University of Edinburgh.

Thesis

for the Degree of

Doctor of Medicine

by

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M.B. C.M.

That the Acidity of Cow's Milk is the best and most reliable indication of its fitness for Human Food.

(based upon the results of

3517 experiments and

upon the examination of

705 samples of Cow's Milk)

94 Bisward Road, Bisward (Cheshire)

April 27th, 1907.
Synopsis of Thesis

Introductory

Quality of milk: Difficulty in urban districts of obtaining a pure milk supply. Diseased, or contaminated or adulterated milk.

The importance of cow's milk in the Infant Dietary.

Composition of Mammalian Milk. Factors which affect composition. Comparison between human milk and cow's milk.

Colostrum.

Adulteration of milk. Objectives to an arbitrary standard. Sale of Food and Drugs Act 1899.

Preservatives in milk.


Chemical Analysis of Milk.

Acidity of milk. My own experiments. Object methods, results & conclusions.

General Conclusions. The real factors to be considered in deciding the suitability of milk for human food are its freshness and the absence of pathogenic bacteria; and the condition under which it has been stored. Sterilisation and the use of preservatives enable stale milk to be sold. The safeguarding of the milk must begin at the dairy. Milk consumed within 12 hours does not require to be sterilised, if delivered in sealed bottles and kept at a low temperature.

The personal responsibility of the Consumer.

The essence of personal responsibility is responsibility to a person. The duty of Local Authorities to demand responsibility
The importance of milk in the dietary, especially of infancy and of disease, is so great that the quality and purity of the milk supply is of supreme moment to the physician.

In urban districts, the difficulty of obtaining pure milk is increasing year by year owing to the growth of towns. More milk is brought from a distance so that supervision of the milk supply is more difficult and greater opportunities are afforded for adulteration.

The evils which result from the consumption of impure milk are very numerous and are frequently inimical to health. It is now generally accepted that tuberculosis and other specific diseases are transmissible by milk. Moreover, stale or sour milk has been proved to cause disease. Into the far-reaching influence of Lactic Acid — the essential constituent of sour milk — upon the human organisms, it is impossible to enter here. But if the view that...
tiredness, fatigue and even natural death itself may be ascribed to the physiological effects of Lactic Acid be correct, the importance of using newly drawn milk in the dietary cannot be exaggerated.

Apart altogether from being the direct cause of disease, an impoverished or an impure milk tends to ill-health by affecting nutrition directly or indirectly.

The periodical and systematic inspection of cattle and of dairies as well as the frequent analysis of milk is therefore absolutely necessary and ought to be enforced by extension of the present laws. The duty of the execution of the laws relating to Food supply has been entrusted by Parliament to the Local Authorities who in spite of recent revelations have not fully realised their responsibility and administration has been lax and punishment, too frequently, is inadequate to the offence.
Owing to the inability or unwillingness of many women to suckle their own offspring, some substitute for mother's milk must be found. In England, recourse is usually had to the milk of the cow. The milk of the mare, ass, goat and buffalo is also used abroad and occasionally in this country.

The composition of mammalian milk has been found to bear relation to the time taken by the newly born offspring to double in weight. The composition of milk is apparently specific for each species; and is also found to vary differently in each species in the various stages of development in the individual. As a practical result of this fact a wet nurse can never completely replace the mother unless her infant had been born on the same day as her foster-child. Climate and other conditions also affect the composition of milk.

The following table and chart (Table 1, Chart 1) give the average analyses of milk secreted by different animals. (The figures are taken from Bunge's Physiological Chemistry p. 116)
<table>
<thead>
<tr>
<th>Animal</th>
<th>Specific Gravity</th>
<th>Total Solids</th>
<th>Proteid</th>
<th>Fat</th>
<th>Calcium Phosphate</th>
<th>Salts</th>
<th>Non-Nitrogenous Solids</th>
<th>Total Nitrogen</th>
<th>Ash</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>1027</td>
<td>12.6</td>
<td>2.3</td>
<td>3.8</td>
<td>6.2</td>
<td>0.3</td>
<td>4.4</td>
<td>180</td>
<td></td>
</tr>
<tr>
<td>Cow</td>
<td>1032</td>
<td>12.8</td>
<td>3.6</td>
<td>3.7</td>
<td>4.9</td>
<td>0.7</td>
<td>2.5</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td>Mare</td>
<td>1035</td>
<td>9.2</td>
<td>2.0</td>
<td>1.2</td>
<td>5.6</td>
<td>0.4</td>
<td>3.4</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Ass</td>
<td>1026</td>
<td>10.4</td>
<td>2.2</td>
<td>1.6</td>
<td>6.0</td>
<td>0.5</td>
<td>3.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goat</td>
<td>1032</td>
<td>14.3</td>
<td>4.3</td>
<td>4.8</td>
<td>4.5</td>
<td>0.7</td>
<td>2.0</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>Buffalo</td>
<td>1032</td>
<td>18.6</td>
<td>6.1</td>
<td>7.4</td>
<td>4.2</td>
<td>0.9</td>
<td>1.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pig</td>
<td></td>
<td>5.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Sheep</td>
<td></td>
<td>6.5</td>
<td></td>
<td></td>
<td></td>
<td>0.9</td>
<td></td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>Dog</td>
<td></td>
<td>7.1</td>
<td></td>
<td></td>
<td></td>
<td>1.3</td>
<td></td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Cat</td>
<td></td>
<td>9.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

Table 1

Analyses of Milk
To illustrate the relation between the composition of an ER (Black) and time taken to double body weight (Red)
To illustrate the differences in composition between human milk (black) and cow's milk (red)
It is seen that Cow's milk contains one third ($\frac{1}{3}$) more protein and one-third ($\frac{1}{3}$) less carbohydrate than human milk, so that the composition of cow's milk must be very considerably modified before it can become a suitable food for infants. Reference will be made later to other differences—such as the difference in the firmness and digestibility of the Curd of human milk and of cow's milk.

Milk is the fluid secreted by the lacteal glands of all female mammals for the nourishment of their young; it must therefore contain all that is necessary for supporting life and for the growth and development of the animal body.

