

## What's New in Sugar Research?

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Friends in the sugar industry: Being in Denver brings back many memories of happy vacations during which Long's Peak was climbed five times. It is pleasant to be here and to talk about your Research Foundation and what it is accomplishing.

As you know, I have been with the Sugar Research Foundation for a little over a year and a half. During this time we have had the advice and counsel of many members of both the cane and beet sugar industries. It is difficult for most members of the beet sugar industry to attend our meetings, which are usually held in New York. Therefore I welcome this opportunity to get better acquainted.

The present policy of the Foundation involves a simple concept: it is to remember to ask the question regarding any proposed research project, "If successful, what value will it have for the sugar industry?" This has annoyed a few scientists but it has saved a great deal of money and concentrated our efforts on subjects of real, potential value.

As examples of the kind of research which we have not done, I should like to mention just two projects. One was to determine the last details of the structure of galactinol, a carbohydrate found in sugar beets by Brown and Serro of Great Western. Emotionally I would have liked to do it; financially I could not justify it and the beet sugar men on our Industry Advisory Committee voted against it. The job was done anyhow on O.P.M. (other peoples' money).<sup>2</sup>

1953 saw the first chemical synthesis of sucrose. I am glad that this has been done. Now it is not necessary to write any more letters explaining why I am not willing to use Foundation funds for accomplishing this. We all honor Ray Lemieux for this achievement. In carbohydrate chemistry, it was equivalent to climbing Mt. Everest. Many of the greatest chemists had tried to synthesize sucrose and failed just as Leigh-Mai lory, Smythe and the other Everesters had tried and failed. The probability that this sucrose synthesis will be of any practical importance to the sugar industry within our lifetime is about the same as the probability that Mt. Everest will be divided into building lots and sold.

The past year has seen the completion of two research projects of great present value to the sugar industry and five more of great potential value. Let's look at them in turn. Five are in the Foundation and two are outside.

First, let's consider the work of Ray Bohn and Foster D. Snell on the value of sucrose vs. dextrose in bread. This was completed by July 1st of 1952, but the results were so lopsidedly favorable to sugar that men in our industry refused to believe them. We had the experiments done over again in other laboratories—Arthur D. Little and the American Institute of Baking—and the facts still emerged the same.

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<sup>2</sup> This proposal did not come from either Brown or Serro.

Briefly the picture is as follows: The sugar is inverted to glucose and fructose by the invertase of the yeast before mixing the dough is even finished. Glucose is selectively fermented, leaving a disproportionate amount of fructose. The relative sweetnesses are glucose 70, sugar 100, fructose 170. Customers prefer the flavor of sweet bread and because of this the sugar in bread, based on flour, has gone from 4 percent in 1945 to 8 percent in 1953. We made the comparison in two ways. At equal cost 6 percent sugar gave sweeter bread than 7 percent dextrose. At equal sweetness 5 percent sugar was cheaper than 8 percent dextrose.

Ray Bohn and I went to the largest bread producer and talked to their chief chemist. He said, "I know you are right. I proved it in my own laboratory."

I said, "Why do you use dextrose?"

He said, "Because I was never able to sell Production on the idea. Let's call them in and see what they say."

We went through the same story with their top production men and ended it with the same question, "Why do you use dextrose?"

After a few moments of silence one of them replied, "I'll tell you why we use dextrose. We believed the advertisements of the corn products industry which said that you could substitute dextrose for sucrose pound for pound in bread and nobody could tell the difference. We thought we were saving a lot of money for our company. If what you say is true and you can prove it, no one should use dextrose in bread."

Two weeks later they threw out the dextrose.

Sugar Information has held baking schools for sugar salesmen in San Francisco, Chicago, New York and New Orleans. This year Ray Bohn is carrying this message to bakers all over America. Sugar has lost \$36 million in annual business to dextrose in the baking industry. We are getting a lot of that back. When the big companies with research laboratories return to sugar, the little ones are apt to come along, too.

The second job which I want to discuss is sugar in pig-starter ration. It began in August, 1952, and was using sugar by the multiple carloads in February, 1953. The project originated in the mind of a former student of mine, Prof. Damon Catron, who is in charge of research in swine nutrition at Iowa State College. He had wrestled for years with the question of how you could get young pigs, starting at about one week of age, to eat more synthetic ration. There were many advantages if the pig-headed little fellows could only be convinced:

1. The mother sow would not step on them or smother them.
2. Sow's milk is deficient in copper and iron, resulting in partial nutritional anemia for the pigs; this could be corrected.
3. After the pigs are three weeks old the sow's milk declines in quantity while the growing pigs require more.
4. The number of filling stations on the sow is limited so that

runts were inevitable with large litters if the pigs had only sow's milk. With a synthetic ration, the geneticists could breed for large litters which reduce overhead costs.

