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LABORATORY EVALUATION OF THREE PROTEIN SOURCES FOR USE IN CHAPATI FLOURS

INTRODUCTION

CHAPATI, a type of unleavened bread prepared from wheat flour and water, is the principal staple food in West Pakistan. Among the poor people it constitutes as much as 90% of the total food intake (Chaudry, 1968). Such heavy dependence on an incomplete protein source has resulted in the prevalence of qualitative dietary protein deficiency.

Supplementing wheat flour with animal and vegetable protein is one of the most promising courses of action being pursued to alleviate protein deficiency in West Pakistan. The rationale for this approach is: (1) The quality of a vegetable protein diet can be improved by properly combining protein from different sources to correct amino acid deficiencies; and (2) a supplemented flour used in chapati could readily find its way into the diets of the target population without changing their food habits.

In 1968 an investigation of protein supplements for chapatis as consumed in West Pakistan was initiated by the Food and Feed Grain Institute at Kansas State University (KSU). As part of an AID-sponsored project aimed at improving the nutritive value of cereal-based foods, the study is being carried out in two phases—developmental and field testing. Several university departments are cooperating to develop processing techniques for the supplements and to assess the nutritive value of the protein sources and of chapatis containing various amounts of the supplements.

But the successful development of protein-supplemented flours for chapati ultimately requires acceptance of the product; if not accepted, even the most nutritious food conceivable is of no value to the malnourished. To produce products with the greatest potential for acceptance, factors that might affect acceptability must be delineated; then, during development, test products must be assessed in light of those factors.

This study was designed to evaluate the laboratory performance of nine protein-supplemented flours for chapati preparation. The term performance has been used to indicate an assessment of those properties that might affect product acceptability. In that persons examining the products in the laboratory were not native consumers, only the potential acceptability of the flour blends could be predicted. Determining consumer acceptability of the products would require in situ testing.

EXPERIMENTAL

Materials

Test flours, obtained from the Department of Grain Science and Industry at KSU, were stored (at 34–40°F) in deodorized glass jars in the Dept. of Foods and Nutrition. They included samples of the 97.0% extraction control flour prepared from Gaines, a soft white wheat (C.I. No. 13448), in Dec., 1969; and 5-lb batches of nine supplemented flours, subsequently prepared by replacing the Gaines control flour (by weight) with 5, 10 and 15% each of fish protein concentrate (FPC), cottonseed flour (CSF) and soy protein concentrate (SPC) and blending each for 15 min in a Wenger Ribbon mixer.

The FPC and SPC had been obtained from commercial sources in Nov., 1968, and May, 1969, respectively; the glandless CSF was a pilot plant sample obtained in Jan., 1969. The supplements had been held in cold storage (40°F) at the Dept. of Grain Science and Industry. Proximate analyses of test flours and supplements were conducted by the Dept. of Grain Science and Industry (Table 1).

Chapati preparation and dough evaluation

A standardized procedure was developed for preparing chapati, so that differences among samples could be attributed to flour composition alone. Each dough, prepared from 300g of flour and 202 ml of demineralized distilled water, was mixed with a Hobart N-50 mixer for 1 min at low speed, then 3 min at medium speed. After mixing, the dough was placed in a Pyrex® casserole, sprinkled with 5 ml of demineralized distilled water, covered, and left to rest at room temperature (76–78°F) for 1 hr.

Each batch of dough was then mixed at medium speed for an additional 1 min and rested for 15 min before being divided into ten 50-g pieces, which were hand-shaped into spheres. Each sphere was flattened with a rolling pin into a disc 6½ in. in diameter, using 1g of flour to prevent the chapati from sticking.

The rolled chapati was transferred quickly to a cast iron griddle preheated to 450°F over two automatically controlled gas burners. The temperature was monitored with a calibrated grill thermometer. After 30 sec the chapati was turned over and pressed with a soft cloth to spread the steam uniformly within the chapati and create two layers. In 30 sec it was turned for the second time, and 30 sec later was removed from the heat; thus total cooking time was 1½ min. The cooked chapati was placed in the cloth-lined drawer of a portable warming tray and kept there until delivered to the panel room for testing of organoleptic properties.

