Chemical Characterization and Functionality Assessment of Protein Concentrates from Oats[1]

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ABSTRACT

Protein concentrates were prepared by alkali extraction from ground groats of Hinoat and Sentinel oat. The concentrates contained 60–70% protein and had a balanced amino acid composition. Globulins comprised the major protein fraction in the concentrates, constituting about 50% of the total protein. Gel filtration and sodium dodecyl sulfate-polyacrylamide gel electrophoresis showed the presence of two major protein subunits in the concentrates, with molecular weights of about 37,000 and 22,000. Isoelectric focusing revealed a complex pattern for the concentrates and the Osborne fractions prepared from the concentrates. Several functional properties of the concentrates, including solubility, emulsification properties, hydration and fat-binding capacities, and foaming properties were assessed and compared favorably with gluten and soy isolate.

There is a constant world demand for less expensive proteins with good nutritional and functional properties (Burrows et al 1972, Hammonds and Call 1972). Although oat provides a potential source of low-cost proteins with good nutritive value (Hischke et al 1968), it is used primarily as an animal feed. This could be partly due to a lack of information on the physicochemical and functional characteristics of oat proteins. Protein concentrates and isolates have been prepared from oat by various procedures (Bell et al 1978; Cluskey et al 1973, 1978; Wu and Stringfellow 1973; Youngs 1974). However, information on these products is limited to chemical composition and description of a few functional properties (Wu and Stringfellow 1973). In this work, protein concentrates were prepared from a high- and a moderate-protein oat cultivar, Hinoat and Sentinel, respectively, by a wet-milling process similar to that described by Cluskey et al (1973). The extracted proteins were characterized by biochemical techniques, and the functional properties were assessed in detail to evaluate the potential of the oat protein concentrates as a food ingredient.

MATERIALS AND METHODS

The two oat varieties, Hinoat and Sentinel, were grown on the Central Experimental Farm, Ottawa, Ont., Canada, in 1978 and 1980, respectively.

Preparation of Protein Concentrates

The oats were dehulled and ground, and portions of the ground groats were defatted by Soxhlet extraction with hexane. The groats were extracted with NaOH at different strengths (0.005–0.05*N*). The groats were mixed with the solvent at various groat–solvent ratios and stirred at room temperature for 1 hr. The slurry was either centrifuged directly or filtered through cheesecloth to separate the bran, followed by centrifugation at 4,000 × *g* for 10 min. The supernatant was neutralized with 2*N* HCl and freeze-dried to yield the protein concentrate. The residue was also neutralized with 2*N* HCl and freeze-dried to yield the starch fraction. The residue on the cheesecloth was also dried and designated the bran fraction.

Chemical Analyses

Nitrogen contents were determined by micro-Kjeldahl analysis (Concon and Soltess 1973). A nitrogen to protein conversion factor of 6.25 was used, and the protein contents were expressed as percentages of the sample dry weight. The phenol-sulfuric acid method (Dubois et al 1956) was used to estimate the total carbohydrate content. Starch determinations were performed by an enzymatic procedure described by Banks et al (1970). The gum, or β-glucan content was estimated by a fluorescent dye technique (Wood 1980). Moisture, ash, and fat contents were determined by approved AACC methods (1971).

Amino acid analyses were performed by hydrolyzing the samples with toluenesulfonic acid according to the method of Liu and Chang (1971), and fractionating the hydrolysates by a Beckman model 121M analyzer.

Osborne Fractionation of Protein Concentrates

The protein concentrates from the defatted groats were fractionated according to the Osborne scheme (Osborne and Mendel 1914), using successively, water, 0.5*M* $CaCl_2$, 70% ethanol, and 0.05*N* NaOH as solvents. A solvent–solid ratio of 10:1 was employed in all cases.

Gel Filtration Chromatography

Gel filtration chromatography of the oat proteins was performed on a 2.5 × 90 cm column of Sephacryl S-200 (Pharmacia Fine Chemicals, Uppsala, Sweden). The buffer used was an AUC solution (0.1*M* acetic acid, 3*M* urea, and 0.1*M* hexadecyltrimethylammonium bromide) (Meredith and Wren 1966). The column was calibrated with standard proteins of known molecular weight, including human γ-globulin, bovine serum albumin, ovalbumin, trypsin inhibitor, and cytochrome C.

