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CORNCOBS AS A SOURCE OF DIETARY FIBER

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The aim of this study was to determine the proximate composition, contents of individual fractions of dietary fiber and selected physicochemical properties of a fiber concentrate produced from corncobs.

Dried and ground corncobs exhibited high total dietary fiber content (about 90 g/100 g d.m.), including a high share of hemicelluloses and cellulose. The analysed preparation exhibited also relatively high water holding capacity and high oil absorption ability.

The composition and analysed properties of the novel maize fiber concentrate indicate its potential application as a dietary supplement in the production of highfiber foodstuffs and in the production of highfiber mixes with specific physiological effects.

INTRODUCTION

Clinical, epidemiological and experimental studies conducted for many years now indicate ways to prevent civilization-related diseases. Apart from a change in lifestyle and diet, this may be promoted by including greater amounts of dietary fiber in the diet. Increased consumption of fiber may be ensured not only by a more frequent use of natural products abundant in this component, but also by its addition to individual dishes or direct consumption of special high-fiber preparation. The availability of the latter on the Polish market is still unsatisfactory, with a shortage of preparations with a precisely defined physiological effect, which could be effectively used in the prevention and treatment of specific diseases.

In this situation, it is advisable to search for new sources of dietary fiber, which could be produced from waste products of the Polish agricultural and food sector.

This study attempted to characterise a novel source of dietary fiber, *i.e.* corncobs, in terms of their proximate chemical composition, dietary fiber fraction and selected physicochemical properties.

MATERIALS AND METHODS

Maize material was obtained by drying, comminuting and grinding dry corncob cores. Cobs of mixed different maize cultivars were obtained from the Swadzim Agricultural Experimental Station of the Poznan University of Life Sciences.

Experimental material consisted of dry corncobs harvested in the years 1991, 2002, 2003 and 2004. Corncobs were subjected to several stages of grinding until mean particle size of approx. 100 mcm was reached.

The proximate composition, *i.e.* contents of protein, fat and ash were assayed using standard methods. Contents of soluble dietary fiber (SDF), insoluble dietary fiber (IDF) and total dietary fiber (TDF), calculated from the sum of the above, were assayed using ash-free enzymatic method by Asp, following Polish Standard [PNA7901115, 1998], while detergent fiber fractions, *i.e.* Neutral Detergent Fibre (NDF), Detergent Hemicellulose (DH), Acid Detergent Lignin (ADL) and Acid Detergent Cellulose (ADC) were assayed according to Van Soest [1963] with modifications [McQueen & Nicholson, 1979].

Water holding capacity by dietary fiber contained in the preparations was determined according to McConnel *et al.* [1974], under conditions imitating those in the stomach (pH 1.8) and the duodenum (pH 8.7) [Górecka, 2004]. Moreover, oil absorption capacity was determined according to Caprez [1986].

Analytical determinations were performed in at least three independent replications and the results were provided per dry matter basis. A one-way analysis of variance was conducted using the Scheffe's test with the Statistica® computer software.

RESULTS

Results of determinations of the proximate composition of ground corncobs from different years, especially the content and composition of dietary fiber, and results of determinations of selected physicochemical properties of these preparations are presented in Table 1.

High-fiber preparations produced from ground dry corncobs harvested in different years show slight and statistically non-significant differences in contents of protein, fat and ash.

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TABLE 1. Proximate composition of ground corncobs harvested in different years and their selected physico-chemical properties (mean ± SD).

Year of harvest	1991	2002	2003	2004
Protein (g/100 g d.m.)	2.85±0.26	2.91±0.31	3.22±0.18	2.85±0.38
Fat (g/100 g d.m.)	0.59±0.05	0.53±0.12	0.48±0.02	0.57±0.05
Ash (g/100 g d.m.)	1.50±0.17	1.69±0.34	1.56±0.03	1.72±0.05
TDF (g/100 g d.m.)	93.21±1.58^{b}	91.18±1.31^{ab}	91.85±0.59^{ab}	89.96±1.46^{a}
SDF (g/100 g d.m.)	2.17±0.37^{c}	1.55±0.07^{b}	1.06±0.13^{ab}	0.78±0.08^{a}
NDF (g/100 g d.m.)	87.02±0.83^{a}	86.02±0.13^{a}	88.80±0.18^{b}	86.13±1.00^{a}
DH (Hemicellulose; g/100 g d.m.)	43.99±1.56	45.97±0.98	46.01±0.53	43.54±0.92
ADL (Lignin; g/100 g d.m.)	6.39±0.95^{b}	3.84±0.39^{a}	3.97±0.22^{a}	3.20±0.33^{a}
ADC (Cellulose; g/100 g d.m.)	35.43±1.03^{a}	36.21±0.72^{a}	38.82±0.50^{b}	39.37±0.25^{b}
Water holding capacity (g/g d.m.) pH 1.8	4.15±0.55^{b}	3.23±0.09^{ab}	2.53±0.13^{ab}	3.36±0.45^{a}
Water holding capacity (g/g d.m.) pH 8.7	4.41±0.44^{b}	3.39±0.20^{a}	2.76±0.36^{a}	3.17±0.20^{a}
Oil absorption capacity (g/g d.m. DM)	1.98± 0.14	2.12±0.06	1.93±0.08	1.78±0.02

a, b, c – group means for different sources, marked with different letters are significantly different at $p<0.05$ (Scheffe test).

