuberculous. Hence it is the cheapest and safest to remove all tuberculous animals from the dairy herd and never thereafter use their milk as human food.

The barns, stalls and watering troughs where tuberculous animals have been kept, fed and watered should be thoroughly cleansed and disinfected. Thereafter the herd must be tested with tuberculin at least every six months. If proper hygienic conditions are maintained the number of cows that react will be fewer at the second test than at the first.

The dairy herds that supply the city of Montgomery with milk have been tested twice with tuberculin. All of the cows have been tested once and part of them twice; between the first and second tests several herds were changed by the sale of tested cows and the purchase of untested cows. The first test showed that about one per cent. of the entire number were tuberculous. In the second test about two and one-fourth per cent. of the entire number tested reacted.

A dairy herd was tested by a qualified veterinarian in a place in Alabama where no law exists to enforce the removal of tuberculous animals from the dairy; over 50 per cent. of that herd of cows reacted. Tuberculin tests in Alabama have thus far proven that many herds are free of tuberculosis, some herds are slightly infected and others have been seriously infected. Hence the necessity for thorough inspection.

How to Make the Tuberculin Test.—Begin with a small

number of animals (say five to ten), and after experience has been gained 20 to 30 may be tested at a time. It is not a good plan to test animals when the days are very hot, unless the barn is well ventilated and can be kept so cool that the cows will not become overheated during the test.

The animals being tested should be fed the same kind of feed, in the same quantity, and at the same time each day of the test; they should also be watered at the same time each day. Likewise the cows should be milked at the regular time during the test. In short the cows that are being tested should be kept under exactly the same conditions during the two days of the test.

If the animals to be tested are not kept in their stalls over night have them placed in their stalls at 5 o'clock in the morning. Begin taking and recording their temperatures at 6 o'clock and repeat this every two hours until 6 or 8 o'clock in the evening. At 8 or 10 o'clock in the evening inject subcutaneously 2 to 3 c.c. of tuberculin into each adult animal weighing 1,000 pounds or less; if the animal weighs 1,200 to 1,500 inject not less than 3 c.c.; for calves use at least 1 c c. These doses apply to that form of tuberculin that is ready for use and not to the concentrated form.

The most convenient place for injecting the tuberculin is on the side of the neck or at the upper part of the shoulder. The best form of hypodermic syringe is one that permits the needle to slip on or into the barrel, and can be thoroughly sterilized by steam, hot water or hot air.

On the following morning begin to take the temperatures at 6 a. m. and repeat the same every two hours until 6 or 8 p. m., as on the previous day.

Now compare the temperature records for the two days. If the temperatures are two or more degrees higher on the second day, for three or more consecutive readings or records, than on the first day the animal is said to have "reacted." In other words the reaction says that the animal has tuberculosis. If the temperature rises for one or two readings, then falls for one or two readings and then rises, such fluctuations will indicate that the animal is more or less suspicious and

should be tested again in two or three months; in the mean time this animal should be quarantined. When the temperatures on the second day are not sufficiently high to indicate a good reaction, yet higher than on the first day, the animal may be regarded as a suspect, and should be quarantined and retested in three or more months; this is especially true if there are tuberculous animals in the herd. If the temperatures run above 102 degrees F. for several readings on the first day it may be difficult to obtain a distinct reaction. When the temperature remains at or above 103 degrees F. for several readings on the first day that animal should be removed and tested at some later period when its temperature is more nearly normal. As a rule it is not best to test a cow in heat, or a cow near the end of pregnancy, or a cow that has recently calved, or any animal that has just been driven a long distance, or any animal that has just been taken from a car or a boat.

Always use good thermometers; the six-inch Hicks thermometer is one of the best. Keep the thermometer at least five minutes in the rectum when taking the temperature. Fresh tuberculin should always be employed. This department makes tuberculin and supplies the city of Montgomery, and several veterinarians in Alabama, with tuberculin upon condition that all reports of the tests are to be forwarded to this department.

The following examples from actual records made in Alabama with tuberculin furnished by this department will illustrate cases of reactions, suspicious cases and cases without reactions:

NO.	DAY.	6a.m	8a.m.	10am	12 m	2p.m.	4p.m.	6p.m.	REMARKS.
1	First	101.2	101 6	101.2	101	101.8	101.8	101.6	
	Sec'd	101.8	101.6	101.4	101 4	101.6	101.4	101.8	Normal or healthy.
2	First	101.2	102	102	101.6	101.8	102	102 2	Good reaction.
	Sec'd	105.4	106	105.2	105.4	105.2	104.2	104	Tuberculous. [day.
3	First		102.6	102.7	103 3	103.6	103.7	103.6	Temp. too high 1st
	Sec'd	102	102	102.7	105.2	103 6	103.5	106	Suspicious case.
4	First		101	101.4	101.8	101.5	102.1	101.7	
	Sec'd		100 5	101.6	102.7	104 8	105.7	105.3	Reaction.
5	First	101.2	101.6	100.2	101.6	102.6	102.6	102	
	Sec'd	103	103	102.2	102	103.2	103.2		Suspicious case.
6	First		102.3	102.9	102.7	103.4	103.6	103 6	
	Sec'd	102.2	102.2	103	103.7	104.6	103 8	104.8	Suspicious case.

Tuberculosis is not the only disease that would disqualify a cow for the dairy. Animals having anthrax, Texas fever, malignant catarrh, contagious pleuro-pneumonia, cow-pox, infectious mastitis, foot-and-mouth disease, pneumonia, peritonitis, enteritis, gastritis, acute indigestion, actinomycosis, should not remain in the dairy while diseased, but may be returned in case of complete recovery. In other words, when cows have any disease with systemic fever, or if there is any danger of toxic products being thrown out of the system with the milk, such animals should be removed from the dairy until they completely recover. Inflammation of one or more quarters of the udder (mammitis or garget) will usually be accompanied by curdled milk and sometimes by pus and broken down tissue elements; in such cases the milk should not be used until the parts affected become healthy.

It may be well to state here that in any disease which decreases the flow of milk it is a good plan to have the cow milked three or more times a day, in order to stimulate the secretion of milk and remove the morbid products from the udder; but the milk should not be used as human food.

The **Kind** and the **Condition** of the **Feed** used at a dairy should be carefully and frequently investigated. Distillery swill, old brewery grains, rotten or decayed grain of any kind, moldy hay, rotten potatoes or turnips, spoiled silage, or any kind of partially decayed feed, should be excluded from the dairy. Fresh brewery grains should be fed sparingly. As a rule good turnips should be avoided because a very small amount is liable to contaminate the milk. Loud smelling, fermenting silage should not be in the stalls at time of milking, because the milk is liable to absorb the bad odor and the bacteria in the silage are liable to infect the milk. Bitter weeds and wild onions should be removed from pastures, if possible, since they transmit a bitter or onion taste and odor to the milk. Col. J. M. Falkner, of Montgomery, Ala., claims that he can remove all of the bitter taste and the onion odor by aerating the milk or cream with compressed air. Since the bitter principle of most weeds that affect milk is volatile it seems possible that compressed air aeration will remove

them from the milk. Boiling or sterilizing in open vessels is said to remove the bitter principle from milk.

The **time** and **manner of feeding** are important. As a rule it is not possible to have dust-free air in a barn if the cows are fed just previous to milking. If the hay or feed is dusty it should be sprinkled and fed a sufficient time before milking so that the dust may be settled, the stalls ventilated, cleaned and sprinkled or flooded previous to the time of milking.

The Water Supply for the cows should be carefully guarded. It may come from a deep well, with sufficient protection from surface drainage—it may be kept in clean tanks, and yet the watering troughs may be foul and filthy. The writer has observed instances where the trough was so foul and smelled so badly that the animals turned from the trough and drank the water that had collected in the puddles in the yard. Too frequently the troughs are surrounded by mud and manure, which make them very difficult to approach and extremely liable to become contaminated by the splashing and spattering of filth. The trough should be located on a slightly elevated place and surrounded with rock, brick or cobble stones and a layer of gravel, so arranged that the drainage will be away from the trough and that it will never become muddy or sloppy around the trough. The watering trough should be thoroughly scrubbed with brushes, etc., at least once per week. The dropping of saliva and particles of food from the mouth soon makes the trough foul if there is nothing else to contaminate it. Avoid ponds, artificial lakes, contaminated runs or creeks that receive surface drainage from pastures or cow lots, and shallow wells that are located in cow lots or other filthy places.

Carefully arrange the **Drainage** of the barns and lots. The stalls should be of proper length, neither too short or too long, and the gutter for carrying off the urine should be in good condition, kept clean and flooded as often as possible. The liquid manure tank which receives the urine from the gutters should be as far away from the barn as possible. The manure pile should also be some distance from the barn and as a matter of economy should be protected from the rain. It

is a good plan to flood and wash the stalls and gutters once or twice per day, because nothing is more frequently injurious to the milk than the dry manure particles that float around in the air and settle on the cows, walls, etc., and then drop into the milk at time of milking. Filthy barns may be responsible for the greatest amount of bacterial infection of the milk.

Good Ventilation will help purify and disinfect the barns. Doors, windows and ventilators should be sufficiently numerous to enable one to direct the drafts and to flood the barn with pure air and sunshine. Winter and summer ventilation may differ in degree, but it should not be neglected in winter even in colder places than in Alabama. Air spaces should be sufficient to give at least 500 cubic feet of air to each cow.

Dairy cows should be given six hours of **exercise** in the open air every day. Of course this is best taken in a pasture, but exercise in a lot, morning and evening, is a relief from the close confinement in stalls. The opposite extreme may be found where the cows are exposed to all kinds of cold, rainy weather. Such treatment means great loss, because it is cheaper to give protection than to give a greater amount of feed in order to produce extra animal heat.