Two adjustments had to be made in the preparation procedure: (1) Because the griddle temperature sometimes reached 500°F during cooking, cooking times were decreased as much as 25 sec in an attempt to give each chapati approximately the same heat treatment; and (2) in that the amount of water in the basic recipe was insufficient to prepare a dough from the flour supplemented with SPC at the 10 and 15% levels, additional water was added at the rate of 1 ml/g of SPC (Johnson, 1970).

Organoleptic panel

Chapatis were examined by a six-member panel composed of the authors and four graduate students who had received training in flavor profile analysis (including orientative work with chapatis). The senior author was panel leader.

Table 1—Proximate analyses of test flours and supplements

Sample	% Nitrogen	% N × 6.25	% Moisture	% Ash
97% extraction Gaines wheat flour	1.536	9.6	8.9	1.5
FPC	12.768	79.8	4.5	–
5% FPC	2.208	13.8	8.2	2.1
10% FPC	2.752	17.2	8.7	2.6
15% FPC	3.488	21.8	8.1	3.2
CSF	9.616	60.1	6.8	–
5% CSF	2.016	12.6	9.0	1.8
10% CSF	2.400	15.0	8.6	2.1
15% CSF	2.800	17.5	8.6	2.4
SPC	10.704	66.9	4.7	–
5% SPC	2.080	13.0	8.4	1.6
10% SPC	2.592	16.2	8.6	1.7
15% SPC	2.992	18.7	8.2	1.8

Panel sessions (30–60 min in length) convened 5 days weekly for 4 wk. All meetings were held in a well-lighted room that was quiet and virtually free of odor.

The ten test flours were examined by the panel for orientation. All ten chapati variations were examined at least twice; the controls were examined most often, to reorient the panel to the baseline. No more than three kinds of chapati were presented to the panelists in any one session, and each chapati variation was presented first in at least one session. Samples were identified for the panelists prior to tasting during the first week of testing only. Subsequently, sample identity was not revealed.

Chapati halves, served warm on preheated china plates, were examined according to standard flavor profile analysis procedures (Cairncross and Sjöström, 1950). Thumbnail-sized pieces from both the center and the edge of each chapati half were tasted. The panelists then examined their samples for certain desirable chapati characteristics (Ahmad, 1960; Murty and Austin, 1963; Sinha, 1964). The session was ended without the round-table discussion of findings (usually a part of flavor profile analysis), because such discussion has been reported to be a possible source of bias (Hall, 1958).

RESULTS & DISCUSSION

EFFECTS of supplementation on flour performance are reported in Table 2. Flavor profile comparisons between each type of supplemented chapati and the control appear in Table 3. The 5, 10 and 15% FPC-supplemented flours had atypical flour and dough properties. All flours and doughs were darker than the cream-colored controls; the doughs (stiffer than the control during mixing) were slack and difficult to handle after resting; and FPC aromatics were detectable during mixing. Even though the consumer might not notice or object to the color differences and might be able to adjust the water absorption, she would be apt to object to the handling properties of the doughs and be alerted by the FPC aromatics, particularly if fish odor were offensive to her.

The eating qualities of all FPC-supplemented chapatis also were atypical. The supplemented samples were darker than the cream-colored control, leathery to crusty on the exterior (rather than pliable like the control), poorly puffed, gummy on the inside, and not easy to chew. All tasted less sweet and less wheaty than the control; the 15%-supplemented chapati had no wheat aromatics which are part of the flavor identity of the control chapati. Additionally, the 10- and 15%-supplemented chapatis (and probably the 5%) were redolent of FPC in both aroma and flavor. Because fishy aromatics are not part of "normal" chapati identity, they probably would adversely affect chapati acceptability. Thus, the 10 and 15% FPC-supplemented chapati flours, and probably the 5% blend, appeared to be potentially unacceptable to the native consumer.