SDS-PAGE

Polyacrylamide gel electrophoresis (PAGE) in sodium dodecyl sulfate (SDS) was performed on 7.5% (w/w) gels in a flatbed LKB Multiphor system, using 0.05*M* imidazole buffer (Fehrnstrom and Moberg 1977). The sample buffer contained 3*M* urea and 1% mercaptoethanol. A constant current of 80 mA was applied, and the time of electrophoresis was approximately 2.5 hr. The gels were fixed in 10% trichloroacetic acid for 1 hr and stained with Coomassie brilliant blue R-250 for 2 hr. A calibration kit (Pharmacia Fine Chemicals, Uppsala, Sweden) containing six standard proteins with subunit molecular weight ranging from 14,400 to 94,000 was used for molecular weight determination.

Isoelectric Focusing (IEF)

IEF was performed on LKB Ampholine PAGplate (pH 3.5–9.5). A constant power of 25 W was maintained, and the run was performed at 10° C for 1.5 hr. The pH gradient was determined using an IEF calibration kit (Pharmacia Fine Chemicals, Uppsala, Sweden) containing 11 standard proteins with known isoelectric points (pI) ranging from pH 3.50 to pH 9.30. The plates were stained by the method of Righetti and Drysdall (1974).

Functional Properties

Solubility was determined in 1% (w/w) dispersions in distilled water. The protein dispersions were magnetically stirred at room temperature for 20 min, and the pH was adjusted with 1*N* NaOH or HCl to values between 1.5 and 11.0. After centrifugation at 10,000

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× g for 30 min, the supernatant was analyzed for nitrogen by the micro-Kjeldahl method.

A turbidimetric method (Pearce and Kinsella 1978) was used to determine the emulsifying properties of the oat protein concentrates. Water hydration capacity (WHC) was determined according to the method of Quinn and Paton (1979). The method for determining fat-binding capacity (FBC) was that described by Lin et al (1974). The foaming capacity and stability were assessed by the procedure of Yatsumatsu et al (1972).

RESULTS AND DISCUSSION

Preparation of Oat Protein Concentrates

Protein concentrates were prepared from Hinoat and Sentinel groats by alkali extraction similar to the wet-milling procedure described previously (Cluskey et al 1973). For Hinoat groats, the amount of protein extracted was found to increase progressively with increase in alkali concentration and pH (Table I), and no optimal pH for extraction was found as previously reported (Cluskey et al 1973). However, at pH above 10.5, browning of the extract became apparent, and viscosity in extracts also began to increase. Similar results were obtained for Sentinel groats. A pH of 9.5 was therefore chosen for preparing protein concentrates, using a solvent–groat ratio of 8:1. The slurry prepared under these conditions could be filtered and centrifuged easily.

The yield of protein in the concentrates and by-products was determined (Table II). The protein concentrates constituted 18–24% of the total weight and contained 65–70% of the total protein. The bran fractions constituted 10–20% of the total protein, whereas the starch fractions contained 5–10% of the total protein recovered. Defatting of the groats did not significantly affect the protein content of the fractions nor the yield of protein. Although Hinoat groats had considerably higher protein content (27%, d.b.) than Sentinel groat (17%), the protein yields in the concentrates were about the same.

Chemical Composition

The chemical compositions of the protein concentrates and by-products are presented in Table III. The concentrates had a protein content of 60–75%, being higher in the Hinoat variety and in the defatted samples. The fat content was high (15–17%) in concentrates prepared from groats without hexane treatment, showing that most of the fat was extracted together with proteins by weak alkali. The bran fractions had a high ash content, probably due to a large quantity of fiber in this fraction. The protein content of the bran fraction was about 15–20%. The starch fractions contained essentially starch, with some residual protein. The protein concentrates and bran fractions were also fairly rich in β-glucan or gum (5–9%). Oats were found to contain about 3.5% β-glucan, which is extractable by alkali (Wood et al 1977). The composition of the protein concentrates was similar to that reported in other oat concentrates (Wu et al 1972, 1973; Youngs 1974).

Amino Acid Composition

The amino acid compositions of the oat groats, protein

TABLE I
Effect of Alkali Concentration on the Extraction of Protein from Hinoat Groats

Solvent	pH of Slurry	Protein Extracted (%)	Protein in Solids (%, N × 6.25)
Water	5.5	11.4	24.9
0.005*N* NaOH	7.3	29.9	40.1
0.015*N* NaOH	9.3	80.6	62.5
0.03*N* NaOH	10.8	83.2	67.9
0.05*N* NaOH	12.1	85.5	68.4

TABLE II
Yield of Protein in Oat Protein Concentrates and By-Products (% dry basis)[a]

