HORSEBEAN AS PROTEIN SUPPLEMENT IN BREADMAKING. III. EFFECTS OF HORSEBEAN PROTEIN ON AROMA AND FLAVOR PROFILE OF MOROCCAN-TYPE BREAD[1]

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ABSTRACT

Organoleptic evaluation of horsebean flour (HBF) and horsebean protein isolate (HBPI) in suspensions and in Moroccan-type bread indicated differences in aroma and flavor characteristics. HPBI greatly reduced bitter taste and virtually eliminated beany aromatics, but added sour and stale notes. The type and level of supplement largely determined the extent of influence on bread flavor and textural quality. Differences in aroma and flavor spectra attributed to type of protein supplement were more easily identifiable in bland crumb than in crust. The differences were more pronounced when supplements exceeded 10%. Generally, HBF breads were sweeter, beanier, more bitter, and less wheaty and sour than breads containing equivalent quantities of HBPI. HBPI breads at all equivalent levels retained bread-like aroma, flavor, and eating qualities. Based on effects of the two supplements on various aspects of breadmaking, as well as on appearance and eating qualities, HBPI, even up to 20% HBF equivalent, would probably meet with better consumer acceptance than HBF.

Flavor is the main drawback that limits the use of legume and oilseed proteins in baked products and meat systems. The major objectionable flavors of raw, full-fat, and defatted soy flour have been described as beany, bitter, or green (1–3). Processing of raw, defatted soy flours into protein isolate caused considerable reduction in the green beany odor and bitter taste and in development of cereal and stale odors (1,3).

Flavor is the total sensory impression perceived by tongue, mouth, throat, and nose when food is eaten: *e.g.*, taste, feelings, odors, and aftertastes, but not texture or consistency (4). Sensory evaluation of food flavor by the flavor profile method is well documented (1, 4–6). Numerous studies relating to flavor aspects of food have shown that taste panels can effectively measure flavor intensity and characterize the flavor of soy protein products (1–3, 7).

Functional and flavor drawbacks of horsebean flour (HBF) as a protein supplement in Moroccan-type bread, observed in a preliminary study, led the investigators to isolate the horsebean protein. Isolation procedure and the amino acid composition appeared in an earlier publication (8). Positive functional effects of protein isolate on physical dough properties and bread quality characteristics were also noted (9). The twofold objectives of the present study were to confirm the elimination or reduction of major objectionable aroma and flavor notes as a result of protein isolation, and to investigate the effects of type and levels of protein supplements on major aroma and flavor attributes of Moroccan-type bread.

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MATERIALS AND METHODS

Two per cent suspensions of HBF and horsebean protein isolate (HBPI) were made in distilled water and allowed to stand 3 hr at room temperature (26°C) with occasional stirring before sensory evaluation for aroma and flavor. These supensions were examined at three different sessions and served to train panelists to identify aroma and flavor notes of horsebean supplements.

Moroccan-type bread (9) was baked and allowed to cool to room temperature (26°C) before sensory evaluation. Six samples (2.5 × 7.5 cm) were cut from middle slices of each of two loaves and placed in odor-free plastic bags. Portions (2.5 × 5.0 cm) of top and bottom crusts were wrapped in plastic, one set per panelist. A portion of the crumb was retained for pH determinations. Panel sessions (50 min) were held in a taste panel room equipped with red lights to obscure color differences among samples. The six test panelists had previous training in examining food aromas and flavors, and in flavor profile analysis. Before formal sessions began, panelists underwent orientation specific to the study. As a result of such preliminaries, crumb and crusts were examined separately. Tasting them together makes it difficult to isolate individual character notes or distinguish between them (6). Aroma examination of crumb, top, and bottom crusts was followed by flavor and aftertaste, which were tasted in the same order as for aroma. Panelists independently recorded aroma and flavor findings and discussed them to define descriptive vocabulary selected from Caul and Vaden (6), with the following additions to reflect aroma and flavor characteristics of supplements used in this study:

Amplitude: Overall impression of aroma or flavor; assessed as low, moderate, and high, and recorded as 1, 2, and 3, respectively.

Beany or legumy: Beany describes raw or green character typical of horsebean. Legumy connotes bean without specific identity but having typical sweet aroma aroma and taste.

Citrusy: An odor reminiscent of citrus fruit juice.

Floury: Connoting raw, white wheat flour.

Old or stale: Descriptive of long-standing flour suspensions.

Toasted: Odor reminiscent of early stage of dry-heated white flour before browning—typical of lightly browned top crusts of control and low-level HBPI breads.

