NOTE

Simple Dry Fractionation of Corn Distillers' Dried Grains and Corn Distillers' Dried Grains with Solubles

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Corn is the major cereal grain used for making ethanol by fermentation (Morris 1983). Stillage, the residue remaining after ethanol is distilled, can be separated to yield a solid and a soluble fraction. Usually, the soluble fraction is concentrated and combined with the wet solids, which then are dried as corn distillers' dried grains with solubles (CDGS). Some corn distillers' dried grains (CDG) and corn distillers' dried solubles (CDS) are also produced. CDG flours have been incorporated into cookies (Tsen et al 1982) and into bread (Tsen et al 1983), and CDG has been evaluated in blended foods for overseas donation programs (Wall et al 1984, Bookwalter et al 1984). The high fiber content of CDG, however, limits the amount that can be put in blended foods. Dry-milling and sieving of CDG produced a fine fraction with reduced fiber content and elevated protein level (Wu and Stringfellow 1982). The highest protein shifts were obtained where CDGS at 21% moisture was pin-milled twice at 14,000 rpm, and CDG at 21% moisture was pin-milled once at 14,000 rpm (Wu and Stringfellow 1982). This paper reports a simpler procedure for fractionating CDG and CDGS by screening. The resulting fine fraction has reduced fiber content and elevated protein level and is produced without grinding or moisture adjustment of CDG before screening. Proximate compositions of screened CDG and CDGS fractions are also reported.

MATERIALS AND METHODS

CDG and CDGS at 5.8 and 6.0% moisture, respectively, were supplied by Brown-Forman Distillers Corp. (Louisville, KY). Both CDG and CDGS were sieved without moisture adjustment with 20-, 35-, 50-, and 80-mesh U.S. standard screens. An 18-mesh screen instead of 20-mesh was used for a 100-lb lot of CDG. Openings of the 20-, 35-, 50-, and 80-mesh screens are 841, 500, 297, and 177 μm, respectively.

Protein, fat, ash, and crude fiber contents were determined by AACC methods (1976). Moisture was determined by heating samples at 105°C to constant weight. Protein content (nitrogen ×6.25) was the average of three micro-Kjeldahl nitrogen analyses. Fat, ash, and moisture determinations were in duplicate. Dietary fiber—the sum of cellulose, lignin, and water-insoluble hemicellulose—was determined from the neutral detergent method (McQueen and Nicholson 1979), whereas crude fiber measured cellulose only. Samples containing 1 mg of nitrogen for amino acid analyses were hydrolyzed for 24 hr by refluxing in 6*N* hydrochloric acid. Hydrolyzed samples were evaporated to dryness in a rotoevaporator and residues dissolved in pH 2.2 citrate buffer. A portion of the acid hydrolysates was analyzed in a Dionex D300 amino acid analyzer (Dionex Corp., Sunnyvale, CA), and the data were evaluated using a computer (Cavins and Friedman 1968).

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RESULTS AND DISCUSSION

Yield and Composition

The yield, protein, fat, ash, crude fiber, and neutral detergent fiber contents of CDG fractions obtained by screening whole CDG are listed in Table I. One pound of CDG was first separated by 20-, 25-, 30-, 35-, 50-, and 80-mesh screens. Protein content increased and crude fiber decreased as particle size decreased (higher mesh screen number). Fat and ash contents showed little variation with mesh size.

Because some of the fractions were quite small, three screens were chosen to separate 100 lb of CDG. The same trend was observed as for six-screen separations. Neutral detergent fiber and crude fiber contents of screened CDG fractions decreased with decreasing particle size. Neutral detergent fiber values are three to four times the crude fiber contents. The through-35-mesh fraction accounted for 36% of CDG and had an enriched protein level (38.9%) and lower crude fiber and neutral detergent fiber values

TABLE I
Yield and Composition of Screened Corn Distillers' Dried Grains (CDG) Fractions (Dry Basis)[a]

