Milk: Whither Research? *

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As we look back upon the progress that has been made in the sanitation and nutritive value of milk, we cannot help but wonder what Dr. Coit and his pioneering collaborators would say if they could see the place of milk in our life today. The production of certified milk is certainly the greatest achievement yet witnessed in the application of sanitary practices to the production and handling of food. Time was when the careful microbiological control and cleanliness as practiced by the brewing trade were held up for the emulation of the food industry. We must have learned our lesson well as evidenced by the complete reversal of the picture: At the first food technology conference held at the Massachusetts Institute of Technology in 1937, Mr. Sippel (speaking as a brewing technologist) extolled the sanitary technology of the milk industry as an example of what the brewers should practice. All this has come about mostly through the influence of certified milk production. Your association blazed the way, and showed that dairy sanitation was practicable and beneficial, yes, and even profitable.

The actual volume of certified milk is relatively small—only about 1 to 2 percent of the total milk consumption. But the high quality of certified milk has greatly influenced the standards of the bulk of the regular milk supply. You gentlemen proved that greater care and cleanliness were possible in the production of fluid milk at large than had previously been thought to be possible. When new information became available, the certified milk dealers have been eager and aggressive to apply it to their operations. You have been foremost in applying sanitary ideals to practice, and have continually stimulated the rest of the industry to follow you. As we chemists put it, you have catalyzed the production of milk in the entire dairy industry. You are still maintaining your leadership, and your application of science, technology, and sanitation to the milk business is still in advance of the field.

Such a background of achievement and dependable performance places a great public responsibility on you as leaders in the continued development of the milk business. Furthermore, your professional affiliations and your social interest gives you the public and official ear, so to speak. Therefore, you are in a strategic position to "sell" desirable developments to the commercial interests, the regulatory authorities, and the public.

What are some of the needs of the dairy industry that require recognition and solution—diagnosis and treatment?

**CONSTITUTION OF MILK**

The first one is to ascertain what is milk. We know that it is a white liquid that contains several percent of butter fat, a little less protein mixture, about the same carbohydrate content, some minerals, a mixture of vitamins, and a number of enzymes. However, we know so little about their constitution and physico-chemical condition that no one can synthesize milk. We do not know as much about our product as the oil companies do about petroleum nor the steel industry about the properties of iron. Yet over several dozen agricultural experiment stations, scores of universities and colleges, and hundreds of plant laboratories in this country are turning out
papers by the thousand—and we still do not know what is the actual composition of the product that we are handling. No one can properly know a product until he can put it together in a laboratory. Without this fundamental information, our advance is by the slow and costly practice of trial and error. It is analogous in some respects to building a house without a blue-print: we get it completed some way but the effect is not so good.

Pressing the case a little farther, we need to know specifically the structure and properties of the milk proteins. We do know their relative biological value, and have ascertained that they are among the best nitrogenous foods that we have. But when we use our surplus milk to produce casein for glues, paper sizing, plastics, paint, and other such commodities in the heavy chemical field, we cannot help but feel that we are violating the conscience of humanity. How can we make casein into paint and billiard balls when half the world is starving for adequate proteins?—and also needed right here in this country, too. There should be developed attractive milk protein foods as substitutes for meat. The proteins in meat sell for twenty times the price of proteins in skim milk—a most attractive spread to stimulate research.

The lactose of milk—what is its physiological role? Milk is the only product that nature made exclusively to be a food when the growth demands of the animal are greatest. It contains lactose in particularly large amounts and the animal organism is peculiarly equipped to handle it. The animal body cannot synthesize it. Furthermore, it is an essential constituent of nerve and brain tissue. Some preliminary research has already shown that animals when fed on a diet containing 20 percent lactose showed a higher content of cerebrosides in their brains than those on a sucrose diet. These considerations seem to give it a uniquely essential nutritive value. It would seem that the young animal cannot properly develop without it. If this is true, then we ought to know it. Who will tell us?

VITAMINS

New vitamins are being found in milk as our knowledge in this interesting field grows. The loss of vitamin C from milk is glibly dismissed as a matter of minor significance, so we proceed to boost the citrus industry as an effective substitute. We found that vitamin D in milk is more effective than when used medicinally independently. If vitamin C in milk possesses an analogous and favorable effect, then it is a matter of great importance whether we neglect its conservation in milk processing and production. Why should we continue to destroy a valuable nutritive constituent merely because we can secure vitamin C from other sources—in competitive products, for example? Researchers in one of our great universities are indicating how this vitamin can be conserved. The industry should awake to its significance.