Product	Weight (%)	Protein in Solids (%, N × 6.25)	Protein Yield (%)
Hinoat groats			
Protein concentrate	24.2	67.9	67.4
Bran fraction	15.4	19.5	12.3
Starch fraction	59.1	1.8	4.4
Total	98.7		84.1
Defatted Hinoat groats			
Protein concentrate	23.8	74.0	69.1
Bran fraction	16.4	22.4	14.4
Starch fraction	56.9	3.7	8.3
Total	97.1		91.8
Sentinel groats			
Protein concentrate	18.3	60.4	65.8
Bran fraction	18.4	17.5	19.2
Starch fraction	54.6	1.8	5.8
Total	91.3		90.8
Defatted Sentinel groats			
Protein concentrate	18.3	62.8	70.0
Bran fraction	17.3	17.0	18.0
Starch fraction	59.2	2.3	8.3
Total	94.8		96.3

[a]Average of duplicate determinations.

TABLE III
Chemical Composition of Oat Protein Concentrates and By-Products (% dry basis)[a]

Product	Protein	Fat	Ash	Carbohydrate	Starch	β-Glucan
Hinoat groats	24.4	6.6	2.3	...	...	...
Protein concentrate	67.9	14.8	3.4	16.1	2.7	7.9
Bran fraction	19.5	1.8	9.1	51.2	7.5	9.4
Starch fraction	1.8	0.2	1.1	98.0	93.0	0.2
Defatted Hinoat groats	25.5	0.3	2.2	...	...	...
Protein concentrate	74.0	0.4	3.2	16.7	4.0	5.5
Bran fraction	22.4	0.9	7.7	49.3	12.4	9.3
Starch fraction	3.7	0.3	1.3	95.1	91.5	0
Sentinel groats	16.8	6.9	2.4	...	...	...
Protein concentrate	60.4	17.2	4.0	20.2	2.7	6.9
Bran fraction	17.5	2.7	7.5	53.2	12.0	7.8
Starch fraction	1.8	0.3	1.1	94.2	92.0	0.3
Defatted Sentinel groats	16.4	0.9	2.5	...	...	...
Protein concentrate	62.8	0.6	4.6	25.5	3.6	7.5
Bran fraction	17.0	0.8	8.4	54.1	8.6	8.5
Starch fraction	2.3	0.2	1.0	100.6	95.6	0.2

[a]Average of duplicate or triplicate determinations.

TABLE IV
Amino Acid Compositions of Oat Groats, Protein Concentrates, and Bran Fractions (g amino acid per 100 g protein)[a]

Amino Acid	Hinoat, Defatted			Sentinel, Defatted			FAO Scoring Pattern[b]
	Groats	Protein Concentrate	Bran Fraction	Groats	Protein Concentrate	Bran Fraction	
Lysine	3.6	3.3	5.4	4.3	3.5	5.5	5.5
Histidine	2.2	2.2	2.7	2.3	2.1	2.6	
Ammonia	2.8	1.6	2.5	2.9	2.5	2.5	
Arginine	6.4	6.8	8.3	6.3	6.3	7.9	
Aspartic acid	7.8	7.9	8.9	8.3	7.6	8.9	
Threonine	3.0	3.1	4.0	3.3	3.0	3.7	4.0
Serine	4.4	4.4	5.2	4.5	4.6	4.3	
Glutamic acid	19.8	21.2	19.3	20.7	21.0	17.5	
Proline	4.7	5.0	5.1	5.3	5.3	5.0	
Glycine	4.2	4.2	5.6	4.9	4.4	5.7	
Alanine	4.2	4.1	6.0	4.9	4.3	5.8	
Valine	5.0	5.1	6.1	5.2	5.1	6.2	5.0
Cystine	1.8	2.2	1.5	2.3	2.9	1.6	3.5
Methionine	1.2	1.3	1.6	1.2	1.4	1.1	
Isoleucine	3.7	3.7	3.9	4.0	3.7	3.9	4.0
Leucine	7.3	7.4	8.1	7.8	7.5	7.5	7.0
Tyrosine	3.3	4.1	3.3	3.3	4.5	3.4	6.0
Phenylalanine	6.1	5.8	6.1	6.3	6.2	5.7	
Total essential	35.0	35.8	40.0	35.7	37.8	36.6	35.0

[a] Average of duplicate determinations.
[b] Values taken from FAO/WHO Joint Ad Hoc Expert Committee, 1973. Energy and protein requirements. WHO Techn. Rep. Ser. 522.