Physiologically considered, milk is a perfect and complete food, for in it are found the four classes of alimentary substance combined in the proportions best adapted for the period during which it forms the exclusive food of the young mammal.

Genuine Cow's milk is a dense opalescent white liquid—it has however not infrequently a faintly yellow tinge. The colour is due to suspended minute globules of fat. Milk
is in fact a natural emulsion. The fat globules vary in size from 0.00005 to 0.00004 inches in diameter.

The average capacity of a cow's udder is five pints and the average annual yield by a milk cow is about 600 gallons.

The specific gravity of Cow's milk varies from 1028.5 to 1035 at a temperature of 15°C.

In normal milk, the Microscope only reveals round oil globules of various sizes enclosed in an envelope, and a little epithelium. In abnormal milk, a large amount of epithelium, pus, casts of the lacteal tubes, etc may be found, and foreign matter such as starch grains and chalk added for purposes of adulteration.

The Chemical Composition of Cows milk is not invariable. The extent of the variation in composition of genuine milk is shown by the following series of Analyses (Table 2)
<table>
<thead>
<tr>
<th>A</th>
<th>Bell 1881.</th>
<th>Specific Gravity</th>
<th>Total Solids</th>
<th>Fat</th>
<th>Solids not fat</th>
<th>Ash</th>
<th>Cream in 24 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>236 Individual Cows.</td>
<td>1037</td>
<td>1032</td>
<td>16.2</td>
<td>12.8</td>
<td>6.9</td>
<td>3.8</td>
<td>11.3</td>
</tr>
<tr>
<td>24 Herds (mixed milk)</td>
<td></td>
<td></td>
<td>14.7</td>
<td>13.2</td>
<td>5.1</td>
<td>4.1</td>
<td>9.9</td>
</tr>
<tr>
<td>B</td>
<td>Bell 1892.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>273 Cows.</td>
<td>1032.9</td>
<td>12.9</td>
<td>4.0</td>
<td>8.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>55 Dairies</td>
<td>1031.9</td>
<td>12.9</td>
<td>4.0</td>
<td>8.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Aylesbury Dairy Co.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>120540 Samples</td>
<td>12.9</td>
<td>4.1</td>
<td>8.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>226009 Samples</td>
<td>12.3</td>
<td>3.5</td>
<td>8.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 2.**

**Analyses of Milk**
Two typical Analyses are as follows:

<table>
<thead>
<tr>
<th>Table 3</th>
<th>no. 1</th>
<th>no. 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albuminote</td>
<td>4.0</td>
<td>3.3</td>
</tr>
<tr>
<td>Fat</td>
<td>3.7</td>
<td>3.6</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>4.8</td>
<td>4.8</td>
</tr>
<tr>
<td>Salts</td>
<td>0.7</td>
<td>0.7</td>
</tr>
<tr>
<td>Total Solids</td>
<td>13.2</td>
<td>12.4</td>
</tr>
<tr>
<td>Water</td>
<td>86.8</td>
<td>87.6</td>
</tr>
<tr>
<td></td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Owing to the variations in the composition of the milk of individual cows, mixed milk is a better basis for the preparation of suitable food for infants than the milk of one cow, for it is more constant in composition and it is known by experience that it is less likely to cause any gastric disturbance.

When the causes of the variation in the chemical composition of cow's milk are considered, it is obvious that any standard adopted as representing the composition of genuine milk must be purely arbitrary.

The milk which immediately succeeds delivery of the calf differs from ordinary milk and is known as Colostrum. After the colostrum stage the milk of the cow gradually alters in quality. At first, until
The second month, the casein and the fat are increased from the tenth to the twenty-fourth month.

<table>
<thead>
<tr>
<th>Composition of Colostrum.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Table</strong> 11</td>
</tr>
<tr>
<td><strong>Casein</strong></td>
</tr>
<tr>
<td><strong>Albumin</strong></td>
</tr>
<tr>
<td><strong>Fat</strong></td>
</tr>
<tr>
<td><strong>Lactose</strong></td>
</tr>
<tr>
<td><strong>Salts</strong></td>
</tr>
<tr>
<td><strong>Water</strong></td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>

In the fifth to the twelfth month, the fat diminishes. The lactose lessens during the first month but increases during the eighth, ninth, and tenth months. The salts increase up to the fifth month; after which they steadily diminish.

Microscopically examined, colostrum is composed of an aggregation of fat globules, united by granular material. It has a somewhat turbid yellowish appearance and it is strongly alkaline in reaction. It contains very little casein but much serum albumin. It is particularly rich in the other solid ingredients, especially fat. It coagulates on boiling. It has a sickly odour and is said to possess
purgative properties. It is generally regarded as unfit for human food but in Wales the milk of a newly calved cow (known locally as "Llaeth fawr" or "Llaeth brith") after being cooked is regarded as a delicacy. The first three milkings are however usually rejected.

Other conditions which affect the quality and composition of milk only require to be mentioned.

(a) The breed of the cow.
(b) Its age.
(c) Its state of health.
(d) Its mental and physical condition.
(e) Its food.
(f) The season of the year.
(g) The time and stage of milking. The milk first drawn off the "foremilk" contains much less fat than the last drawn off the "skippings".

The purity of milk is determined in two ways. (a) By bacteriological examination and (b) by chemical examination. Pollution of milk is detected by the former, and adulteration of milk by the latter.
In the safeguarding of the quality of the milk supply, frequent and systematic analyses are necessary, and ought to be undertaken by the municipal authorities.

It is a matter for regret that the adulteration of milk is regarded as a comparatively trivial offence punishable and adequately punishable by the infliction of a comparatively small fine. A third or even possibly a second conviction ought to be punishable by imprisonment without the option of a fine.

Until recently, the variability in composition of genuine milk made it difficult to prove adulteration—it was often successfully urged that the milk though poor in quality was not adulterated.

An article of food is adulterated or impoverished if it has been mixed with any other substance or if any part of it has been abstracted so as in either case to affect injuriously its quality, substance or nature. An article of food is not adulterated by reason of the addition of any preservative or colouring matter of such a nature and in such quantity as not to render the article injurious to health.
The Council of the Society of Analysts proposed 11.5 per cent as the standard for total solids which should contain not less than 3 per cent of fat nor less than 8.5 per cent of non-fatty solids. The Government Laboratory at Somerset House was content with a minimum of 2.75 per cent of fat. After long controversy, the difficulty of determining a standard quality was removed by the Sale of Food and Drugs Act 1889.

