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Waxy Corn a New Crop

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WHEN JAPAN took the Netherland East Indies, we not only lost our main supply of rubber and tin, but also our tapioca starch. “So what?” you may wonder. “Can’t we get along without tapioca pudding?” We can, but most of the tapioca starch we imported wasn’t for pudding—it was used in the manufacture of gums, muclages, adhesives, wood glues and for cloth and paper sizings. We need that kind of starch and we have been importing about 350 million pounds each year.

Perhaps the most promising substitute is the cornstarch made from waxy corn. Waxy corn isn’t exactly a new crop—the United States Department of Agriculture got its first sample of it in 1908 from a missionary in China.

It is rather unlikely that waxy corn will be the sole substitute for tapioca starch. Sweet potato starch can replace tapioca starch for some purposes and a considerable quantity of waxy sorghums will be milled in 1942. Waxy types are also known in barley, millet and rice. It is not possible at this time to predict the relative importance of the several waxy cereals in replacing tapioca starch.

If waxy corn were used to supply all markets formerly met by tapioca, it would require more than 10 million bushels of this corn annually. The price of tapioca starch varies with the grade. Since 1930 the price of tapioca flour, the cheapest grade of such starch, has been consistently around one-half cent a pound less than that of cornstarch.

Of course, for a nation that produces more than 2 billion bushels of corn annually and Iowa with crops of over 500 million bushels, obviously this new crop cannot be used profitably by many farmers. But for a limited number it may pay well because the substitute for tapioca is needed badly.

In 1936 small quantities of flint, flour, dent, pop, sweet and waxy corn were milled and studies made of the resulting starches. Their physical characteristics were quite similar, except for the waxy starch which closely resembled tapioca rather than ordinary cornstarch. Pastes of waxy starch are viscous, and relatively transparent in appearance. Upon standing they do not set to a stiff gel, as will other unmodified starches. Added to these interesting properties is the attractive possibility that hybrid waxy corn would provide starches of greater uniformity and ease of standardization than imported tapioca starch.

Although waxy corn has been known for many years, it has always been grown on a very limited scale. The plants of waxy corn cannot be distinguished from ordinary corn. Ears of waxy corn appear to be somewhat more starchy than ordinary corn. The only safe way to distinguish between the two types, however, is by staining. Ordinary cornstarch stains blue with iodine solution, whereas waxy cornstarch stains a reddish brown.

Dr. G. N. Collins of the U.S.D.A. made a special study of the waxy character and in 1909 reported that it was inherited as a simple genetic recessive. For a number of years this character was used extensively by those interested in inheritance problems in corn. In 1926 Brink and Abegg of the Wisconsin station reported that normal and waxy cornstarch had different physical properties.

On the basis of actual tests carried out by several manufacturers of adhesives, paper sizings and food products, it was apparent that waxy starch could be substituted.
for tapioca in most of its important industrial uses. Before waxy corn could compete as a starch source, however, it was necessary to develop strains with better yielding ability. The waxy strains used by the geneticist were low in yield and had small seeds which were often red or blue in color. Rather than attempt to develop satisfactory inbred lines from such material, it was decided to introduce the waxy character into some of our standard lines by means of backcrossing. The majority of this work was done by Dr. Merle T. Jenkins of the U. S. Department of Agriculture.

Each of the four inbred lines involved in Iowa 939 were crossed with a waxy strain. The resulting hybrid was then crossed back to the original inbred line. Backcrossing to the original line was continued through seven or more generations. Tests were made in each backcrossed generation to insure holding the waxy character. The waxy character was thus freed from most of the undesirable characteristics of the original stock and then reisolated by selfing.

These recovered waxy lines can’t be distinguished in the field from the original lines. A limited number of yield comparisons involving Iowa 939 and waxy 939 have indicated that the waxy type is about 10 percent lower in yield. A number of additional inbred lines are now being converted to waxy. With this newer material it may be possible to produce high yielding waxy hybrids.

In November, 1941, when it became apparent that there would be no further imports of tapioca starch, it was decided to increase the existing waxy corn stocks as rapidly as possible to relieve the shortage. Only 335 seeds of one waxy single cross and 3800 seeds of another were then available.

A part of this seed was planted in the greenhouse at Ames to produce a “winter” crop of seed and the rest was grown by Dr. Merle T. Jenkins in the greenhouse at Beltsville, Maryland. The increase from these 4,135 seeds we have used at the Iowa Station this year to plant a 20-acre double crossing plot, and 19 acres are being grown for increase under isolation to produce advanced generation seed stocks.

Assuming normal yields in 1942 and 1943, sufficient double-cross waxy hybrid seed can be available by 1944 to plant the entire acreage required to produce the 350 million pounds of waxy starch necessary to replace completely the tapioca starch previously imported.

The commercial plantings of waxy corn in 1942, totaling 326 acres, were made from advanced generation seed of a double-cross. The use of such seed is normally discouraged because of its decreased yieldng ability, but now it is necessary to produce the largest amount of seed in the shortest period of time. The increase from the 1942 commercial plantings will provide the first milling test of waxy corn on a commercial scale. The 1943 commercial plantings will be made in part from first generation double-crossed seed and in part from advanced generation seed.

The production of waxy corn on a commercial scale will present some new problems. Since the waxy characteristic is inherited as a simple recessive and is masked by pollen from normal plants, it will be necessary for fields to be semi-isolated from other corn. If this is not done the resulting crop may be so badly contaminated with pollen from other corn that the peculiar starch properties will be lost. Care will also be necessary to avoid mixing with ordinary corn in the crib, elevator or in transit.

Just as waxy corn starch has special properties which make it satisfactory for certain purposes, so does ordinary corn starch have certain special properties and uses. A mixture of unknown proportions of these two types could well be useless from the starch consumers’ standpoint. To avoid any difficulties arising from these two types of mixtures it seems likely that waxy corn will be produced under contract in restricted localities.

Until we have more knowledge concerning isolation and production problems, our waxy corn stocks will not be released for general production.

When one speaks of 350 million pounds of starch it is an impressive-sounding figure. When this is converted to the acreage required to produce this amount of starch, however, the figure is much less impressive, because it will require roughly only 300,000 acres. This acreage estimate is based on the assumptions of a yield of 40 bushels per acre and 30 pounds of starch per bushel.

The extent to which waxy corn starch will replace tapioca remains to be determined. However, from the natural increase of stocks now available we shall be able to satisfy any reasonable demand by 1944.

[Image with the ear of waxy corn and a man examining it]