As concentration of an added substance is progressively increased, its identity need not be perceived linearly. Rather, an increment may be recognized by a panel in two ways: 1) its identity may be intensified and thus perceived, and 2) one of its character notes may protrude from its flavor complex in such a manner that it is more easily perceived and, therefore, more frequently reported. Both phenomena may occur simultaneously. When progressive increments of supplement did not intensify the character notes that were perceived at lower concentrations, the percentage of panelists who perceived specific aroma and flavor notes was useful in characterizing the flavor of the product examined. Mean intensity and percentage of panel responses were computed from a total of 18 responses.

In addition to identifying specific aroma and flavor characteristics, the protein-supplemented breads were scored on a 5-point scale (1 = most like control; 5 = least like control). These breads were compared with the control assigned a value of 1. The scores assigned to each type of bread were reported by at least 70% of the panel, and based on a total of 18 responses.

RESULTS AND DISCUSSION

Suspensions of HBF and HBPI

As judged from the percentage of panel response and intensity of character notes (Table I), suspensions of HBF possessed predominantly beany and floury aromatics. Nutty, bitter, or resinous aromatics were noted occasionally. The flavor was primarily bitter with beany and floury aromatics, the first two notes lasting into the aftertaste. Panelists stated that HBF possessed relatively more total aroma and flavor, stronger beany character and bitter taste with smooth mouth-feel than HBPI. In contrast, HBPI was considered to be more bland in overall aroma and flavor but with sour taste, a stale aromatic, and gritty mouth-feel.

Isolating protein from HBF notably altered aroma and flavor (Table I). The isolation process virtually eliminated true horsebean aromatics and left a slight legumy note. The percentage of panel reporting "beany" dropped from 83 (HBF) to 33% (HBPI) and the intensity was considerably reduced. Intensity of bitterness was also reduced. With the stronger beany note eliminated, a stale note was detected in aroma. The citrusy aromatic and sour taste of HBPI could have been the function of pH, which was 4.6 for HBPI compared with 6.8 for HBF. The gritty mouth-feel of HBPI was associated with lower water solubility of HBPI.

TABLE I
Percentages of Panelists Reporting Indicated Aroma and Flavor Characteristics of 2% HBF and HBPI Suspensions

HBF	Relative Intensity[a]	Panel %	HBPI	Relative Intensity	Panel %
		Aroma			
Beany	1+	83	Legumy	) (+	42
Floury	1−	41	Citrusy	1	50
Resinous-bitter	1	25	Floury	1−	33
			Stale	1+	83
		Taste			
Beany	2−	83	Legumy	) (+	33
Bitter	2−	100	Bitter	) (+	83
Floury	1+	66	Floury	1+	50
			Stale	1	83
			Sour	1−	50
		Aftertaste			
Bitter	) (+	100	Sour	) (+	93
Beany	) (+	83	Tongue-drying or -Puckering		93

[a]Intensity key:) (+ = Between threshold and slight, closer to threshold; 1 = slight; 1+ = between slight and moderate, closer to slight; 2− = between slight and moderate, closer to moderate.

TABLE II
Composite Flavor Profiles and pH of HBF-Supplemented Breads[a]

	0%		5%		10%		15%		20%	
Flavor of crumb										
Amplitude		1−		1		1+		2		2
	Wheaty	1+	Wheaty	1+	Wheaty	1	Wheaty	1	Wheaty	1
	Yeasty	1−	Yeasty	)(+	Yeasty	)(+	Yeasty	)(+	Yeasty	)(+
	Sour	)(+	Sour	)(+	Sour	)(+	Sour	)(+	Sour	)(+
	Sweet	1+	Sweet	1	Sweet	1	Sweet	1	Sweet	1
	Stale	)(	Doughy	1−	Doughy	)(			Stale	)(+
			Legumy	)(+	Legumy	1−	Legumy	1+	Legumy	1+
			Bitter	)(	Bitter	)(+	Bitter	1−	Bitter	1−
Aftertaste			Sweet	)(	Sweet	)(+	Legumy	)(+	Legumy	1−
	Sour	)(	Sour	)(+	Sour	)(+	Sour	)(	Sour	)(
							Tongue coating		Bitter	)(
									Tongue coating	
pH of crumb		5.25		5.4		5.5		5.7		5.8
Flavor of top crust										
Amplitude		1		1+		1+		2		2
	Toasted	1−	Browned flour	1	Browned flour	1+	Browned flour	1+	Browned flour	1+
			Caramel	1−	Caramel	1−	Caramel	1−	Caramel	1
							Burnt	1−	Burnt	1−
	Wheaty	1	Wheaty	1	Wheaty	1	Wheaty	1−	Wheaty	1−
	Sweet	1	Sweet	1	Sweet	)(+	Sweet	)(+	Sweet	)(+
	Sour	)(	Sour	)(	Sour	)(+	Sour	1−	Sour	1−
							Legumy	)(+	Legumy	)(+
			Bitter	)(−	Bitter	)(	Bitter	1−	Bitter	1−
Aftertaste	Toasted	)(+	Browned flour	)(	Browned flour	1−	Browned flour	1−	Browned flour	1−
	Sweet	)(+	Sweet	)(+	Sweet	)(	Sweet	)(+	Sweet	)(+
							Bitter	)(+	Bitter	)(+