The **location** of the **barn** and other **dairy buildings** should be carefully selected. It is best to locate them upon elevated places where surface drainage can be readily obtained. Combination buildings should be avoided. It is unwise to have silos, milk room and stalls all under one roof or too near one another. Cow stalls should never surround a silo, because ventilation is poor and the cows suffer with heat. The stalls should be so arranged that the feed may be given to each animal from the front. The partitions between the stalls should prevent one animal from reaching another. The stalls should be at least four feet wide and have the proper length. If the stalls are too long the manure and urine will not fall into the gutter; if the stalls are too short the hind quarters and the tail will be in the gutter filth when the cow lies down.

The **cow** should be kept **clean** by brushing and, if necessary, by washing. This not only prevents milk from be-

coming infected, but also improves the condition of the cows to such a degree that they will give more milk. A clean cow, properly groomed, will give more and purer milk than an ungroomed cow. Dairy cows should be thoroughly brushed and cleaned at least once per day; the best time to do this is at 8 or 9 o'clock in the morning. Just before milking, the udder, the abdomen, the flanks and thighs should be brushed, to remove all loose hair and dust particles. It is a good plan to wash the udder, especially the teats, but they should be completely dry before milking.

The **milker** should observe strict **personal cleanliness.** When milking he should wear a special suit of washable overalls and jacket or a long washable apron with sleeves. It is necessary that he should have three or four changes of milking suits or aprons. The hands should be washed and the finger nails be cut close and well brushed. After milking one cow he should thoroughly cleanse his hands before milking another, because this insures greater cleanliness and prevents the transmission from one cow to another of such diseases as infectious garget and cow-pox. The practice, which is too common among negro servants, of wetting the teats with the milk, and milking the cow entirely by stripping, cannot be too severely condemned. The milking should be done with the full hand by producing a wave of pressure that begins at the upper part of the teat or the lower part of the quarter and passes down over the teat to its lower end; this is produced by the successive closing of the thumb and fingers in a grasping manner. This involves no pulling or friction, and every drop of the milk can thus be removed from the udder. By using the stripping process in milking the friction and pulling causes scales and dust particles to fall into the milk.

In order that the reader may comprehend the necessity for cleanliness in all things in connection with the dairy a list of dirt **impurities found in milk** by microscopic examination will here be given:

Manure particles; soil particles; cow and human hair; mold, bacteria and other fungi; woolen, cotton and linen

threads; fodder and other food particles; parts of insects; down from birds; skin scales, etc.

As much as 3 to 15 milligrams of dry impurities have been found in one litre of milk in some of the dairies in Germany. As a rule most of the impurities get into the milk at the time of milking. The fact that the dairy cows in Europe are kept more hours per day in the stall than the cows of America will account for this great quantity of impurities. When dairy cows are kept in the stalls only a short time in the morning and evening and spend the rest of their time on clean pastures they can easily be kept clean; yet they will not be hair-clean and dust-clean without brushing and sometimes washing.

But some one may say that the strainer and the separator will remove all these filth particles from the milk. It is true that many of these impurities are removed, provided they are not soluble; but these particles inoculate the milk with various kinds of bacteria and introduce injurious soluble impurities that cannot be removed by the strainer or the separator. Milk is a good food for bacteria and many of them begin to grow and multiply as soon as they get into it; then they destroy some of the nutritive materials in the milk. Sometimes the dust particles may carry disease-producing bacteria into the milk; this is frequently the case if any of the cows in the dairy have tuberculosis in a form in which the tubercle bacilli are thrown off in the excretions; it is also true if any of the dairy servants have tuberculosis and expectorate indiscriminately around the dairy. It is just as essential to have healthy servants in a dairy as it is to have healthy cows.

Grotenfelt gives the following primary principles to regulate the work in a dairy barn:

1. The manure is to be cleaned out one and one-half hours before milking time.
2. The stable is to be aired every time it is cleaned out.
3. The cows should be watered before every milking.
4. The feeding should take place at least one and one-half hours before milking.
5. The cow should have a rest of one and one-half hours three times a day, during which time the stable is closed.

(This is applicable only where cows have no run or pasture, or are kept closely confined for milking three or more times per day.)

6. The cows should be groomed twice a day; their udders, hind limbs, flanks and abdomen should be washed before every milking.

7. The cows should be allowed to exercise in winter during the warm part of the day; (in summer or almost any season in Alabama they may be allowed to exercise during any part of the day that is most convenient.)

The **source** of **water** used at the dairy for washing cans, bottles, buckets, hands, etc., is very important. It should be from a deep well that is entirely separated from the barn, from the cow lots, or any source of surface filth. The surface drainage should be away from the well and the well should be so located that the seepage will not come from any contaminated source. The deeper the well the less liable it is to be contaminated with germs. Also the deeper the water in the well within certain limits the purer will be the upper portions of that water, providing it is not constantly being contaminated by surface drainage or seepage water. As a rule, it is best to have the level of the water in the well some distance below the surface unless the well is cemented some distance below the surface. Most bacteria will not grow or multiply in water unless it contains some organic matter. Hence the bacteria that accidentally get into pure well water become inactive and sink to the bottom of the well. In other words, more bacteria are found at the bottom of the well than in any other portion of the water; consequently, the water should not be drawn directly from the bottom of the well, but may be drawn within eight or ten feet of the bottom. The outlet of a water tank should not be from the bottom; but should be some distance above the bottom so that the germs and dirt which settle will not be carried out with the water that is used directly or indirectly for human or animal consumption, or to wash dairy apparatus. However, it is wise to have an outlet directly in the bottom of a water tank so that the tank may be thoroughly cleansed. A water tank should be cleansed

three or four times per year; this may be done by thoroughly scrubbing and washing the bottom and sides of the tank. In cleaning a well it is essential that the wall of the well, some distance above the bottom, should be thoroughly cleaned with brush and water; then remove all the loose dirt and water from the bottom of the well.

If there is sufficient organic matter in well-water, germs may be growing upon the surface and sometimes below the surface; but, as a rule, the organic matter in well water is insufficient to keep the germs growing, and the inactive or non-growing germs soon sink to the bottom of the well.

When water runs low in wells, as in the fall of the year, infectious diseases (typhoid fever, etc.,) are more prevalent.

Steam and hot water must of necessity be used in order to cleanse many of the dairy utensils; but this should in no way lead one to omit securing a pure water supply for all dairy purposes. If bottles are used, they and crates in which they are carried should be thoroughly cleansed and the bottles should always be sterilized previous to filling, because infectious diseases (diphtheria, scarlet fever, etc.,) may be carried from one family to another if the bottles are not always sterilized immediately after cleansing and before filling them. **Delivering milk in bottles** is the cleanest and **best method.**

Composition of Milk.

The chief constituents of milk are water, fat, casein, albumen, milk-sugar, and ash. Other substances are found in milk in small quantities, but they are not of sufficient importance to require discussion here. The terms **milk solids** or **total solids** embrace all the substances (solids) in milk except the water. The term **milk serum** is almost equivalent to skim or separated milk; it embraces all the milk substances except the fat. The **solids not fat** or the **serum solids** include all the solid constituents of milk except the fat; the solids not fat are the casein, albumen, milk-sugar, and ash.

The quantity of **water in milk** varies from 80 to 90 per cent. As a rule cow's milk will contain from 84 to 88 per

cent. of water. In South Carolina the law fixes the maximum limit of water in milk at 88.5 per cent.; Minnesota, Massachusetts and New Hampshire, at 87 per cent.; five other states, at 87.5 per cent., and eight other states, at 88 per cent. The city of Montgomery fixes the maximum limit at 87.5 per cent. It is obvious that a high percentage of water means a poor milk and a low percentage of water means a rich milk, provided there are no solid adulterants added to the milk.

The **fat in milk** is in the form of an emulsion in the milk serum. An enormous number of fat globules are suspended in the milk serum. The size of the fat globules may vary slightly in the different breeds of cattle. One drop of milk may contain 100,000,000 fat globules. Chemically speaking, milk fat is a compound of fatty acids and glycerine. About 92 per cent. of pure milk fat is a mixture of glycerine and insoluble fatty acids (palmitic, stearic and oleic acids), and about 8 per cent. of milk fat is made up of glycerides of volatile fatty acids (butyric, caprylic and caproic acids). The glycerides of the volatile acids of milk fat are very unstable; they give the flavor and aroma to butter and serve to distinguish genuine from artificial butter. When the glycerides of these volatile fatty acids are decomposed by bacteria or light, the volatile acids are set free and they produce the unpleasant odor in rancid butter.

The fat in cow's milk ranges from 3 to 6 per cent.; the average is about 4 per cent. As a rule if the fat in a cow's milk falls below 3 per cent. she does not pay for her feed. The mixed milk from a dairy herd should not fall below 3 per cent. in fat contents, and, except in unusually rich milk, it will not exceed 5 per cent. The minimum legal standard for most of the states is 3 per cent.; Georgia and Minnesota require milk to contain 3.5 per cent. of butter fat; Rhode Island places the minimum limit at 2.5 per cent. The city of Montgomery requires milk to contain 3 per cent. of butter fat, and the limit should be raised to 3.5 per cent.

Milk-sugar or **lactose** is very similar in chemical composition to cane sugar, but it is not nearly so sweet and is less soluble in water. Normal cow's milk contains from 4 to 6

per cent., with an average of about 5 per cent., of milk-sugar. This average may be reduced to about 4 per cent. in sour milk. Sour milk is a result of the action of bacteria upon the milk-sugar. The bacteria decompose the milk-sugar and one of the products of this decomposition is lactic acid, which curdles the milk or precipitates the casein. If milk is kept free of bacteria, or if all the bacteria in milk are destroyed by sterilization and the milk is thereafter kept free from germs, it will remain sweet indefinitely.

Casein and **albumen** are the chief protein compounds of milk. When the milk is first drawn from the udder the casein is in the form of caseinogen, but it is soon changed into casein. Casein contains phosphorus and sulphur, which chemical elements are not found in any of the other protein compounds of milk. Dilute acids precipitate the casein and thus curdle the milk. If the acid is neutralized by some alkali (lime water or soda) the casein will be redissolved. Rennet will also precipitate casein, and the curd thus formed is used in making cheese; but this curd cannot be redissolved by adding lime water or soda. The quantity of casein in cow's milk will vary from 2 to 3.5 per cent.

