SOME TEXTURAL AND FLAVOR CHARACTERISTICS OF SELECTED PLANT PROTEIN AND WATER SYSTEMS

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Flavor and textural features of a rapeseed protein concentrate (Brassica napus, Tower variety, water-washed, solvent extracted) were examined as part of a survey of the sensory features of assorted plant protein sources. The flavor characteristics studied were limited to: total flavor intensity, flavor pleasantness, bitterness and astringency; these were examined in uncooked and cooked water slurries of flours from nine different species. The textural features of viscosity, mouthcoat, dryness and stickiness were assessed in cooked water slurries of air-classified protein concentrates from fababeans (Vicia faba, minor) and field peas (Pisum sativum) as well as rapeseed. Uncooked slurries were prepared simply by steeping the flours in water. Cooked slurries were prepared by heating covered mixtures with continuous agitation, to 98C, except for rapeseed, which was heated only to 80C. Samples were equilibrated overnight before portioning. All sensory measurements were made using the method of magnitude estimation where the magnitude of a sensation is judged as a ratio of that in an identified reference.

Patterns describing total flavor intensity and flavor pleasantness were developed from scores assigned to samples of cooked and uncooked slurries of the nine species, each at solids contents of 0.5, 1.0, 2.0 and 4.0% (w/v). Uncooked and cooked samples were examined in separate experimental sequences with panels of seven and ten members respectively. The presentation of species to panelists was randomized within each solids concentration.

In general the total flavor intensity of all uncooked flour slurries increased as solids content increased. However, the coefficients of determination (r^2) relating these two variables were significant in only four of the nine species: rape, pea, faba, triticale. In cooked slurries, the relation of flavor intensity to soilds content was poorer for every species, than in the uncooked. Apparently the concentration differences within a species series were not always perceptually distinct in flavor and cooking minimized those distinctions that were present among raw samples.

Analysis of variance showed that, while flavor intensity scores differed among flours and between cooking conditions, specific flours behaved differently in responce to cooking. Lupin, rape and pea flours had the strongest flavors among the uncooked samples while the cereal flours were blander (Table 1A). When cooked, all the pulse flours decreased in flavor intensity, while the cereal flours remained relatively unchanged.

The pleasantness scores summarized in Table 1B show that flours which had stronger flavor intensities were less pleasant than blander flours. For uncooked flours, pleasantness generally decreased with increasing solids concentration. Cooked flour pleasantness appeared independent of concentration for all flours except lupin and rape; the latter showed a significant negative linear relationship (r^2= .99). Cooking failed to improve the pleasantness of rapeseed and had no effect on the cereal flours. However, the lupin, soy, pea and fababean improved in pleasantness with cooking; the effect on pea flour was dramatic.

TABLE 1.

EFFECT OF COOKING ON FLOUR FLAVOR SCORES (REF = 2% UNCOOKED WHEAT)

Plant Species	A. Flavor Intensity[1]			B. Flavor Pleasantness[2]		
	Uncooked	Cooked	Cooking Effect	Uncooked	Cooked	Cooking Effect
Lupin	32.1[a]	17.2[b]	$P < .01$	0.7[d]	5.2[c]	$P < .01$
Rape	26.6[b]	21.6[a]	$P < .05$	1.1[d]	1.6[d]	not sig.
Pea	28.3[b]	11.9[cde]	$P < .01$	1.3[d]	8.9[ab]	$P < .01$
Soy	21.8[c]	13.2[cd]	$P < .01$	4.4[c]	8.0[b]	$P < .01$
Faba	17.0[d]	12.2[cd]	$P < .05$	4.1[c]	8.9[ab]	$P < .01$
Oats	14.0[d]	10.6[cde]	not sig.	8.6[b]	9.2[ab]	not sig.
Rye	10.1[e]	9.8[de]	" "	8.2[b]	10.1[a]	" "
Triticale	9.1[e]	8.1[e]	" "	10.2[ab]	11.0[a]	" "
Durum	6.4[f]	8.8[e]	" "	10.9[a]	10.9[a]	" "

[1,2] Lower scores = less intense flavor, less pleasant flavor.

[a] Values in the same column with same letter are not different ($P < .05$).

Bitterness and astringency measurements made in a further test of cooked and uncooked flours at a single solids concentration (2% w/v), only partially explained the differences observed earlier in flavor intensity and pleasantness. Cereals were less bitter and less astringent than the pulses (Table 2). However, cooking had little effect on the intensities of these parameters. In fact, the only significant effects of cooking were to increase the bitterness of lupin flour and astringency of rape ($P < .05$).