ENZYMES

An almost neglected field is that of the enzymes. One might well ask, "What is the value of knowing what they are?" We do not know the full answer but one reason is the discovery of phosphatase—and thereby we speak volumes.

BACTERIA

There is need for information on the bacteriology of milk. The application of high-temperature—short-time pasteurization to milk has revealed that our bacteriological control was not as effective as we had thought. The mechanical engineering of pasteurization has progressed much farther than the bacteriology involved. The improvement in our quality control when we changed to the new tryptone-glucose-skim milk agar medium is further indication that the bacteriological field is still yielding to new researches. We hope (and expect) that some one yet will find a method for estimating the
number of organisms present without using any of the relatively costly equipment and time-consuming labor now required. The chemists have done this in their field; the bacteriologists will have to come to it.

What is the effect of bacterial growth on milk? The literature carries numerous references to isolated studies, all showing qualitatively that measurable effects are found. No one has taken up this clue and followed it persistently to ascertain its extent or significance. Enough has been done to indicate that this field could profitably be further explored.

TECHNOLOGY

With regard to the technology of milk, we are now witnessing great developments in transition. Ten years ago it would have taken a hardy visionary or independent thinker to say anything favorable regarding the utilization of flash pasteurization. Now we see high-temperature-short-time pasteurization, conveniently termed "high-short," undergoing extensive study and development. We need to integrate its bacteriology, chemistry, and technology.

We thought that our surface coolers were good, and that our internal tubular equipment was effective—but now look at the cabinet coolers and the plate types. Shall we stop here and call this book closed? We ought both to heat and cool more quickly.

Pasteurization equipment is in great need of improved development. There have been some new types of bulk equipment, but they are new only in relatively minor details. No fundamentally new principle of design or power has been forthcoming since the somewhat bungling use of the electric current led to the entrenchment of steam heating. A public health contribution of great value would be a unit to pasteurize economically small batches of milk.

Experience in other aspects of the food industry has shown generally that large batches of foodstuffs cannot be processed to yield as fine a flavored product as small batches, especially when cooking and heating are involved. This is the bane of "factory foods". The organoleptic difference between the aroma of fresh milk and that of stale or old milk indicates the possibility in this direction.

How does heating effect milk? We know that some changes in physical-chemical equilibrium are brought about. We cannot design equipment and processing to reduce these effects until we have a method of measuring them. The engineer must wait for our data—or proceed haphazardly by trial and error.

The preservation of milk needs much study. The good results achieved in the preservation of human milk by quick freezing is a pointer to show what is possible in this field. However, we need data on the effects of refrigeration on milk, both in the liquid state as well as in the frozen one. Why does freezing break the fat emulsion? Does it denature the protein? Is there a combination between any hydrolyzed carbohydrate and protein? Where do the off-flavor effects come from? If we knew the latter, we should be in a good position to work out a preventive.

The commercial distribution of milk may well be studied. Much is said about the present high cost of delivering milk to the householder. Very little seems to be done to find a solution—except buying companies, exchanging customers, and consolidating routes. Conditions of living are changing much faster than our distribution practices.

RESEARCH POLICY

In the above rapid survey of a few of the fields that need research, we have not mentioned any studies in the chemistry and technology of butterfat. We now call attention to the program of the U. S. Department of Agriculture in its research in this field. Here is a subject that has needed fundamental investigation. It is the basis of the butter-making industry. Numerous investigators have made contributions to our knowledge in this field, but here is a group who are living with the problem, continuously, persistently, refusing to be di-
One of our great state organizations is doing the same with the bacteriology of butter. This is the type of research that we need, one that does not stop with the publication of a paper but is based on a long view of the problem, that stays with the study long enough to reach a conclusion that has some degree of finality and completeness to it and that may not be easily refuted by a superficial paper published from some other group.