The **albumen** of milk is somewhat similar to that in blood and in the white of an egg. It is not precipitated by dilute acids or by rennet, but it can be coagulated by heating the milk to 170 degrees F.; it then collects in a film on the surface of the milk. The quantity of albumen in cows' milk will range from .5 to .8 per cent.

There are other unstable, and somewhat indefinite, protein compounds in milk, but they are small in quantity and the chemists do not agree as to their properties.

The average amount of total protein constituents in milk is 3.3 per cent. of the entire milk. "Milk with a low fat content will contain more casein and albumen than fat, while the reverse is generally true in case of milk containing more than 3.5 per cent. of fat."

The **ash** or **mineral matter** is made up of "chlorides and phosphates of [sodium, potassium, magnesium and calcium; iron oxide, and sulphuric and citric acid are also present in

small quantities among the normal mineral milk constituents." The average amount of total ash in cows' milk is about .7 per cent. The mineral constituents of milk are least liable to variation.

Clostrum or the first milk is that which is secreted immediately after the birth of the calf. It contains a large percentage of albumen and ash, and a small amount of milk sugar. It is thick, yellow, and coagulates when boiled. The first milk is said to be nature's purgative to remove the meconium from the alimentary canal of the offspring. In four or five days the clostrum is no longer secreted and the milk becomes normal.

Milk is slightly heavier than water; its **specific gravity** ranges from 1.029 to 1.034 at 60 degrees F. The variation in the specific gravity is due to the variations in the relative quantities of water and the solids in the milk. Milk that is rich in fat will usually have a low specific gravity, because the fat is lighter than water. If, however, the fat be removed the specific gravity will be raised; skim milk ranges from 1.033 to 1.037. The addition of water to milk, or the removal of fat from milk, are the two most common methods of fraudulently changing the composition, specific gravity and value of milk.

Variations in the **composition** of normal or pure **cow's milk** are due to the variations in the breed, individuality of the cow, to the methods of feeding and handling, and to the length of time since the cow became fresh. It is a matter of common observation that certain breeds give richer milk than others, while some breeds may give large quantities of relatively poor milk. Different cows of the same breed will vary to some extent in the quality and quantity of their milk. A well balanced ration given in sufficient quantity will cause a cow to yield milk to her greatest capacity. The breed, the individuality of the cow, and the length of time since calving will also have a direct influence upon the quantity; but the quantity of milk may be most quickly and easily changed by changing the feed and the method of handling the cow. However, the richness of the milk or the proportion of fats and

other milk solids cannot be radically changed by varying the composition or the kind of feed. Feeding fat or giving feed almost free from fat will not materially change the composition of the milk. Giving dry feed and restricting the amount of water allowed the cow may decrease the quantity of milk and slightly increase the proportion of total solids in the milk.

Comparative composition of various kinds of milk. *

Kind of Milk	Water	Total Solids	Total solids						Fuel value per lb.
			Protein			Fat	Carbohydrates (milk sugar)	Mineral matters (ash)	
			Casein	Albumin	Total protein				
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct*	*p c.*	*Per ct.*	*Per ct.*	*Calo's*
Woman	87.4	12.6	1.0	1.3	2 3	3.8	6.2	0.3	319
Cow...	87.2	12.8	3.0	.5	3.5	3.7	4 9	.7	313
Dog	75.4	24.6	6.1	5.1	11.2	9.6	3.1	.7	671
Ewe	80.8	19.2	5.0	1.5	6.5	6.9	4.9	.9	503
Buffalo.	81.4	18 6	5.8	.3	6.1	7.5	4.1	.9	506
Cat.....	82.1	17.9	3.1	6.0	9.1	3.3	4.9	.6	400
Goat.	85.7	14.3	3.2	1.1	4.3	4.8	4.4	.8	365
Llama..	86.5	13.5	3.0	.9	3.9	3 2	5.6	.8	312
Ass.....	89.6	10.4	.7	1.6	2.3	1.6	6 0	.5	222
Mare ...	91.5	8.5	1 2	.1	1.3	1.2	5.7	.3	180

* Konig, Chemie der menschlichen, Nahrungs und Genussmittel, 3d ed., I, pp. 267-362.

Determining the Per Cent. of Fat in Milk.

The most simple and practicable method for closely estimating the per cent. of fat in milk is the one discovered by Prof. Babcock, of Wisconsin. It is now universally called **The Babcock Test.**

The necessary apparatus consists of a centrifugal machine; graduated milk, cream, and skim milk test bottles; pipettes; an acid measure; and sulphuric acid having a specific gravity of 1.82. This apparatus may be obtained from any dairy supply house. If the centrifugal machine has a diameter of 20 inches it should be capable of making not less than 700 revolutions per minute; if the wheel is 12 inches in diameter it should make 1,200 revolutions per minute. The size and speed of the wheel should be sufficient to give enough centrifugal force to separate the fat.

Procuring the Sample of Milk to be Tested.—The best

time to procure the sample is immediately after the milk has been drawn from the cow and before the cream begins to rise. Milk that has stood some time should be poured from one vessel into another until the cream is evenly and thoroughly distributed in the milk. It is impossible to secure an average sample of the milk when the cream is partly churned or small granules of butter appear on the surface of the milk. It is not practicable to sample a large quantity of curdled milk, but a small amount may be thoroughly mixed if the curd be dissolved by slowly adding powdered soda.

The sample should be thoroughly mixed just before the pipette is filled. The pipette should be rinsed two or three times with the milk before it is filled; fill the pipette up to the 17.6cc. mark; empty it into the graduated milk test bottle, care being taken to let the milk flow from the pipette slowly down the inside of the neck of the milk bottle.

In order to get the best results the temperature of the milk should be between 60 and 70 degrees F., especially if the acid used has a specific gravity of 1.82. The milk may be cooler if the acid is a little stronger.

The acid measure is now filled up to the 17.5 c.c. mark with sulphuric acid (not less than 1.82 or more than 1.83 sp. gr.); the acid should be poured slowly down the inside of the neck of the milk test bottle. Now thoroughly mix the acid and the milk in the bottle by gently shaking the bottle with a circular motion. The casein is precipitated and then dissolved, and the solution soon becomes very dark brown in color, a result of the charring of the milk sugar by the sulphuric acid. If the acid is too weak, or there is not enough acid used, it will not dissolve all of the casein; if it is too strong, or there is too much acid, the fat may be slightly charred and black specks may collect at the bottom of the fat column.

The bottles are now placed in a centrifugal machine in such a position that the wheel will be evenly balanced; then the machine is turned at full speed for five minutes; the bottles are taken out, filled with hot water up to the graduated scale point No. 7; they are then put back into the machine and whirled at full speed for one or two minutes. Some author-

ities advise, after whirling the bottles five minutes, to add or to fill the bottles with hot water up to the neck; whirl them one minute; then fill with hot water up to the point 7 and whirl again for one minute. After the last whirling take out the bottles, stand them in hot water, read and record the percentages of fat. The per cent. of fat is indicated by the length of the column of liquid fat in the graduated neck of the milk tube. In measuring the length of the fat column the reading should be taken from the lower end to the extreme upper limit of the fat.

The color of the fat will indicate to some extent the strength of the acid used: if the fat is quite dark the acid is too strong; if white, undissolved material collects at the bottom of the fat; or the fat is very light in color, the acid is too weak; if the fat has a golden yellow color the acid has the proper strength.

The following precautions should be used in making the Babcock test:

1. Secure a fair or average sample of the milk. The Scovell sample tube or the "milk thief" may be used in procuring samples from a large dairy can.

2. Secure acid of proper strength; acid having 1.82 specific gravity is usually the best. If the milk is very rich 20 to 21 c. c. of the acid may be used.

3. Be careful to pour the acid into the bottle so that it will follow the inside surface of the bottle to the bottom. This can be accomplished by slightly inclining the neck of the test bottle.

4. Carefully, slowly and thoroughly mix the acid and milk in the bottle.

5. In adding hot water to the bottles to bring the column of fat up into the graduated neck, use soft, rain, or distilled water; never use hard water.

6. Be careful in measuring the fat; it must be kept hot by standing the bottle in hot water, in order to measure it correctly.

7. Keep the acid tightly corked with a rubber or glass stopper, because it will quickly absorb moisture from the air and

become too weak. Never pour water into strong sulphuric acid.

8. The graduated test bottle, the pipettes, the acid measure, should be thoroughly cleansed immediately after finishing the test. The waste from the bottles contains a large per. cent. of sulphuric acid and this is very corrosive; it should be emptied only into glass or glazed earthen vessels.

9. The temperature of the milk should be between 60 and 70 degrees F.

For the **analysis** of **cream** special cream testing bottles are made; the best one is Winton's. Cream may be diluted with a definite quantity of water and the milk test bottles can then be used, but the cream test bottles give more accurate results. Market or dairy cream may contain as low as 9.5 per cent. of fat or as high as 40 per cent. However the per cent. of fat in cream will usually range from 15 to 30. Cream containing 25 per cent. of fat is rated as a rich cream.

There are also special bottles for **testing skim** or separated milk, **buttermilk** and **whey,** in order to find their fat content. The double-necked test bottle is the one that should be used. With it the fat may be estimated to single hundredths of one per cent.

