Food Chemistry 43 (1992) 259–264

Chemical composition and nutritive value of various breads in Saudi Arabia*

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(Received 30 August 1989; revised version received and accepted 17 January 1990)

Six types of local breads; namely, samouli, mafrood, burr, tannouri, tamees and korsan commercially baked from local wheat flour were investigated for their chemical composition and nutritive value.

Carbohydrate content varied from 70·8% for korsan to 82·3% for mafrood. Protein content varied from 12·2% for samouli to 13·8% for korsan. Tamees bread showed the highest fat content (3·3%) whereas burr bread showed the lowest fat content (0·6%). Dietary fibre ranged from 2·6% for tamees to 10·6% for korsan. Korsan also exhibited the highest ash content (3·02%) followed by tamees (1·97%) and burr (1·40%). Other breads had lower ash contents (0·84–0·98%). The energy content ranged from 354·6 kcal/100 g for korsan to 398·1 kcal/100 g for tamees.

Among minerals, Na ranged from 66·4 to 288, K 111–281, Ca 8·7–15·1, P 114–345, Mg 41·4–110, Fe 3·5–4·4, Zn 0·4–2·0, Cu 0·3–0·6 and Mn 0·6–3·6 mg/100 g. All types were low in Ca giving rise to low Ca:P ratios.

Cystine and lysine were the most limiting essential amino acids, and glutamic acid and proline were the highest non-essential amino acids. The chemical scores range from 32 to 35.

Based on FAO RDA, 100 g of Saudi bread would provide 11–124%, and 26·5–30% the daily energy and protein requirements for adult males, respectively. It can be concluded that these types of bread are cheap sources of calories, protein and some minerals. The low caloric values of burr and korsan breads and their high dietary fibre contents make them nutritionally important when planning for low calorie and high fibre diets for the people of Saudi Arabia.

INTRODUCTION

Bread has been considered a basic food throughout the recorded history of civilized man. Bread is a good source of energy and therefore can help to solve one of the major problems of malnutrition; namely, lack of calories (Mickelsen, 1975). In Egypt for instance, Balady bread is vitally important to millions of low-income families because it provides much of the energy and protein in their diets (FAO, 1977; Mousa *et al.*, 1979). Man can secure an adequate intake of all essential amino acids when bread provides 90% of his protein intake (Mickelsen, 1975).

The role of bread in the diet has been recognized by the Saudi government. As a result the baking industry has developed from a traditional and manually operated industry to a highly automated one. Approximately two-thirds of the total flour production (5400 tons/24 h) are used for breadmaking (Anon., 1987) and over 90% of the bread is now produced in large bakeries and distributed to consumers via grocery stores and supermarkets (Anon., 1985).

In Saudi Arabia, the *per capita* consumption of cereals increased from 94·4 to 122·6 kg/year during the period 1974–1986. Cereals provided 1219·6 cal and 33·5 g protein per person per day in Saudi Arabia during the period 1983–1986 (Anon., 1988). The caloric and protein contribution of cereals to the daily diet were 40·5 and 39·9%, respectively (Anon., 1988). Al-Mohizea and Mousa (1989) estimated that the apparent average bread consumption in Saudi Arabia is 355 g per day while, in Kuwait, with similar food habits, consumption has been estimated at 277 g/day (Bourisly *et al.*, 1982).

All commercial types of breads baked in Saudi Arabia are made of local wheat flour of variable

* Paper No. 5 of the scientific research series on bread in Saudi Arabia, supported by the Agricultural Research Centre, College of Agriculture, King Saud University, Riyadh 11451, Saudi Arabia.

extraction rates (75–100%). Bakery flour is bleached and enriched with thiamine, niacin, riboflavin and iron. The types and quantities of other ingredients added to the flour depend on the kind of bread. In most bakeries the ingredients are added in rough amounts, without exact weighing, based on the baker's experience. The basic ingredients—flour, salt, oil (mostly palm oil), and shortening, are locally produced. Sugar, yeast (instant yeast), chemical leavening agents, and bread improvers are imported, mostly from European countries. Information on the formula, breadmaking technology, and physical characteristics of six types of bread was investigated by Mousa & Al-Mohizea (1987). Rheological properties and chemical composition of different bread flour extractions produced in Saudi Arabia were reported by Mousa (1989). Only Sawaya *et al.* (1984) studied the nutritive value of Saudi breads.