That act empowered the Board of Agriculture to issue Regulations prescribing a standard of quality for milk. The Regulations issued in 1901 provide that:

1. When a sample of milk (not being sold as skimmed milk or separated or condensed milk) contains less than 3 per cent of milk fat, it shall be presumed until the contrary be proved that the milk is not genuine by reason of:
   (a) The abstraction there from of milk fat or
   (b) The addition thereto of water.

2. When a sample of milk contains less than 8.5 per cent of milk solids other than milk fat, it shall be presumed until the contrary be proved that the milk is not genuine by reason of...
(a) the abstraction therefrom of milk solids other than butter-fat or (b) the addition thereto of water.

One objection can be urged against the adoption of a standard of quality for milk. The composition of cows milk has already been shown to vary considerably. A fixed standard of quality will tend to reduce the average amount of cream in the milk sold, for cream can be abstracted from a portion of the milk and sold separately, the separated milk being added to the remainder of the milk in such quantity as to reduce the percentage of fat to the legal minimum. The quantity of fat in a sample of milk is easily and rapidly estimated and the dilution may therefore be accurately accomplished within a very few minutes.

With regard to the addition of Preservatives to milk, it is doubtful whether such addition is legal or illegal. The majority of the convictions obtained depend upon evidence given to prove that the added preservative was injurious to health. That contention is scarcely credible as regards the addition of Boric Acid or of Salicylic acid in small quantities.
Convictions have been obtained on the ground that the admixture was not disclosed at the time of sale. Conviction for the addition of preservatives to milk ought not however to depend upon legal technicalities; for the real objection to such addition depends upon the fact that the lactic acid fermentation is either retarded or prevented by them—while the more dangerous putrefactive changes proceed unchecked and unnoticed.

The Departmental Committee on the Use of Food Preservatives recommended that the use of any preservative or colouring matter in milk offered for sale be an offence under the Acts relating to the Sale of Food; and with recommendation I cordially agree.

In this connection, it is convenient to review briefly the Law of Food Supply.

It is a Misdemeanour at Common Law to sell food or drink with the knowledge that it is dangerous or unfit for human consumption. In addition to the liability to criminal proceedings there was always, and there still is, the liability to civil proceedings. It was held in 1894 by Lord Justice Mathew that there is...
an implied warranty at Common Law on a sale of provisions by a dealer that they are fit for human consumption. There appears to be no doubt that either at Common Law or under the Sale of Goods Act 1893 — an Act to which public attention ought to be drawn — a person who has suffered from eating wholesome food can recover (on an implied warranty that it was fit for human consumption) from the person who sold it.

Milk supply is regulated by Statute, by Regulations issued by the Board of Agriculture and by the Local Government Board under statutory authority and by Byelaws made locally. Reference is only made to the more important Statutes and Regulations.

1. The Public Health Act 1875. Sect. 116 et seq.
2. The Infections Diseases (Prevention) Act 1890.
3. The Sale of Food and Drugs Acts 1875, 1879, 1899.
5. The Regulations for the Sale of Milk issued by the Board of Agriculture under the Sale...
6) Model Regulations with respect to Dairies, Cowsheds and Milkshops issued in 1899 by the Local Government Board to all Urban and Rural Sanitary Authorities.

The more important enactments are briefly summarised:

1. Diseased or unsound or unwholesome milk or milk unfit for the food of man, exposed for sale or deposited in any place for the purpose of sale, or of preparation for sale and intended for the food of man, may be seized by the Medical Officer of Health or Inspector of Nuisances and carried away to be dealt with by a justice. Actual seizure is unnecessary if the Public Health Act Amendment Act 1890 has been adopted.

2. Adulterated milk, i.e. milk to which water has been added or from which fat has been abstracted is dealt with under the Sale of Food and Drugs Acts. Inter alia, the Act of 1899 requires that every tin or other receptacle containing condensed, or separated or skimmed milk must be clearly labelled. The same Act enacts that a sample of milk may be taken in course
of delivery or of transit.

(3) If the Medical Officer of Health suspects any dairy anywhere of causing or being likely to cause infectious disease he may with an order from a Justice inspect the dairy and if accompanied by a Veterinary Surgeon inspect the Animals therein. The Local Authority may prohibit the supply of milk from the dairy until all danger of infection is removed.

(4) Regulations are in force for the registration of Dairymen, the construction of Dairies, Water-supply of Dairies, Sanitary State of Dairies, Contamination of Milk, Existence of Disease among Cattle.

The Royal Institute of Public Health appointed in 1904 under the Chairmanship of Sir Wm. R. Smith, a Committee to consider the best means of ensuring a clean milk supply.

In October 1906, the report was issued - and as the conclusions and recommendations contained in it would involve, if generally accepted and adopted, considerable legislation to remedy the present unsatisfactory condition of the public milk supply, I have briefly epitomised its most important parts.

The Committee gave full consideration
to all questions affecting the farm, to questions affecting the transit of milk and to questions affecting the distribution of milk.

It was proved to the satisfaction of the Committee that the milk supply of many large towns was frequently affected with Tubercle, i.e. contained Tubercle bacilli and also contained pus corpuscles, mucus, streptococci, staphylococci and blood corpuscles.

It was estimated that no less than fifty per cent of London dairymen habitually used preservatives to prevent early souring.

The suggestions and recommendations made by the Committee include:

(a) That the food for the cows be fresh and in a good state of preservation; without containing anything capable of communicating abnormal flavours to the milk or of causing the cows to scour.

(b) That the tails and hind quarters of the cows be clipped before the cattle are brought in for the winter.

(c) That the milk of recently calved cows be not used until three clear days have elapsed after parturition.