The **Gravimetric Method** of **determining** the **fat** content of milk is the most accurate. There are several modifications of this method, but the process given here is known as Adams' method.*

"About 5 grams of milk are rapidly and accurately weighed in a tared platinum dish. A paper coil, made by loosely rolling up a strip of fat-free paper, about 20 inches long and 2½ wide, held in position by a wire clamp, is held, one end up, in the dish, allowing a portion of the milk to be absorbed. The coil is reversed and the remainder of the milk to the last trace is absorbed by the other end of the coil, care being taken to handle it by the clamp only. The coil is placed in the air bath, being held in vertical position by introducing the loop of the clamp into a clasp attached to the sides of the bath. As in the case of the determination of the solids, the temper-

* New York City Board of Health report 1896, p. 168.

ature must be constant from 100 to 105 degrees C. Two and one-half hours drying is usually sufficient. The coil is known to be dry when a cold watch-glass being held over one end of it, immediately after it is removed from the bath, does not show a deposit of moisture. In making this test the coil must be held in a vertical position. The dry coil is placed in an extracting apparatus, the form known as Knoefler's being preferred, connected with an upright condenser and a tared flask, and extracted with a pure anhydrous ethyl ether for two hours. The ether is distilled and may be used again, the flask placed on water bath until all odor of ether has disappeared, then in air bath having a constant temperature of 100–105 degrees C. for one-half hour or until fat is of constant weight. The coil should be re-extracted until there is no longer a gain of fat. The weight of fat is calculated in the usual way. The flask used above should be dried in air bath and cooled in air-bath before weighing. A flask containing the fat should be cooled in the same way. Care must be taken not to electrify the flask by rubbing the same when dry. The ether used must be free from residue, water and alcohol. Fat-free paper (commercial) must be proved to be free from extractive matter."

The Total Solids may be determined as follows:

"Five grams of milk (thoroughly mixed by gentle agitation) are weighed in a dry, tared, flat-bottom, 'lead-tin' or platinum capsule (diameter 1⅜ inches, and ¾ of an inch deep; it is important that the dish is no smaller than this). This dish is placed on a water bath, a piece of clean filter paper being in contact with the bottom, and when the water has apparently all evaporated is transferred to an air bath (carefully regulated to maintain a temperature of from 100 to 105 degrees C.) and allowed to remain for 2½ hours. After cooling in a dessicator dish, and the contents are weighed, return to air bath for one-half hour and again weigh. If necessary this reheating and reweighing are repeated until solids cease to lose in weight. From this final weight calculate total solids." *

* New York City Board of Health Report, 1896, p. 168.

A close estimate of the **total solids** and the solids not fat may be made when the fat content and the specific gravity of the milk are known. Determine the per cent. of fat by the Babcock Test and the specific gravity by the use of the Quevenne lactometer. (Full directions for determining the specific gravity with the lactometer may be found in Farrington and Woll's "Testing Milk and Its Products," pages 80 to 85.) The specific gravity of milk should not be taken until one-half hour (better six or eight hours) after the milk has been drawn, since the specific gravity is always lower if taken immediately after the milk is drawn than it is when the milk has stood for some time. This may be due to the escape of gases or to mechanical changes in the proteids. Be careful to have the temperature of the milk as near 60 degrees F. as possible when the specific gravity is taken. After thoroughly mixing the sample, pour the milk into the lactometer cylinder and take the specific gravity at once before the cream begins to rise. If the cream rises the specific gravity will be that of skim milk.

Farrington and Woll have derived the following simple formulæ and rules for estimating the solids not fat and the total solids:

"Solids not fat equal 1/4L plus .2f

Total solids equal 1/4L plus 1.2f

"L being the lactometer reading at 60 degrees F. and f the per cent. of fat in the milk.

"Rule a. To find the per cent. of solids not fat in the milk, add two tenths of the per cent. of fat to one-fourth of the lactometer reading, and

Rule b. To find the per cent. of total solids in the milk, add one and two-tenths times the per cent. of fat to one-fourth of the lactometer reading."

The following method of determining the solids not fat is taken from the Maine Experiment Station Report for 1897, page 94; but the table and the method were derived by Prof. Babcock, of Wisconsin Experiment Station:

"Method of Making the Test.—To take the specific gravity with the lactometer it is necessary (1) that milk be free

from air bubbles, and in order to insure this it should stand at least one-half hour after being drawn; (2) that it should be thoroughly mixed by pouring from one vessel to another, avoiding any violent motions that would be likely to collect air bubbles, then brought to the proper temperature, 60° F., placed in a vessel of sufficient depth and diameter to allow the lactometer to float freely, and the mark on the stem to which the instrument sinks read. The lactometer can easily be read to half spaces when it is necessary to be quite accurate. In case it is not convenient to bring the milk to the temperature of 60° F., a correction may be made, where the variation is not more than 10°, by adding to the lactometer reading 0.1 for each degree the temperature exceeds 60°, and subtracting 0.1 for each degree below 60. For example, a lactometer reading of 32 at 65° F., corrected would read 32.5; at 55° F., corrected, 31.5.

After finding the per cent. of fat, and taking the lactometer reading, the per cent of solids not fat may be found by the table given on page 235. Find the per cent. of fat in one of the side vertical columns, and the lactometer reading at the top of the table in the line of figures marked lactometer reading, then look down the column of figures directly under the lactometer reading till on line with the per cent. of fat, and the figures found at this point will be the per cent. of solids not fat in milk.

For example, suppose the per cent. of fat is 4.5 and the lactometer reading is 32, then the per cent. of solids not fat will be 8.92. Suppose the lactometer reads 33 instead of 32 in the above example, then the per cent. of solids not fat would be 9.17. The per cent. of solids not fat added to the per cent. of fat gives total solids."

Per cent. of fat.	Quevenne Lactometer Readings at 60 Degrees F.											Per cent. of fat.
	26	27	28	29	30	31	32	33	34	35	36	
1.0	6.70	6.95	7.20	7.45	7.70	7.95	8.20	8 45	8.70	8.95	9.20	1.0
1.1	6.72	6.97	7.22	7.47	7.72	7.97	8.22	8.47	8.72	8.97	9.22	1.1
1.2	6.74	6 99	7.24	7.49	7.74	7 99	8.24	8.49	8.74	8.99	9.24	1.2
1.3	6.76	7.01	7.26	7.51	7.76	8.01	8.26	8.51	8.76	9.01	9 26	1 3
1.4	6.78	7.03	7.28	7.53	7.78	8.03	8.28	8.53	8.78	9.03	9.28	1.4
1.5	6.80	7.05	7.30	7 55	7.80	8.05	8.30	8.55	8.80	9.05	9.30	1.5
1.6	6.82	7.07	7.32	7.57	7.82	8.07	8.32	8.57	8.82	9.07	9.32	1.6
1 7	6.84	7.09	7.34	7.59	7.84	8.09	8.34	8.59	8.84	9.09	9.34	1.7
1.8	6.86	7.11	7.36	7 61	7.86	8.11	8.36	8.61	8.86	9.11	9 37	1.8
1 9	6.88	7.13	7.38	7.63	7.88	8.13	8.38	8.63	8.88	9.13	9.39	1.9
2.0	6.90	7.15	7.40	7.65	7.90	8.15	8.40	8.66	8.91	9.15	9.41	2 0
2.1	6.92	7.17	7.42	7.67	7.92	8.17	8.42	8.68	8.93	9.18	9.43	2.1
2.2	6.94	7.19	7.44	7.69	7.94	8.19	8.44	8 70	8.95	9.20	9.45	2.2
2.3	6.96	7.21	7.46	7.71	7.96	8.21	8.46	8.72	8.97	9.22	9 47	2 3
2.4	6.98	7.23	7.48	7.73	7.98	8.23	8 48	8.74	8 99	9 24	9.49	2.4
2.5	7.00	7.25	7.50	7.75	8.00	8.25	8.50	8.76	9.01	9 26	9.51	2.5
2.6	7.02	7.27	7.52	7.77	8.02	8.27	8.52	8.78	9.03	9.28	9.53	2.6
2.7	7.04	7.29	7.54	7.79	8.04	8.29	8.54	8.80	9.05	9.30	9.55	2.7
2.8	7.06	7 31	7.56	7.81	8 06	8 31	8.57	8.82	9 07	9.32	9.57	2.8
2.9	7.08	7.33	7.58	7.83	8.08	8.33	8.59	8.84	9 09	9.34	9.59	2.9
3.0	7.10	7.35	7.60	7 85	8.10	8.36	8.61	8.86	9.11	9.36	9.61	3.0
3.1	7.12	7.37	7.62	7 87	8.13	8.38	8 63	8.88	9.13	9.38	9.64	3.1
3.2	7.14	7.39	7.64	7.89	8.15	8.40	8 65	8 90	9.15	9.41	9.66	3.2
3 3	7.16	7.41	7.66	7.92	8.17	8.42	8.67	8.92	9.18	9.43	9 68	3.3
3.4	7.18	7 43	7.69	7.94	8 19	8.44	8 69	8 94	9 20	9.45	9.70	3.4
3.5	7.20	7.45	7.71	7 96	8 21	8.46	8 71	8.96	9.22	9.47	9.72	3 5
3.6	7.22	7.48	7.73	7.98	8.23	8.48	8.73	8.98	9.24	9.49	9.74	3.6
3 7	7.24	7.50	7.75	8.00	8.25	8.50	8.75	9.00	9.26	9.51	9.76	3.7
3.8	7.26	7.52	7.77	8.02	8.27	8.52	8.77	9.02	9.28	9.53	9.78	3.8
3.9	7.28	7.54	7.79	8.04	8.29	8.54	8.79	9.04	9.30	9.55	9.80	3.9
4.0	7.30	7.56	7.81	8.06	8.31	8.56	8.81	9.06	9.32	9.57	9.83	4.0
4.1	7.32	7.58	7.83	8.08	8.33	8.58	8.83	9.08	9.34	9.59	9 85	4.1
4.2	7.34	7.60	7 85	8.10	8.35	8 60	8.85	9.11	9.36	9.62	9 87	4.2
4.3	7.36	7.62	7.87	8 12	8.37	8.62	8.88	9.13	9.38	9.64	9.89	4.3
4.4	7.38	7.64	7.89	8.14	8.39	8.64	8.90	9.15	9.40	9.66	9 91	4.4
4.5	7.40	7.66	7 91	8.16	8.41	8.66	8.92	9.17	9 42	9.68	9.93	4.5
4.6	7.43	7.68	7.93	8.18	8 43	8.68	8.94	9.19	9.44	9.70	9.95	4.6
4.7	7.45	7.70	7.95	8.20	8 45	8.70	8.96	9.21	9.46	9.72	9.97	4.7
4 8	7.47	7.72	7.97	8.22	8.47	8.72	8.98	9 23	9.48	9.74	9.99	4.8
4.9	7 49	7.74	7.99	8.24	8.49	8.74	9.00	9 25	9.50	9.76	10.01	4.9
5.0	7.51	7.76	8.01	8.26	8.51	8.76	9.02	9.27	9.52	9.78	10.03	5 0
5.1	7.53	7.78	8.03	8.28	8.53	8.79	9.04	9.29	9.54	9.80	10.05	5.1
5.2	7.55	7.80	8.05	8.30	9.55	8.81	9.06	9.31	9.56	9.82	10 07	5.2
5.3	7.57	7.82	8.07	8.32	8.57	8.83	9.08	9.33	9.58	9.84	10.09	5.3
5.4	7.59	7.84	8.09	8.34	8.60	8.85	9.10	9.36	9.61	9.86	10.11	5.4
5 5	7.61	7.86	8.11	8.36	8.62	8 87	9.12	9.38	9.63	9.88	10 13	5.5
5.6	7.63	7.88	8.13	8.39	8.64	8.89	9.15	9.40	9.65	9.90	10.15	5.6
5.7	7.65	7.90	8.15	8.41	8.66	8.91	9.17	9.42	9.67	9 92	10.17	5.7
5.8	7.67	7.92	8.17	8.43	8.68	8.94	9.19	9.44	9.69	9 94	10.19	5.8
5.9	7.69	7.94	8.20	8.45	8.70	8.96	9.21	9.46	9.71	9.96	10.22	5 9
6.0	7.71	7.96	8.22	8.47	8.72	8 98	9.23	9.48	9.73	9.98	10.24	6 0

