Food Chemistry **27** (1988) 107–113

Nutrients Composition of Flours Used in Preparation of Various Breads in Bahrain

A. O. Musaiger

Nutrition Unit, Public Health Directorate, Ministry of Health,
PO Box 42, Manama, Bahrain

F. Abu-Dagga

Central Analytical Laboratory, Kuwait Institute for Scientific Research, Kuwait

&

S. Alloush

Bahrain Center for Studies and Research, Bahrain

(Received 20 April 1987; accepted 6 May 1987)

ABSTRACT

The chemical and amino acid compositions of flour mixtures used in different kinds of breads in Bahrain were determined. Proximate analysis was found to be comparable. Protein ranged from 9·5% to 10·3%. All flour mixtures had low levels of fiber (0·3–0·5%), indicating low extraction rates of flours used in preparing bread. Mineral compositions were also comparable, except for potassium and phosphorus. The sodium value of flour mixture used in tanoor *bread (7·7 mg/100 g) was higher than that of other flour mixtures (3·1–4·0 mg/100 g), possibly due to contamination of the flour with salt during the blending process. No differences were observed between the amino acid profiles of the flour mixtures studied. All flour mixtures contained low levels of lysine, isoleucine, valine and threonine when compared with the FAO/WHO reference protein.*

INTRODUCTION

Cereals, especially rice and wheat, are one of the most important sources of nutrients in the Arabian Gulf region. In Bahrain, the consumption of wheat is growing rapidly. Government importation of wheat increased from 20 000

tons in 1976 to 37 000 tons in 1985, an 85% gain (Bahrain Flour Mills Company, 1986). A high proportion of wheat flour is used for breadmaking, since bread is considered an essential component in the Bahraini diet. Various kinds of breads are commercially produced, including *tanoor* (the local staple bread), chapati, Arabic and European sliced breads. Mixtures of flour having different extraction rates are used in the preparation of these breads. From a nutritional standpoint, the nutrient compositions of such flour mixtures are important as indicators of the quality and quantity of bread consumed.

The nationalized Bahrain Flour Mills Company produces at least three kinds of flours and supplies these to the market at subsidized prices. Flour for bread preparation is also available from other sources on the open market.

In Bahrain, information on the nutritive value of flours for use in breadmaking by commercial bakeries is not available. Such information is needed to provide data on the nutritional value of breads and as base-line data for estimating the amounts of important nutrients necessary to fortify flours. (In Bahrain, locally milled flour is not enriched at mills.)

This paper attempts to determine the chemical and amino acid compositions of various flour mixtures used in preparation of breads commercially produced in Bahrain.

MATERIALS AND METHODS

Materials

Mixtures of flours used for preparation of *tanoor*, European white sliced, chapati and Arabic breads were obtained from commercial bakeries and restaurants in Bahrain's two major cities, Manama and Muharraq. Samples of mixtures used for European white sliced and Arabic breads were obtained from two bakeries. Due to a high variation among mixtures used in *tanoor* bread previously reported (Musaiger & Alloush, 1986), samples of *tanoor* mixtures were obtained from three bakeries. Sample mixtures used for chapati were obtained from two restaurants, since no commercial bakeries produced such bread. The samples were collected on the same day, wrapped in polyethylene bags and sent to the laboratory for moisture determination. Samples then were freeze-dried and refrigerated for further analysis.

Methods

Moisture, protein, crude fat, crude fiber and ash were determined according to the standard AOAC method (1984). Protein content was calculated using

the factor N × 5·7. Carbohydrates were estimated by the difference between 100 and the sum of the figures for moisture, fat, protein, crude fiber and ash. Energy was calculated using the factors 4, 4 and 9 kcal/g for protein, carbohydrates and fat, respectively.

For mineral determinations, freeze-dried samples were solubilized by wet digestion with a mixture of nitric, perchloric and sulfuric acids. The mineral then was measured by inductively coupled plasma-optical emission spectroscopy (ICP) according to the method outlined by Wolink *et al.* (1984).