[a])(= Threshold;)(+ = between threshold and slight, closer to threshold; 1 = slight; 1+ = between slight and moderate, closer to slight; 2− = between slight and moderate, closer to moderate.

TABLE III
Composite Flavor Profiles and pH of HBPI-Supplemented Breads[a]

	0%		5%[b]		10%[b]		15%[b]		20%[b]	
Flavor of crumb										
Amplitude	1−		1−		1		1+		1+	
	Wheaty	1+	Wheaty	1+	Wheaty	1+	Wheaty	1+	Wheaty	1+
	Yeasty	1−	Yeasty	1−	Yeasty	) (+	Yeasty	1−	Yeasty	1−
	Sour	) (+	Sour	) (+	Sour	1−	Sour	1	Sour	1
	Sweet	1+	Sweet	) (+	Sweet	) (+	Sweet	) (+	Sweet	) (+
	Stale	) (	Doughy	) (+	Doughy	) (+	Legumy	) (+	Legumy	) (+
					Bitter	) (−	Bitter	) (+	Bitter	) (+
Aftertaste	Sour	) (	Sour	) (	Sour	) (+	Sour	1−	Sour	1−
					Bitter	) (	Bitter	) (	Bitter	) (
							Tongue-feel		Tongue-feel	
pH of crumb	5.25		5.1		5.0		4.9		4.9	
Flavor of top crust										
Amplitude	1		1−		1−		1+		1+	
	Toasted	1−	Toasted	1−	Browned flour	1	Browned flour	1	Browned flour	1
	Wheaty	1	Wheaty	1	Wheaty	1	Wheaty	1−	Wheaty	1−
	Sweet	1	Sweet	1	Sweet	1−	Sweet	) (+	Sweet	1−
	Sour	) (	Sour	) (+	Sour	) (+	Sour	) (+	Sour	1
					Bitter	) (−	Bitter	) (	Bitter	) (
Aftertaste	Toasted	) (+	Toasted	) (+	Browned flour	) (+	Browned flour	1−	Browned flour	1−
	Sweet	) (+	Sour	) (	Sour	) (	Sour	) (+	Sour	) (+
							Bitter	) (	Bitter	) (

[a]) (= Threshold;) (+ = between threshold and slight, closer to threshold; 1 = slight; 1+ = between slight and moderate, closer to slight; 2− = between slight and moderate, closer to moderate.
[b] Actual percentages were 0, 2, 4, 6, and 8, respectively.

Crumb Flavor

Flavor notes for crumb and top crusts of the control and eight protein supplemented breads are presented in Tables II and III. Bottom crust aromas, examined during orientation, were omitted during testing sessions owing to lack of time. Percentages of panel reporting specific aroma and flavor characteristics are shown in Table IV.

Flavor of control crumb was described primarily as a complex of sweet and

TABLE IV
Percentages of Panelists Reporting Specific Aroma and Flavor Characteristics of HBF- or HBPI-Supplemented Breads