To Determine Ash or Salts in Milk, "proceed as directed in the air-bath method for determining the total solids in milk, using a platinum dish." "The dry solids, after weighing, are gently ignited over a rose burner or in a muffled furnace, taking care not to allow the heat to rise above a dull red. When ash appears white or gray cool in a dessicator and weigh. Calculate percentage of salts or ash." *

In milk inspection, as a rule, it will not be necessary to make an accurate chemical determination of the casein and albumen or the milk sugar. The question of the kind and quantity of sugar in the various forms of condensed or evaporated milk is important and should be investigated. For methods of determining the casein, albumen and milk sugar, we refer the reader to Farrington and Woll's "Testing Milk and Its Products," "Fresenius," and Bulletin No. 43, p. 189, Chemical Division of U. S. Department of Agriculture.

Milk Adulteration.

Adding water and **abstracting cream** are the most common fraudulent means of adulterating milk. With a legal milk standard it is not difficult to detect such frauds. If there is no legal standard the inspector or his sample collector should go to the dairy and collect a control sample which he knows has not been adulterated. Every cow's milk will not meet the required legal standard in fat or solids not fat. But the purchaser of milk buys with the idea that the milk conforms to the legal standard. If it does not the vendor should reduce the price of milk accordingly, or, better still, procure cows that will yield standard milk. The mixed milk of a herd, as a rule, will meet the legal standard if the milk is not adulterated.

The removal of cream may be detected by the Babcock test the fat removed by skimming, or the deficiency in fat may be determined by the difference between the per cent. of fat obtained in the sample and the per cent. required by law, or the per cent of fat found in the control sample. In other words, the legal standard per cent. of fat minus the per cent. of fat

* New York City Board of Health Report, 1896, p. 169.

found in the sample, equals the per cent. of fat removed by skimming.

The following formulæ, with slight changes, are taken from Woll's Handbook for Farmers and Dairymen, 1897, pages 207-8:

In the formulæ let

Lf equal legal standard fat per cent.
Sf equal sample fat per cent.
LSnf equal legal standard per cent. of solids not fat.
Snf equal sample per cent. of solids not fat.

For rapid, practical results, determine the fat by the Babcock test, and the solids not fat by the lactometer with the rules, and table previously given.

I. If cream alone is removed from the milk it may be detected by

Formula: Lf — Sf = per cent. of fat removed.

II. Calculations of watered milk may be based on the percentage of solids not fat in the milk by

Formula: $100 - \frac{Snf \times 100}{LSnf}$ = per cent. of foreign water in milk.

Example: If sample contains 7.2 per cent. solids not fat and 9 per cent. is the legal standard for solids not fat then

$100 - \frac{7.2 \times 100}{9} = 20$ per cent. by weight of foreign water in the sample of milk or $\frac{1}{5}$ of the milk is added water.

III. The quantity of water added may be expressed in per cent. of water added based upon the weight of the original milk.

Formula:

$\frac{100 \times LSnf}{Snf} - 100 =$ per cent. of water added to original milk.

Example—Same as in II:

$\frac{100 \times 9}{7.2} - 100 = 25$ per cent. of water added or $\frac{1}{5}$ of milk is added water.

IV. Milk may be watered and skimmed. Determine per cent. of foreign or added water by II or III; and the per cent. of fat removed by this

Formula:

$Lf - \frac{LSnf \times Sf}{Snf} =$ per cent. of fat abstracted.

Example: If sample contains 8 per cent. of solids not fat and 2.5 per cent. of fat, and if 3 per cent. fat and 9 per cent. of solids not fat are the legal standards, then

$$3 - \frac{9 \times 2.5}{8} = .18\frac{3}{4}$$ per cent. by weight of fat removed.

Chemical Adulterants or Impurities.

Drugs are added to milk as preservatives; some are added to change the specific gravity of milk and occasionally coloring matter is added to make the milk appear richer.

Commercial milk, cream or butter may contain one or more of the following adulterants: Boracic acid, borax, salicylic acid, sodium salicylate, carbonate of soda, bicarbonate of soda, lime water, formalin. The majority of commercial preservatives are made up of one or more of the following drugs: Borax, boracic acid, sodium salycilate, salicylic acid, and formalin. As a rule, any preservative or coloring matter that is used in milk without giving due notice to the purchaser must be considered as a fraudulent adulteration. The following test may be made to determine the presence or absence of chemical adulterants.

"**Borax** and **Boracic** Acid: 100c.c. of milk are made alkaline with lime water dried, and the mixture gently burned to ash. The residue is acidified with concentrated hydrochloric acid, and the mixture washed in a small flask with 20c.c. of methyl alcohol. The flask is connected with a condenser and about 10c.c. of the methyl alcohol distilled into a small platinum dish. The dish is placed in a dark closet or room and the alcohol ignited, when, if a trace of boric acid or borax were present, it burns with a grass-green flame. Blank tests must be made with the re-agents used to prove absence of boric acid in them."*

"Place in a porcelain dish one drop of milk with two drops of strong hydrochloric acid and two drops of turmeric tincture; dry this on water bath; cool and add a drop of ammonia by

* N. Y. Board of Health Report, 1896, p. 169.

means of a glass rod. A slaty color, changing to green, is produced if borax is present."*

"Salicylic Acid or Its Salts: The milk is coagulated by means of a few drops of acetic acid and filtered, the filtrate is shaken with ethyl ether in a separating funnel. The ether is carefully drawn off and evaporated in a glass dish on the water bath. The residue, if any, is treated with a very little water, filtered, and a drop of neutral ferric chloride added. A violet color indicates presence of salicylic acid or its salts."†

"20c.c. of milk are acidulated with sulphuric acid and shaken with ether; the ether solution is evaporated, and the residue treated with alcohol and a little iron chloride solution; a deep violet color will be obtained in the presence of salicylic acid."‡

"Alkaline carbonates may be detected by the strong alkaline character of the ash, and by its effervescing with dilute acids. A quantitative determination may be made by titrating the water solution of the ash with n/10 sulphuric acid, using lakmoid as an indicator." ¶

"To 10c.c. of milk add 10c.c. of alcohol and a little of a one per cent. rosolic acid solution. Pure milk will give a brownish yellow color; milk to which soda has been added, a rose red color. A control experiment with milk of known purity should be made."§

"Formaldehyde or 'Formalin': A few drops of milk are floated on a small amount of concentrated sulphuric acid, containing a trace of ferric chloride. If formaldehyde is present, a violet blue ring will appear at the line of demarkation."‖

"A solution of diphenylamin is made with water and just enough sulphuric acid to secure a proper solvent effect. The milk to be tested, or better the distillate therefrom, is added to this solution and boiled. If formalin is present, a white

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* Farrington and Woll's Testing Milk, p. 195.
† N. Y. City Board of Health Report, 1896, p. 169.
‡ Farrington and Woll's Testing Milk, p. 196.
¶ N. Y. City Board of Health Report, 1896, p. 169.
§ Farrington and Woll's Testing Milk, p. 197.
‖ N. Y. City Board of Health Report, 1896, p. 169.

flocculent precipitate is formed; if the acid used contains nitrates a green precipitate is formed."

Skimmed or watered milk, or skimmed and watered milk, may have sufficient cheese or butter color added to give it a rich yellow appearance, which readily deceives the average purchaser.