The objective of this study was to determine the chemical composition and nutritive value of six common types of bread (samouli, mafrood, burr, tannouri, tamees and korsan) which are commercially prepared in Riyadh's bakeries from local wheat flours of different extraction rates.

MATERIAL AND METHODS

Bread samples

Two hundred-and-forty loaves of samouli bread were obtained from 15 bakeries (16 loaves/bakery) and 80

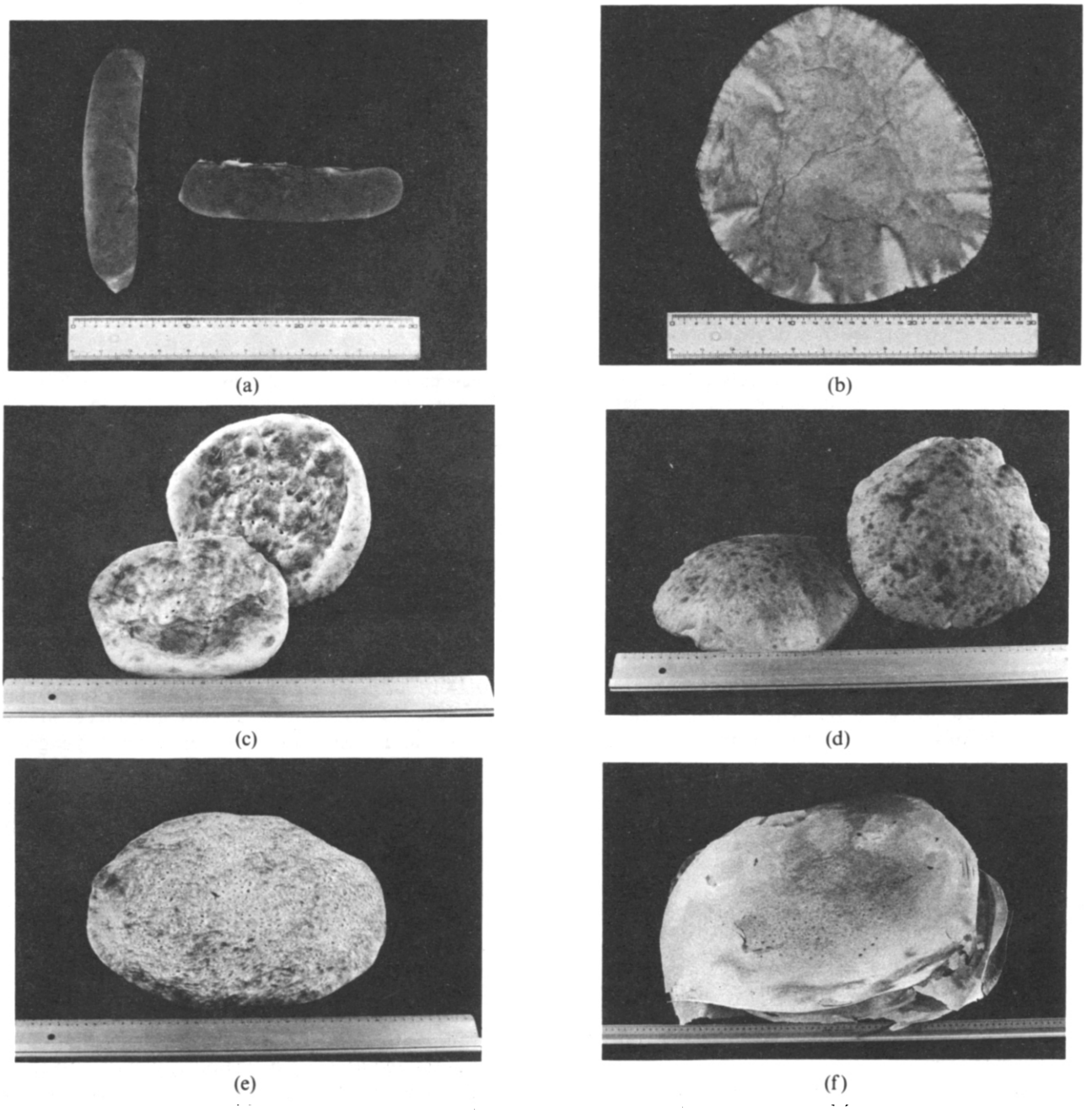

Fig. 1. Photographs of six types of bread. (a) Samouli; (b) Mafrood; (c) Tannouri; (d) Burr; (e) Tamees and (f) Korsan.

loaves each of mafrood, tannouri, burr, tamees and korsan (Fig. 1) were collected from 10 bakeries (eight loaves/bakery) in Riyadh city during September 1984 through May 1985. They were dried at room temperature, ground using a Wiley Lab. Mill, Model 4 (Arthur H. Thomas Co. Phila., PA, USA) and sieved through 1·0 mm steel screen. They were well mixed and representative samples were stored at 4°C in airtight containers until analyzed.