TABLE V
Distribution of Osborne Solubility Fractions in Oat Groats and Protein Concentrates (% total soluble protein)[a]

Fraction	Hinoat, Defatted		Sentinel, Defatted	
	Groat	Protein Concentrate	Groat	Protein Concentrate
Albumin	15.9	20.8	16.2	23.6
Globulin	53.0	47.1	51.5	49.8
Prolamin	12.2	12.0	15.2	12.5
Glutelin	19.9	20.2	17.1	18.6

[a] Average of duplicate determinations.

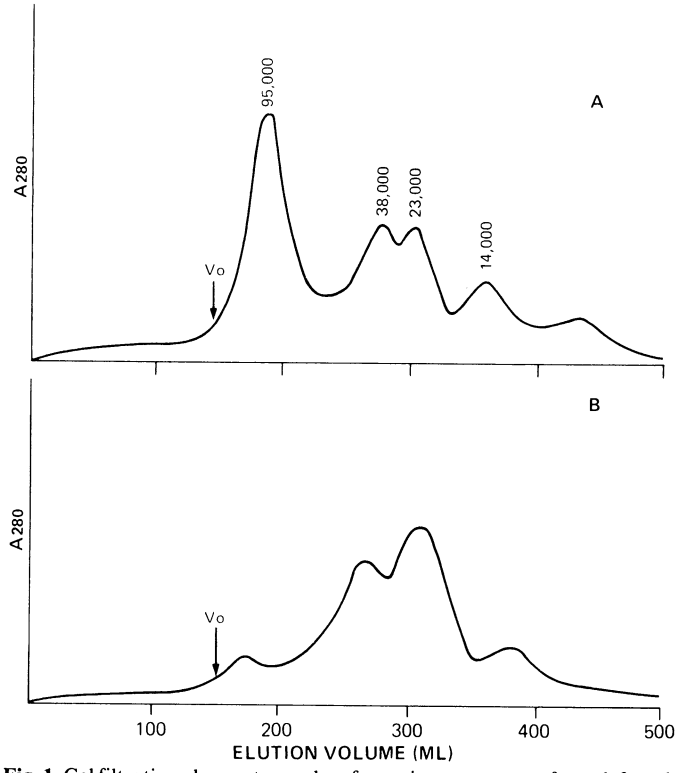

Fig. 1. Gel filtration chromatography of protein concentrates from defatted Hinoat groats: **A,** unreduced; **B,** reduced, alkylated.

concentrates, and bran fractions are shown in Table IV. The amino acid composition of the groats and protein concentrates was similar to that reported for oats (Draper 1973, Wu et al 1973), with lysine being the limiting amino acid. When compared to the FAO/WHO pattern, threonine and the S-containing amino acids were slightly lower in the groats and concentrates (Table IV). However, the total essential amino acids in the concentrates were slightly higher than recommended by the FAO, due to a relatively high content of the aromatic amino acids. The bran fractions were found to have higher lysine and total essential amino acid content than the groats or protein concentrates.

Osborne Fractionation

Table V shows the distribution of the four major solubility fractions in the protein concentrates. The distribution in the groats is also shown for comparison. The globulin was the major fraction in both the groats and concentrates, constituting about 50% of the total soluble proteins. This is consistent with the findings of other workers (Peterson and Smith 1976, Wu et al 1972) and indicates that most of the globulin in the groats can be extracted by alkali. Most of the albumin was extracted by alkali, as indicated by albumin content of more than 20% in the concentrates compared to about 16% in the groats. The concentrates also contained about 12% prolamin and approximately 20% glutelin, quantities that are lower than in other cereals (Shukla 1975). The present data show that the distributions of Osborne fractions in the concentrates were not markedly different from those of the groats, indicating that alkali did not preferentially extract a specific class of protein from the groats, except perhaps albumin.

Gel Filtration Chromatography

Figure 1A shows the chromatogram of the protein concentrate prepared from defatted Hinoat groats. Five peaks were resolved with apparent molecular weights ranging from 95,000 to less than 10,000. The chromatograms of concentrates from the two cultivars were not markedly different. Protein concentrates were also reduced and alkylated according to Friedman et al (1970), and then fractionated by chromatography. The pattern shows that the peak near the void volume (V_o) almost completely disappeared (Fig. 1B), suggesting that protein components in this fraction have a high tendency to aggregate, possibly formed through disulfide bond linkages between lower molecular weight components. The two major protein peaks in the concentrates, excluding the one near V_o, have a molecular weight of 38,000 and 23,000, respectively. (Fig. 1A, B).

