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OPPORTUNITIES FOR RESEARCH IN THE ICE CREAM INDUSTRY

by
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DR. LARSON: Mr. Chairman, ladies and gentlemen: I am very glad that the last speaker had to catch his train and therefore spoke before I did, because he has given a splendid introduction to what I have to say. His entire discussion indicates the necessity of research. He told about these changes in industry and the developments that are taking place. If you stop to think an instant, you will realize that every one of these is dependent upon research. The ice-cream industry, like any other, cannot go forward without it. Your great Association here evidently appreciates that and understands it, because during the past year you have added to your committees a committee on Research, the purpose of which, I understand, is to promote and aid research work in the industry. I am not going to discuss research as such, or tell you much about what you are to do in the way of research in this industry, although I shall touch upon that briefly. But I shall rather try in a few words and I shall not keep you long, to point out what it has done and what it can do for an industry; and also to try to arouse interest for this line of work on the part of those who do not have it.

I also hope that what I say will lead more of you to use the research method of progress, to use science in your industry more than you have in the past. I myself am not a scientist, but I have been associated for a good many years with men who are; and my duty is to direct their activities, to make their burdens as light as possible, and to help them carry on their work. It is difficult to measure the progress which has been made in research; but we do [redacted] have one or two ways of measuring work in pure science, at least. And when I say "pure science", I can best illustrate it by the development of the radio. Dr. Maxwell, a physicist in England in 1864, in working with mathematics found that there were electrical waves longer than light waves, and this furnished the basis for the present radio. That was pure science. In this country the radio has been developed in an enormous way by means of applied science.

One way in which the progress in science is measured is by the Noble prize. Perhaps many of you know that Alfred Nobel, a Swede who invented dynamite, left his fortune to be given in three prizes each year for the most notable work in science. A committee of the Academy of Science of Sweden was formed to determine the winners of these prizes. They are given for work in physics, chemistry, and physiology, including medicine. Since 1900, when this was started, 72 prizes have been given for the discovery of something along those lines of greatest value to the world. It is interesting to note the countries in which these great scientists have lived. Out of these 72 who have been honored, Germany had 21, the United Kingdom 11, France 10, The Netherlands 6, United States 4, Sweden 4, Denmark 3, Switzerland 3, Austria, Canada, Italy, and Russia each 2, Belgium and Spain each 1.

Of course, some of these countries having a large number of prize winners are small. On the basis of population, you find that The Netherlands, Denmark, and Switzerland, had one for every million people; Sweden had one for every million and a half; Germany and Austria had one for every three million; The United Kingdom and France had one for every four million, and the United States one for every twenty-eight million of people.

Another measure that is interesting to me along the line of pure science or fundamental research is the discovery of elements. When you went to school you learned that we had between 60 and 70 known elements. Today we have 92. It is interesting to know that the last five that have been discovered have radio activity. Out of these five has come the X-ray, the radio, and radium.

All of the industries which have developed through these discoveries have the last five elements. Of course, some of them were discovered very early. In making a comparison of the different countries, it is not fair to the scientists in this country to start with the beginning. However, since 1894, seven elements have been discovered by scientists of Great Britain, four from France, four from Germany, one from Denmark, one from Austria, one from Czecho-Slavakia and one from the United States.

This does not mean that we have no research workers in this country. It does not mean that we have not made progress. But our progress and development have consisted largely in using this fundamental research that has been done by other countries. There is no other land in the world which has made such great progress in applied science. We have encourage it in every way in this country.

It is interesting to me to know, however, that the industries in this country are now appreciating more than ever before the need of fundamental research. Some of the biggest organizations are spending enormous sums of this work. The General Electric Company has men working on pure science; they have been told to "go ahead and investigate these problems, without application to our industry, necessarily." This company has one man, Dr. Langmeier who has been working on the structure of the atom for the last two or three years. In the course of some recent investigations on a purely abstract problem he made the observation that under certain conditions hydrogen was changed from the molecular form in which it ordinarially exists to the atomic state.

He reasoned that when this atomic hydrogen reunited great heat would be generated. From this developed the molecular hydrogen blast lamp with which such refractory metals as aluminum, nickel, and chrome-steel may be welded. Moreover, since no oxygen is used in the flame, welds are made without oxidation of the surface of the metal.

The chief reason, I believe, for the lack of fundamental research in the colleges and universities is that they have grown so rapidly. In the last 35 years the number of men in these institutions has increased 400 per cent. We have more men at the present time in the colleges and universities of the United States than in all the other countries combined. In the great expansion of universities and colleges, men were brought in to do research work. Before much was accomblished, however, they were crowded with students, making research impossible by the students with the inclination and the ability to do this kind of work.