Chemical analysis

Samples were analyzed in duplicate for moisture, protein, ash and fat according to AACC methods (AACC, 1983). Total dietary fibre was determined using a combination of enzymatic and gravimetric methods as described in the technical bulletin No. TDFAB-1 of Sigma Chemical Company (1985) based on the methods of Prosky *et al.* (1984 and 1985). Available carbohydrate values were obtained by difference (AOAC, 1984). Energy contents were calculated by multiplying protein, fat and carbohydrate contents by factors of 4, 9 and 4, respectively.

Minerals were determined by wet ashing of flour samples as described by Osborn & Voogt (1978). Concentration of Na and K determined using an EPPENDORF 700 flame photometer. Ca, Mg, Fe, Cu, Zn and Mn were determined using an IL, model 251 atomic absorption spectrophotometer. The total phosphorus was determined using the ascorbic acid method developed by Abu-Lehia (1987).

Amino acids, except tryptophan, were determined after hydrolysis of protein with 6N HCl for 24 h at 100°C in a vacuum according to LKB protein chemistry note No. 27 (LKB, 1983), using an LKB Amino Acid Analyzer model 4150 ALPHA. Chemical scores were calculated based on the lysine content of 343·75 mg/g of nitrogen in the amino acid reference pattern (FAO/WHO, 1973).

RESULTS AND DISCUSSION

Proximate composition

The proximate composition of various breads are given in Table 1. Protein content ranged from 12·2 to 13·8%. Korsan and burr breads prepared from 95% extraction flour had the highest protein contents while tamees, samouli, mafrood and tannouri prepared from straight grade flour of 75% extraction had the lowest protein contents. It is clear that the protein content of the breads is related to the extraction rate of the flour used. Similar findings were reported by Hallab *et al.* (1974) on Arabic breads, Sawaya *et al.* (1984) on bread in Saudi Arabia and Tabekhia and Toma (1979) on bread in Egypt.

The ash content ranged from 0·84 to 3·02%. Korsan had the highest ash content. Tamees had a relatively high ash content (1·97%), due to the use of sodium bicarbonate in the formula (Mousa & Al-Mohizea, 1987). It is well known that the ash content of bread depends on the flour extraction used and the inclusion of other ingredients, such as non-fat dry milk and salt, in the bread formula (Sawaya *et al.*, 1984).

The fat content of tamees bread was the highest (3·3%) due to the addition of fat and sesame seed to bread baking as described by Mousa and Al-Mohizea (1987). Samouli bread also had a relatively high fat content (2·1%) because of the addition of vegetable oil in the basic formulation and the absorption of oil from the bottom of trays which are usually greased with vegetable oil before samouli dough is placed in these trays prior to baking (Mousa & Al-Mohizea, 1987). This finding is in agreement with the results of Sawaya *et al.* (1984), and Tabekhia and Toma (1979).

Korsan bread had the highest dietary fibre content (10·6%) followed by burr (7·0%) while other breads varied from 2·6 to 4·0%. The higher dietary fibre contents of korsan and burr (Table 1) were ascribed to the use of high extraction flour (96–100%) as reported by Mousa and Al Mohizea (1987).

Carbohydrate content varied from 70·8% for korsan to 82·3% for mafrood bread. The use of different flour extractions with a different carbohydrate content could in part explain the carbohydrate results reported recently by Mousa (1989), who found that carbohydrate content showed a moderate decrease from 84·7 to 79·8% with the increase of flour extraction from 75 to 95% due to the increase in fibre, fat, protein and ash contents.