(d) That milk from diseased cows be not used.
(e) that, immediately after milking, the milk be passed through a metal sieve covered with a fine cloth and then passed over a refrigerator
(f) that all manure be removed from the cowsheds in the morning after milking; and in the afternoon at least one hour before milking
(g) that a systematic Veterinary examination of the cows be required
(h) that all cows showing symptoms of ill health be isolated
(i) that all milk vessels be used only for the reception of milk and that they be thoroughly cleansed and scalded after use.
(j) that milk be bottled at or near the farms and packed in cases for distribution.

The adoption of all these recommendations would really involve the Municipalisation of the Milk supply. It would be impossible to enforce them by any system of inspection. The price of new milk would certainly be raised and the higher cost would naturally press most heavily upon the poorer classes.

Farms on which many of the above recommendations have been adopted have been established and are able to realise profit but only by charging a higher price for the milk.
The greatest and most important source of milk contamination is the house of the consumer. Milk is stored in open vessels, in the warm kitchen, and is readily contaminated by dust and by means of flies. The law already provides against the supply of diseased and adulterated milk but no precautions, no regulations, no supervision can ensure against the consumption of milk in an impure state.

Some idea of the profit derived by dealers in adulterated milk and of the consequent loss to the public may be obtained from the estimate given by the Medical Officer of Health to the West Riding of Yorkshire in a report to the Sanitary Committee in 1903. A milk dealer selling 20 gallons of milk daily at 4d. a quart and watering or skimming the milk to the extent of 10 per cent would make nearly £50 per annum illicit profit by the sale of water.

As the visits of the inspector occur only at intervals, there is every inducement for a dishonest dealer to adulterate milk. In Sheffield with a population of 240,000 the public paid in 1892 more than £5,000 for coater supplied to them as milk.
Chemical Analysis of Milk.

It is needless to point out that the specific gravity of milk gives no indication of its purity. Abstraction of cream and the addition of water will produce the specific gravity of genuine milk.

Richness of milk may be approximately estimated by allowing it to stand for twelve hours. 1 part of cream is equivalent to 0.2 parts of fat. In average milk, 8—12 parts of cream are usually found.

(1) The Albuminates of milk consist of Casein and a small quantity of serum albumin—true albumin—sometimes termed Lactalbumin. The lactalbumin remains in solution after the casein has been precipitated.

(a) Casein, the chief nitrogenous constituent of milk, is not coagulated by heat but is readily coagulated by rennet or by acids. It exists in milk as Caseinogen, probably a combination of Casein with Calcium (or other) phosphate. The combination is destroyed by the addition of acid and in consequence the casein is precipitated.

The curd obtained from human milk is finer and more granular and therefore...
more digestible than the curd obtained from cow's milk. Herein lies one difficulty in adapting cow's milk as the food of infants. Two methods are in use to prevent the formation of a thick curd (1) By the addition of chemicals (such as Bicarbonate of Soda and Lime water) (2) By the addition of mucilaginous fluids which act mechanically (such as Barley water.) The result is not wholly satisfactory in either case.

(2) **Milk Fat** is very complex in composition. It consists of fatty acids in combination with Glycerol forming triglycerides. The fatty acids in milk are (1) The Soluble fatty acids - Butyric, Caproic, Caprylic and Capric (2) The insoluble fatty acids - Myristic, Palmitic, Stearic and Oleic.

3. The **Carbohydrate of Milk is Lactose** or Milk sugar, \( C_{12} H_{22} O_{11} + H_2O \). It is an isomer of cane sugar peculiar to the milk of the mammalia. Lactose has only a small degree of sweetness. It is converted by dilute acid into Galactose and Lactoglucone. It reduces Fehling's solution and is decomposed
by fermentation into Lactic Acid (CH₃.CH.OH.COOH)

(4) The Mineral matter in Milk i.e. the Ash obtained by the careful ignition of the solids left after the evaporation to dryness of a quantity of milk has the following percentage composition.

<table>
<thead>
<tr>
<th></th>
<th>K₂O</th>
<th>24.0</th>
<th>P₂O₅</th>
<th>26.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na₂O</td>
<td></td>
<td>8.2</td>
<td>Cl.</td>
<td>13.9</td>
</tr>
<tr>
<td>CaO</td>
<td>22.4</td>
<td></td>
<td>SO₃</td>
<td>2.5</td>
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<tr>
<td>MgO</td>
<td>2.6</td>
<td></td>
<td>FeO</td>
<td>Trace</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>99.9</td>
</tr>
</tbody>
</table>

(5) Free Citric Acid is also a constant constituent of milk—about 0.5 gram to a litre of human milk and about 1.5 grams to a litre of cows milk.

(6) According to the conventional grouping of acids and bases the Salts of milk are the Chlorides of Potassium and Sodium, the Phosphates of Calcium, Magnesium, and Potassium with traces of the Sulphates of these metals.
When milk is allowed to stand for some time, a separation of fat takes place known as the rising of the cream. If allowed to stand a while longer, milk undergoes fermentative changes due to the activity of various Micro-organisms. Chief among these is the Bacillus Acidilactici. Under its influence, the milk sugar is decomposed. Lactic Acid is formed. The milk becomes sour and curdles.

The chemical change is represented by the equation:

\[(C_{12}H_{22}O_{11} + H_2O) \rightarrow 4(CH_3.CH.OH.COOH)\]

Lactose \hspace{1cm} Lactic Acid

Like most fermentative changes, it is a process of Hydrolysis.

It is to the significance of the formation of Lactic Acid and to the conditions under which it is produced that I first directed my attention.

The Acidity of milk is the best and most facile guide for determining the freshness of milk and its suitability for human food.
Newly drawn milk is said to be amphoteric in reaction; but the reaction of every milk tested by me was distinctly acid, though milk was brought directly from the dairy and tested within fifteen minutes of milking. The least acidity recorded by me was equivalent to 1 cc. $\frac{3}{10}$ NaOH in 5 cc. corresponding to 0.18 per cent Lactic Acid.

[Decinormal Caustic Soda is a solution of 4 grams in 1 litre and therefore 1 cc. of such solution is equivalent to 0.004 grams NaOH. The molecular weight of Lactic Acid (CH$_3$.CHOH.COOH) is 90. Therefore 1 cc. NaOH $\frac{3}{10}$ per 5 cc of milk is equivalent to 0.18 per cent lactic acid.]