Amino acid composition, other than cystine, was determined by acid hydrolysis, using a ratio of 10:1 of sample to 6N HCl (mg/ml). Samples were hydrolyzed for 18 h at 110°C and then analyzed by amino acid analyser according to the method of Savoy *et al.* (1975). Cystine was measured as cysteic acid, as described in Moore (1963).

RESULTS AND DISCUSSION

Proximate composition of three flours produced by the Bahrain Flour Mills Company is shown in Table 1. No differences in moisture and protein content were observed among these flours. The level of ash, however, ranged from 0·51% in flour 0 to 0·98% in flour 2. This variation can be attributed to the differences in the extraction rates of these flours.

Wheat flours used in Bahrain are usually blended from two wheat varieties, prime hard and Australian standard. Enriched flours are available on the open market and are mainly imported from the United States. However, most bakeries prefer to use the flour produced by the Bahrain Flour Mills Company because of its lower subsidized pricing.

Table 2 presents the proximate and mineral compositions of flour

TABLE 1
Proximate Composition[a] of Various Flours Produced by Bahrain Flour Mills Company

Proximate composition (g/100 g)	*Flour 0*	*Flour 1*	*Flour 2*
Extraction rate (%)	72–75	78–80	82–85
Moisture	14·0	14·1	13·3
Protein (N × 5·7)	10·8	10·8	10·4
Ash	0·51	0·76	0·98

Source: Bahrain Flour Mills Company.
[a] Expressed on a fresh-weight basis.

TABLE 2
Proximate and Mineral Composition[a] of Various Flour Mixtures Used in Preparation of Breads in Bahrain

Composition	*Flour mixture A* (tanoor)	*Flour mixture B* (*European*)	*Flour mixture C* (*Arabic*)	*Flour mixture D* (*chapati*)
Proximate composition (g/100 g)				
Moisture	12·1	12·6	12·3	11·9
Protein (N × 5·7)	9·6	9·5	9·5	10·3
Crude fat	1·2	1·2	1·1	1·2
Crude fiber	0·4	0·3	0·5	0·4
Ash	0·7	0·5	0·6	0·5
Carbohydrates	76·0	75·9	76·0	75·7
Energy (kcal/100 g)	354	352	352	354
Mineral composition (mg/100 g)				
Na	7·7	3·6	4·0	3·1
K	155·2	128·9	142·9	116·8
Ca	20·6	17·1	18·4	15·6
Mg	41·8	33·3	37·7	28·0
Fe	1·3	1·1	1·2	1·0
Cu	0·2	0·3	0·2	0·3
Zn	1·1	0·9	1·0	0·7
P	132·1	110·5	114·4	90·8
Mn	1·6	1·0	1·3	0·8

[a] Average of two determinations, except for flour mixture A (average of three determinations), expressed on fresh-weight basis.

mixtures used in the preparation of various breads in Bahrain. No major differences were observed in the proximate analysis of the mixtures. The average protein content of mixtures varied from 9·5% in flour mixtures B and C to 10·3% in flour mixture D. Crude fiber levels reflected the extraction rates of flours and ranged from 0·3% in flour mixture B to 0·5% in mixture C. The low fiber levels indicated that flour used in the preparation of breads in Bahrain had low extraction rates. Ash levels ranged from 0·5% in flour mixtures B and D to 0·7% in flour mixture A. No linear relationship was found between ash and fiber, which may be attributed to the distribution of ash and fiber in the wheat kernel. Ziegler & Greer (1971) reported that ash is mainly available in the inner bran layer, while fiber is available in the outer bran layer.

Except for flour mixture A, the mineral values were comparable among flour mixtures. Mixture A had higher levels of all minerals, due to the wide variations in the proportions of flour mixtures used for preparing *tanoor*

(Musaiger & Alloush, 1986). Sodium levels ranged from 3·1 mg/100 g in flour mixture D to 7·7 mg/100 g in flour mixture A. The higher amount of sodium in flour mixture A was possibly due to the contamination of flours by salt during mixing (Musaiger & Alloush, 1986).