Table 1. Proximate compositions (dry basis) and energy values of various breads in Saudi Arabia

Analysis	Type of bread					
	Samouli	Mafrood	Tannouri	Burr	Tamees	Korsan
Crude protein (N×5·7) (%)	12·8	12·8	12·8	13·4	12·3	13·8
Crude fat (%)	2·1	1·2	1·1	0·6	3·3	1·8
Dietary fibre (%)	4·0	2·9	3·3	7·0	2·6	10·6
Ash (%)	0·98	0·84	0·96	1·40	1·97	3·02
Available carbohydrates (%)	80·7	82·3	81·8	77·6	79·8	70·8
Energy (kcal/100 g)	390·5	391·2	388·3	369·4	398·1	354·6

Minerals

The mineral composition data presented in Table 2 showed that korsan bread contained higher amounts of potassium, phosphorus, magnesium, zinc, copper and manganese than the other types of bread due to the use of high extraction flour. Tamees contained the highest sodium and calcium concentrations, and this could be ascribed to the use of sodium bicarbonate in the formula and sesame seed on its surface before baking. Although samouli is baked using straight grade flour, it had an amount of iron equal to that of burr which is baked from high extraction flour. This may be ascribed to the enrichment of white flour with iron in the local flour mill (Anon., 1987). The differences in minerals within the bread types refer also to the baking formula as reported by Emodi and Scialpi (1980).

Amino acids

The amino acid compositions of the six bread types are presented in Table 3 and indicate that cystine and lysine are the most limiting essential amino acids while glutamic acid and proline are the highest non-essential

Table 2. Mineral contents (dry basis) of various breads in Saudi Arabia

Minerals (mg/100 g)	Type of bread					
	Samouli	Mafrood	Tannouri	Burr	Tamees	Korsan
Na	119	69·9	83·2	66·4	301	288
K	111	111	115	194	112	281
Ca	10·3	8·7	9·9	9·6	15·1	13·2
P	114	121	120	219	120	345
Ca:P	0·09	0·07	0·08	0·04	0·13	0·04
Mg	41·4	53·7	44·1	71·6	55·2	110
Fe	4·4	3·5	3·6	4·4	3·9	3·5
Zn	0·5	0·7	0·4	0·9	0·7	2·1
Cu	0·3	0·4	0·4	0·4	0·3	0·6
Mn	0·6	0·7	0·7	2·0	0·7	3·6

Table 3. Amino acids compositions (g/100 g protein) and chemical scores of various breads in Saudi Arabia in relation to FAO/WHO pattern

Amino acids (g/100 g protein)	Type of bread						FAO/WHO 1973 pattern
	Samouli	Mafrood	Tannouri	Burr	Tamees	Korsan	
Essential amino acids:							
Lysine	1·8	1·8	1·9	1·9	1·8	1·2	5·5
Methionine (M)	0·8	1·9	2·4	3·4	3·9	2·0	—
Cystine (C)	0·3	0·6	0·9	0·3	0·8	0·5	—
M + C	1·1	2·5	3·3	3·7	4·7	2·5	3·5
Phenylalanine (P)	5·6	6·0	6·1	4·4	5·4	4·5	—
Tyrosine (T)	2·6	3·1	3·2	2·5	2·7	2·6	—
P + T	8·2	9·1	9·3	6·9	8·1	7·1	7·0
Leucine	7·5	7·8	8·0	6·0	7·6	6·1	7·0
Isoleucine	3·2	3·6	3·9	2·5	3·6	2·5	4·0
Valine	4·1	5·0	5·6	4·6	5·0	3·7	5·0
Threonine	3·2	3·1	3·1	1·9	2·9	2·3	4·0
Total essential amino acid (E)	29·1	32·9	35·1	26·6	33·7	25·4	36
Non-essential amino acids:							
Aspartic acid	4·9	4·9	4·6	3·9	4·7	4·3	—
Glutamic acid	39·2	40·2	41·1	28·9	39·0	29·6	—
Alanine	3·5	3·6	3·4	3·6	3·7	3·4	—
Proline	12·9	13·2	13·6	12·9	13·2	10·3	—
Serine	5·4	5·1	5·1	5·1	5·6	4·2	—
Glycine	4·0	4·1	3·8	4·1	4·4	3·7	—
Histidine	2·5	2·6	3·0	1·9	2·2	1·9	—
Arginine	3·8	4·1	4·2	3·0	3·5	3·9	—
Total non-essential amino acids (N)	76·2	77·8	78·8	63·4	76·3	61·3	—
E/N ratio	0·4	0·4	0·5	0·4	0·4	0·4	—
Chemical score	33	33	35	35	33	32	100