Protein Type	Control	HBF Percentage				HBPI Equivalent HBF Percentage			
	0	5	10	15	20	5	10	15	20
Aroma of crumb									
Wheaty	94	72	72	78	61	78	67	72	72
Yeasty	89	72	72	67	56	89	89	83	83
Lactone	89	83	50	50	44	72	67	72	67
Estery-sweet	67	90	72	67	78	61	56	67	61
Sour	50	50	50	44	50	72	72	67	67
Musty	...	44	56	50	50	39	50	44	44
Legumy	...	72	89	100	100	28	33	44	50
Flavor of crumb									
Wheaty	94	72	83	56	61	72	72	72	78
Yeasty	56	72	61	61	39	61	61	56	61
Sour	61	61	78	50	56	89	94	94	94
Sweet	78	89	78	78	67	62	83	67	67
Stale	28	...	...	...	22	...	...	...	...
Doughy	...	33	22	...	...	22	22	...	...
Legumy	...	44	94	100	100	...	...	28	39
Bitter	...	22	28	33	44	22	22	28	28
Flavor of top crust									
Toasted	83	22	...	...	...	83	61	...	...
Browned	...	78	100	100	100	...	39	100	100
Caramel	...	39	39	67	83	...	...	22	33
Burnt	...	...	...	83	83	...	...	...	...
Wheaty	78	89	72	56	56	72	67	78	78
Sour	28	33	39	22	22	72	67	72	61
Sweet	72	67	67	56	72	50	39	44	50
Legumy	...	...	...	33	33	...	...	...	...
Bitter	...	33	44	89	78	39	22	28	33
Flavor of bottom crust									
Toasted	...	...	...	...	...	...	...	...	...
Browned	100	100	100	100	100	100	100	100	100
Caramel	22	22	22	22	33	...	...	...	28
Burnt	...	33	50	78	78	...	33	33	39
Wheaty	67	61	50	56	44	56	50	72	50
Sour	...	...	22	22	28	33	50	56	72
Sweet	72	56	72	61	61	44	56	39	33
Legumy	...	...	...	...	44	...	...	...	...
Bitter	...	28	72	94	67	22	39	39	28

sour tastes, wheaty and yeasty aromatics. Fleeting stale or old flour aromatic aromas were observed at times. Lactone and estery sweet, predominant aromatics of control bread, were discerned individually in aroma (Table II), and not detected in flavor. Only threshold sour lasted into aftertaste.

Supplementing flour with HBF or HBPI notably altered the aroma and flavor spectra of crumb and crust, with type and level of supplement largely determining the magnitude of changes. As shown in Table IV by percentage of the panel reporting specific notes, some flavor components were altered more than others. Wheaty aromatics of crumb were suppressed at all levels of HBF and HBPI. Crumb containing 15 or 20% HBF was less wheaty in flavor than those with 5 or 10% HBF. Breads made with HBPI at protein equivalent to 15 or 20% HBF were reported as wheaty more often than respective HBF crumb.

Crumb of all HBF breads showed sweet tastes similar to the control, although the sweet taste may have been detected more often at 5% and less often at 20%. At equivalent and all levels, HBPI crumb and crust were less sweet than either control or HBF breads. Frequency of reports of sour taste of HBF breads did not appear to differ from that of the control. On the other hand, HBPI sharply increased the percentage reporting sourness at all levels of supplementation, and sourness was perceived at higher intensity. The pH values of all HBPI breads were lower than those of control or HBF breads. Increasing concentration of HBF raised the pH by 0.2 to 0.6 units, and increasing HBPI lowered pH 0.2 to 0.4 units.

Although legumy aromatics were a major contribution of HBF to crumb flavor, at 5% HBF legumy character was perceived by only 44% of the panel, while at 10, 15, and 20% HBF all panel members reported a legumy note, with progressive intensities from recognition to slight. True horsebean identity was reported with greater frequency with HBF at 15 and 20%. Among HBPI crumb, the legumy flavor note was not perceived until 15 and 20% equivalents were used. Even at 20% HBPI, it was recognized by only 39% of the panelists.

Bitter taste was contributed by both protein additives. Though perceived at all levels in crumb and crust of HBF breads, it was observed more often and at higher intensities at 15 and 20% than at 5 and 10% HBF. Unlike HBF, progressive increments of HBPI did not change the intensity and changed only slightly the percentage detecting bitter taste. At 15 and 20% levels, HBF samples were reported bitter more often and at slightly higher intensities than for HBPI samples.

Crust Flavor

Top crust flavor of the control bread was composed of toasted and wheaty aromatics with slightly sweet and a trace of sour tastes. Increasing the HBF caused extensive browning of top and bottom crust. Browned flour and caramelized and burnt aromatics accompanied by a trace of bitterness were typical of HBF bread, top crust. Compared with the control, HBF exceeding the 10% level slightly lowered the intensity of sweet taste, definitely suppressed wheaty aromatics, and slightly intensified sour and bitter tastes. Progressive increases in bitter taste occurred with each increment of HBF and may be associated with increased browning. Legumy tastes were not detected until HBF reached 15%. Chief aftertastes were associated with browning and sweetness. At equivalent supplementations, breads made with HBF had more pronounced crust flavor than either the control or breads made with HBPI. At all levels of HBPI, there was relatively much less crust browning and lower flavor intensity than in the breads made with HBF supplement. They were also more sour, less sweet, less bitter, and at the two highest levels, retained more wheaty character than did bread made with HBF.