SDS-PAGE

Figure 2 shows the SDS-PAGE patterns of the protein concentrates and the Osborne fractions prepared from the Hinoat concentrates. Protein standards and their molecular weights are shown in Fig. 2a. Figure 2b and c show the patterns of the protein concentrates from Hinoat and Sentinel groats, respectively. The two cultivars have similar patterns, with two major bands corresponding to apparent molecular weights of 37,000 and 22,000, respectively. These correspond closely to the two major protein peaks observed by gel filtration chromatography in the presence of mercaptan. Two minor components with molecular weights of 62,000 and 15,700 were also found in the concentrates. Three albumin subunits with apparent molecular weights of 40–47,000 were detected, and two minor bands with molecular weights of 25,000 and 15,700, respectively, were also visible (Fig. 2d). The globulin pattern (Fig. 2e) closely resembled that of the concentrates. The molecular weights of the two major components were similar to those reported for the α- and β-subunits of oat globulin (Peterson 1978). The similarity between the patterns of the concentrates and globulin is apparent because globulin is the major soluble fraction in both the groats and concentrates (Table V). Prolamin showed two subunits, one diffuse band (mol wt = 26,000) with low affinity for the dye, although shown as an intense band when fixed with TCA, and a lower molecular weight (17,500) subunit (Fig. 2f). The glutelin pattern was similar to that of the concentrates or globulin, showing the two major subunits (Fig. 2g). Some high molecular weight components, possibly aggregates, were shown near the origin in the glutelin pattern. No major differences existed between the SDS-PAGE patterns of the Osborne fractions from the two cultivars.

IEF

Figure 3A shows the electrophoretic patterns of oat proteins on a pH gradient (pH 3.5–9.5). Figure 3B shows the same patterns against a dark background. The protein standards and their pIs are shown in Fig. 3A, B; a and h. Apart from minor differences, the IEF patterns of the protein concentrates from the two cultivars were similar (Fig. 3A, B; b and c). Oat protein concentrates contained a large number of isoelectric components (over 50 bands) with pIs covering a wide pH range, but with most of the major components between pH 4.0 and 7.5. Four acidic bands (pI below 4) had low affinity for the protein dye but could be detected against a dark background (Fig. 3B). Albumin from Hinoat protein concentrate had a complex pattern and, similar to the concentrate, had mostly acidic bands (Fig. 3A, B; d). The globulin also contained a large number of isoelectric components covering a wide pH range (Fig. 3A, B; e) but lacked some of the acidic components found in the concentrates and albumin fractions. The IEF pattern of prolamin was less complex (Fig. 3A, B; f), lacking the highly acidic and basic components found in other fractions, but containing a few unique components with acidic pI poorly stained by Coomassie blue (Fig. 3B). Three to four skewed prolamin bands had pIs between pH 6.1 and 6.3; the reason for the distortion is not clear. The IEF pattern of the glutelin (Fig. 3A, B; g) was similar to that of globulin, except for the lack of some basic bands and the presence of a highly acidic component (pI = 3.5), shown as a white band close to the anode (Fig. 3B). When the IEF patterns from the Osborne fractions of the two cultivars were compared, no major differences were observed.

TABLE VI
Emulsifying Properties of Oat Protein Concentrates, Gluten, and Soy Protein Isolate[a]

	EAI (m^2/g)[b]		ESI (min)[c]	
	pH 7.5	pH 5.0	+0.1*M* NaCl	No NaCl
Hinoat protein concentrate	45.2	14.7	1.0	8.0
Defatted Hinoat protein concentrate	37.0	14.0	1.0	7.2
Sentinel protein concentrate	53.4	15.6	1.5	6.5
Defatted Sentinel protein concentrate	40.4	13.5	1.4	6.2
Wheat gluten	49.4	13.0	1.6	17.6
Soy protein isolate (Supro 610)	35.0	12.2	6.5	25.2

[a] Average of duplicate determinations.
[b] EAI = Emulsifying activity index.
[c] ESI = Emulsion stability index.

TABLE VII
Water Hydration and Fat-Binding Capacity of Oat Protein Concentrates, Gluten, and Soy Protein Isolate[a]

	WHC (ml/g)[b]	FBC (ml/g)[c]
Hinoat groat protein concentrate	2.70	2.62
Defatted Hinoat groat protein concentrate	1.95	2.80
Sentinel groat protein concentrate	2.45	2.25
Defatted Sentinel groat protein concentrate	2.00	2.50
Wheat gluten	0.98	0.85
Soy protein isolate (Supro 610)	2.50	1.83

[a] Average of duplicate determinations.
[b] WHC = Water hydration capacity.
[c] FBC = Fat-binding capacity.