Calcium levels in all flour mixtures were low and ranged from 15·6 mg/100 g in flour mixture D to 20·6 mg/100 g in flour mixture A. In contrast, phosphorus values were higher, indicating a low Ca:P ratio. Iron contents were very similar, and low, in all flour mixtures (1·0–1·3 mg/100 g). This is of specific concern for flour fortification, particularly because iron deficiency anaemia is a significant public health problem in Bahrain and the enrichment of flour with iron is one of the measures used in the prevention of this condition. It is important to note, however, that the bioavailability of iron in wheat flour is under question. Previous studies (Elwood *et al.*, 1970; Rahnotar *et al.*, 1981) demonstrated that the iron present in wheat bread is poorly absorbed even if the flour is enriched with iron. The levels of phytate and fiber in flour also appear to play roles in iron absorption, as these compounds have been found to inhibit the absorption of iron (Reinhold *et al.*, 1975; Faraji *et al.*, 1981). In the present study, no attempt was made to determine the phytate content in flour mixtures or the factors affecting iron bioavailability. It is hoped that these will be subjects of other investigations.

Proximate and mineral compositions of flour mixtures in the present study were in reasonable agreement with those reported for 72% to 78% extraction flours used in Kuwait (Eid *et al.*, 1983). With the exception of protein, our chemical analysis agreed favourably with that reported by Khatchadourian *et al.* (1985) in Saudi Arabia. The protein contents of flours used in Bahrain were lower than those used in Saudi Arabia, because the wheat produced in Saudi Arabia is relatively higher in protein value (Khatchadourian *et al.*, 1985).

The amino acid composition of various flour mixtures is shown in Table 3. There were slight variations in amino acid profiles between flour mixtures. Mixture B contained higher levels of asparagine and glutamic acid, when compared with other flour mixtures. All flour mixtures were deficient in isoleucine, lysine, valine and threonine when compared with the FAO/WHO provisional pattern (1973). Lysine, the first limiting amino acid in wheat flour, ranged from 1·6 g/100 g in flour mixture D to 2 g/100 g protein in flour mixture B. Threonine, the second limiting amino acid, varied from 2·2 g/100 g in flour mixture C to 2·7 g/100 g protein in flour mixture B. The variation in amino acids may be attributed to the differences in the distribution of protein in the wheat kernel, and the manner in which the kernel is fractionated during milling (Ponte, 1971). This may suggest that the flours used in preparation of bread in Bahrain are lacking some essential amino acids unless milk or other compounds are added to the mixture. In

TABLE 3
Amino Acid Composition[a] of Various Flour Mixtures Used in Preparation of Breads in Bahrain
(g/100 g protein)

Amino acid	*Flour mixture A*	*Flour mixture B*	*Flour mixture C*	*Flour mixture D*	*FAO/WHO pattern*
Aspartic	5·8	7·2	4·7	5·2	—
Threonine	2·3	2·7	2·2	2·5	4·0
Serine	4·6	5·7	4·6	5·2	—
Glutamic	32·1	42·2	32·6	35·0	—
Proline	9·7	12·5	12·2	10·7	—
Cystine	0·9	1·3	1·2	1·2	—
Glycine	3·0	3·5	3·5	2·9	—
Alanine	2·5	2·8	3·0	2·4	—
Valine	3·0	3·5	3·4	3·0	5·0
Methionine	1·2	1·4	1·3	1·4	—
Isoleucine	1·5	2·1	1·3	1·8	4·0
Leucine	5·5	7·0	5·7	6·8	7·0
Tyrosine	4·2	4·5	4·0	4·0	—
Phenylalanine	4·9	5·8	5·7	4·9	—
Histidine	1·6	1·9	1·6	1·5	—
Lysine	1·9	2·0	1·8	1·6	5·5
Arginine	3·1	3·5	3·1	3·0	—

[a] Average of two determinations, except for flour mixture A (average for three determinations), expressed on fresh-weight basis.

general, milk is not added to *tanoor*, chapati or Arabic breads produced in Bahrain, while some bakeries add skim milk to European breads. However, bread is rarely the sole dietary item and the Bahraini meals usually include high protein foods such as meat, fish, cheese and legumes. Therefore, an improvement in the protein quality of diet can be achieved by such supplementation.