Bread Identity

Overall (inclusive of crumb and both crusts) aroma, flavor, and mouth-feel quality were described during orientation as the main attributes of bread identity. Mouth-feel was defined as sensations of the first bite through crust and crumb and subsequent chewing before swallowing. The typical aroma, flavor, and mouth-feel of Moroccan-type control bread served as the basis for judging bread identity of the protein-supplemented breads. Bread identity scores (1 = most like control; 5 = least like control) increased as the highest HBF supplement was reached (Fig. 1). In contrast, 5 and 20% HBPI breads scored 1–2 and 2–3, respectively, in all attributes of bread identity.

Although 5 through 15% HBF changed all three attributes of bread identity, aroma and flavor consistently received a higher contrast-score than mouth-feel. Compared with the HBF series, progressive increments of HBPI from 5 to 20% equivalents caused less change in bread-like aroma, flavor, and mouth-feel. As found for HBF, of the three dimensions of bread identity, mouth-feel factors were affected least by HBPI.

Both type and content of protein supplements affected the loss of bread-like aroma, flavor, and eating quality of the protein enriched breads. The type of protein played a more dominant role when supplements exceeded 10%. With increasing but equivalent contents of added protein, HBPI breads retained not only more bread-like identity but also showed less detrimental influence on

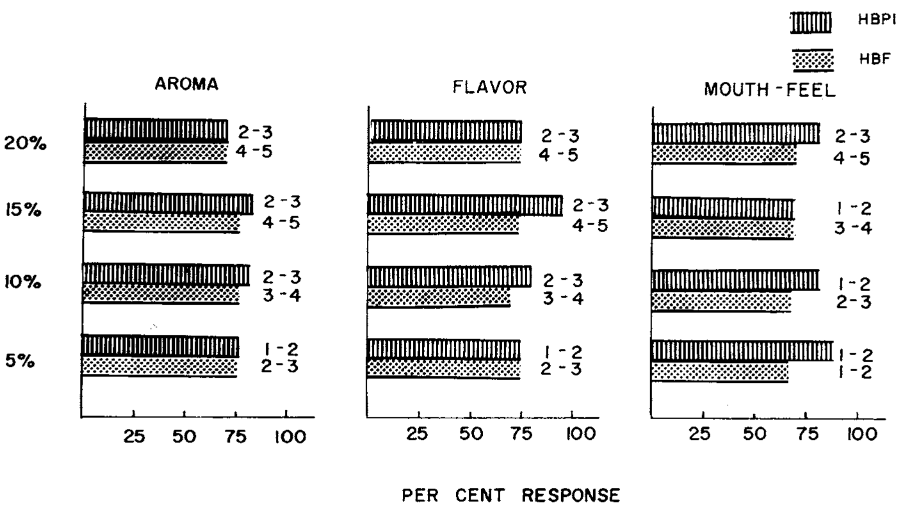

Fig. 1. Effect of horsebean flour (HBF) and horsebean protein isolate (HBPI) levels on bread identity rating (1 = most like control, and 5 = least like control).

crumb and crust texture than did HBF breads. Although panelists differed in declaring extent of loss of bread identity, they consistently judged the HBPI breads more like the control than HBF breads at equivalent protein levels.

During orientation, panelists observed other differences between control and protein-supplemented breads in crust color and textures of crumb and top crust. Control bread possessed soft, moist, and fine crumb and grain, with pale-colored, tender top crust. Dryness and compactness of crumb increased as HBF increased. Top crust, amber-colored up to 10% supplement, changed to dark reddish brown at 15 and 20% supplement. With up to 20% supplement, HBPI breads maintained soft, moist, and fine crumb and grain similar to the control and a tender, amber top crust.

CONCLUSION

This study confirmed that objectionable beany aromatics and bitter taste could be considerably reduced with the use of HBPI. Bread enjoys popularity and any attempt at fortification that alters its desirable attributes to a minimum degree has a greater probability of acceptance by the consumer. Based on the effects of HBF and HBPI on various aspects of breadmaking and bread quality characteristics, the conclusion can be drawn that HBPI at all equivalent levels (even up to 20%) retained bread-like aroma, flavor, and textural quality to a greater degree than HBF breads, and would most likely meet with better consumer acceptance than HBF at equivalent levels.

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