When the lactic acid formation amounted to 0.4 per cent, the milk is distinctly sour to the taste.

If the acidity amount to 0.6 per cent the milk coagulates owing to the spontaneous separation into a firm solid mass known as the "curd" which consists of the fatty and proteid constituents of milk, and a clear liquid known as "Whey" which consists essentially of a solution
of milk sugar and mineral salts.

The further changes which take place in the composition of milk after curdling, depend upon the nature of the Bacteria which have gained access to it. Different organisms produce different fermentations.

My experiments were divided into two series. The first series were carried out in the summer between the months of May and September, and the second series in the winter between the months of October and March.

The experimental milk was kept in open bottles at room temperature. The conditions of everyday life were imitated as far as possible. The apparent inconsistency of the observations is therefore explained. The milk was tested at my own house and in a Liverpool Hospital Laboratory.

An initial difficulty had to be overcome. The Home or discard results differed very considerably from the Hospital or Liverpool results. The Home experiments gave a considerably higher acidity than the Hospital experiments. And when "Home" milk was brought to "Hospital" and tested
and "Hospital" milk taken "home" and tested similar discrepancies were recorded.

The milk was diluted with tap water twentyfold before testing. The discrepancies were explained by the fact that Liverpool water was neutral in reaction while discard water was distinctly acid — the average acidity of discard water was equivalent to \( \frac{1}{27} \text{cc} \) of \( \text{NaOH} \) per 100 cc. of water. With this correction, the estimations were in agreement.

Incidentally, it was found that lead was in solution both in Liverpool and discard waters. Liverpool water is obtained from Lake Vyrnwy, an upland surface peaty water, discard water is obtained from wells sunk in a Jurassic sandstone near a tidal estuary. The natural acidity explains the plumbosolvency of the Liverpool water, while excess of chlorides explains the solution of lead in discard.

The acidity of milk was estimated by titrating 5 c.c. of milk diluted with 95 c.c. of tap water against a decinormal solution of Soda Hydrate.
Phenolphthalein was used as an indicator. A standard tint was adopted and all titrations made to correspond with it.

The milk for the first or "Summer" series of experiments was always obtained from the same dairy at the same time and was tested about ten hours after milking. The milk for the second or "Winter" series was obtained from various dairies. It was examined at about the same hour. The greater variations in recorded acidity are probably due to the varying periods which elapsed between the times of milking and testing.

The first experiments in the two series were directed to determine the acidity of New Milk as delivered to the Consumer.

[5 c.c. of milk were diluted to 100 c.c. by means of tap water and titrated against decinormal Sodic Hydrate; Phenolphthalein being the indicator.]

The results of the examination of 179 samples are given in the following table [Table 6.1] and shown graphically in Chart 3.
<table>
<thead>
<tr>
<th>Number of Samples</th>
<th>66</th>
<th>53</th>
<th>60</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Extremes</td>
<td>Averages</td>
<td></td>
</tr>
<tr>
<td>First day</td>
<td>1.4 - 1.7</td>
<td>1.55</td>
<td>1.32</td>
</tr>
<tr>
<td>Second day</td>
<td>1.6 - 1.8</td>
<td>1.68</td>
<td>1.74</td>
</tr>
<tr>
<td>Third day</td>
<td>1.5 - 2.4</td>
<td>2.04</td>
<td>1.89</td>
</tr>
<tr>
<td>Fourth day</td>
<td>1.6 - 5.5</td>
<td>3.91</td>
<td>3.32</td>
</tr>
<tr>
<td>Seventh day</td>
<td>7.8 - 10.5</td>
<td>9.26</td>
<td>4.34</td>
</tr>
</tbody>
</table>

Table 6

Acidity of Fresh Milk
Chart No. 3.
To illustrate Table No. 6. (Acidity of Milk.)
It is seen that the acidity of milk increases day by day steadily and progressively. In many cases however it was noted that the acidity was less on the second day than on the first day. Less often it was less on the third day than on the second. A similar arrest of action is observed in many other bacterial fermentations.

I did not consider it necessary to determine the continuous effect of varying temperatures upon the production of lactic acid but two series of experiments were undertaken to determine how acid production was affected by maintaining raw milk for different times at a temperature approximating to blood temperature.

In the first series milk was maintained at a temperature of 30°C for half an hour and in the second series at a temperature of 30°C for three hours.

The amount of acid production in both series was greater than that in milk not heated. For this reason it is obviously of importance that milk should be rapidly cooled and maintained at a low temperature. The influence of temperature is also shown
By the differences in acidity on the first and subsequent days of the samples of milk examined during the prevalence of warm weather and of the samples examined during the winter.

It will be noticed that in the first series, a marked fall of acidity was noticed in one sample on the fourth day. The experiment was recorded but the probability is that by an error in transcription 1.2 was written instead of 2.2 or 3.2. (Table 7, Chart 4.)

The addition of small quantities of antiseptics was also found to influence acid production.

Experiments were made with hydrogen peroxide added to (1) fresh milk, (2) fresh milk raised to a temperature of 30°C for half an hour and (3) fresh milk raised to an equal temperature for three hours and (3) with formalin added to fresh milk heated for three hours at a temperature of 30°C and (4) with Bactic acid.

The results of the experiments are summarised in Tables 8, 9 and 10.
<table>
<thead>
<tr>
<th></th>
<th>Milk warmed 63.0°C for 15 minutes</th>
<th>Milk warmed 63.0°C for 3 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>69 samples</td>
<td>68 samples</td>
</tr>
<tr>
<td></td>
<td>Extremes</td>
<td>Average</td>
</tr>
<tr>
<td>First day</td>
<td>1.4 - 1.7</td>
<td>1.55</td>
</tr>
<tr>
<td>Second day</td>
<td>1.5 - 2.4</td>
<td>1.80</td>
</tr>
<tr>
<td>Third day</td>
<td>1.7 - 10.6</td>
<td>2.90</td>
</tr>
<tr>
<td>Fourth day</td>
<td>1.2 - 11.8</td>
<td>5.50</td>
</tr>
<tr>
<td>Seventh day</td>
<td>8.4 - 11.5</td>
<td>9.90</td>
</tr>
</tbody>
</table>

**Table 7.**

Acidity of Fresh Milk, maintained for varying times at 30°C.
Chart 4. To illustrate the effect of temperature on the development of acidity
Table 8.

