Water Soluble Carbohydrates in Four Crops Cut for Silage

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Corn (Zea mays) has long been a major carbohydrate (energy) source for livestock feed in the United States and other parts of the world. The carbohydrates present in dent corns are largely in the form of starch with little sugar in the endosperm of the kernel. With the increasing use of corn for silage, interest has been aroused in varieties containing sugars in the endosperm of the kernel or varieties that do not set seed, which causes a build up of sugars throughout the stalk and leaves.

A study of the water soluble carbohydrates present in starchy dent, sweet dent, and sweet stalk (male sterile) corns and a forage sorghum harvested for silage (kernel endosperm at hard dough stage) was initiated in 1960. The purpose of this study was to identify the types and amounts of the major water soluble carbohydrates present in the above crops.

REVIEW OF LITERATURE

Evans (4) found an increase in the percentage of reducing sugars in corn kernels 15 to 22 days after silking. This increase was followed by a decrease in sugar content to a relatively constant value after 36 days, at which time the kernels were all dented. Data by Bernstein (1) indicate that there was no significant change in the quantities of reducing sugars during endosperm development in corn kernels. However, sucrose showed a marked increase during the first 3 weeks of endosperm development and then remained rather constant. Van Reen and Singleton (6) found that sucrose in the stalks of inbred lines of corn kernels were all dented. Data by Bernstein (1) indicate that there was no significant change in the quantities of reducing sugars during endosperm development in corn kernels. However, sucrose showed a marked increase during the first 3 weeks of endosperm development and then remained rather constant. Van Reen and Singleton (6) found that sucrose in the stalks of inbred lines of corn increased from late whorl stage through early ear development and then decreased. There were no great differences in sugar content noted between plants with or without ears until 3 or more weeks after pollination, at which time those stalks without ears increased in sucrose percentage as compared to stalks with ears. Stalks without ears also maintained their high sucrose content longer than ear-producing stalks. A study of the carbohydrates in maize by Loomis (5) indicates that glucose, fructose, sucrose, and dextrins are available for translocation from the leaf and stalks to the developing kernels. Of these compounds, sucrose appeared to be the major translocated form.

EXPERIMENTAL PROCEDURE

The major types of water soluble carbohydrates in the leaves and stalk and ears or head of the crops studied are indicated in paper chromatograms shown in Figures 1 and 2. The intensity of color and size of spot on the chromatogram also provides a rough approximation of the quantities of the various carbohydrates present.

Chromatograms of extracts from ear or head (Figure 1) indicate that the major water soluble carbohydrates present were fructose and glucose, both monosaccharides, and sucrose, a disaccharide. Maltose, a disaccharide, was present in relatively high concentration in sweet dent corn. A trace of maltose was also detected in the grain of the other crops studied. Since maltose is a product of the enzymatic hydrolysis of starch, it may have been a secondary product formed during the extraction process. However, inasmuch as there was only a trace of maltose in starchy dent corn, it may be concluded that maltose was a major component of the water soluble carbohydrates present in the ear of sweet dent corn and not a secondary product formed during the extraction process.

The data (Table 1) indicate that the ear of sweet stalk corn had the greatest content of total water soluble carbohydrates when compared to the ear or head of the other crops studied. However, there were few kernels on the cob.