amino acids in the bread samples. These results reflect the influence of flour composition, as a basic ingredient used in breadmaking, on the amino acid content of bread samples (Mousa, 1989). The data are partially compatible with literature reports which indicate that lysine is the most deficient essential amino acid in bread (Bender 1958; Hallab *et al.*, 1974; Jansen, 1962; Sawaya *et al.*, 1984). Korsan bread (unleavened bread) had the lowest amino acid values due to its simple formula which consisted of flour, salt and water only without the addition of yeast which is added to the other bread types under study (Mousa & Al-Mohizea, 1987). Block and Bolling (1943) reported that yeast protein contains all the essential amino acids and hence it is a biologically complete protein. On the other hand, tannouri bread had the highest total essential amino acids (E) and total non-essential amino acids (N) contents (Table 3).

Nutritive value

The energy contents presented in Table 1 ranged from 354·6 kcal/100 g for korsan to 398·1 kcal/100 g for tamees, which means that 100 g of bread will provide 11–12% of the daily energy requirements for adult males based on the Food and Agriculture Organization (FAO) of the United Nations Recommended Daily Allowances (RDA) (Anon., 1981). Barrett (1975) reported that over 50% of the world's countries receive more than one-half of their total caloric intake from bread.

Bread types in Saudi Arabia are considered a relatively good protein source (12·2–13·8%), but they are low in lysine content (1·2–1·8 g/100 g protein). The results are in agreement with the data on Arabian bread reported by Hallab *et al.* (1974), Khalil and Hallab (1975) and Sawaya *et al.* (1984). A hundred grams of bread provides 26·5–30% out of the daily protein requirements based on FAO RDAs (1981). Chemical scores based on the FAO/WHO reference pattern (1973) ranged from 32 to 35 for the six types of bread. Chemical scores of Saudi breads are in agreement with those of Sawaya *et al.* (1984).

Most of the local breads except tamees are low in fat content, especially burr bread which contains 0·6% fat, as compared to USA breads which contain 2·7–4·4 fat (Ranhotra *et al.*, 1984).

The high dietary fibre content of korsan and burr breads (10·6 and 7·0% respectively) and their low caloric intake make them nutritionally important when planning for low calorie and high fibre-diets.

With respect to minerals when expressed in terms of FAO RDAs (1981), 100 g of bread would furnish approximately 1·9–3·4% for Ca and 35–44% for Fe, of the daily requirements of an adult male. So, it is clear that the bread types in Saudi Arabia are good sources of Fe and Mn, but, on the other hand, they are poor in Ca as is the case with other types of breads in other parts of the world.

In conclusion, bread types in Saudi Arabia are different in their chemical composition and nutritional value due to the flour extraction rates and other ingredients used in baking formulae. It is hoped that these data will provide useful information for the dietitians and help the current efforts to compile food composition tables for local Saudi food items and composite dishes.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the valuable technical assistance of Mr. I. S. Abu-Sultan throughout this work.

REFERENCES

Abu-Lehia, I. H. (1987). The use of ascorbic acid for phosphorus determination in milk. *J. Coll. Agric. King Saud Univ.* Vol. 9, No. 2, pp. 219–27.

American Association of Cereal Chemists (AACC) (1983). Approved Methods of the AACC, 8th ed. The Association St. Paul, MN. USA.

Anon. (1981). Food and Agricultural Organization (FAO) dietary standards for the adult. In *Introductory Nutrition.* Helen A. Guthrie. (5th ed) Chap. 14, The C. V. Mosby Company, St. Louis, MO 63141 USA, p. 377.

Anon. (1985). Industrial Studies and Development Center. Tech. Rep. (ISDC), Riyadh, Saudi Arabia (in Arabic).

Anon. (1987). Saudi Organization of Silos and Grain Milling. Annual Report. (SOSGM), Riyadh, Saudi Arabia. (in Arabic).

Anon. (1988). Saudi Arabian Food Balance Sheets. 2nd. Vol. Dept. of Economic Studies & Statistics. Ministry of Agric. & Water. Riyadh, Kingdom of Saudi Arabia.

Association of Official Analytical Chemists (AOAC) (1984). *Methods of Analysis.* (14th ed), The Association, Arlington, VA, USA.