The appearance of the flours and doughs is the use property that probably would limit the acceptability of the CSF blends. All supplemented flours and doughs were darker than the control and contained black specks (from the cottonseed flour). Other atypical use properties that could adversely affect acceptability include initial dryness and subsequent inelasticity of the doughs, as well as emanation of CSF aromatics from the 10 and 15% flours and all of the doughs during mixing. Although CSF aromatics (not dissimilar to that of wheat flour character) might not adversely affect the acceptability of the flour blends, the

Table 2–Performance comparisons between each type of supplemented flour blend and the control

	FPC			CSF			SPC		
	5%	10%	15%	5%	10%	15%	5%	10%	15%
Flour									
Appearance	–	–	–	–	–	–	?	?	?
Aroma	?	?	–	?	–	–	?	?	–
Flavor	–	–	–	?	–	–	?	–	–
Dough									
Appearance	–	–	–	–	–	–	+	+	+
Aroma-mixing	–	–	–	–	–	–	–	–	–
Aroma-cooking	+	+	?	+	+	?	+	+	+
Mixing properties	–	–	–	–	–	–	–	–	–
Handling properties	–	–	–	?	?	?	?	?	–
Cooking properties	+	–	–	+	+	+	?	–	–
Chapati									
Appearance	–	–	–	–	–	–	+	–	–
Aroma	–	–	–	–	?	–	?	?	–
Flavor	–	–	–	–	?	–	?	–	–
Texture	–	–	–	–	–	–	+	–	–

+ similar to the control
? small differences occasionally found
– definitely different from the control

Table 3–Flavor profile comparisons between each type of supplemented chapati and the control

	FPC			CSF			SPC		
	5%	10%	15%	5%	10%	15%	5%	10%	15%
Aroma									
Amplitude	?	–	–	?	?	–	?	?	?
Toasted wheat	–	–	–	–	?	–	+	–	–
Starchy	–	–	–	+	–	–	?	?	?
Raw doughy	–	–	–	–	–	–	–	–	–
FPC character	–	–	–						
CSF character				–	?	–			
SPC character							?	?	–
Flavor									
Amplitude	–	–	–	–	–	–	?	?	?
Sweet	–	–	–	–	+	+	+	+	+
Toasted wheat	–	–	–	–	–	–	+	–	–
Starchy	+	+	+	?	–	?	+	+	?
Raw doughy	+	?	?	?	?	?	?	?	?
FPC character	–	–	–						
CSF character	–			–	?	–			
SPC character							?	–	–
Aftertaste									
Wheat	?	–	–	–	–	–	+	?	?
Sweet	?	–	–	?	–	–	+	?	–
FPC character	?	–	–						
CSF character				?	?	–			
SPC character								?	?

+ similar to the control
? small differences occasionally found
– definitely different from the control

consumer probably would object to the atypical handling properties of the doughs.

Appearance seems to be the quality most likely to limit the acceptability of CSF-supplemented chapatis for eating. All samples were darker than the control and contained black specks. Other factors that might limit the use of CSF as a chapati supplement include the gumminess, less-than-full puffing, and suppressed wheat character of the chapatis. CSF aroma and flavor probably would limit chapati acceptability only at the 15% level, and perhaps not even at that level if not objectionable to the consumer.

The use properties of SPC-flour blends would most likely adversely affect acceptability of the 10 and 15% samples. The 5% SPC-supplemented dough was abnormally dry, but the 10- and 15%-supplemented flours would not form doughs until additional water was added to the basic recipe. All supplemented doughs were redolent of SPC during cooking, but that might be forgotten by the consumer (particularly at the 5% level, because the 5%-supplemented chapati was not definitely off in aroma or flavor). The presence of SPC at all levels of supplementation reduced the elasticity of the doughs, but that effect might not be noticed by the consumer, in that none of the doughs were difficult to handle. But the 15%-supplemented dough had a sandy texture, which would alert the consumer, who typically kneads chapati dough by hand. During cooking, both the 10- and 15%-supplemented chapatis browned more extensively than the control (typically cream colored with many light-brown spots). Cooking time and/or temperature could be adjusted, but possibly at the sacrifice of a well-cooked chapati inside.

SPC supplementation affected the appearance and texture of both the 10 and 15% chapati samples which were described as dark, dry and crisp. These atypical characteristics would be apt to affect acceptability adversely if cream-colored, pliable chapatis are desirable. An adjustment in the water absorption might eliminate the dryness and crispness but would not alter the abnormal color. SPC aroma and flavor might be expected to adversely affect acceptability of the 15%-supplemented chapati and possibly of the 10% sample as well.

Based on use properties and eating qualities, it is reasonable to believe that the 15% SPC-supplemented flour would be unacceptable to the consumer. The 10% blend probably would be unacceptable, unless water absorption could be adjusted effectively and atypical chapati color and flavor would not be objectionable. SPC supplementation at the 5% level probably would not adversely affect the acceptability of the flour blend.

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