"The presence of foreign coloring matter in milk is easily shown by shaking 10c.c. of milk with an equal quantity of ether; on standing, a clear ether solution will rise to the surface; the solution will be yellow colored if artificial coloring matter has been added to the milk, the intensity of the color indicating the quantity added; natural, fresh milk will give a colorless ether solution."*

"Annato or Butter Color: 100c.c. of milk, made strongly alkaline with sodium carbonate, are placed in a small cylinder; a strip of filter-paper, about $\frac{1}{2}$ inch wide and five inches long, is introduced, and the whole allowed to stand in the dark for twelve hours. If annato is present, the strip of paper, after washing, will be a pale salmon color, which is changed to a decided pink by moistening with a solution of stannous chloride, and after drying at the temperature of the room to a bluish color, on treatment with strong sulphuric acid."‡

Acidity of Milk.—Freshly drawn milk exhibits an amphoteric reaction to litmus; it colors red litmus blue, and blue litmus red; but in a short time after the milk is drawn, it shows an acid reaction to the phenolphtalein test. This acidity is probably due to acid phosphates, to carbonic acid gas and to the acid reaction of the casein. This milk will not taste sour and is considered sweet. The acid or sour tasting milk is due to lactic acid, which is a product of the action of bacteria on lactose or milk sugar. If there is .3 to .35 per cent. of lactic acid in milk it will taste sour. The acid-forming bacteria get into the milk at the time of milking, through uncleanliness; and after milking, through careless handling (keeping it in a warm room, unclean bottles or cans, adding

*Farrington and Woll's Testing Milk, p. 92.

‡ N. Y. City Board of Health Report, 1896, p. 169.

impure water, exposing to germ-laden air, etc.) Within certain limits, the greater the number of bacteria per c.c. of milk, the greater the acidity of the milk. Hence a test for the acidity of the milk will give a more or less definite idea of the degree of bacterial infection, and this will suggest the cleanliness or uncleanliness of the milking and of the handling of the milk thereafter. The temperature at which the milk is kept and the age of the milk must always be taken into consideration in drawing the conclusion as to the dairy cleanliness or uncleanliness. As a rule, any acid test showing a higher per cent. of acidity than .07 is due to lactic fermentation.

Test for Acidity of Milk. "20c.c. of milk is measured into a porcelain casserole; a few drops of an alcoholic phenolphtalein solution are added, and a soda solution (n/10) is dropped in slowly from a burette until the color of the milk remains uniformly pinkish on agitation. 1c.c. of n/10 alkali corresponds to .009 grams of lactic acid, or to .045 per cent. when 20c.c. are taken."*

Farrington's alkaline tablet test may be used more readily and conveniently.†

A test for cleanliness or uncleanliness in milking and in handling milk may be more definitely determined by a bacteriological examination; this will determine the number of bacteria per cubic centimeter and the various kinds of bacteria in the milk.

Bacteria in Milk.

The first few streams of milk drawn from the udder contain bacteria; the remainder of the milk may come from the udder free of germs; but it soon becomes contaminated by mixing with the first milk, by dust, dirt, hair and other particles from the cow's udder and skin; from the hands and clothes of the milker; from the air; from the unclean milk vessels; and from the impure water used in washing the milk vessels and used in fraudulently adulterating the milk. When the

* Farrington and Woll's Testing Milk, p. 195.

† Farrington and Woll's Testing Milk, pp. 99-105.

udder is diseased, as in tuberculosis, infectious mastitis, etc., the milk as it comes from the udder may contain tubercle bacilli or the other infectious germs.

Milk being a good food for bacteria, a great majority begin to grow and multiply as soon as they get into the milk. This is especially the case if the temperature of the milk is not reduced below 45 degrees F. in a short time after the milk is drawn from the udder. Very few germs can grow at such a low temperature, and those that can grow under such a condition will do so very slowly; many times the milk may be used before these low temperature germs can seriously injure it.

Determining the number of bacteria in a cubic centimeter of milk is called a **quantitative bacteriological analysis.** Determining the different kinds of bacteria and their peculiar characteristics is called a **qualitative bacteriological analysis.** Many times these analyses are very difficult, tedious, and expensive. The most important conclusion to be drawn from the number of bacteria in a given quantity of milk is that, as a rule, the greater the number of bacteria the greater the filth in the milk and in the handling of the milk. Grotenfelt found that samples of milk drawn "in a pasture on a fresh, somewhat damp summer morning showed the following average results as regards their bacterial content:"

Immediately after drawing from the udder, 10 bacteria per c.c. of milk; one-half hour after milking, 88 bacteria per c.c.; two hours after milking, 1,530 bacteria per c.c. These numbers are very small, and show that the milk was as nearly free of bacteria as it is practicable to obtain it. The milking was done in a clean, dewy pasture, surrounded by woods, where the air was still. These were clean conditions. Grotenfelt further says that a sample of milk drawn in a filthy and dark cow stable showed, in three fourths of an hour after milking, "not less than 670,000 bacteria per c.c." "The bacterial content of three samples of milk taken on three consecutive days from this stable did not vary much—the analyses showing the following average figures per c.c.: 730,000; 560,000, and 780,000."

Sedgwick and Batcheldor found in milk from the Boston milk supply an average of 2,335,500 bacteria per c.c. in 57 samples of milk. Sixteen samples of milk collected from groceries in Boston contained 4,577,000 per c.c., and those samples obtained from "well-to-do families on the Back Bay" contained an average of 1,438,000.

Sedgwick found that sewage of Lawrence, Mass., contained from 100,000 to 4,000,000 bacteria per c.c.

Bitter places the maximum limit for milk fit for human food at 50,000 bacteria per c.c., and Buffalo puts the limit at 10,000 per c.c.

The above examples of quantitative bacteriological analysis show that the greater the filth surrounding the milking, the more the milk is handled or changed from vessel to vessel and exposed to germ-laden air, and the older the milk, the greater the number of the bacteria in the milk. In order to obtain pure milk, cleanliness must begin with the barns, cows, vessels and milkers before the milk is drawn, and be continued during the milking and throughout all the processes of handling the milk. Furthermore, the milk must be kept at or below 45 degrees F. **Cleanliness is the great means of preventing bacterial contamination. Continuous vigilance along the line of cleanliness is the price of pure, clean, wholesome milk.**

The question of the **kind** of **bacteria** is very **important** in most instances, and somewhat indifferent in other cases. As long as the number of ordinary bacteria in milk is low they do not seriously injure the milk, unless the bacteria are disease-producing, or they injure the products (butter, cheese) to be made from the milk. There are germs, such as Conn's "Bacillus No. 41," that are valuable because they act in such a manner as to produce a pleasant flavor and aroma in the butter made from the milk. Likewise there are useful bacteria which produce an agreeable flavor and chemical change in cheese. But, as a rule, all bacteria that grow and multiply extensively in milk or cream which is to be used without change as human food, injure more or less its nutritive value. There is possibly one exception to this general statement, but

this exception has not been firmly established; some germs are said to assist in the process of digesting the milk in the alimentary canal. This supposition, however, is in want of positive proof. Experiment station men say that sour milk, which contains less nutrient material than sweet milk, will generally produce better results when fed to pigs than similar milk in a sweet condition. Woll says that this may be due to the stimulation of the appetite by the lactic acid in the sour milk, or in its aiding digestion by increasing the acidity of the stomach juices.

Sour Milk.—The class or group of bacteria that act on milk sugar and produce lactic acid are very numerous and are nearly always present in the milk. They multiply so rapidly that the milk soon becomes very sour. As a rule these lactic acid-producing bacteria grow more rapidly than any other germs, especially until the quantity of acid reaches .8 per cent.; then the lactic acid germs cease to grow. The germ that is said to be the most common lactic reagent is Hueppe's *Bacillus acidi lactici*. This germ will not grow in milk when the lactic acid reaches the limit of .8 per cent.; yet all the milk sugar is not changed into lactic acid. Several kinds of acid-producing bacteria may be growing at the same time in the milk; but, as a rule, one kind soon gains the ascendancy.

In the process of "ripening cream" one or more of the lactic acid-producing bacteria are used. Sometimes most of the accidental germs are destroyed by heating the cream or milk to about 158 degrees F.; after cooling it to below 100 degrees F., the cream or milk is inoculated with a specific germ that will produce the ripening or souring, and at the same time give a pleasant taste and aroma to the butter. As a rule, if the milk and cream are kept clean the ripening will take place as the result of the few germs that accidentally infect them; and the butter will have a pleasant taste and aroma.

The lactic acid-producing bacteria form the greatest number of accidental germs in milk; they are non-spore forming bacteria and consequently can be killed by heating the milk to 158 degrees F. for 20 or 30 minutes.

Alkaline-Producing Germs.—There are several bacteria

that will cause milk to exhibit an alkaline reaction. At times these germs are very injurious, yet they may not seriously interfere with the milk unless it stands for some time. However, they frequently prevent the ripening of cream and thus seriously interfere in the process of making butter. When they predominate in the dairy the best way to eradicate them is by thoroughly cleaning and disinfecting the barns, buckets, cans, churns, etc. At the same time it may be best to inoculate the fresh milk or cream, or pasteurized milk or cream, with a favorable germ by using a pure culture, or by using ripe cream or buttermilk from another dairy where they are making good butter.

Butyric Acid Fermentation may be a result of the action of one of several groups of bacteria upon the glyceride of butyric acid. This action sets free the butyric acid and produces the well known rancid or bitter taste of old butter. Butyric fermentation may occur in milk and give it a bitter taste. This bitter taste may be distinguished from the bitter that is produced by the cow eating bitter weed (*Helenium tenuifolium*, etc.,) by the fact that the bitter from the bitter weed is present in the milk immediately after it is drawn, and the **bitter taste produced by bacteria** appears some time after milking, or may appear some time after the milk has been boiled or cooked. According to Freudenreich certain forms of casein and milk-sugar fermentations may result in producing a bitter product. Some claim that the bitter product is produced by spore-forming bacteria that act chiefly upon the casein or albumen. Bitter-producing germs must be fought by cleanliness and disinfection. Bitter milk from bitter weeds must be fought by removing the weeds from the pasture or feed; by aerating the milk or by boiling the milk in an open vessel. The last mentioned method is doubtful.

Ropy, Stringy or **Slimy Milk** may be produced by a number of different species of bacteria. It may be a result of a series of fermentations, a kind of decomposition. Some investigators have isolated from ropy milk micrococci or spherical celled bacteria, while others have isolated bacilli or

rod like bacteria. In fact, nearly twenty species of bacteria have been found that will produce ropy milk. In some cases the ropiness appears to be due to "the swollen outer cell membrane of the bacteria themselves; in others it is due to different substances formed from the proteids in the milk, and, occasionally, the milk sugar." (Russell.)