5. The pigs could keep healthy by eating antibiotics.

6. The sow could be bred more frequently if the pigs are fed artificially, thus reducing overhead further. It might also make life more interesting for the sow.

The problem was to make the synthetic ration more palatable to the pigs. Pelletizing or granulating to eliminate dust from the feed helped, but it was not enough. Catron was listening to the radio one day when sugar-coated cereal was being advertised. Would pigs have a sweet tooth as young humans do? He asked C. & H. to support the work, and they referred him to the Foundation.

Results came rapidly. Pigs first indicated a preference for sugar-coated pellets over those with sugar mixed all the way through. After a while, however, the clever little animals learned to suck off the sugar and spit out the rest of the pellet so now results are better with uncoated pellets containing fifteen or twenty percent sugar. I often wish that food faddists had as much appreciation of sugar as pigs do.

Feed men were alert to go after a market which they never had before. They adopted it rapidly. Some, not quite so bright, are using dextrose in spite of the fact that dextrose gives less sweetness than sucrose per dollar spent. Before long we hope to have results indicating that pigs are smarter in some ways than the victims of dextrose salesmen.

The results can be expressed in two ratios. The average pig used to weigh 27 pounds at seven weeks of age; now, with the sugar ration many litters have averaged 67 pounds at the same age. This is important because feed efficiency is greater when the pigs are young. It takes only 1.7 pounds of feed to produce a pound of gain with the new ration. Fifteen years ago the over-all figure to marketable weight was five pounds of feed per pound of gain. The best comparable figure now is just under three. This is why greatest economy is obtained by inducing the young pigs to gorge themselves.

The third discovery of prime importance to us is ammoniated beet pulp, which has been known for about eleven years but which has not looked practical till just recently. The difficulty was that the Millar process for ammoniating beet pulp used elevated temperatures and pressures. The problems involved in getting dried beet pulp in and out of a pressure zone and controlling its temperature while it reacts with ammonia did not appear simple.

Now we know that neither heat nor pressure is necessary to make beet pulp react with ammonia and develop a protein equivalency ( $N \times 6.25$ ) or 22 percent or roughly half that of soya bean meal. It looks as if all you need is a gas-tight container, a tank of ammonia, and a valve which you can regulate.

There was, of course, a question as to whether the beet pulp ammoniated by the new technic would work satisfactorily with the rumen bacteria.

It is these microorganisms which have to be kept vigorous, for they take the simple amide structures and convert them to protein, which the cattle then turn into beefsteak and milk casein.

Just last week the word came from Cornell where tests were run at our request in an artificial rumen. The bacteria not only thrived but they dissolved fifty percent more cellulose than the controls run on ordinary beet pulp in the presence of ammonium salts.

Much work remains to be done with feeding tests. On Monday of this week members of the Industry Advisory Committee met and discussed with me just where these tests should be run. If they are successful, as we hope, a great step forward will be taken in supplying protein equivalent to the feed industry of the west and middle west. The implications are also important for countries such as Great Britain and Germany, where acreage is limited and population dense.

Dr. M. M. Rosenberg of the University of Hawaii has recently discovered that as much as 28.6 percent of cane blackstrap molasses may be added to poultry ration with good results. Under Hawaiian conditions, a saving of 7 cents is obtained in feed cost per dozen eggs. This is in striking contrast to statements in the previous literature which indicated that 3-6 percent molasses is all that chickens will tolerate. Work needs to be done with beet molasses also. It is estimated that 29,500,000 tons of poultry feed will be made and used in the United States this year. If anything like 20 percent of molasses were used in this, the molasses supply would be hopelessly inadequate. Here is a large new outlet for molasses which is just coming over the horizon.

Discovery number four is anti-enzyme tooth paste which is reported to be capable of protecting normal teeth against caries for about 12 to 16 hours. There has been so much ballyhoo about ammoniated and chlorophyll dentifrices that it would be easy to dismiss this as another variety of the same old game of bunkum. This might be a mistake. Clinical data, some of which have been published and some of which will soon appear, indicate that the anti-enzymes may be the most important discovery in the history of tooth decay.

They act by inhibiting the action of the enzymes which convert imple sugars into lactic acid. Lactic acid, if allowed to remain in contact with a tooth, will dissolve it. "We in the sugar industry have been reluctant to accept the sugar-lactic acid theory of tooth decay, which makes a villain of our favorite compound. If the results continue to be as favorable as they are at present, the caries rate will be reduced some 80 percent and we can no longer continue to oppose the sugar-lactic acid theory.

Fortunately for us, it seems likely that if Dr. Fosdick proves this theory he will also be taking the heat off of us. It will be possible to eat sticky candy all day and still develop no caries.