Acidity of milk to which 0.1 per cent of Hydrogen peroxide was added.

<table>
<thead>
<tr>
<th></th>
<th>Unheated 46 Batches</th>
<th>Heated 30°C 1/2 hr. 76 Samples</th>
<th>Heated for 3 hours 68 Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Extremes   Average</td>
<td>Extremes   Average</td>
<td>Extremes   Average</td>
</tr>
<tr>
<td>1st Day</td>
<td>1.4-1.7  1.55</td>
<td>1.4-1.7  1.55</td>
<td>1.4-1.7  1.55</td>
</tr>
<tr>
<td>2nd Day</td>
<td>1.4-1.6  1.54</td>
<td>1.3-1.8  1.65</td>
<td>1.3-1.2  1.70</td>
</tr>
<tr>
<td>3rd Day</td>
<td>1.5-1.9  1.67</td>
<td>1.4-2.1  1.74</td>
<td>1.5-2.5  2.00</td>
</tr>
<tr>
<td>4th Day</td>
<td>1.6-2.8  1.97</td>
<td>1.5-3.5  2.10</td>
<td>1.5-7.1  3.10</td>
</tr>
<tr>
<td>7th Day</td>
<td>5.5-8.7  7.60</td>
<td>1.7-10.5 7.10</td>
<td>3.1-10.5 6.90</td>
</tr>
</tbody>
</table>

Table 9.

Acidity of milk heated to 30°C containing 0.1 per cent of Formalin.

<table>
<thead>
<tr>
<th></th>
<th>Extremes</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>68 Samples</td>
<td></td>
<td></td>
</tr>
<tr>
<td>First Day</td>
<td>1.4-1.7</td>
<td>1.55</td>
</tr>
<tr>
<td>Second Day</td>
<td>1.6-2.8</td>
<td>2.00</td>
</tr>
<tr>
<td>Third Day</td>
<td>1.6-3.5</td>
<td>2.20</td>
</tr>
<tr>
<td>Fourth Day</td>
<td>1.6-3.3</td>
<td>2.40</td>
</tr>
<tr>
<td>Seventh Day</td>
<td>1.5-3.7</td>
<td>2.60</td>
</tr>
</tbody>
</table>
Chart 5.

To illustrate Tables 8 & 9. Effects of preservatives on Acidity.

<table>
<thead>
<tr>
<th>1.0</th>
<th>1st Day</th>
<th>2nd Day</th>
<th>3rd Day</th>
<th>4th Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note the resemblance in form between the upper curve and the curve of unheated untreated milk.
<table>
<thead>
<tr>
<th></th>
<th>Liverpool</th>
<th>Liscard</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>New Milk</td>
<td>Milk + Bic Acid</td>
</tr>
<tr>
<td>First Day</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Second Day</td>
<td>1.32</td>
<td>0.97</td>
</tr>
<tr>
<td>Third Day</td>
<td>1.43</td>
<td>1.17</td>
</tr>
<tr>
<td>Fourth Day</td>
<td>2.51</td>
<td>1.49</td>
</tr>
</tbody>
</table>

Table 10.
To show the influence of the addition of Bic Acid on Acid Production.
Chart 6.

To illustrate the effect of Boric Acid on Acid Production.

The parallelism between the Liverpool and hiscarcd curves is to be noted. The hiscarcd curve however shows distinctly a loss of acidity on the third day. (See text.)
The acidity of milk is not affected by the addition either of hydrogen peroxide or of formaldehyde. In the milk to which hydrogen peroxide was added, acid formation is slower than in untreated milk. The taste of the milk is unaffected. After standing twenty-four hours such milk appears to be richer, containing a larger volume of cream than other milk; probably, the separation of the cream is more complete. The presence of hydrogen peroxide was demonstrable in some samples as long as five days after its addition.

The addition of formalin did not affect either the taste or acidity of milk. Formalin proved itself a much more effective preservative than hydrogen peroxide. Its presence could always be demonstrated in milk to which it had been added even after such milk was boiled.

Behring and other chemists have investigated the action of formaldehyde and of hydrogen dioxide on milk. The results of their observations may be thus summarised:

1. Formaldehyde solution so changes the milk that it no longer reacts with the rennet ferment— the larger the quantity of formaldehyde added
and the longer the time before testing, the more noticeable the change.

1. Formaldehyde inhibits—even when present in very small quantities—the proteolytic action of pepsin and of pancreatin

2. The addition of 1 part of 40 percent formaldehyde solution to 5,000—10,000 parts milk suffices to preserve the milk from 6 to 12 days. Even in milk so preserved the organisms of putrefaction are not always destroyed.

3. Hydrogen Dioxide in the proportion of 1—3 per cent preserves milk from becoming sour for from 3 to 6 days. It does not affect the rennet reaction nor does it inhibit proteolysis.

From these experiments, and from my own, I conclude that the addition of either hydrogen dioxide or of formalin to milk as a preservative can be justified.

Boric acid in small quantity delayed the formation of lactic acid, but unless added in excessive quantity did not prevent putrefactive changes.

Milk to which Bicarbonate of Sodium was added rapidly became sour, and milk
Made faintly alkaline with Ammonium Hydrate rapidly became acid and curdled.

Sterilised Milk. I examined a large number of samples of sterilised milk obtained from the milk depots of the Liverpool Corporation and I also sterilised myself a number of samples of milk and tested them at intervals.

The milk was sterilised by heating in an Autoclave at a temperature of 204° - 211°F for half an hour.

The number of samples of Corporation sterilised milk examined was 36, and the bottles had been kept over an average period of 53 days. The average acidity on opening the bottles was found to be 1.9 (as against 1.55 the acidity of ordinary fresh milk) and corresponding to the acidity of the second or third day of ordinary unsterilised milk. Although some of the milk had been diluted with water so as to render it suitable for very young infants, the acidity (after allowing for dilution) of all the samples was approximately the same.