TABLE 2.

BITTERNESS AND ASTRINGENCY SCORES OF FLOUR SLURRIES (N = 24).

Parameter	Lupin	Rape	Pea	Soy	Faba	Oats	Rye	Triticale	Durum
Bitterness[1]	6.4[a]	4.4[a]	5.7[a]	4.7[a]	4.9[a]	1.8[b]	1.9[b]	1.6[b]	1.6[b]
Astringency[2]	6.8[a]	5.7[ab]	4.3[bc]	4.2[bc]	3.4[cd]	1.6[e]	2.1[de]	2.1[de]	2.6[de]

[1,2] Reference = .08% caffeine and .08% alum resp.; lower score = less intense

[a] Values in the same row with the same letter are not different ($P < .05$).

Textural characteristics of rapeseed, fababean and pea protein concentrates were defined from scores assigned to cooked pastes with 10, 12, 14 and 16% solids in water. Seven panelists developed definitions for the parameters measured, selected appropriate references and judged all treatments three times. Cohesiveness, slipperiness and wateriness were assessed by the panel but were excluded from further definition because they failed to be observed in more than 1/3 of the 84 observations per species. Table 3 shows the exponents from the power function, $S = kC^n$; these describe the relationship of the sensory response to increasing solids concentration for those parameters which qualified for definition. Geometric means ($G\bar{X}$) of the magnitude estimates of each parameter are presented for each species, but their reliability is questionable unless an exponent (n) is also shown;

the latter was calculated only when there was a significant linear relationship between sensation and concentration. It is apparent from the GX̄'s that rapeseed pastes were more viscous, mouthcoating and drying than pea and fababean pastes. Similar exponents (n) show that the sensory responses to changes in concentration were similar. While higher stickiness scores were assigned to rapeseed, a linear relationship between perceived stickiness and solids concentration was not illustrated. Pea pastes showed a sharper slope (n) for stickiness than fababean pastes.

TABLE 3.

PERCEIVED DIFFERENCES IN TEXTURE AMONG SPECIES

Protein Conc. Species	Viscosity[1]		Mouthcoat[2]		Dryness[3]		Stickiness[4]	
	n	GX̄	n	GX̄	n	GX̄	n	GX̄
Rape	3.11	1.60[a]	0.88	1.55[a]	1.58	2.00[a]	-	1.91[a]
Pea	3.51	1.31[b]	-	0.85[b]	-	0.83[b]	4.94	1.21[b]
Faba	3.34	1.18[b]	1.45	0.85[b]	-	0.65[b]	3.00	1.00[b]

[1,2,3,4]References=sweet,cond.milk, whipped topping, pured peas, peanut butter, resp.

[ab]Values in the same column with the same letter are not different ($P < .05$).

Apparent viscosity measured with the Brookfield viscometer confirmed that rapeseed pastes were thicker than pea and fababean pastes. This is shown by the consistently higher log intercepts (k) for rapeseed in Table 4, at each solids content. The exponent (n) in Table 4 describes the decrease in viscosity of the pastes as shear rate increased from 3 to 60 rpm's. Rapeseed pastes were apparently more shear-thinning than the other two.

TABLE 4.

APPARENT VISCOSITY IN RELATION TO SHEAR RATE ($P = k\ (rpm)^n$)

Protein Concentrate Species	10% Solids		12% Solids		14% Solids		16% Solids	
	k	n	k	n	k	n	k	n
Rape	4.1	-.77[a]	5.4	-.87	5.6	-.87	5.9	-.90[a]
Pea	3.2	-.58[b]	4.2	-.73	4.7	-.73	4.8	-.71[b]
Faba	3.7	-.60[b]	4.6	-.73	5.2	-.73	5.4	-.74[b]

[ab]Values in the same column with the same letter are not different ($P < .05$)

When the sensory estimates of viscosity were examined in relation to the Brookfield readings (cps) at 60 rpm, there were higher correlations among pea and faba values (r = .99; .98) than for rapeseed (r = .93). This may have been a consequence of the greater shear-thinning effect in rapeseed which was not segregated in the sensory measurements. The lines describing the relationship between sensory and physical estimates of viscosity had similar, and relatively flat slopes (n = .37, .43 and .51 for rape, faba and pea, respectively). This means that differences in viscosity predicted by the physical instrument would overestimate thickness differences perceived in the mouth. For example a 10-fold change in Brookfield reading would be perceived as only a 2.5 fold increase in thickness.

The approaches to flavor and texture used here should be helpful in assessing the sensory differences among rapeseed protein concentrates from different cultivars and different processes.