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CORN FIBER: AN OLD BY-PRODUCT WITH A *CORN*UCOPIA OF FUTURE USES

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Abstract

Corn fiber, a byproduct of current industrial wet-milling operations, is being used in these studies as a starting material for preparation of unique carbohydrate- and lipid-based food and non-food products. Corn hull fiber (pericarp) contains approximately 65-75% carbohydrate and about 2-4% lipid. Reflecting this ratio, our focus is on developing carbohydrate products with large market potential and on (higher-valued) lipid products with small to moderate sized markets. As a result, several new products have been developed including 1) a unique, colorless, highly water soluble hemicellulose product with neutral flavor and low viscosity useful for food and non-food applications and 2) a novel "Corn Fiber Oil" containing only about 75-85% triacylglycerols, with the remainder composed of beneficial phytosterol-fatty acyl esters, tocopherols, phytosterols, and ferulate-phytosterol esters. These developments are contributing to future new uses of corn.

Key Words: Corn fiber; oil; pericarp; hemicellulose; food gums; oryzanol; ferulate phytosterol esters; nutraceuticals; industrial products.

Introduction:

Corn fiber is an abundant (4 million tons produced / year) byproduct of the corn wet milling industry. During wet milling, each bushel of corn generates approximately 6 pounds of fiber [1], representing an almost 10% yield. Several types of "fiber" streams are generated during wet milling. The kernel hull, or pericarp, is the primary component, making up roughly 5% of the kernel's weight. Many of our studies described below were performed on this fiber which has the following approximate composition:

<u>Composition of Corn Hull Fiber</u>

Hemicellulose	35 - 40%
Starch	20 - 25%
Cellulose	10 - 12%
Protein	10 - 12%
Oil	2 - 4%
Other	10 - 15%

Corn fiber has little inherent value and it's primary use is as a component of corn gluten feed (CGF) which usually sells for only 3-5 cents per pound. Because of uncertain markets for CGF and the desirability of milling more corn for the production of value-added products (including ethanol), there is a strong interest in finding new uses for corn fiber. The major component, hemicellulose, has been studied extensively (see [2] for a review) and it has been

proposed as a useful food ingredient because of its film forming, thickening, emulsifying, and stabilizing properties. Despite these attractive properties and the many documented efforts [3-6] to prepare a commercially useful corn fiber hemicellulose, no product of that type exists on the market today. This may be due in part to the undesirable dark coloration and residual "corny" flavor of products prepared in the past. While much attention has been paid to the hemicellulose and other carbohydrate components of corn fiber, no known investigation of the oil has ever been performed to date. This may be due to the low levels (2-4 wt %) of oil in the fiber and to the presumption that this oil would be similar in quality to that of regular corn oil isolated from corn germ.

Research Program Objectives

In light of the factors expressed above, our goal is to develop new carbohydrate (especially hemicellulose) and lipid-based products from corn fiber that have functional and/or nutritional properties useful for satisfying future market applications.

Initial Results

Corn fiber hemicellulose (CFH). We have successfully developed a novel procedure for preparing a purified hemicellulose B fraction from corn fiber in yields of about 35%. The process uses food-grade reagents in an alkaline medium to solubilize a CFH B fraction that is devoid of undesirable color, phenolic residues, and flavor. It is readily soluble in aqueous solutions and imparts very low viscosity (10% solution = 208 cPs). One hundred gram quantities of CFH B are readily prepared on the lab scale. Initial functional properties and compositional analysis are being conducted to determine the utility of CFH B for food gum, adhesive, and other applications. For further technical details, see the related poster abstract in this proceedings volume.

Corn fiber oil (CFO). Work on this project has established the new concept of extracting a unique oil from corn fiber, i.e. corn fiber oil. Corn fiber was extracted with hexane or supercritical CO_2 (SCF). Fiber was extracted unground and also ground to 20 and 80 mesh size. Hexane and SCF extractions gave similar yields that were proportional to the mesh size (surface area) of the fiber. Under these conditions from 0.3 to 3.3 wt% of a unique oil was extracted with the following approximate composition

APPROXIMATE COMPOSITION OF CRUDE CORN FIBER OIL (CFO)

Lipid Class	Wt% of Oil
Triacylglycerols	77 - 82%
Phytosterol-FA esters	8 - 10%
Free Fatty Acids	<3%
Phytosterols	1 - 3%
Ferulate-Phytosterol Esters	6 - 7%

Unlike typical corn oil extracted from corn germ, CFO contains significant quantities of

additional phytosterol-fatty acid esters, free phytosterols, and ferulate-phytosterol esters. All three of these natural products have potential to provide beneficial changes in serum cholesterol levels when they are consumed in the diet. Ferulate-phytosterol esters (sometimes called "oryzanols") are thought to be responsible for the serum cholesterol lowering effect seen in humans consuming rice bran oil [7]. It is noteworthy that the levels of these ferulate-phytosterol esters are three to four times higher in CFO than that reported for rice bran oil. In addition, the phytosterol portion of CFO is different from that of rice bran oil and may impart additional beneficial properties. Our initial feeding studies of CFO in a recognized hamster model system have provided positive results. Results of these studies and additional technical information can be found in the related abstract in this proceedings volume.

Patent Status

CFO composition of matter, preparation, and use patent filed.
CFH B patents in preparation.

Future Goals

Scale-up of lab scale processes. As these technologies advance, both processes for CFH B and CFO will be scaled up to kg scale by collaboration with Engineering researchers at the Eastern Regional Research Center (ERRC,ARS,USDA Wyndmoor), the Southern Regional Research Center (SRRC, ARS, USDA, New Orleans), and at selected industry locations.

Targeting Specific Markets.

Future Corn Fiber Hemicellulose applications include use as a food gum, emulsifier, film former, and nutraceutical food ingredient. Industrial uses include paint thickeners, adhesives, and coating ingredients.

Corn Fiber Oil will be fully characterized as a cholesterol lowering ingredient. Future markets include nutraceutical products and specialty food oils. Fortification of regular corn oil to upgrade value and health promoting benefits will have positive effects on the large corn oil market and have an even greater impact on corn growers and processors than sales of CFO alone. The unique ferulate-phytosterol esters in CFO are also being evaluated for agricultural chemical and pharmacological applications.

To ensure that all potential markets are examined, additional samples will be tested in-house and with outside collaborators to investigate new biological properties and to develop alternative food and non-food uses. Samples may be made available to other interested parties through Material Transfer Agreements or other Technology Transfer mechanisms.

Cost Analysis. Through collaboration with the cost engineering program in ERRC's Engineering Science Research Unit, processes are being analyzed and modified to generate cost-effective approaches to produce corn fiber oil and hemicellulose products. This adds a new dimension of industrial relevance to our publicly funded research program.

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