I found the acidity of milk to be unchanged by sterilisation, and I therefore came to the conclusion
that the milk used for sterilisation at the Corporation Depôts was between 18 and 24 hours old at the time of sterilisation.

None of the samples examined were absolutely sterile. The milk usually curdled very soon after the bottles were opened or else became offensive. Milk in unopened bottles placed in the incubator at 37°C and kept there for two or three days curdled in the majority of cases.

The number of samples of milk sterilised and examined by me was 58. The average acidity at the time of sterilisation was 1.17. Twenty-four hours after opening the acidity was 1.20. In forty-eight hours it amounted to 1.31 and in seventy-two hours to 1.34. After that time the majority of the samples were offensive.

**Table II. Acidity of sterilised milk**

<table>
<thead>
<tr>
<th>58 Samples</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial</td>
<td>1.17</td>
</tr>
<tr>
<td>2nd day</td>
<td>1.20</td>
</tr>
<tr>
<td>3rd day</td>
<td>1.31</td>
</tr>
<tr>
<td>4th day</td>
<td>1.34</td>
</tr>
</tbody>
</table>

(See Chart 7, p. 47).
It is obvious therefore that sterilised milk should be consumed within a short time of the opening of the bottle. Owing to the non-formation of lactic acid, the danger signal of sourness is not available. Puerperal changes occur early and may render the milk poisonous.

Various other methods of preserving milk have been suggested such as aeration under great pressure but their cost and difficulty of general application render them unsatisfactory and they may be all regarded as unpracticable.

*Chart 7.* (To illustrate the prevention of acid formation by sterilisation)

(Note that the scale is greatly exaggerated compared with that used in previous charts)
The bacteriology of milk has been exhaustively studied both from a scientific and from a commercial point of view. Milk is an ideal nutritive medium for it contains all the substances for bacterial life and growth and the slight acid reaction is also favourable.

It has been asserted that newly drawn milk, like blood, possesses bactericidal properties and that it is possible to obtain from the udder of the cow perfectly sterile milk. Under ordinary circumstances however cow's milk contains an enormous number of bacteria of different species.

Cow's milk may be and generally is polluted
(1) At the time of milking or during manipulation at the dairy
(2) During transit
(3) At the Milk Shop
(4) In the Home of the Consumer.

The Report of the Medical Officer of Health Liverpool 1905 states that between August 1896 and December 1905, 4,167 samples of milk were examined bacteriologically for
Bacillus Tuberculosis which was found in 186 cases.
Out of 1753 Town Samples the bacillus was present in 30 equivalent to 1.7 percent.
Out of 2404 Railway Samples (i.e. Milk brought from a distance) the bacillus was present in 156 equivalent to 6.5 percent.
Out of the total of 4167, the bacillus was present in 186 equivalent to 4.5 percent.

**Table 12.**

**Bacteriological Examinations of Milk**

**City of Liverpool 1905.**

<table>
<thead>
<tr>
<th>Source of Milk</th>
<th>No. of Samples</th>
<th>Bacillus Tuberculosis</th>
<th>B. Eubacterioides Sporogenes</th>
<th>Bacillus Coli Communis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Railway</td>
<td>348</td>
<td>12</td>
<td>16</td>
<td>168</td>
</tr>
<tr>
<td>Town</td>
<td>212</td>
<td>1</td>
<td>2</td>
<td>35</td>
</tr>
<tr>
<td>Total</td>
<td>560</td>
<td>14</td>
<td>12</td>
<td>203</td>
</tr>
</tbody>
</table>

The first milk which flows from the udder in the process of milking the Foremilk is always rich in bacterial life because it has been retained in the Milk ducts since the last milking. It not only forms a suitable nidus but also an efficient incubator for bacteria which gain entrance through the imperfectly
closed teats of the udder. The bacteria may pass
even into the udder and thus cause inflammation
"Mastitis." The bacteria found in foremilk
nearly all belong to the group which cause
Lactic Acid fermentation by decomposing the
milk sugar. The bacteria may be so numerous
as to alter materially the composition of
milk. It is essential therefore that milk
drawn for Pasteurisation should not contain
foremilk.
Disease producing bacteria are only very rarely
found in the Foremilk.

The number of bacteria in milk
depends chiefly however upon the Age of the
milk and the temperature at which it has
been kept. As a result of a number of
experiments the optimum temperature was
found to be 77°F or 25°C. After being
kept at that temperature for 24 hours, the
milk contains the maximum number of
bacteria - a temporary decline is then to
be noticed owing to the inhibitory action
of the bacterial products and the lessened
amount of suitable palatable. Chemically
examined as has been noted before, the
milk shows also a temporary diminution
in acidity.

The influence of temperature is so paramount upon the number of bacteria that it has been truly said "that the keeping of milk is more a matter of temperature than of cleanliness. Milk preserved at a low temperature will keep sweet for a long time but it eventually becomes filled with bacteria of a more unwholesome type than those which grow at a high temperature. The influence of time and temperature on the number of bacteria is shown by the following table.

Table: Number of Bacteria per 1 c.c. of milk at 50° F and 70° F.

<table>
<thead>
<tr>
<th>Number of bacteria at Outlet, 46,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temp</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Number of bacteria</td>
</tr>
</tbody>
</table>

Without any standard nor any uniformity in the numerical estimation of bacteria in milk has been adopted but it has been suggested that 50,000 Microorganisms per cubic centimetre should be regarded as a maximum limit for milk intended for human consumption.

Pathogenic
organisms require a higher temperature for growth than ordinary fermentative bacteria and toxicity of milk is increased by its being kept at a high temperature, and it is also increased with length of keeping.

From the methods by which bacteria are introduced into milk, it is natural to expect to find species belonging to the following four groups.

1. Ordinary bacteria of air, soil and water
2. Bacteria of sewage or of intestinal origin
3. Fermentative bacteria
4. Pathogenic Bacteria

The bacteria of sewage and of intestinal origin are principally the Bacterium Coli Commune and the Bacillus Enteritidis Sporogenes.