Ropy milk bacteria can be eradicated from the dairy by cleanliness, disinfection, and possibly by sterilizing. In Holland slimy or ropy fermentation of milk is desired in the manufacture of Edam cheese. The Norwegians make a popular drink by producing a slimy change in milk; the milk is infected by introducing the leaves of the common butterwort.

Chromogenic or **Color-Producing** germs are sometimes found in milk. **Red Milk** may be due to the presence of blood from an injured or diseased udder. In such cases the milk will appear red at the time of milking. Milk may appear red when one or more of pigment-producing germs grow in it. The most common germ that produces this red tinged milk is called the *bacillus prodigiosus*. This germ is reported to be rarely, if ever, found in America. However, in October, 1897, the writer isolated it from a rotten cotton boll. Another red milk germ is the *bacillus lactis erythrogenes* (Hueppe). *Sarcina rosea* is also said to produce a red color in milk. These red milk germs not only develop a red pigment in milk, but also produce coagulation of the casein. The *bacillus prodigiosus* may form trimethylmin, which gives milk a herring-like smell and taste. Cleanliness and disinfection are the means of getting rid of the red milk germs.

Blue Milk may be a result of the growth of certain germs in milk. This must not be confounded with what is commonly known as blue milk, which is blue-tinted, poor milk, or milk that appears blue after the cream has been removed. The blue pigment, developed by the *bacillus cyanogenus*, will appear, in from one to three days after infection or inoculation, as isolated, bluish-colored patches on the surface of the milk; after a time the entire surface of the milk may become coated with a blue film. The action of this germ on the milk is unknown. Butter made from infected cream will not

keep well. This germ is easily killed by heat and disinfectants, but it will survive a long period of drying.

Yellow Milk may appear as the result of the action of several species of germs. Some of these precipitate and then dissolve the casein. Some produce a bright lemon color in milk, while others give the milk an orange tint. Violet and green tints may be produced by certain pigment-producing germs. These germs are rarely found in milk. When they occur, more attention to cleanliness will eliminate them from the dairy.

The Yeasts usually produce in milk an alcoholic fermentation; they change the milk sugar into alcohol, water and carbonic acid gas. Skimmed milk may be inoculated with yeast and a very nutritive drink, called kephir or koumiss, will be produced. Kephir is usually made from cows' milk, while koumiss is made from mares' milk. Yeast fungi are the predominating organisms in these alcoholic fermentations of milk; but there may be some bacteria and molds in the mixture. Koumiss is said to be more easily digested than milk and is sometimes given to invalids instead of milk.

Casein Ferments are all spore-forming bacteria, and consequently are very difficult to destroy. The *tyrotherix* group of bacteria, first studied by Duclaux, and the potato bacillus (*bacillus mesentericus vulgatus*) and the *bacillus subtilis* are some of the germs that produce casein fermentation. Some germs may break up or decompose the casein and produce unpleasant smelling gases, carbonic acid gas, ammonia and water; such germs usually decompose the casein without precipitating it. Other germs may precipitate and then dissolve the casein. Still other casein ferments simply coagulate the casein; some of these coagulate the casein very like the rennet ferment. In fact Conn has prepared a germ in the form of a dry powder, which acts like rennet on milk casein. Casein ferments may act after the lactic fermentation is completed; and, "in all probability, they are intimately concerned in the curing of cheese in which the casein is broken down into soluble compounds." (Russell.)

Disease-Producing Bacteria.

The most important disease-producing germ that is found in milk is the *bacillus tuberculosis*. This germ may gain admission to the milk from a tuberculous udder; it may occasionally get into the milk with the dust that has been infected by the expectoration of tuberculous persons and tuberculous cattle. Tubercle bacilli do not grow or multiply to any appreciable degree in commercial milk, because the growing temperature limits* are between 80 and 104 degrees F., and, when under the most favorable growing conditions, they grow very slowly. In the mixed milk from a herd or in the milk from a single cow the number of tubercle bacilli are so few that it is very difficult to find them by microscopic examination. Generally not more than one cow in a herd will have tuberculosis of the udder or of the lymphatic glands near the udder; consequently, in the mixed milk of a herd, the tubercle bacilli are so few that it is almost impossible to detect them. In some cases the germs in milk may be thrown to the bottom of a small vessel and then examined. The following method,† described by Hammond, a student of the McGill Veterinary College, is one of the most practicable:

"Taking milk to which (preferably in order to arrest the growth of other bacteria which are apt to hide the tubercle bacilli) 5 per cent. of glacial carbolic acid has been added, put 15 c.c. of the milk into each of the two tubes, then centrifugalize it for 25 minutes (preferably in the hand centrifugal machine manufactured by Bausch and Lomb, Rochester, N. Y.); the supernating fluid is poured off; the precipitated debris, bacteria, etc., which contains the bacilli, is then treated with about 3 c.c. of a 5 per cent. caustic potash solution, is mixed up thoroughly by giving a good shake and is left for two or three minutes. The tube is then filled up to the 15 c.c. mark with distilled water and centrifugalized for

* The variety of tubercle bacilli in fish may grow at a much lower temperature, and the variety of tubercle bacilli in birds may grow at a higher temperature.

† American Veterinary Review, Aug., 1898, p. 322.

about twenty minutes. If now the supernating fluid be taken off the minute quantity of debris at the base of the tube can be examined right away; or, if the material is required in a purer condition, completely free from caustic potash, a series of dilutions and centrifugalizations with distilled water can be carried on."

With a drop of the sediment from the bottom of a tube make a smear on a clean cover glass; stain with Gray's or Ziel's carbol-fuchsin, warm and allow stain to remain five to ten minutes; decolorize for a few seconds in a 10 to 20 per cent. acid solution (hydrochloric, nitric or sulphuric acid); wash in distilled water, dry and mount in balsam. Examine with a one-twelfth or a one-sixteenth-inch oil-immersion objective. The tubercle bacilli will have a distinct red color, while all other germs will be decolorized.

A few drops of the sediment from the bottom of a centrifugalized milk may be injected into the abdomen, under the skin or into a vein, of a rabbit or guinea pig. In from ten to twenty days the guinea pig will have developed sufficient tuberculous changes to permit one to make an accurate microscopic test for tubercle bacilli.

The question as to whether a tuberculous cow without apparent tuberculosis of the udder will throw off tubercle bacilli in the milk is not fully determined; but it is very probable that such cows will not give infectious milk. Some authorities have conveyed tuberculosis to pigs by feeding them milk from tuberculous cows: the udder may have been involved in all of these cases. No doubt many infants, children and some grown persons contract tuberculosis by drinking infected milk. If the dairy cows have not been tested with tuberculin for tuberculosis it is always the safest to pasteurize or sterilize the cream, butter and milk that comes from such a dairy. Some have thought that the separator would remove all the germs from the milk and cream, but the fact is that germs remain in the cream and the milk after the process of separation. Consequently dairy herds that supply milk, cream or butter to the public should be tested with tuberculin, and all animals that react should be removed from

the herd. Cream and butter from a tuberculous cow are almost as infectious as the milk.

The most practicable and positive method of determining the presence or absence of tuberculosis in a herd is the tuberculin test. Every cow should be tested at least once a year; and in herds where tuberculosis has been found every cow should be tested twice a year. Remember that a physical examination of the cow or a microscopic test of the milk are not as far-reaching or accurate in picking out of the herd every animal that is tuberculous as the tuberculin test. However, these aids to a diagnosis may supplement, or may be used in connection with, the tuberculin test.

It may be well to state here that tubercle bacilli, from man, cattle, birds and fish, are the same or identical, but slightly modified by the variations in the condition of the different hosts. Yet, under favorable conditions, tubercle bacilli from cattle can be transmitted to man, and the bacilli from man may be transmitted to cattle. Tubercle bacilli from birds and fish cannot readily be transmitted to man or other animals, but such infection may occur because the germ is only slightly modified in fish and birds.

Typhoid bacilli have been found in milk. Hart reports fifty epidemics of typhoid fever with 3,500 cases, and Dr. Freeman, of New York, collected records of fifty-three epidemics with 3,226 cases; in all of these epidemics the typhoid bacilli were distributed by milk infected with that germ. When typhoid cases appear along a certain milk-wagon route, or when many of the patrons of a certain milk depot contract typhoid fever, the health officers at once search for the source of the infection at the dairy from whence the milk comes.

The milk is most frequently infected with typhoid bacilli by using infected water to wash the milk cans, bottles, separators, hands, etc. The water in a well or river may become infected by surface drainage. This is very frequently the case when a dairy hand or some one near the dairy has typhoid fever. It is usually a result of careless handling of stools and urine from a typhoid patient. According to a recent investigator,* the urine from a typhoid patient will contain typhoid

* Central Bl'tt fur Bac., Band XXIII, No. 14, p. 517.

bacilli for one to two months, during the fever and convalescing period and for some time afterwards.

Typhoid bacilli will grow and multiply very readily in milk when the temperature is between 80 and 100 degrees F. According to Frænkel and others,* typhoid bacilli may live, and in some instances grow, in butter-milk having an acid reaction. According to Russell,† milk may become infected with typhoid germs in the following ways:

"1. Infection by the milker who has been near a person sick with the fever, and whose clothes have become infected.

"2. Infection of the milk by allowing it to stand in a room that was next to that occupied by a typhoid patient.

"3. Direct infection of milk vessels by infected water used for cleansing purposes."