Al-Mohizea, I. S. & Mousa, E. I. (1989). Bread consumption pattern in Riyadh, Saudi Arabia. (In progress).

Barrett, F. (1975). The role of bread in international nutrition. *Cereal Foods World*, **20**, 323.

Bender, A. E. (1958). Nutritive value of bread protein fortified with amino acids. *Science*, **127**, 874.

Block, R. J. & Bolling, B. (1943). Arch. Biochem. 3, 217. In *Baking Sci. and Technol.* ed. Pyler, E. J., (1975) Vol. 1, chap. 5 (Yeasts, molds, and bacteria), Siebel Publishing Company, Chicago, Ill, USA, p. 101.

Bourisly, E. N., Elimam, A., Ben Afia, K. & Al-Gayer, M. (1982). Bread consumption in Kuwait, KISR Ann. Rept. Kuwait.

Emodi, A. S. & Scialpi, L. (1980). Quality for bread fortified with ten micronutrients. *Cereal Chem.*, **57**, 1.

FAO. (1977). *Production Yearbook.* Food and Agric. Org. of the UN, Rome, Italy.

FAO/WHO. (1973). Energy and protein requirements. FAO nutritional meetings report series No. 52, WHO technical report series No. 522. Food and Agric. Org, of the UN, Rome, Italy.

Hallab, A. H., Khatchadourian, H. A. & Jaber, I. (1974). The nutritive value and organoleptic properties of white Arabic bread supplemented with soybean and chickpea. *Cereal Chem.*, **51**, 106.

Khalil, J. K. & Hallab, H. A. (1975). Nutritive value and chemical composition of Arabic bread supplemented with cheese-whey. *Pak. J. Biochem.*, **8,** 57.

Jansen, G. R. (1962). Lysine in human nutrition. *J. Nutr.*, **76,** 1.

LKB (1983). LKB protein chemistry note. No 27. LKB, Biochrom Ltd. Cambridge, England.

Mickelsen, O. (1975). The nutritional value of bread. *Cereal Foods World*, **20,** 308.

Mousa, E. I. (1989). Rheological characteristics and chemical compositions of commercial flours for breadmaking in Saudi Arabia. *King Saud Univ. J.*, Vol. 1, Agril. Sci (1).

Mousa, E. I. & Al-Mohizea, I. S. (1987). Bread baking in Saudi Arabia. *Cereal Foods World*, **32,** 614.

Mousa, E. I., Ibrahim, R. H., Shuey, W. C. & Maneval, R. D. (1979). Influence of wheat classes, flour extraction and baking methods on Egyptian Balady bread. *Cereal Chem.*, **56,** 563.

Osborne, D. R. & Voogt, P. (1978). *The Analysis of Nutrient in Foods.* Academic Press Inc., Ltd., London, UK.

Prosky, L., Asp, N., Furda, I., DeVries, J. W., Schweizer, T. F. & Harland, B. F. (1984). Determination of total dietary fiber in food products, and total diets: Interlaboratory study. *J. Assoc. Off. Anal. Chem.*, **67,** 1044.

Prosky, L., Asp, N., Furda, I., DeVries, J. W., Schweizer, T. F. & Harland, B. F. (1985). Determination of total dietary fiber in food products: Collaborative study. *J. Assoc. Off. Anal. Chem.*, **68,** 677.

Ranhotra, G., Gelroth, J., Novak, F., Bohannon, F. & Matthews, R. (1984). Proximate components in selected variety breads commercially produced in major US cities. *J. Food Sci.*, **49,** 642.

Sawaya, W. N., Khalil, J. K., Khatchadourian, H. A. & Al-Mohammed, M. M. (1984). Nutritional evaluation of various breads consumed in Saudi Arabia. *Nutr. Rep. Int.*, **29,** 1161.

Shakir, S. R., Sedky, A. & Mohamed, M. S. (1960). Studies on Egyptian bread. II. Chemical composition of some types of bread consumed in various localities of Egypt. *Alex. J. Agric. Res.*, **3,** 89.

Sigma. (1985). Total dietary fibre assay kit. Technical bulletin No. TOFAB–1. Sigma Chemical Company. St. Louis, MO 63178, USA.

Tabekhia, M. M. & Toma, R. B. (1979). Chemical composition of various Egyptian breads. *Nutr. Rept. Int.*, **19,** 377.