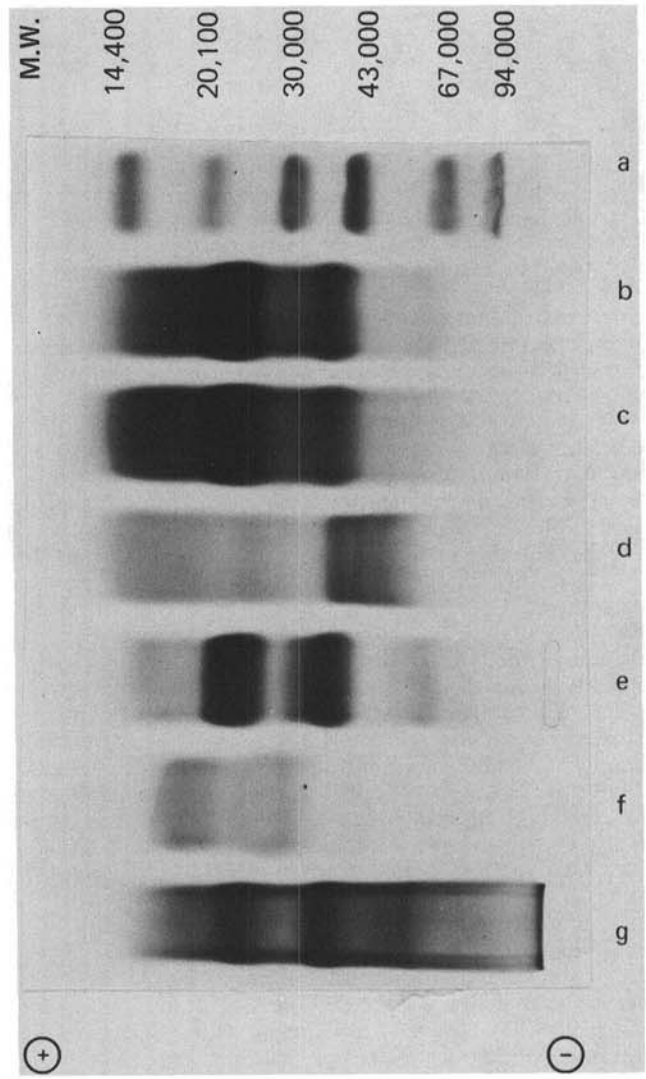

Fig. 2. Sodium dodecyl sulfate-polyacrylamide gel electrophoresis patterns of oat protein concentrates and Osborne solubility fractions. a = Marker proteins; b = Hinoat protein concentrate; c = Sentinel protein concentrate; d = albumin; e = globulin; f = prolamin; g = glutelin. The Osborne fractions were prepared from Hinoat protein concentrate.