I want to give you, briefly, a few examples of what I mean when I say that fundamental research is essential to the development of the industry.

A few years ago in the laboratories in Washington, we had two men who were working on butter-fat deterioration. They were not butter experts. They were chemists and bacteriologists. They found that when a certain amount of acid was developed in cream certain bad flavors developed when the butter was stored after being made from such cream. At the time, it was not thought much of; but a couple of plants took advantage of this discovery. Two years ago, after the results of this discovery had been used throughout this country, we had more than 100,000,000 pounds of surplus butter in storage. If this butter had been the kind that was made before this discovery, the dairy industry would have received a blow such as it had never had before. However, instead of this more than 100,000,000 pounds of butter being fishy and off-flavor, it came out of storage with a good flavor and passed off in the channels of trade the following spring without any serious detriment to the industry.

In the cheese field we felt that we could not increase our consumption without improving the curing in order to get better varieties of cheese. We are importing now one-fifth as much cheese as we are making in the United States. Some 60,000,000 pounds is imported from foreign countries. Since a great deal of Swiss cheese is consumed in this country, we started some investigations to determine the method of making it -- a method which would be scientific and would make a uniform high quality of product. For a great many years cheese has been made in Switzerland as an art. The Swiss knew little of the organisms which produced the holes or the flavor associated with them. For many years the practice in this country has been to import the best Swiss cheese makers. A few years ago we put some men to work on this subject -- men who did not know how to make Swiss cheese and had not been in a Swiss cheese factory. They studied the gases which were in these holes and made other bacteriological and chemical analyses. Later they isolated for the first time the organisms that during all these years had produced the flavors associated with Swiss cheese. Up to this time a large percentage of Swiss cheese, even in Switzerland, was not of high quality. Much of it was not good enough to export to this country. A great deal of the cheese made in this country was sometimes so inferior to that from ten to twenty-five per cent had to be sold for less that the cost of making. By using these cultures, a factory can make 85 to 95 per cent fancy or No. 1 grade cheese ~~many~~ much of which will be equal to the imported product.

Recently I received a letter from one of the largest manufacturers of Swiss cheese in New York. We had sent a young man from our laboratory who had never made Swiss cheese outside of our laboratory. However, he knew how to use the cultures. During the past year these manufacturers, with the help of this laboratory man have made over 90 per cent fancy and No. 1's. Before last year they had only 10 per cent of this quality. When you realize that there is a profit in only the fancy and No. 1'x, the value of this service and information is obvious. In the same way, investigations are being made with condensed milk and other products.

The production of milk is being studied from many angles. One of the serious problems of the dairy industry is that of reproduction. We must have calves every year, in order to have a continuous supply of milk. But replenishing the herd is uncertain; it has been so for some time, and it seems to be getting worse. And, as Dr. McCollum told you here, Vitamin E is apparently a factor in it.

Four years ago, when Dr. Evans was working on the reproduction of rats, I thought there was a possibility that these studies would be useful with other animals. So for the last four years we have been cooperating with Dr. Evans, and it was through that work that this Vitamin E was discovered. Although with rats he used the oil of the germ of wheat, this was not applicable to larger animals. We found in our investigations that sprouted oats apparently has a large amount of this accessory product that is instrumental in nutrition for reproduction. Last year we had seven heifers in our herd that had been mated at seven different months without success; and after feeding them sprouted oats for five or six weeks, six of them conceived at the first mating. During the last few months we have had two cows, 13 years old, which have not had calves for over two years, although they have been mated every month for the past year. After feeding these old cows on sprouted oats for six weeks, both of them conceived upon the first mating.

This is not a complete investigation as yet. It only gives you an example of the possibilities in it. And if this works out as it seems to be doing, it will be worth millions to the dairy industry.

One of our projects on ice cream is an attempt to determine the relation of viscosity and possibly surface tension of mix to over-run and texture, taking into account the change in physical properties during the freezing due to the whipping, and the constantly changing concentration due to the separation of salts, sugars, and ice crystals. This has entailed much preliminary work on the solubility relationships of salts and sugars at different temperatures.

This investigation is designed to establish a standard method of making experimental ice cream, in which all the factors can be controlled with reasonable certainty.

It will then be possible by varying one factor only such as brine temperature, dasher speed, time of freezing, temperature of whipping, and such questions as the relation of heat treatment of the milk and other ingredients of the mix, to determine the effect of manufacturing methods on the texture of the finished product.

