

PASTEURISATION

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PREFACE TO THE SECOND EDITION

FOUR years have elapsed since this volume first appeared, and that period has witnessed a steady development in the pasteurisation of milk and in other forms of heat treatment. That these processes are likely to become more important to the life of the community in the near future is evidenced by the powers already conferred upon the Minister of Food regarding heat-treatment and by the proposals now put forward for this process to become compulsory for all milk other than that produced from tuberculin-tested cows. These powers should certainly become operative at an early date in order to give full protection to the milk-consuming public.

No apology is made for the stress which has been laid upon the need for efficiency, particularly with regard to the high-temperature, short-time process which, in this volume, has received the increased consideration to which it is entitled. In some quarters, too much inefficient treatment has provided a basis for doubts regarding the advantages to be derived from the process. No purveyor of food can afford to produce an article regarding which doubts may arise and for this reason it is hoped that both plant operators and supervisory officials will derive some useful information from the succeeding pages which will assist in the production of an article that is above suspicion. If this result is achieved and a better understanding regarding the technique of milk processing ensues, the author will feel amply repaid.

H. H.

May, 1947.

PREFACE

FOR many years, all suggestions that milk should receive any form of heat treatment have been strenuously denounced by otherwise well-informed persons. Pasteurisation in particular has borne the brunt of considerable criticism which has not detracted in the slightest from its usefulness as a means of guaranteeing the safety of the country's milk supplies. All food-stuffs should, of necessity, be free from disease-producing organisms, milk being no exception in this respect, and it is only by the application of efficient methods of treatment that safety can be guaranteed.

All methods of pasteurisation carried out in this country are not satisfactory, and this lack of efficiency has provided the critics with their most weighty arguments against the process. No one can deny, least of all those whose criticism is so widely advertised, that the process will, if properly understood and efficiently carried out, guarantee a safe article for human consumption, which is a factor of paramount importance.

The author's aim has been to answer all critical statements by emphasising the need for efficient pasteurisation of all milk for the general well-being of the community at large, and in this he hopes that he has succeeded. A thorough understanding of the methods employed is vitally necessary not only for the public health administrator but also for the plant operator, and detailed attention has been given to these matters. The essentials of efficient operation and control of processing plants must, of course, be thoroughly understood. These have received special emphasis. This volume attempts to place before all interested parties the necessity for processing, the methods necessary to ensure that all milk is rendered safe, and the control measures required to attain this desirable state of affairs. If this end can be achieved generally and the public supplied with a safe, guaranteed milk, to their general benefit, then the author will feel that his efforts have been amply repaid.

HARRY HILL.

TOWN HALL,
PALMER'S GREEN, N. 13.
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PASTEURISATION

CHAPTER I

INTRODUCTORY

THE public health problems connected with milk supply and particularly with regard to supplies for large centres of population, have become matters of fundamental importance and continue to engage the serious attention of public health authorities in every civilised country. Public opinion is beginning to object to any lack of hygienic precautions in the distribution of milk intended for human consumption and is demanding that its quality should be constantly improved. In other words, the consumer is rapidly becoming aware of the fact that milk should be rich in nutritive constituents and, in addition, should be free from any organisms which may be harmful to health.

The laboratory worker has demonstrated that milk is frequently the responsible agent for the transmission of infectious diseases, and it is generally known that typhoid and paratyphoid fevers, diphtheria, scarlet fever, tuberculosis and undulant fever, together with other less common infectious diseases and human ailments, are easily propagated by means of milk.

There are innumerable ways in which the liquid may become contaminated and unsafe from the hygienic standpoint. Probably the chief of these is the fact that milk is normally handled many times between the time of its production and its delivery to the consumer. Further, there is difficulty in ensuring that each separate handling is carried out with all the precautions prescribed by modern hygienic requirements, while it must be remembered that any single operation, if improperly executed, may completely nullify the effect of others.