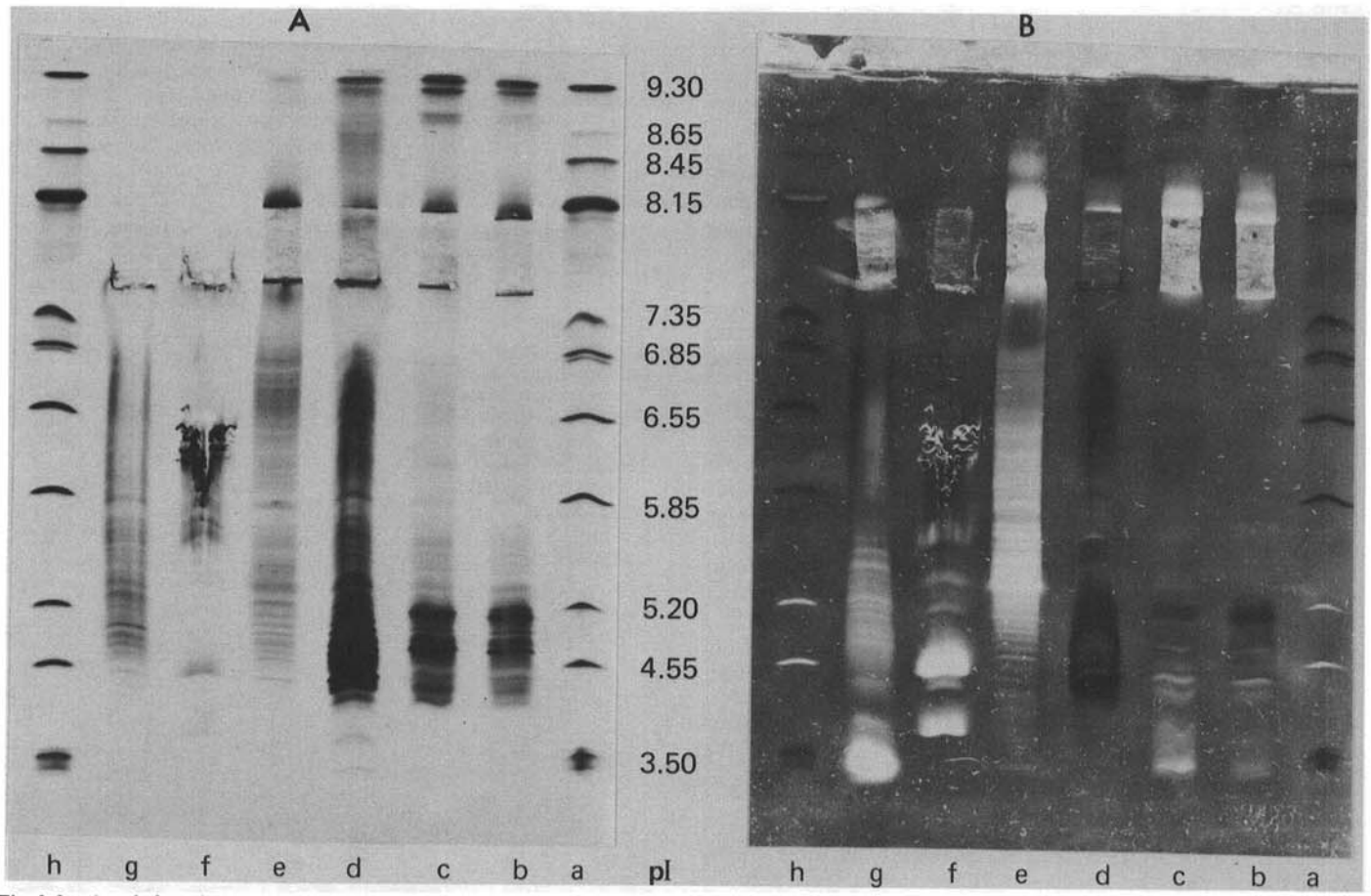

Fig. 3. Isoelectric focusing patterns of oat protein concentrates and Osborne solubility fractions: **A,** viewed against a white background; **B,** viewed against a dark background. a, h = Marker proteins; b = Hinoat protein concentrate; c = Sentinel protein concentrate; d = albumin; e = prolamin; g = glutelin. The Osborne fractions were prepared from Hinoat protein concentrate.

A comparison of SDS-PAGE and IEF patterns indicates a high ratio of isoelectric to molecular weight forms in the oat proteins. This was also reported in the storage proteins of maize (Gianazza et al 1976), potato tubers (Stegemann 1975), and cottonseed (King 1980). The functional requirements for storage proteins may be so unspecific that one form has little evolutionary advantage over another, leading to a proliferation of isoelectric species (Righetti et al 1977). Additionally, this charge heterogeneity may improve the chances of inducing nutritionally superior varieties (King 1980).

Solubility

The pH-solubility curves of protein concentrates from Hinoat and Sentinel groats are shown in Fig. 4. Both samples showed the familiar bell-shaped curve, with minimum solubility between pH 5 and 6. The solubility at both acidic and alkaline pH was high, particularly at pH above 8. The Hinoat protein concentrate had a solubility curve much narrower than that of Sentinel, with lower solubility at pH 4–6 and slightly higher solubility at alkaline pH. The solubility of the protein in concentrates from defatted groats was also determined and was found to be slightly lower at all pH values than samples prepared from groats not defatted with hexane.

Emulsifying Properties

Table VI presents the emulsifying properties of oat protein concentrates and two widely used plant proteins, wheat gluten (Industrial Grain Products, Montreal, P.Q., Canada), and soy protein isolate (Supro 610, Ralston Purina Co., St. Louis, MO). Emulsifying activity index (EAI) and emulsion stability index (ESI) were measured. EAI is related to the interfacial area of the emulsion, whereas ESI is a measure of the turbidity change of an SDS-stabilized emulsion with time (Pearce and Kinsella 1978). Results show that at pH 7.5, oat protein concentrates have an EAI comparable to gluten but slightly higher than soy isolate. At pH 5.0, the EAI was much lower in all the oat samples, suggesting that solubility is directly related to emulsifying capacity, since the solubility was lower at pH 5 than pH 7.5 (Fig. 4). The EAI of gluten and soy isolates were also markedly lower at pH 5 and were slightly lower than the values of the oat concentrates. Defatted oat concentrates had lower EAI than the nondefatted samples. This may be due to the lower solubility of the defatted materials.