All this is, of course, based on the assumption that present indications are substantiated. If the anti-enzymes do not stop tooth decay, this will

constitute a major failure of the sugar-lactic acid theory and will tend to discredit it. In either case the sugar industry will benefit.

If the anti-enzyme dentifrices are as successful as present data indicate, all of the manufacturers of competitive brands will be forced into a race for an even better enzyme inhibitor. There is little doubt that such a product will in time be discovered and caries will become still less important. We are supporting research at Tufts with this objective. Many compounds have already been discovered which look better than present anti-enzymes on a preliminary screening test.

The Roper survey showed that there are three tangible reasons why people do not use sugar: fear of obesity, fear of caries and fear of diabetes. Every doctor now knows that sugar does not cause diabetes; this fact is slowly diffusing to the laymen. If the anti-enzymes perform as expected against caries, it will enable us to concentrate on other problems of the sugar industry.

Fear of obesity is undoubtedly the greatest single deterrent to sugar consumption. This is understandable; the principal nutritional function of sugar is to furnish calories and calories are what the obese person is trying to minimize. The Metropolitan Life Insurance Company has repeatedly emphasized the decrease in life expectancy which overweight or obese persons show as a group. It is characteristic of Americans not to be satisfied with any method of doing anything which is slow, laborious, and unpleasant. Science has given us so many short cuts and labor-saving devices that it is easy for the general public to believe that coal-tar sweeteners provide a painless method of dieting.

I suspected that this was not true. The theory of hunger developed by Jean Mayer in Fredrick Stare's laboratory at Harvard is that the desire for food in normal, non-diabetic persons is determined by the level of blood sugar. It predicted that sweeteners derived from coal tar such as saccharin and Sucaryl, which would be expected not to affect the blood-sugar level, would also not affect the appetite. Experiments with rats have confirmed this conclusion. Two matched groups of rats were each given all the dry food and all the water they wanted. The water of one group contained 10 percent sugar, corresponding in nutritive value to a soft drink. The other group of rats drank water containing a coal-tar sweetener of the correct composition to match the 10 percent sugar solution in sweetness.

At the end of the test period both groups of rats still weighed the same. Those which drank the sugar ate less dry food because their blood-sugar level was raised and this depressed their appetites—even as you and I. We are in the process of repeating this experiment with obese humans. Here there are two psychological factors which presumably do not operate with rats.

When a person drinks a bottle of No-Cal or puts a saccharin tablet in his coffee, he is reminding himself that he is trying to reduce. This is a psychological prop; it may help a little.

On the other hand, people generally have an exaggerated opinion of the number of calories in a bit of sugar. The correct figure for a level teaspoonful is 18 calories. Persons interviewed recently by Leo Burnett Company in Chicago guessed from 50 to 600, believe it or not.

Many of us have seen examples of the obese dowager who eats two thousand calories at a meal and then puts a saccharin pill in her coffee with an air of "Well, now I've done my reducing for the day!" Or the man who is careful to drink a "dry" beer which is nearly free from dextrose (he calls it "sugar") and forgets that the calories of beer are almost entirely in the alcohol.

It is Dr. Stare's guess that this latter effect will more than balance the psychological-reminder angle of using coal-tar Sweeteners and that when the results are in, a year and a half from now, it will probably be found that saccharin and Sucaryl do not help people lose weight. Your Foundation is betting a considerable amount of money that the results will come out this way. Of course, no one can be sure at this stage.

You may wonder, if the coal-tar-sweetener bubble is likely to be punctured this easily, why we are worried about coal-tar sweeteners. Frankly, I am not. The thing which worries me is that sugar is the whipping-boy of the whole food industry. We carbohydrate people have been singularly inarticulate. In consequence, while per capita meat consumption has been gaining, flour and potatoes have been dropping and sugar barely held its own. We Americans now have a strangely distorted diet with only 48.5 percent of the calories derived from carbohydrates, 40 percent from fat and 11.5 percent from protein.

Leading nutritionists are pointing out the chemical connection between this high-fat diet and the formation of cholesterol which partly plugs our arteries and capillaries, restricts the flow of blood, and causes high blood pressure and heart trouble. In 1952 51.6 percent of all deaths in America were attributed to heart disease. In Italy, where the calories in the diet attributed to fat are down to a normal 20 percent (compared to our 40 percent), a man in the 35-year age group has only 21 percent the probability of death from heart trouble as one in the same age group in the United States.

Suppose you take the percentage of the calories in the various national diets due to fat and plot it on a horizontal axis. Then take the probability of a man in the 55-59 age group dying of a heart attack in a given year and plot this along the vertical axis. You have a point for each country for which such statistics are available. The points connect in a smooth curve with the United States at the top with the most fat and most heart disease, Japan at the bottom with the least fat and least heart disease, and all the other countries in order in between.