Most of the organizations that are interested in and capable of conducting investigations in the science and technology of the milk industry are state or commercial laboratories. They must work on problems that impress their supporters. Many a good scientist is kept grinding out bulletins when he would better be expending his energies in the laboratory seeking facts. Administrative officials are only too prone to gage the productivity of a laboratorian by the list of his publications. This creates a false sense of values. It makes the publication more important than the problem. Moreover, it floods the literature with a mass of papers which lack depth of treatment. The researcher is compelled to publish quickly before he has had time to do a thorough job. He may flit, so to speak, from one problem to another. He has time only to make bricks; he has not the time to build an edifice.

The state experiment stations and some of the government laboratories are in this class. The legislators want to justify their appropriations, and the people want action. There is some justification for many of the quick laboratory investigations—sometimes erroneously called research—that deal with immediate and local problems. However, a perusal of the current dairy literature shows relatively too great a number of papers called research but only investigational in scope. We need more quality and less quantity.

NEED FOR MORE KNOWLEDGE
The dairy industry cannot hope to make great new strides without new fields of knowledge being opened up. We are now suffering from a lack of this. Our industry has caught up with our laboratories, and both our technology and our science are at about the same level. This speaks well for our technology but not so well for the state of our science. The proper and healthy state of things should place the discoveries of science well in advance of our technology. Both science and technology lose perspective because one is pushing the other, crowding it, so to speak, and "cramping its style". Science, to develop properly, must be unfettered—but directed. It must lead; it cannot be driven.

One of the great needs of the milk business is to interest a group of properly trained scientists in its problems, provide them with adequate facilities, and then forget them for five years. Give them a chance to do something. Just assure such a staff is disturbed by interrogations as to what have you new, or how soon will you publish, or why do you need this or that apparatus, or you spend too much time in the library, so surely will their enthusiasm be weakened, their energies dissipated, and their vision obscured.

Well might it be asked as to what are the prospects of research being productive. No one can answer this definitely. However, it is interesting to note that Kay and Graham's recent discovery of the basis for the phosphatase test that is useful in determining the treatment of milk came as a byproduct of their investigations on the enzymes in milk. They were engaged in a strictly "high-brow" (if I may so call it) research—and they stumbled onto this. In general, that is the normal course of the kind of research that opens up new fields.

If the motor transportation industry had left development in its field to the engineering laboratories of the state colleges and universities, how far would it have progressed? If the electric companies had done likewise, where would they be now? Rubber, glass, pharmaceuticals, steel, photography, communications—their names personify present-day
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progress. Industry established its own research and development program—one that it controlled and directed. This gave permanence and objectivity to a long-time course of investigation. These industries paid the price and are reaping the dividends.

CENTRAL RESEARCH INSTITUTE

The dairy industry is too large to be content with hit or miss research. It should be interested in and capable of opening up new fields for the sale of dairy products. In united effort, there is strength.

The dairy industry should have its own central research laboratory. Such an institution, owned, directed, and controlled by the dairy industry itself, is certain to pay for itself over a number of years. Those of other industries have yielded undreamed-of results. Why should the great dairy industry, as large in financial transactions as the steel industry, sit on the banks and watch the procession go by! Such a program would correct the present near-stagnation and open up new fields of development and usefulness. It should constitute insurance against loss of position to competing industries, and furnish the best prospects for creating new products for new markets.

Obviously, the scope and type of work of such an industrial institute would have to be confined to the interests of the dairy industry as a whole. The first immediate task would be to assemble, select, and interpret the great mass of literature that is now being published every year. The data should be put in usable form for the busy industrialist, and strongly documented for the researcher.

This one feature would capitalize on the immense expenditures for investigations that now are largely wasted by remaining obscure.

Another project would be to foster interest in milk research among present highly trained investigators in well-equipped laboratories. This would enable us to utilize present personnel and plant that others have paid for. Such work would minimize duplication and serve as a clearing-house for information among interested groups.

Numerous other projects would make such an organization useful and profitable. After once established and functioning along these and other practical lines, it would be largely, if not entirely, self supporting financially.

SUMMARY

So in summarizing the foregoing presentations, we consider that the professional standing and accomplishments of your two organizations place you in a strategic position to take the lead in organizing a central research institute for the dairy industry. This great business is in need of new knowledge. The latter can be secured most effectively by interesting properly trained men and encouraging them to work undisturbed by immediate commercial considerations. The individual companies can take care of applying the data. Unless the dairy industry arouses itself, it will find its present markets invaded by competing products. Yesterday’s victories are history. Present needs require present remedies. Since coordinated research is the surest basis for progress, then this great industry should get busy.

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