This will also involve the perfection of methods by which the physical properties of ice cream can be measured and expressed in mathematical terms.

Very little data is available regarding the mechanism of the physical reactions which take place when ice cream is frozen. A knowledge of these reactions is essentially the foundation of any problem pertaining to the freezing of ice cream.

The study of these reactions may be developed in three ways: (1) A study of the solubility-freezing-point-temperature relationships of cane sugar, milk sugar, and milk salts. This study will show the reactions that theoretically can take place during the freezing of ice cream. (2) A demonstration that some or all of these reactions do or do not take place when ice cream is frozen. (3) The study of the quantitative relationships of these reactions. At present considerable progress has been made on (1) and (2).

To illustrate: Since the proteins and fat of ice cream exert little or no effect on its freezing-point relationships, for the purpose of this study, we shall consider simply the relationships of the salts, milk sugar, and cane sugar. In freezing ice cream we usually separate ice first. With the attainment of lower and lower temperatures more and more ice separates out. The separation of this ice concentrates the sugars and salts in the unfrozen portion of the mix. Points are reached when this unfrozen portion becomes saturated to milk sugar, then to the individual salts, and finally to cane sugar. As these various concentrations are reached the sugars and salts can crystallize out, although they do not necessarily have to do so. Since it is apparently true that the cane sugar is the most soluble ingredient of ice cream it at once follows that when its saturation point is reached, if crystallization takes place, the ice cream may be frozen solid at this point. Data so far obtained show that cane sugar does separate in ice cream at a temperature of about 10°F., but that the separation is not complete and therefore the ice cream is not frozen solid. The exact location of this point, which is really the temperature at which water, ice, and sugar can exisit in equilibrium, has not been determined before and had necessitated much work.

Another point of interest is the well known fact that milk sugar exists in solution in two forms, the alpha hydrate and the beta anhydride. At equilibrium there is present 1.5 times as much beta as alpha. The alpha form is the least soluble and crystallizes out first. When this occurs, if time is allowed, the beta form starts to change to alpha, and finally all the sugar that will precipitate comes out as the alpha hydrate. With the rapid freezing of ice cream this reaction does not have time to proceed. Theoretically, the solubility of the beta product may be exceeded, and it can precipitate. Physical chemical measurements indicate that this does take place. As yet beta crystals have not been isolated from an ice-cream mix, but the precipitation in ice cream of the soluble beta form explains theoretically much of the phenomena of sandy ice cream.

We are therefore engaged in making a complete study of the solubility relationships of milk sugar, cane sugar, and water, and in determining the bearing of these relationships on the mechanism of the freezing of ice cream.

In ice cream work a great deal must be done in attempting to find some relationship between the viscosity, surface tension, and density of the mix, and the overrun or whipping quality of the mix. Assuming that it is the unfrozen portion of the mix which controls overrun, information already gained from the physical relationships of ice cream show that these attempts have been unsuccessful, because the physical measurements of a mix before it enters the freezer are no indication of the values of the mix in the freezer. For instance, the structure that has developed in the mix during ripening is immediately destroyed when the paddles get to work. Then with the lowering of the temperature in the freezer these values again change, and with the increased salt-sugar concentration in the freezer brought about by ice separation, the values are further altered.

With our knowledge of the physical equilibria it is now possible to determine with considerable accuracy the viscosity, surface tension, and density of the unfrozen portion of the mix at any instant of the freezing process. With the measurement of the whipping ability of the mix under specified conditions any relationship between overrun and these other physical properties should at once be apparent.

The proper measurement of this whipping ability is another problem in itself which is to be worked out, through a careful control of the variable factors of the freezing process and a study of the effects exerted by a number of these factors.

Having worked these problems out and developed some system of physical measurement, plasticity, tensile strength, penetrability, etc. by which to standardize the finished product, it is hoped that an important contribution to the ice cream industry will have been made.

My chief purpose in giving this talk here, as I said, is to encourage you to give more attention to research and to take an interest in the work of your committee. I also want to say here that I think this industry is fortunate in having such men as you have on your research committee, men who are both trained and experienced in the ice cream business. I predict a great good, if you will cooperate with them. And I hope you will cooperate. In one of the other branches of this dairy industry, one large company said, "We have a bigger laboratory than anybody else. Why should we cooperate? We will just be giving the rest of them all we learn." But, that particular concern is getting more from the other fellows now than they have ever developed.

I hope that you will cooperate with your research committee. I know that the committee that you have will cooperate with us, and that is what we want.

I thank you.