Of course, this might have been a coincidence so let's try it again with the 45-49 age group. Here the curve is lower; younger men have less heart trouble. But again you get a smooth curve with the United States at the top, Japan at the bottom and the others in order on the curve in between.

This is still inconclusive by itself but the chemical evidence is very convincing. A recent series of between 2,000 and 3,000 autopsies showed that 92 percent of men dying from all causes had in some degree a condition called atherosclerosis. The lining of the coronary artery had become coated with a fatty deposit consisting of 70 percent of cholesterol.

Where does this excess cholesterol come from? Most is synthesized in the liver.

Last November an article by Medes *et al* in the *Jour. of Biol. Chem.* reported that slices of liver still living and functioning in a nutrient solution generated cholesterol ten times as fast from fatty acid as when they were fed dextrose.

Fatty acid molecules with radioactive C<sup>14</sup> atoms were fed to men and within hours some of the radioactivity was detected in the blood cholesterol.

Blood cholesterol values, while fluctuating from one individual to another, are higher in countries on high-fat diets. The normal, middle-aged American man is quietly getting ready for the thrombosis which eventually and inevitably will kill him unless something else gets him first. If you put this man on a low-fat diet, it takes just five days for the blood cholesterol to get down to where it should be. The chemistry of this is simple and fascinating; each time through the intestine some of the cholesterol is converted by bacterial action to an insoluble hydrocarbon called squalene, which is eliminated.

If the carbohydrate industries were to recapture this 20 percent of the calories in the U. S. diet (the difference between the 40 percent which fat has and the 20 percent which it ought to have) and if sugar maintained its present share of the carbohydrate market, this change would mean an increase in the per capita consumption of sugar of more than a third with a tremendous improvement in general health.

This will never happen while the present climate of public opinion in regard to sugar remains unchanged. We are in an era—almost unique in world history—when in the United States, and a certain few other favored countries, there is more food available than people can eat. Each food industry has to get up and fight for its place in the limited human stomach.

The ignorance about sugar on the part of even intelligent, well-educated people is astonishing. It often includes a great deal of misinformation. It needs to be removed. It is for these reasons that I am unhappy about advertising which implies that sugar is in some unique sense the cause of obesity. I do not think that coal-tar sweeteners are, in themselves, of surpassingly great importance to the sugar industry. The attitudes toward sugar which No-Cal advertising fosters will, unless vigorously opposed by efforts of the sugar industry, make it impossible for us to grow into the place in the American diet which we should rightfully occupy.

On September 21 the members of Sugar Association voted unanimously to spend \$600,000 per year for at least three years to tell the story of sugar in the diet. This decision to stand up and fight was reached after much

debate and prolonged consideration. But there is a point at which any virtue can be carried too far, even that of turning the other cheek. We hope that Leo Burnett can do for sugar what has been done for meat. There will be no bunkum and no ballyhoo, only a process of presenting the facts about sugar in an interesting way.

I hop to see the industry repeat some of this information by printing it on sugar bags. We have missed a wonderful opportunity to tell people the truth about sugar on the billions of sugar bags which customers take home from the grocery.

Last month we selected our liaison man for advertising and public relations. He will work with Leo Burnett Company and Selvage, Lee & Chase, our public relations firm. His name is David Quinlan and he comes to us from the anthracite industry. Like myself, he has much to learn about sugar, but he learns fast.

You have seen our first advertisement. Factual, scientifically correct, simple and easy to comprehend, it is the prototype of many more to follow. At last people who never had a course in biochemistry are going to learn that sugar is what keeps every human being alive and with energy to face our daily problems.

The response from the first advertisement has been most gratifying. Many of us have seen the editorial which FOOD FIELD REPORTER devoted to it. They called our ad a "masterpiece: something which happens once in a copywriter's lifetime." Barricini wants to put one in each box of candy and we are cooperating. Telegrams and letters have poured in both to Sugar Information and, I understand, to member companies. Some are written by crackpots like the one which read "Why don't you use a pistol, it's quicker?" but most, by far, are complimentary and ask for more information. We had an excellent theme lined up for ad number two but under the inspiration of this response Leo Burnett dreamed up another which carries still more punch.

I believe that a powerful reason for this interest is that nutritional quacks have made a dishonest living for many years by extreme and unjustified attacks on sugar in the diet. The fact that the sugar industry never seemed to fight back meant to many people that there was little or nothing which could be said in favor of sugar. It comes as a great surprise that a good case can actually be made for sugar in the diet of even obese people.

Ladies and gentlemen, there is much more which could be told about what your Foundation is doing. Many other projects are showing promise, but we shall have to save them for another day when they are further along. The future for sugar looks very hopeful.