Enriched Protein- and β-Glucan Fractions from High-Protein Oats by Air Classification

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ABSTRACT

High-protein oat groats were defatted once (1X) or three times (3X) and air-classified. The protein contents of the 1X and 3X defatted materials were 23.4 and 23.5%, respectively; the combined high-protein fine fractions from air classification had protein contents of 30.1 and 32.7%. These fractions accounted for 21 and 24% of the weight (and for 27 and 33% of the total protein) of the 1X and 3X defatted groats, respectively. The coarse residue fraction (>30 μm) from air classification of 1X and 3X defatted groats had β-glucan contents of 16.9 and 17.7%, respectively, compared with 6.1-6.2% in the original defatted groats. These coarse residue fractions accounted for 30 and 28% weight and 82% of total β-glucan of the 1X and 3X defatted groats, respectively. Useful protein shifting was 25% for the 1X and 30% for the 3X defatted groats. Useful β-glucan shifting was 104% for the 1X and 107% for the 3X defatted groats. Air classification of high-protein oat groats may have commercial potential for producing protein concentrate and enriched β-glucan fraction in a single process.

Materials and Methods

Preparation of Defatted Oat Groats

Otee oats, lot number WM-DM-2, (23.5% protein, db) are high-protein spring oats developed cooperatively by the Illinois Agricul-

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Nonwheat Grains and Products

This article describes the enrichment of protein and β-glucan from high-protein oats by air classification.
RESULTS AND DISCUSSION

Air Classification

Yield, starch, protein, β-glucan, fat, and ash contents of 1X and 3X defatted Otee groats after air classification are given in Table I. Yield data for each fraction was rounded off to the nearest percent. Otee groats had 7.8% fat (db) (not shown in Table I). More than 50% of this fat was removed by defatting once with hexane.

The 1X defatted groats had 23.4% protein. Fraction 3B had the highest starch content (67%) among the five major fractions 1B through 5B, and fraction 5B had the lowest starch content (15%). Fractions 1B and 4B had lower starch content than fractions 2B and 3B. Fractions 1B and 5B had higher protein content than the groats, and fractions 3B and 4B were lower in protein. Although the fractions 1B and 5B had similar high-protein contents, they were not identical. Fraction 1B had very fine soft particles and was considerably lower in both ash and fat as compared to the coarse hard particles in fraction 5B. The largest fraction by weight was fraction 5B, which accounted for almost a third of the groats weight. It is unusual to find an increase in protein for coarse residue, although similar results were observed with fractionated sorghum flour (Stringfellow and Peplinski 1966). For wheat flour, coarse residue protein value approaches that of the starting flour (Peplinski et al. 1964, Stringfellow and Peplinski 1964, ). Fractions 1A and 2A-5A, ultra-fine material collected in low yield from the exhaust air bag, had 80-81% protein. β-Glucan contents increased with increasing particle size from fractions 1B to 5B, and there was a large increase in β-glucan content between fractions 4B and 5B. Fraction 5B had higher ash and fat contents than the 1X defatted groats, but other fractions had lower ash and fat contents.

The air-classified fractions from 3X defatted groats (Table I) followed the same general pattern as the 1X defatted groats. However, fractions from the lower fat groats gave lower protein content for fractions 2B-3B. β-Glucan content of fractions 4B and 5B were higher than the corresponding fractions from 1X defatted groats.

Combined high-protein fractions of both the 1X and 3X defatted groats are compared with the coarse high β-glucan fraction in Table II. The combined high-protein fine fractions from 1X defatted groats had a protein content of 30.2% and accounted for 21% of the groats weight and 34% of the total protein. The corresponding combined high-protein fine fractions from 3X defatted groats had a protein content of 32.5% and accounted for 24% of the weight and 33% of the total protein.

The coarse residue fractions had higher protein contents than the groats and accounted for 28% and 30% of the weight and 34-36% of the total protein of the groats (Table II). The coarse residue fraction had much higher β-glucan contents than the groats (16.9-17.7% vs. 6.1-6.2%) and accounted for 82% of the total β-glucan of the groats.

The yield, amount of total protein, and amount of total β-glucan of the combined fractions 2B, 3B, and 4B (not included in Table II because they were lower in both protein and β-glucan than the starting material) can be readily obtained by subtracting the sum of combined high-protein fine fractions 1A, 2A-5A, 1B, and coarse residue fraction 5B from 100%.

Useful Protein Shifting and β-Glucan Shifting

Useful protein shifting of 1X defatted groats was 25%. The 3X defatted groats had an useful protein shifting of 30% (Table II). For comparison, the useful protein shifting of Garland defatted groats with 1.4% fat was 37% (Wu and Stringfellow 1973).

When material with 10% initial β-glucan content was separated by air classification into fraction 1 with 33.3% yield and 30% of β-glucan content and fraction 2 with 66.7% yield and zero β-glucan content, the β-glucan shifting was 133%. A useful β-glucan shifting value of more than 100% is thus possible. Our useful β-glucan shifting values of 104 and 107% in Table II showed that air classification of defatted Otee groats was an excellent method to yield enriched β-glucan fraction.

Amino Acid Composition

Combined high-protein fine fractions 1A, 2A-5A, 1B, (21-24% yield of defatted groats) may have potential as a protein
concentrate in human food. To evaluate the nutritional value of these fractions, the essential amino acid composition of 3X defatted Otee groats and air-classified fractions are compared with the recommended amino acid pattern (WHO 1985) for preschool child (2–5 years) and a school child (10–12 years) in Table III. The essential amino acid composition of 1X defatted Otee groats and air-classified fractions were very similar to 3X and are not shown. The air-classified fractions had very similar amino acid composition when compared with the groats. Although Otee groats had much higher lysine content than most cereals, they were still deficient in lysine when compared with the WHO recommendation for a preschool child, although adequate for school age child. Other essential amino acids of these fractions, however, met or exceeded the WHO recommendation for children.

**CONCLUSION**

Air classification of 1X defatted high-protein oat groats may have commercial potential for producing protein concentrate and enriched β-glucan fraction in a single process. However, air classification of the 3X defatted oat groats resulted in only moderate increase of total initial protein in the combined high-protein fractions, but no increase in the amount of total β-glucan in the high β-glucan fraction. It appeared that air classification of 3X defatted groats led to little worthwhile gain over 1X defatted material.

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**LITERATURE CITED**


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