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THE OCCURRENCE AND BIOLOGICAL ACTIVITY OF FERULATE-PHYTOSTEROL ESTERS IN CORN FIBER AND CORN FIBER OIL

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1. Summary

Corn fiber is a pericarp-rich fraction obtained during the processing of corn via "wet-milling." Wet milling of corn is used by all companies that produce corn starch and corn sweeteners, and by many companies that produce fuel ethanol from corn. All commercial "corn oil" is prepared by the extraction of only the germ fraction of the kernel. In contrast, extraction of corn fiber with hexane yielded an oil (comprising about 1.2 wt% of the fiber) which we termed "corn fiber oil." This oil contained ferulate-phytosterol esters, similar in structure to "oryzanol," a cholesterol-lowering substance found in rice bran and rice bran oil. The oil extracted from corn fiber contained high levels of ferulate-phytosterol esters (6.0 wt%), which is about 4-fold higher than their levels in rice bran oil. Corn fiber oil also contains free phytosterols (2.2 wt%) and phytosterol fatty acyl esters (6.8 wt%).

2. Introduction

Norton (1995) and Seitz (1989) reported that hexane extraction of corn bran produced an extract that contained high levels of ferulate-phytosterol esters, similar in composition to "oryzanol" found in rice bran and rice bran oil. Oryzanol has been shown to lower the levels of serum cholesterol in laboratory animals and man (Kahlon et al., 1992 and Nicolosi et al., 1991). We recently reported that an oil containing high levels of ferulate-phytosterol esters was extracted from corn fiber by hexane and supercritical CO₂ (Moreau et al., 1996). The present study was undertaken to investigate the quantities of oil and composition of oil obtained from "white fiber," a wet milling product that is partially dried before being mixed with steepwater and dried to yield corn glutea feed.

Corn fiber oil (crude) was prepared by shaking 4g common corn fiber ("white fiber from yellow dent #2 corn supplied by Cargill Inc., Dayton, OH) ground to 20 mesh with a Wiley Mill (Thomas Scientific, Philadelphia, PA), with 40 ml hexane, in a 55ml screw-top tube for 1h. The lipid extract was then filtered through a 5.5 cm Whatman (Clinton, NJ) GF/A, glass microfiber filter and injected directly into the HPLC.

The HPLC system used for the separation of nonpolar lipid classes consisted of a Hewlett Packard (Avondale, PA, USA) Model 1050 ternary gradient system (HPLC pump, autosampler, and UV/visible detector), and an Alltech-Varex Mark III ELSD (Alltech Associates, Deerfield, IL). The column was a LiChrosorb DIOL, 5 μ m, (3 x 100 mm from Chrompack, Inc., Raritan, NJ), and the flow rate was 0.5 ml/min. The solvents were: A, hexane/acetic acid, 1000/1, v/v; and B, hexane/isopropanol, 100/1, v/v. (Both were mixed fresh daily to eliminate variability caused by evaporation and/or absorption of moisture). The linear gradient timetable was: At 0 min, 100/0; at 8 min, 100/0; at 10 min, 75/25; at 40 min, 75/25; at 41 min, 100/0; at 60 min, 100/0; (%A/%B, respectively).

4. Results and Discussion

Hexane extraction of ground fiber yielded an oil that comprised about 1.2 wt% of oil from the fiber. The levels of hexane-extractable oil in samples of ground fiber from other wet milling plants ranged from 0.54 to 3.68 wt% (Moreau et al, 1996). HPLC-ELSD analysis of the corn fiber oil (Figure 1) revealed the following components: phytosterol-fatty acyl esters (6.75 wt%), triacylglycerols (79.14 wt%), free fatty acids (4.45 wt%), *p*-coumarate-phytosterol esters (<0.1 wt%), γ -tocopherol (<0.1 wt%), free phytosterols (2.21 wt%), 1,2-diacylglycerols (0.64 wt%), ferulate-phytosterol esters (6.04 wt%), 1,2-diacylglycerols (0.77 wt%).

Norton (1995) reported that the most abundant ferulate-phytosterol ester in corn pericarps is sitostanyl-ferulate (Figure 1). Free sitostanol is more effective at lowering serum cholesterol than other phytosterols (Vanhanen et al, 1993). In contrast oryzanol, the cholesterol-lowering ferulate-phytosterol ester fraction that comprises about 1.5% of rice bran oil is comprised mainly of cycloartenyl-ferulate (Kahlon et al, 1992). We have recently conducted preliminary hamster-feeding studies and verified that corn fiber oil is at least as effective as rice bran oil in lowering serum total and LDL cholesterol, and we now plan to conduct similar studies with purified ferulate-phytosterol ester from corn fiber oil.

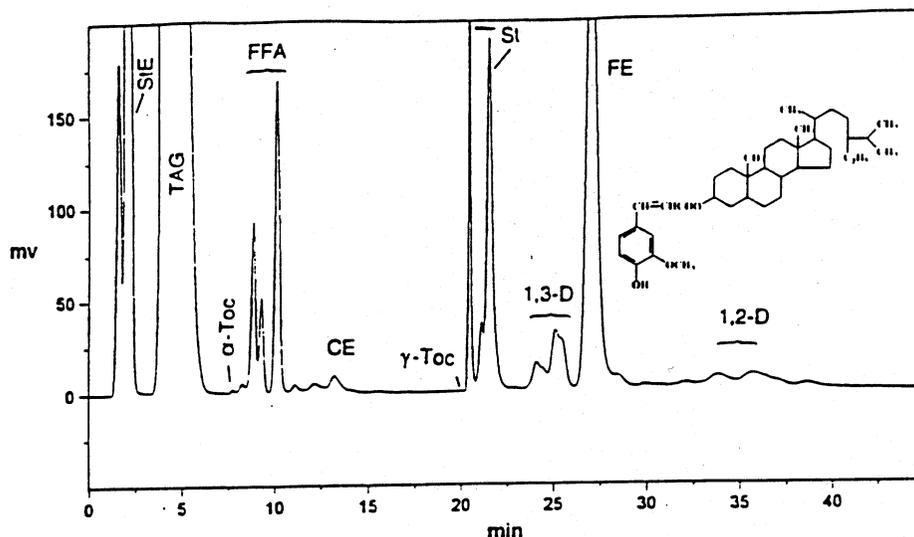


Figure 1. HPLC-ELSD chromatogram of corn fiber oil. Insert shows the structure of sitostanyl-ferulate, the major ferulate-phytosterol ester in corn fiber oil (Norton, 1995). Abbreviations: StE, phytosterol fatty acyl ester; TAG, triacylglycerol, α -Toc, α -tocopherol; FFA, free fatty acids; CE, *p*-coumarate-phytosterol esters; γ -Toc, γ -tocopherol; ST, free phytosterols; 1,3-D, 1,2-diacylglycerols; FE, ferulate-phytosterol esters; 1,2-D, 1,2-diacylglycerols.

5. References

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