They have high contents of total dietary fiber (TDF) ranging from 89.9 to 93.2 g/100 g d.m. and neutral detergent fiber (NDF) ranging from 86.0 to 88.8 g/100 g. Primary fiber fractions in the preparations are hemicelluloses (43.5-46.0 g/100 g) and cellulose (35.4-39.4 g/100 g).

Preparations produced from corncobs harvested in different years differed slightly in fiber content and composition. These differences were not found in the case of the primary fiber component, *i.e.* hemicelluloses, while the others were statistically significant, but too minor to be able to significantly affect biological properties of these preparations.

All preparations analysed showed high water holding capacity in both analysed medium reactions, with a slightly higher ($p<0.001$) capacity found for the preparation from 1991.

DISCUSSION

The primary raw material for the production of leading high-fiber cereal preparations is bran. Oat, wheat, barley, rice and corn bran is used to this end. Sometimes additionally such other sources of cereal fiber are used as straw and glumes, as well as whole ears of corn [McKee & Latner, 2000].

Maize, due to its popularity and large scale cultivation, especially in the USA, has been the subject of numerous literature reports on the potential application of its different parts in the production of dietary fiber preparations. Most frequently corn bran is used, obtained as a by-product during wet milling of kernels [Anderson, 1985]. Gould & Dexter [1991] suggested also a possibility of obtaining fiber from stems (corn straw) and whole ears of corn. Whole ears of corn are also commonly used to produce ground grain and silage in feeding farm animals [Beck & Rödel, 1986; Depies & Armentano, 1995]. However, no reports are found on the use of corncobs in human nutrition.

Corncobs are used in furfural production (50% of all furfural production is from corncobs) [Kadam & McMillan, 2003], in the production of dyes [Robinson *et al*., 2002] and metal ion adsorbents [Vaughan *et al*., 2001], as well as carbonaceous adsorbents [Tseng & Tseng, 2005].

As it was shown in this study, corncobs are suitable for the production of high-fiber preparations due to the high content of fiber (especially of its insoluble fractions). Considerable availability of the material, the fact that they may be easily obtained and processed, together with high keeping quality of dried corncobs also need to be mentioned here.

Additionally, we need to point to our unpublished results of determinations made for contents of mercury, lead and cadmium in high-fiber preparations obtained from the harvests of 1991. They showed much lower heavy metal contents in the preparation from corncobs in comparison to wheat bran and apple and raspberry pulp. This may indicate their relatively low contamination with dust and heavy metals, probably resulting from the fact that ears of corn throughout plant vegetation are naturally covered by kernels and husks, in contrast to cereal grain, from which bran is produced.

Detailed data on the fraction composition of dietary fiber in the analysed preparations and their water and oil holding capacity make it possible to forecast their biological effect on the organism. The application of the presented new high-fiber preparation as a dietary additive and in the production of foodstuffs, due to the high content of insoluble dietary fiber, may result in reduced energy value of meals and affect the sensation of stomach filling, thus inhibiting the sensation of hunger and lowering energy consumption. Due to the high share of cellulose, this preparation may also prove helpful in the treatment of such diseases of the alimentary tract as constipation, digestive tract diverticulosis, hemorrhoids, gastric and duodenal ulcers, as well as colon cancer [Hasik *et al*., 1997; Suter, 2005].

High water holding capacity of the analysed preparations in both medium reactions confirms their capacity of swelling and inhibiting the sensation of hunger, as well as affecting peristalsis [Hasik *et al*., 1997]. In turn, oil holding capacity indicates the capacity to bind cholic acids and cholesterol in the alimentary tract and secrete them with feces, thus leading to reduced blood cholesterol level [Ebihara & Nakamoto, 2001].

CONCLUSIONS

1. Ground corncobs, being a concentrated source of dietary fiber, exhibit high contents of hemicelluloses and cellulose, as well as capacity to bind water and oil.

2. Corncobs may be used both as food additives and in the production of high-fiber mixtures with action designed to affect alimentary tract functions and slimming.

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