Milk, as the medical profession has repeatedly pointed out to the public, is a good and indispensable food, which is used daily by the majority of families to whom, when produced and distributed under hygienic conditions, it brings health and strength. Unfortunately, if such requirements are not observed, it may be the cause of disease and death. It is the staple food of old people and invalids; it brings vitality to children and should consequently

contribute to the sound development of future healthy generations. Again unfortunately, it may be the means of destroying children's health, thereby depriving society of factors which are most essential to its progress, and the public have been left to learn by bitter experience of disease and epidemics that raw milk, as produced at the present time, may be unsafe for their consumption. The vital importance of milk is leading public opinion to insist on the adoption of suitable control measures by the licensing authorities concerned, and it is the duty of such bodies to allay any doubts regarding the efficacy of our public health system by providing them with a clean and safe milk supply. It is extremely humiliating to realise that members of the United States Army when in this country were forbidden to drink milk unless supplied from tubercle-free herds *and* pasteurised in addition. Milk in its natural state was regarded by the United States authorities as highly dangerous to health.

At the present time, it is impossible to guarantee the safety of milk as produced. One result has been to cause the responsible authorities to strive by every possible means to obtain a product for human consumption as safe as humanly possible. This endeavour has resulted in a spate of legislation in order that the liquid should correspond more closely with scientific discovery and satisfy the essential requirements of public health. As a result, continued progress has been achieved in the production of milks treated by heat to give them added safety, the process generally adopted for this purpose being pasteurisation. It must be apparent that pasteurisation has come to stay whether one agrees with such treatment or not. Particularly is this so when one considers the powers vested in the Minister of Food under Regulation 55G of the Defence (General) Regulations, 1939 to make Orders specifying the grades of milk which may be sold in any particular district, pasteurised milk being one of these.

Louis Pasteur, the great French scientist, first explained the benefits to be derived from the application of heat to certain foodstuffs, although he was not primarily responsible for demonstrating the value of such methods. That distinction falls to an Italian biologist, Lazzaro Spallanzani, who, in 1768, conserved food by means of heat. The employment of this method of food preservation was also investigated by the Swedish chemist, Carl

Wilhelm Scheele in 1782, while in 1795, Nicholas Appert, the inventor of canning, applied his process to milk, this contribution to scientific knowledge resulting in the award of 12,000 francs by Napoleon.

Although these scientists forestalled Pasteur in the application of heat as a means of food preservation, it is to him that posterity owes the present process of pasteurisation. Pasteur was interested in the organisms present in milk; during the early part of his career he paid considerable attention to the problem of bacterial growth in that liquid. Between 1857 and 1862, he proved that milk became sour owing to the multiplication of organisms which he believed obtained entrance from the atmosphere. He demonstrated that heating milk would destroy many of the organisms present and thus postpone souring, and his report on this subject was presented before the Scientific Society at Lille in August, 1857.

Between the years 1860 and 1864, Pasteur was also engaged in investigating the causes of wine spoilage and he demonstrated that a temperature of between 122° to 140° F., when applied for a few minutes, would preserve the product from abnormal fermentations and souring. During the period when he was undertaking his research work on milk, a milk product, preserved by heat, was placed on the market in America. In 1856, Gail Borden obtained patent rights for a method of concentrating milk under a vacuum, his work following on the lines of research undertaken by Pasteur.

In spite of the discoveries of Pasteur and Borden, twenty years elapsed before the value of heat as a means of safeguarding the milk supply was realised. The first commercial pasteuriser was manufactured in Germany during 1880 by Ashborn, of Hildesheim, while about the same time, Fresca, of Berlin, produced a similar plant. A few years later, a Danish pasteuriser appeared and, by 1885, milk was regularly pasteurised in Copenhagen and Stockholm, not primarily for public health reasons but from a commercial viewpoint.

In 1886, the German chemist, Franz von Soxhlet, advanced matters a step further by advocating the sterilisation of all milk used for infant feeding. He stated that infants fed on such milk possessed a greater chance of survival and, far in advance of his time, he invented a method of sterilising milk in bottles, which

he patented. His methods were investigated by Caillé and Jacobi in New York during the years 1888-89, and they urged that similar methods should be employed in America.