At this stage we can conclude that, although commercial bakeries used various mixtures of flours for preparing breads, there are no major differences in the nutrients content of these mixtures. The low fiber values in all flour mixtures studied indicate that a high proportion of flour with low extraction rates were used in the mixtures. Since iron levels in the flour mixtures studied were low, more attention should be paid to the enrichment of flour with iron and perhaps other nutrients. However, studies in the bioavailability of iron in wheat flour and the effect of baking on the nutrients present in the flour are needed to evaluate the levels of nutrients required for enrichment.

ACKNOWLEDGEMENT

This study was sponsored by the Bahrain Center for Studies and Research, Bahrain.

REFERENCES

AOAC (1984). *Official methods of analysis* (14th edn), Association of Official Analytical Chemists, Washington, DC.

Bahrain Flour Mills Company (1986). *Annual Report, 1985.* Manama, Bahrain.

Eid, N., Bourisly, N., Bond, C., Hussain, A., Eliman, A., Ben-Afia, K., Al-Gayear, M. & Mameesh, M. (1983). *Fortification of flour and bread in Kuwait.* Kuwait Institute for Scientific Research, Kuwait.

Elwood, P. C., Benjamin, I. T., Fry, F. A., Eakins, J. D., Brown, D. A., Dekock, P. C. & Shah, J. U. (1970). Absorption of iron from chapati made from wheat flour. *Am. J. Clin. Nutr.*, **23**, 1267–71.

FAO/WHO (1973). *Energy and protein requirements.* World Health Organization, Technical Report Series No. 522, Geneva.

Faraji, B., Reinhold, J. G. & Abadi, P. (1981). Human studies of iron absorption from fiber-rich Iranian flat bread. *Nutr. Rep. Int.*, **23**, 267–78.

Khatchadourian, H. A., Sawaya, W. N. & Bayoumi, M. I. (1985). The chemical composition and rheological properties of flours milled from two major wheat varieties grown in Saudi Arabia. *Cereal Chem.*, **62**, 416–18.

Moore, S. (1963). The determination of cystine as cysteic acid. *J. Biol. Chem.*, **238**, 235–7.

Musaiger, A. O. & Alloush, S. (1986). A study on tanoor bread in Bahrain. Paper presented to the *First Conference on the Development of Food Industries in the Arab World*, Kuwait Institute for Scientific Research, Kuwait. (In Arabic.)

Ponte, J. G. (1971). Bread. In: *Wheat, chemistry and technology* (Y. Pomeranz (Ed.)) (2nd edn), American Association of Cereal Chemists, Minnesota, 675–735.

Rahnotar, G. S., Gelroth, J. A., Torrence, F. A., Bock, M. A., Winteringer, G. L., Faridi, H. A. & Finney, P. L. (1981). Iranian flat breads: Relative bioavailability of iron. *Cereal Chem.*, **58**, 471–4.

Reinhold, J. G., Ismail-Beigi, F. & Faraji, B. (1975). Fiber vs. phytate as determination of the availability of calcium, zinc and iron. *Nut. Rep. Int.*, **12**, 75–85.

Savoy, C. F., Heinis, J. L. & Seals, R. G. (1975). Improved methodology for rapid and reproducible acid hydrolysis of food and purified protein. *Anal. Biochem.*, **68**, 562–71.

Wolnik, K. A., Fricke, F. L. & Gaston, C. M. (1984). Quality assurance in the elemental analysis of foods by inductively coupled plasma spectroscopy. *Spectrochimica Acta*, **39B**, 649–55.

Ziegler, E. & Greer, E. N. (1971). Principles of milling. In: *Wheat, chemistry and technology* (Y. Pomeranz (Ed.)) (2nd edn), American Association of Cereals.