STUDIES ON CARBOHYDRATE FRACTIONS IN HYBRID MAIZE AND SOME LOCAL MAIZE VARIETIES

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SECTION I

INTRODUCTION

AND

REVIEW OF LITERATURE

Maize is widely used for food, feeding, and industrial purposes. It is used primarily as a food for humans in most areas of the world. The annual world production of maize is nearly 476 billion pounds (Kent-Jones, 1957). Like all other cereals, maize is not a complete food, because its proteins are notably low in tryptophane, which may serve as a precursor of niacin, the curing agent of pellagra. On the other hand, maize contains with zein an almost equal amount of an adequate protein, namely glutelin, which is capable of supporting a normal rate of growth as shown by Osborne and Mendel (1911).

Besides its use as food, maize yields more industrial products than any other grain. It is probably the cheapest and the purest organic material of agriculture available for large scale industrial use. From the standpoint of national economy, greater use of corn in industry is needed. However, expanded industrial utilization of corn has to be attained locally such as textile, bakery, sizing of papers, plastic, detergents, and fermentation industries.

The industrial uses of maize may be divided into the main following categories :-

Dry milling processes; which utilize large quantities of maize. Its main products are corn meal and flour.

On the other hand wet milling industries are greatly interested in the starch part of the maize kernel because of its chemical and colloidal nature which make it useful for various food and industrial purposes such as bakery, plastic, paper, and textile industries (Cannon, J.A. et al, 1952). Moreover hemicelluloses in yields of 32% to 40% were extracted from commercial coarse fiber as an important by-product of the wet milling process. Corn hemicelluloses are superior to other commercial gums in regards to their high solubility, complete dispersion in water, and high tolerence for a wide range of acidity. These hemicelluloses may be used as adhesive material, or as fixing agent in textile industry (Wolf, M.J. et al, 1953). Wet milling industries produce starch, feed, syrup, sugar, oil, dextrins, and gums (pentosans). This type of milling requires strains which are high in starch, oil, and protein. Since maize contains around 70% (dry basis) starch, a variation of one or two per cent is important in large scale operations (F.A.O., 1958).

Maize is also an important raw material used by distilling industries in the production of ethanol, butanol, and acetone (F.A.O., 1958).

Thus it is obvious that conducting a survey of the chemical composition of the local maize kernels (varieties and hybrids), and of the physical properties of its constituents is highly important in order to provide information needed for the increased industrial utilization of maize.

STRUCTURE OF THE MATURE CORN KERNEL

Maize belongs to the botanical genus Zea and comprises about 507 varieties. There are, however, only two types of commercial importance, namely Zea indurata "flint corn" and Zea indentata "dent corn".

The corn grain consists of an outer hull, or pericarp (A) (Fig. 1) which is composed over most of the kernel of four layers of cells; epidermes (16), mesocarp (17), cross cells (18), and tube cells (19). The pericarp constitutes on average 5.5% of the whole grain. The basal remnants of the silk (1) are attached to the pericarp on the basal region of the grain. On the opposite side of the grain, there is the tip cap (14). The endosperm (B) which forms the major part of the corn kernel (82%), is essentially the storage tissue in which are found the nutrients and mostly consists of starch. The outermost layer of the endosperm is the aleurone layer (2) under which there is the horny endosperm (4) near the center of the kernel and under the dent is the starchy endosperm (3). The embryo or the germ (D) is situated at the base of the kernel. It forms about 11.0% - 11.5% of the grain weight and is composed of :-

1 - The scutellum (5) which is primarily a feeding organ for the germinating embryo, and forms about 10.1% of the embryo. It consists of scutellar epithelium, parenchyma, conductive tissue, and epidermis (16).

2 - The embryonic axis which is the rudimentary plant. It consists of ; epicotyl or plumule (7), coleoptile (6), primary root (11), and mesocotyl (8).

The relationship between the structural parts of the corn grain is the basis for many types of processing. Moreover, these structural parts differ in their chemical composition. Thus when they are separated in processing, the products and by-products obtained differ characteristically in their composition.

The tissues of the different regions of the corn grain are discontinuous. This discontinuity facilitates their separation during the wet milling process for the

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Chemical Composition of the Mature Corn Kernel :

The greatest portion of the carbohydrates and other constituents of maize plant are stored in the kernels. The proximate chemical composition of maize varies somewhat as a result of the effect of heredity and environment.

The average chemical composition of the maize kernel at an average of 18.5% moisture content reported by Kerr (1950) is given in Table 1.

Table 1. Chemical composition of maize kernel.

	Percent
Moisture	18.5
Starch	55.5
Crude protein	8.2
Ether extract	3.0
Ash	1.5
Crude fiber	2.4
Pentosans	5.1
Water soluble and undetermined	5.8
	100.0

The major constituents of maize kernel i.e. starch, protein, oil, and ash are distributed in the different regions of the grain as shown by Cannon, J.A. (1952) in Table 2.

Table 2. Distribution of chemical constituents in the maize kernel (per cent of total constituent, M.F.B.)

Component	Per cent			
	Hull 5.8	Endosperm 81.1	Germ 11.0	Tip cap 1.4
Carbohydrates	6.65	87.11	4.71	1.56
Starch	0.50	97.90	1.30	1.00
Protein	2.00	74.30	22.90	0.80
Oil	1.10	15.10	83.00	0.70
Ash	2.40	17.00	79.60	0.80

Porst, C.E.G. (1912) who reported an average pentosan content of 5.77% for the corn kernel, found 48.6% of the pentosan in the hull, 1.7% in the endosperm, and 8.4% in the germ. Ver Hulst, et al. (1923) reported

Endosperm Types of Maize Kernel :

Maize is extremely variable. The main types of maize kernel are; dent, sweet, flint, pop, waxy, and floury maize. These types, however, may be modified greatly by breeding and selection (F. A. O., 1958).

It was observed by Eynon, L. (1928) that the endosperm tissue of the corn kernel consists of two main regions; the crown region containing starch which is packed quite loosely in contrast to the tightly-held starch embedded in the horny regions of the endosperm. Crown starch consists primarily of round granules, while in the horny regions starch granules are smaller polygonal embedded in sheets of finely divided glutenous material. This structure makes it difficult to remove the protein coagulation completely from maize starch. This is the reason why wet milling industry claims that flinty types do not steep and process as well as softer types. The proportion of crown to horny starch and the shape of the crown region in the maize kernel are distinguishing characteristics for the different types of maize grain. In the more floury