Pasteurisation, in its early stages, was prompted by commercial considerations and a number of different types of apparatus were devised with a view to maintaining the keeping qualities of large volumes of milk as cheaply as possible. The inventors aimed at reducing any spoilage likely to occur when supplies had to be transported from far afield, for it was obvious that there were considerable advantages to be derived from being able to lengthen the life of such milk. Volume of output, therefore, became much more important than efficiency, always provided the life of the milk was preserved, and "continuous-flow" apparatus was considered to be the most desirable type of plant. Public health research workers had, by now, turned their attention to milk and had discovered that organisms of animal diseases, such as tuberculosis, could be carried by the liquid to the detriment of the consumer. They also discovered that these organisms could be destroyed by the pasteurisation process, always provided that time and temperature were correct and that a given quantity of milk was treated at any one time. These investigators specified suitable temperatures and periods of heating, but their ideas were naturally unpopular with people supplying milk whose chief interest lay in the volume which could be handled as cheaply as possible, and the apparatus then manufactured was chiefly designed to attain that end.

The method of holding heated milk in tanks for a period of 30 minutes was first tried experimentally in 1895 by Monrad in Copenhagen, and as the results obtained were an improvement on the "Flash" method then universally employed, its adoption was suggested to all health authorities. Little success in these efforts was achieved, and it was not until 1907 that Dr. Charles E. North, in New York, installed the first large-scale low-temperature plant. This method of heat treatment rapidly developed in the United States of America, but it was not until 1922 that any official action to control milk treatment in this country was taken by the Minister of Health. In that year the term "pasteurisation" was given a definite legal meaning by the Milk and Dairies (Amendment) Act, while later, in the same year, the first Milk (Special Designations) Order became operative, to be rapidly

superseded in 1923 by another Order which remained in force until 1936.

During the years which have followed, public health pioneers had to struggle against prejudiced opponents of the process. Compared with other scientific developments, the pasteurisation process always appears to have offered ample material for controversy, so much so that the layman may well have given up hope of ascertaining the true position. For all practical purposes, however, the question may be taken as settled, by far the largest body of knowledgeable opinion being definitely in favour of the process, although it must be admitted there is a strong and vociferous minority who are against the application of any form of heat treatment to milk. Such criticism cannot be attributed entirely to vested interests or even to mere ignorance; if this were so, little notice need be taken of it. It seems that there is a body of unprejudiced, responsible people proclaiming in perfectly good faith that pasteurisation is undesirable for a variety of reasons and does more harm than good. Confusion has been caused by statements made by this body of otherwise well-meaning persons and these fallacies can only be dissipated by considering the objects which satisfactory processing must achieve.

Before doing so, it is necessary to outline briefly the methods by which milk may be treated by heat. These are as follows:—

(1) *Pasteurisation*. The most popular system of processing milk by heat, several methods being employed for this purpose, of which the high- and low-temperature processes and pasteurisation-in-bottle are the only ones legally recognised.

(2) *Stassanisation*. A Continental process as yet hardly out of the experimental stage, particularly in this country, and one which is another form of high-temperature, short-time treatment for which it claims to be an efficient substitute.

(3) *Sterilisation*. A process by which milk is heated sufficiently to destroy practically all bacteria which it may contain.

(4) *Homogenisation*. A certain proportion of milk is treated in this manner prior to pasteurisation and always before it is submitted to the sterilisation process. The aim of this treatment is to emulsify the fat globules so as to ensure an equal cream content throughout the liquid.

Whichever process is chosen, careful attention must be paid to the following points:—

- (a) How far is the process efficient in attaining its object?
- (b) Is the process detrimental to the food value of milk?
- (c) Does processing increase the retail price of the product?

An efficient pasteurisation process must satisfy three different requirements. Milk must be treated hygienically, it must be rendered safe for human consumption, and the nutritional value must not be impaired. It would seem, perhaps, that too much is expected of the process, but it must be emphasised that if up-to-date equipment, designed according to modern requirements and suitably installed and operated, is employed, these requirements can be adequately met.