Mesh	Yield, % of CDG	Content, % Protein	Fat	Ash	Crude Fiber	NDF[b]
CDG		26.0	9.5	1.7	17.0	57.9
on 20	29	14.5	9.3	1.8	22.4	nd[c]
20-25	8	15.6	8.8	1.7		
25-30	16	21.8	8.9	1.4	17.6 (20-35)	nd
30-35	8	26.6	9.5	1.3		
35-50	21	29.3	9.0	1.4	13.1	nd
50-80	14	42.1	8.4	1.5	10.1	nd
Through 80	3	49.3	9.1	2.4	nd	nd
on 18	20	15.8	9.2	1.8	22.3	71.3
18-25	26	16.8	8.4	1.6	18.6	68.1
25-35	18	25.1	9.4	1.5	15.9	58.3
Through 35	36	38.9	10.6	1.7	13.4	42.8

[a]Data above dotted line were from a 1-lb sample out of a 100-lb bag, and data below dotted line were from an entire 100-lb bag.
[b]NDF = neutral detergent fiber.
[c]nd = not determined.

TABLE II
Yield and Composition of Screened Corn Distillers' Dried Grains with Solubles (CDGS) Fractions (Dry Basis)

Mesh	Yield, %	Content, % Protein	Fat	Ash	NDF[a]
CDGS		29.5	9.3	4.4	40.8
on 20	13	16.9	12.0	2.0	62.5
20-35	22	19.8	10.9	2.6	58.3
35-50	17	31.3	10.6	4.1	43.6
50-80	32	36.5	7.4	5.9	29.7
Through 80	16	36.8	7.6	6.5	18.1

[a]NDF = neutral detergent fiber.

compared to coarser fractions. Some slight difference in sized fraction yields occurred between 1-lb and 100-lb samples. The results for the 100-lb lot are likely more representative because of lower sampling uncertainty or stratification of material upon shipping.

Protein shift is a calculated value to compare protein enrichment. It is defined as the sum of the amount of protein shifted into the high-protein fractions and out of low-protein fractions as a percentage of the total protein present in the starting material (Gracza 1959). The protein shift values for both the 1-lb and 100-lb samples are 36%. The highest protein shift was obtained for CDG (39%) at 21% moisture and pin-milled once at 14,000 rpm (Wu and Stringfellow 1982). Thus, almost the same protein shift value for CDG can be obtained by screening alone, with no moisture adjustment or milling.

Table II shows the yield and composition of fractions obtained from screening 1 lb of whole CDGS. Protein and ash contents increased, and lipid and neutral detergent fiber contents decreased as particle size decreased (higher screen number). The CDS has higher ash content than CDG (National Research Council 1956). The increasing ash content of CDGS fractions as particle size decreased indicated that finer fractions are richer in CDS than the coarser fractions. The protein shift value for CDGS fractions (Table II) was 25%. In comparison, the maximum protein shift for CDGS was 50% when CDGS at 21% moisture was pin-milled twice at 14,000 rpm (Wu and Stringfellow 1982). Apparently, the presence of solubles causes CDGS to behave differently than CDG in terms of screening, milling, and moisture effect on milling.

Amino Acid Composition

The amino acid compositions of CDG and its screened fractions show no large differences, and are similar to those reported earlier (Wu and Stringfellow 1982). Because no large difference in amino acid compositions of screened fractions was observed for CDG or for CDG and CDGS dry-milled fractions (Wu and Stringfellow 1982), amino acid composition for CDGS sieved fractions was not determined.

CONCLUSION

Simple screening of CDG and CDGS gave small particle size fractions enriched in protein and low in fiber, as compared with original materials. Better protein separation was observed for CDG than CDGS. A simple separation of CDG and CDGS with a 35-mesh screen gave fine fractions with substantially higher protein content, as well as lower fiber value compared with the starting materials. In addition, protein shift by sieving CDG was equivalent to that achieved by a more complex dry-milling procedure (Wu and Stringfellow 1982). Fractions with a wide range of protein and fiber contents may increase the potential of CDG and CDGS for food applications. For example, the through-35-mesh fraction from CDG may be a valuable food additive because of its high protein and lower fiber contents, whereas coarser fractions may be used in high-fiber food. Further process studies to improve the flavor of CDG by a cost-effective method will be reported in subsequent work.

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