The fermentative bacteria chiefly belong to the Lactic Acid group. They probably gain access to the milk from the air of the byre or dairy and possibly from the soil. Other fermentations which occur are (1) The Butyric acid fermentation - involving the decomposition of lactic acid. The Bacillus butyricus is found in water, soil and dust. It is a facultative anaerobe.

(2) Coagulation fermentations without acid production e.g.
The recent fermentation of milk and the production of Casease. (3) Alcoholic fermentation of milk, e.g. the Koumiss and Kephir fermentations. After lactic acid fermentation has taken place a vinous fermentation due to the presence of yeasts takes place.

Of more importance are the disease-producing organisms found in milk - e.g. the bacteria associated with Tuberculosis, Scarlet Fever, Enteric Fever, Cholera, Diphtheria, Sore Throat and Epidemic Diarrhoea.

(1) Tuberculosis.

The identity of the bacillus of human and of bovine tuberculosis is accepted by the Royal Commission on Tuberculosis and it is also held that tuberculosis may be transmitted to the human subject by means of tuberculous milk. Although a very proportion of milk cows in this country are affected with tuberculosis it would appear that the milk of tuberculous cows is only infective if there be tubercular disease of the udder. Milk from such cows shall not be used for human food. The udder is infected in about two per cent of milk cows. The proportion is lower in cows than in the
country — the statistics for Liverpool have already been quoted.

(2) Enteric Fever.

The transmission of Enteric Fever by means of milk is really due indirectly to contaminated water used to wash the milk vessels or added to milk. Direct infection of milk is very rare. Two cases however in my own experience are worth recording. In the first the milk was infected during its journey to the cellar in which it was stored being flooded by sewage while the drains were being flushed. Two children drank some of the milk and both contracted Enteric Fever. In the second case, milk supplied to a patient suffering from Enteric Fever was swallowed by another patient who contracted Enteric Fever.

(3) Diphtheria.

Diphtheria has been transmitted through milk accidentally infected. Only four cases (Newman) of the actual detection of the Bacillus diphtheriae in ordinary milk are recorded. Certain outbreaks of diphtheria suggested that the cow itself might suffer from diphtheria. Much experimental work was done by Klein who claimed to have demonstrated in the milk of cows inoculated with Bacillus diphtheriae.
The specific bacillus. A specific eruption was produced on the udder of the cow. The evidence is not however conclusive. The probability is in favour of the human infection of milk rather than the bovine infection.

(4) Scarlet Fever.

Since 1882, numerous epidemics of Scarlet fever have been attributed to the milk supply. The Hendon outbreak of 1885 was investigated by Mr. W. H. Power, who concluded that a certain condition of certain milch cows which had for its outward manifestation an eruption on the teats and udders communicable from cow to cow was responsible for the outbreak.

(5) Thrush

The mould Oidium albicans the cause of thrush frequently occurs in milk.

(6) The throat

Outbreaks of sore throat have frequently been ascribed to milk. Some of the milk was obtained from a cow suffering from mastitis. In other cases the milk is supposed to have been infected by milk maids who were suffering from sore throat. Possibly some of the outbreaks may have been mild Scarlet fever.
(7) Diarrhoea

Since 1892, numerous outbreaks of diarrhoea have been traced to contaminated milk. Two organisms have been isolated from such milk: (a) the Bacillus Enteritidis Ferrogenes and (b) the Bacillus Coli Communis. It is probable that the bacilli are conveyed by dried faecal pollutions transmitted through air or carried by flies. Into the aetiology of Infantile diarrhoea it is not possible to enter here. But it may be pointed out that the prevalence of Summer diarrhoea is contemporaneous with the period during which the house flies are most active and most numerous.
Summary and Conclusions:

It has been shown

(1) That disease may be produced in man by the consumption of newly drawn milk, obtained from an apparently healthy cow.

(2) That certain diseases from which milk-cows suffer are transmissible to man (or cause disease in man) through the ingestion of milk.

(3) That milk may be contaminated at the dairy, during transit, and during storage so that its consumption causes disease.

(4) That the usual fermentative changes which occur in milk (which are protective to the consumer) may either be arrested or disguised by the addition of "preservatives" which (though they may "inhibit") do not prevent other changes occurring which may render the ingestion of the milk deleterious to health.

(5) That "stale" milk is capable of producing disease.

(6) That newly drawn milk is almost invariably but faintly acid in reaction.

(7) That the "age" of normal milk may
be determined by its acidity. The
"age" of milk not only depends upon
the period which has elapsed since
milking but also on conditions of
storage—temperature being of supreme
importance.

(8) That injury to health varies with
the age of the milk. Newly drawn milk
rarely affects health.

(9) That the best test of the suitability
of milk for human consumption is the
degree of acidity. It is easy of applica-
ion and might therefore be used with
advantage at the time samples are
taken for analysis.

Acidity exceeding 0.18 per cent lactic acid
is evidence that the sample is fresh.
Acidity not exceeding 0.27 per cent
lactic acid indicates that the milk
had been drawn about 12 hours.
If the acidity do not exceed 0.36
per cent lactic acid, the milk may
be used but a greater acidity
ought to involve the rejection of the
milk.

(10) That the use of "sterilised" milk is
becoming more general, more especially for the feeding of babies and young children. An opinion is prevalent that the process of sterilisation renders the use of milk which would otherwise be rejected safe and unobjectionable. It cannot be too emphatically stated that the same care and precautions ought to be taken in the dairy and during storage in the case of milk used for sterilisation as in the case of milk used without sterilisation. Even if the nutritive value of milk be not altered, even if the sterilisation be complete, only freshly drawn milk sterilised forthwith ought to be permitted to be sold as “Sterilised milk.” The only means of determining whether such milk was used is by testing the acidity of “Milk sold as “sterilised.”

(11) That injury to health from “diseased” milk is comparatively rare, that most recorded cases of illness ascribed to milk were due to “stale” milk or to contaminated milk. The importance of determining the acidity of milk.
is thus further shown.

(12) that (in conclusion) the use of
preservatives in milk being made illegal,
sterilisation of milk not affecting its
initial acidity, the only test capable
of being applied in the household as to
the suitability of milk for human
consumption is the test I advocate:
namely the determination of acidity.