Milk contains a large amount of protein in a colloidal state and is an extremely favourable liquid for bacterial development. In addition to acidifying organisms, it also contains proteolytic, peptonising and putrefying bacteria. Owing to the rapidity with which acidifying organisms develop under favourable circumstances, the action of the other bacteria in milk is somewhat curbed. If the acidifying organisms were entirely destroyed, those which remain would cause the milk to putrefy instead of sour. Such putrefaction is not unknown, particularly following a too speedy or excessive application of heat.

The ideal method of treatment is one which does not completely destroy the lactic-acid organisms but merely inhibits their growth and vitality, a sufficient number remaining in milk to prevent the liquid's putrefaction by the other bacteria present. This retardation of souring has probably caused critics of the system to state that pasteurisation is practised in order that the keeping quality of milk may be prolonged. This accusation might have been true in the early stages of development as already mentioned, but cannot be said to apply at the present time. Public health authorities are demanding that the consumer should be protected from *all* disease-producing organisms which may be present and this request has been ably answered by the more enlightened members of the distributive trade. The demand for safety is being insistently made by all persons interested in public welfare who refuse to be deterred by allegations that the nutritive value of milk is radically altered by the application of heat at pasteurising temperatures. Experiments have proved that the nutritive value of such milk is almost equal to that of the raw variety with the additional guarantee of safety.

Though the conditions regarded as indispensable to efficient pasteurisation can be satisfied, it does not mean that this is so in every case. Pasteurisation is primarily an industrial process

depending for its success upon the sound employment of special equipment and the constant recognition of certain well-defined rules. Equipment does exist which can definitely and satisfactorily fulfil all conditions expected of the process. Therefore, no technical difficulties prevent the attainment of this aim. The fact that every type of plant cannot fulfil these conditions is not in itself a logical ground for opposing its wider application.

Innumerable statements have been made for and against this method of treatment and the process will doubtless continue to evoke either serious criticism or lavish praise from all interested parties for some considerable time to come. It cannot be denied that a large quantity of milk produced in this country is treated by heat in various ways. Enquiries will show that opinions as to the merits or demerits of pasteurisation vary according to the individual whose views are sought. It is the present consensus of the highest medical opinion that such treatment, if efficiently carried out, provides a desirable and essential safeguard, applicable to milk at relatively small cost without materially affecting the food value of the product; therefore, if such opinion were sought, the answer would be that some form of heat treatment was essential to render milk safe. Indeed, at the Annual Meeting of the British Medical Association held in 1945, the following resolution was agreed to:

“That the council is instructed to insist that the Ministry of Health and the Ministry of Food shall secure legislation immediately requiring all milk for human consumption to be pasteurised.”

Public health authorities and also many members of the distributive trade would agree with the expressed opinion of the profession. When careful consideration is given to the public health viewpoint, it is amazing that while for the last eighty years the process of pasteurisation has been available for the purpose of rendering milk safe, it would appear that its general introduction has been awaiting the emergence of public opinion in its favour. It is essential that a definite lead should be given in order to forestall any public criticism regarding the failure of those responsible to protect milk consumers from disease or even worse.

A large number of milk producers and distributors, however, appear to be against either pasteurisation or any other form of

heat treatment, arguing that such processes are detrimental to the consumer's health, inasmuch as the food value of milk is impaired by heating, whatever temperature is employed. No doubt it is obvious to all concerned with the production of milk that, without some form of heat treatment, large quantities of milk now produced annually could not be sold, especially when consideration is given to the long distances which it may have to travel before reaching the consumer. In such instances, if pasteurisation in one of its various forms were not applied, large quantities of such milk would sour before delivery.

Everyone will agree that milk should always be produced in a pure, hygienic condition, but the solution of this problem is far from being achieved. Suggestions, plans and schemes for dealing with this matter are either in force or have been mooted, but one cannot pretend to ignore the difficulties experienced in obtaining milk which is safe when produced. However great the care taken, however scrupulous producers or distributors may be, there will always occur cases of involuntary negligence, accidents and defects of the human machine, which even the most stringent precautions at the point of production will never entirely eliminate. Pasteurisation is a practical process which does not "improve" milk but simply renders it safe. It must be remembered that the process should not be employed to provide an excuse for any failure to observe hygienic precautions at the source, nor for laxity on the part of producers, since unhygienic milk may, after treatment, become unfit for general distribution.