Diphtheria is another disease that is sometimes transmitted by means of infected milk. Ernest Hart, of England, collected statistics of seven epidemics of diphtheria, with 500 cases; and Dr. Freeman, of New York, obtained records of eleven epidemics, with 501 cases: all of these eighteen epidemics were transmitted by means of infected milk. Klein claims that he found diphtheria bacilli in the milk of two inoculated cows. Abbott failed to find the germ in a similar experiment. The actual infection of cows with diphtheria bacilli may not be fully determined, but the clinical records of diphtheria epidemics show conclusively that milk can be the carrier of the germ. Sternberg says: "Milk is a favorable medium for the growth of this bacillus, and, as it grows at a comparatively low temperature (58 degrees F.), it is evident that this fluid may become a medium for conveying the bacillus from an infected source to the throats of previously healthy children." ‡

Abbott says that the bacillus of diptheria is destroyed by heating, for ten minutes, at 58 degrees C. or 136.4 degrees F. Hence pasteurizing or sterilizing will readily destroy them. But the best plan is for the inspector to see that there is no

* Central Bl'tt. fur Bac., Band XXIII, No. 17, p. 752.

† Russell's Dairy Bacteriology, p. 97.

‡ Manual of Bacteriology, p. 362.

contamination at the dairy or in the handling of the milk by persons that have been near diphtheria patients, or by keeping the milk in or near rooms or houses where diphtheria exists.

Scarlet Fever may be transmitted by means of infected milk. The real cause of this disease has not been discovered, yet several epidemics of scarlet fever have been traced to infected milk. Hart records fifteen epidemics of scarlet fever, with 800 cases, and Dr. Freeman gives twenty-six epidemics, with 1,593 cases: all of these forty-one epidemics were traced to infected milk. It has been reported that cattle and horses have scarlet fever, but this has been disputed by good authorities. No person or substances coming from a house where scarlet fever exists should be permitted at or near a dairy; at least such persons should never be allowed to work in a dairy. Neither should milk be placed in or near an infected house.

Asiatic Cholera has been transmitted in India by means of infected milk. Milk may become infected by the use of infected water or by infected clothes of a dairy servant. The comma bacillus can live and grow in milk until the milk becomes distinctly acid. This germ is killed by heating for ten minutes at 52 degrees C. or 125.6 degrees F. During cholera epidemics the milk supply should be carefully guarded, since it may be the means of spreading the disease.

Epidemics of acute poisoning, throat troubles and foot-and-mouth disease have been reported as having been transmitted by infected milk. It is also possible that cow-pox, yellow fever and malarial fever may be transmitted by means of infected milk.

The most common and constant germ found in the manure of cattle and other animals is the *bacillus coli communis*, which closely resembles the typhoid bacillus. It, no doubt, causes serious intestinal troubles (indigestion, diarrhea, etc.,) among infants and children; consequently it is imperative that every effort be made to prevent manurial infection of milk.

Milk may be put in condition to be kept sweet and wholesome by various processes. The use of drugs or chemical

agents is, in any form, an adulteration; therefore they cannot be legally used. Physical agents, that do not change or decrease the nutritive value of the milk, may be used. But the best way to keep milk sweet and fresh is to prevent infection or contamination of the milk by strict and forced cleanliness. **Clean, raw milk is now considered the purest, the most easily digested, and the best of all kinds of milk.**

But if the dairy is not run on strict lines of cleanliness and all diseased cows are not removed from the herd, the dairyman, the milk-dealer, or the consumer may be compelled to use some physical agent to destroy the germs and thus preserve the milk, and many times prevent disease. **Germ-laden milk should be pasteurized** or **sterilized.**

Pasteurization of milk consists in heating the milk to 158-167 degrees F. for 20 to 30 minutes; then it should be cooled as rapidly as possible; placed upon ice and kept there until used. Physicians are inclined to object to pasteurized milk, because the useful (?), digestive-aiding bacteria and the albumen ferments are destroyed. Pasteurization will not destroy the spores of the injurious germs, but it will nearly always kill the adult bacteria in the milk, and if the process is repeated on three consecutive days it will destroy all of the bacteria in the milk.

Technically speaking, **Sterilization** means the complete destruction of all the germs in milk. This may be accomplished by heating the milk to 212 degrees for 15 minutes at or about the same time on three consecutive days; or by heating the milk, under pressure, to 260 to 300 degrees F. Ordinarily, sterilization means heating the milk to 212 degrees F. for 20 to 30 minutes. It will impart a burnt or cooked taste to the milk, coagulate the albumen, cause the globules of fat to unite, convert the soluble into insoluble lime salts, destroy the useful (?) germs, and change the color of the milk. Some of these changes seriously interfere with the nutritive value and digestibility of the milk. Ordinary sterilization will not always kill the spores of the injurious bacteria, yet it will kill all of the adult germs. Sterilized and pasteurized milk may become sour in 48 hours if it is not kept on ice.

For an extended discussion of the methods of sterilization and pasteurization see Bulletin No. 44 of the Wisconsin Experiment Station, and Bulletin No. 53 of the Alabama Experiment Station.

How to Disinfect a Barn or Dairy House.—The ceiling and the walls should be as smooth as possible, so that little or no dust will be caught by them; they should also be made of material that will stand washing. It goes without saying that the floors should be made to stand frequent flooding and scouring. In disinfecting the first requisite is thorough cleansing of ceiling and walls with water, soap and brush. If possible use hot instead of cold water. The floors should then be scrupulously cleansed. The walls and ceiling may next be covered with a whitewash that contains one fluid ounce of formalin or carbolic acid to every gallon of whitewash; or formalin may be added to water in the proportion of one fluid ounce to one gallon of water, and sprinkled over the ceiling, the walls and floors at night. The building should then be kept closed until next morning, when it may be thoroughly ventilated. A 2 to 4 per cent. solution of creolin may be used instead of the formalin solution. A strong formaldehyde gas generator may be kept going in the cleaned and closed building during the night. If the dairy buildings are kept scrupulously clean it will not be necessary to disinfect them more frequently than once a year.

Modified Milk.—This term usually means the changing of cow's milk so that its composition will be very near the same as mother's or woman's milk. According to chemical analyses cow's milk contains about three times as much casein as woman's milk, and the latter contains 6.2 per cent. of milk sugar, while the former contains only 4.9 per cent. Hence, if cow's milk is fed to an infant, the milk should be so modified that its composition will closely approximate that of mother's milk. In some of the large cities the Walker-Gordon Laboratory Company prepare and sell modified milk; but a relatively accurate modified milk may be made at home under the direction of the family physician or the qualified graduate nurse. This subject is very plainly treated in "The Care and

Feeding of Children," by Dr. Holt. This little book costs only 50 cents, and every mother should read it and practice what it teaches.

The law given below is the one in force in the city of Montgomery, Ala. The minimum limit for milk fat or butter fat should be 3.5 instead of 3 per cent. Furthermore the provision that permits persons who own one or two cows to sell milk without paying city license or without having their cows inspected for tuberculosis is very poor sanitary medicine. These cows, above all others, are most liable to have tuberculosis, because they are so closely confined, fed family slops, and are more frequently in close contact with tuberculous persons. Every cow which produces commercial milk should be frequently inspected and tested, once or twice a year, for tuberculosis.

AN ORDINANCE

To Regulate the Sale of Milk in the City of Montgomery.

Be it ordained by the City Council of Montgomery, as follows:

Section 1. That all milk dealers, firms or corporations and dairymen, who sell or supply milk in any way to or for the people of Montgomery shall be required to take out an annual license from the City Clerk at the rate of five dollars for ten cows and under, and ten dollars for any number exceeding ten cows; provided, that this shall not apply to persons who have not exceeding two cows for family use, selling their surplus milk to immediate neighbors.

Sec. 2. *Be it further ordained*, That no person, firm or corporation shall sell, exchange or deliver, or transport, or have have in his or her or their possession for the purpose of sale any milk which contains more than eighty-seven and fifty one-hundredths (87.50) per centum of water, or less than 3 per cent. of butter fat, and the specific gravity of which at sixty (60) degrees Fah. shall be between one and twenty-nine one-thousandths (1.029) and one and thirty-three one-thousandths (1.033); and all milk of a lower grade or quality

than specificed by this section shall be taken and condemned as adulterated and impure, and the vendor thereof fined as provided for in section VII.

SEC. 3. *Be it further ordained*, That all skimmed or separated milk that is to be sold or held for sale in any way by any person, firm or corporation, shall contain not less than nine (9) per centum of milk solids, exclusive of butter fat. Violations of this section shall be punished as provided for in section VII.

SEC. 4. *Be it further ordained*, That all additions to milk of water, ice, chalk, borax, salicylate of soda, or any coloring matter, or any substance which changes the taste, the specific gravity, the color, or the normal chemical constituents of the milk, shall render it impure, unfit for sale, and the possessor thereof liable to a fine.

SEC. 5. *Be it further ordained*, That all dairy cows, which produce milk for the Montgomery market shall be free from all diseases that would in any way affect the milk, especially of all infectious diseases that are communicable to man or produce an elevation of systemic temperature, such as tuberculosis, anthrax, Texas fever, pneumonia, parturient apoplexy (milk fever), malignant catarrh, etc., etc. No cow shall be used in a dairy which supplies milk to the people of Montgomery, unless she has been tested by the inspector with tuberculin for tuberculosis. All dairy cows thus tested shall be marked in the ear with a tag bearing a serial number, and "Montgomery, Ala.," and such cows may be re-tested as often as the inspector may deem it necessary.

SEC. 6. *Be it further ordained*, That dairy cows producing milk for the Montgomery market shall not be fed distillery waste, usually called "swill," or upon any substance in a state of putrifaction or rottenness, or upon any other substance that is unwholesome, or that will in any way affect the healthfulness of the milk.

Furthermore, the cows of the dairy shall be allowed free movement in the open air at least six (6) hours every day. The barns, sheds and stalls in which said cows are fed and milked shall be properly ventilated, lighted, drained and

cleaned, all of which shall be subject to inspection by the inspector.

SEC. 7. *Be it further ordained*, That any violation of the foregoing sections shall be punished by a fine of not less than one ($1.00) dollar or more than one hundred ($100.00) dollars for each and every offense.

Adopted September 28, 1896.

Approved September 30, 1896.

The **references** consulted in the preparation of this bulletin were:

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