The ESIs of oat protein concentrates were determined in the presence and absence of NaCl. The ESIs were much lower in the presence of salt. When compared to soy isolate and gluten, the ESI of oat proteins was considerably lower both in the presence and in the absence of salt (Table VI).

Water Hydration and Fat-Binding Capacity

The ability of the oat protein concentrates to bind water and fat is presented in Table VII. The results show that concentrates from defatted groats have a lower WHC than those not treated with hexane. Oat proteins have WHC in the same range as soy isolate but higher than that of gluten. Wu et al (1973) determined the hydration capacity of oat protein concentrates and found that it was also equal to that of Promin D, a soy protein preparation. The FBC of oat protein concentrates were found to be slightly higher than soy isolate and much higher than gluten.

Foaming Properties

Table VIII lists the foaming capacity and stability of oat protein concentrates, gluten, and soy isolate. There was a marked difference between the foaming capacity of oat proteins from defatted and nondefatted groats. The result suggests that the presence of fat has a deleterious effect on the foaming capacity of oat proteins. When compared to the other two plant proteins, defatted oat proteins have a foaming capacity comparable to that

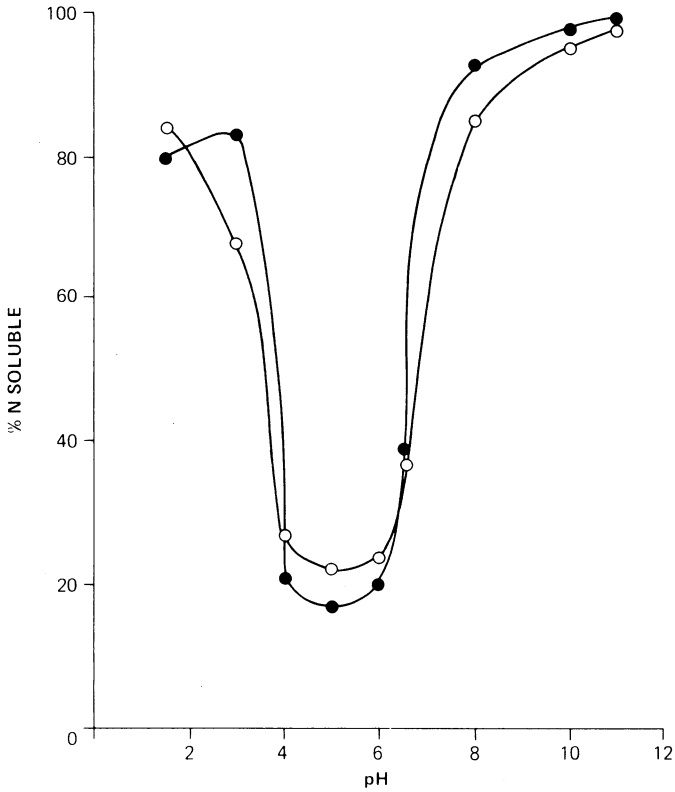

Fig. 4. Nitrogen solubility curve of oat protein concentrates from Hinoat (•) and Sentinel (o) groats.

TABLE VIII
Foaming Properties of Oat Protein Concentrates, Gluten, and Soy Protein Isolate

	Foaming Capacity (%)[a]	Foam Stability (%)[a]	
		30 min	60 min
Hinoat groat protein concentrate	25	55	40
Defatted Hinoat groat protein concentrate	120	70	52
Sentinel groat protein concentrate	25	50	40
Defatted Sentinel groat protein concentrate	85	70	53
Wheat gluten	100	40	30
Soy protein isolate (Supro 610)	135	74	70

[a] Average of duplicate determinations.

of gluten and soy isolate. The foam stability of the protein samples was determined at 30- and 60-min intervals after foam formation. The foam stability of the defatted oat proteins was higher than that of the nondefatted proteins.

CONCLUSIONS

Oat provides a source of good-quality protein at a relatively low cost and can be competitive with other vegetable proteins if specific, desirable functionality can be identified. In the present study, oat protein concentrates were found to have some functional properties including emulsifying, foaming, hydration, and fat-binding capacities that compare favorably with two widely used plant proteins, gluten and soy isolates. The relatively high water- and fat-absorption capacity of the protein concentrates suggests potential use as a meat binder or extender, and in doughs and bakery products (D'Appolonia and Youngs 1978). Oat protein concentrates have been used with some success to fortify neutral and acidic beverages (Cluskey et al 1976). Further work will be conducted to evaluate oat proteins in utility systems, which mimic food preparation in all its particulars (Pour-El 1980). This should help to promote the use of oat, the production of which has been in a gradual decline in most parts of the world.

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