Differences of opinion as to the value of processing milk are always likely to be present in any community, but there is little doubt that pasteurisation has come to be recognised as a means of affording valuable assistance in securing a disease-free milk supply at least for some time to come. Therefore, in order to silence much of the criticism now voiced abroad, every person dealing with this process should have a sound knowledge of the principles and technique involved. In no other way can satisfaction be guaranteed or criticism nullified.

CHAPTER II

NECESSITY FOR PASTEURISATION

THE pasteurisation of milk has been practised for many years and there is little doubt that this method of processing is likely to become more widely demanded. As with all scientific discoveries, its advantages and disadvantages have been debated on innumerable occasions, often in an exceptionally heated manner. It must be admitted there is, without any doubt, considerable divergence of opinion even between the various sections of the milk industry. Although the process has received consistent ridicule in certain quarters, it must again be emphasised that its employment for the treatment of all raw milk supplies is essential and should be no longer delayed. This may appear to be a rather sweeping statement, and it is therefore necessary to consider the reasons why compulsion is so urgently and generally required.

In considering this process, there are two aspects to be borne in mind. These are the commercial *and* the public health points of view. The existence of such separate and not always reciprocal interests has somewhat confused the issue, but it should be definitely understood that the final desideratum is a *safe* milk supply for the entire milk-consuming population of this country.

Commercially, pasteurisation embodies the following conditions. Primarily, the price of the finished article should not be raised above the purchasing power of the poorest consumer. The cream-line must not be affected to any great extent, since milk possessing a deep cream-line is more favourably received by the majority of customers than is milk in which it is absent. Finally, the appearance and taste of the milk should not be altered. Consideration must also be given to the fact that an enormous quantity of milk is distributed in the large centres of population which must necessarily travel long distances before it reaches the consumer. In such circumstances some form of heat treatment is essential for its preservation. It is quite safe to say that pasteurisation has been the means of enabling quite a large proportion of the milk produced annually to reach the consumer in a saleable condition. In confirmation of this, Sir George Newman, when Chief Medical Officer of the Ministry of Health, stated :

"It is generally recognised that milk obtained from perfectly healthy cows, under the cleanest conditions, cooled immediately and distributed with the least possible handling and delay, is the best that can be procured. The difficulty in existing circumstances, however, of securing such ideal conditions for milk production inevitably restricts its supply. In a highly urbanised country such as England, transport and distribution complicate the problem of a satisfactory milk supply and in order that an adequate, safe, and cheap supply of milk should be readily available for every one, it is necessary to have to recourse to pasteurisation, which has already proved so valuable in the milk supply for cities in the United States of America."

All foodstuffs should be as fresh as possible when consumed but, owing to circumstances which often exist in the larger urban areas, it is necessary that the keeping quality of milk should be improved without altering its food value, so that it may be delivered to the public in a sweet condition. If this were not possible, a large proportion of our population would be forced to forgo this essential food, while many producers would be unable to dispose of their milk.

As Sir George Newman has stated, the ideal would be for all milk to be produced from *perfectly healthy* cows, under hygienic conditions, and for it to be consumed within the shortest possible time after production. There is likely to be greatest difficulty, however, in freeing herds from tuberculosis and in maintaining freedom from this disease, in addition to the expense attached to such eradication. Efforts to rid dairy herds of this infection have been made and subsidies have been paid to producers to encourage the attainment of this desirable state of affairs with little success. Such efforts must, of course, be continued, but the public have the right to demand that all milk should be rendered safe during the interim period which must elapse until this ideal is fulfilled. Milk of such high quality is likely, by reason of its excellence, to be always limited in quantity and, on account of its high cost, to be out of reach of the majority of the consuming population. The bulk of the milk supply does not attain such a high standard and this fact, when considered in conjunction with transport difficulties, clearly indicates the necessity for pasteurisation, not only for the sake of safety, but also to prevent losses through souring.

Efficient pasteurisation is the only method by which the distributor is enabled to *guarantee* that his milk is free from any