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PREPARATION AND NUTRITIONAL EVALUATION OF HIGH PROTEIN BREADS CONTAINING OILSEED PROTEIN CONCENTRATES

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Breads were made containing protein concentrates prepared from cottonseed, rapeseed and groundnut cake. Skim milk powder and certain vitamins and minerals were also added to improve the nutritive value of the breads. Nutritional evaluation of the breads showed that the breads containing blends of oilseed protein concentrates and skim milk powder were found to be much better in all respects than that made of wheat flour and were slightly inferior to that containing skim milk powder alone.

In earlier communications[1,2,3] preparation and biological evaluation of oilseed protein concentrates has been reported. They possess a bland taste and permit ready blends with cereal flours without having any deletorious effect on their physical properties. Because these are concentrated source of protein, addition of a small quantity is required to step up the protein content of the material. However, it was observed that a blend of oilseed protein concentrate with animal proteins, such as fish protein concentrate or skim milk powder, gave a higher net protein utilization value than using the oilseed protein concentrate alone because of mutual supplementation of deficient amino acids in the two proteins. It was, therefore, considered desirable to utilize blends of oilseed protein concentrates and skim milk powder in enriching wheat flour.

Because of its easy digestibility leavened bread is becoming our important diet particularly in the diets of children, invalids and convalescents. Bread enrichment has been carried out for a number of years in many countries of the world. The protein nutritional value of the bread has been improved by the addition of skim milk powder, soy flour, fish flour, lysine and methionine elsewhere.[4,5]

It will be of great value to produce an enriched bread with necessary vitamins, minerals and enough protein to take care of nutritional requirements of vulnerable groups of the population.

In preliminary trials with these protein concentrates several formulae were tried. It was observed that incorporation of 7–8% of the protein mixture does not appreciably affect the baking properties of the dough. The high protein bread was similar to unfortified control bread with respect to loaf volume, texture, appearance and taste. Preliminary calculation of protein score and net dietary protein calories % (NDp cals %) according to the method of Miller and Payne[6] showed that the breads would yield an NDp cals% of about 8, which is considered suitable for young children,[7] hence no attempt was made to further increase the amount of protein mixture in the bread. The present report deals with the preparation and nutritional evaluation of these enriched breads along with breads (1) containing skim milk powder and (2) wheat flour only to serve as controls.

Materials and Methods

Protein concentrates from indigenous cakes were prepared according to thd methods described earlier.[1,2] Since commercial groundnut cake contained a lot of hulls groundnut protein concentrate was prepared from dehulled and defatted groundnuts in the laboratory. The protein content of cottonseed, rapeseed and groundnut protein concentrates as determined by semimicro-Kjeldhal method were 76.0, 70.0 and 92.0% respectively.

Good quality skim milk powder (protein 35%) was obtained through the courtesy of Dr. S.M.K. Wasti of Mayo Hospital, Lahore. Other ingredients were purchased locally.

Preparation of Breads.—Water (220 ml) was added to Baker's yeast and the suspension was allowed to stand for 10 min. Sugar and salt were dissolved in another lot of 200 ml water. The remaining dry ingredients, i.e. wheat flour, skim milk powder, protein concentrate, vitamin and mineral mixture were mixed together and the above two mixtures were added to dry mix and made into a dough with the addition of required quantity of water, i.e. 200–220 ml., determined earlier by Farinography. The mixed dough was fermented for 4–5 hr at 80°F and then the desired amount of dough was added to the mould pan and placed for another hour at 95°F. The dough was baked at 400–450°F for *ca* 40 min.

Wheat flour breads were also prepared in the above manner except that no protein supplements, vitamins and minerals were incorporated.

The composition of the breads containing various protein concentrates and other nutrients along with a wheat bread without any added nutrients is shown in Table 1. The formulae of the fortified breads were designed in such a manner that the total protein content was *ca.* 14% on dry weight basis and the proportion of protein contributed from protein concentrate and skim milk powder was equal.

Nutritional Evaluation of Breads.—Moisture, protein (N% × 6.25), fat, ash, calcium iron and crude fibre were determined according to the methods given in A.O.A.C.[8] Calories were determined by means of bomb calorimeter by the method of Miller and Payne.[9]

Net protein utilization operative (N.P.U. %) was determined according to the method of Platt, Miller and Payne[10] using male albino rats weighing 30–35 g. Net protein utilization standardized (N.P.U. st) was calculated according to the formula:[11]

$$NPU_{st} = \frac{NPU_{op} \times 54}{54 - \text{protein cal \%}} - 8$$

Net dietary protein calories% (NDp cal%) were calculated by the formula:[10]

$$\text{NDp cal \%} = \text{N.P.U. op} \times \text{protein calories \%}$$

Digestibility, feed efficiency and protein efficiency were determined according to the method described earlier.[12]

Results

Results of nutritional evaluation of breads are given in Tables 2–4. It will be observed from Table 2 that the enriched breads had a higher content of protein, calcium and iron as compared with unenriched control. There was, however, no appreciable difference between breads with respect to other constituents.

Maximum N.P.U. $_{op}$ is given by bread containing skim milk powder followed by breads containing rapeseed protein concentrate, cottonseed protein concentrate and groundnut protein concentrate in decreasing order (Table 3). N.P.U.$_{st}$ which according to Miller and Payne[13] is equal to protein score and is independent of the level of protein in the diet also follows the same course. N.P.U.$_{op}$ of breads containing cottonseed protein concentrate and skim milk powder and skim milk powder alone are almost similar while those containing cottonseed protein concentrate and groundnut protein concentrate have lesser values than either of the above blends. It will be noticed that the wheat flour bread has an N.P.U.$_{st}$ of 47% only while breads containing protein concentrates gave values ranging from 63–72%. Thus blends of protein concentrates with wheat

TABLE 1.—COMPOSITION OF BREADS[1] (For 1 kg mix).

Protein supplement	Wheat flour g	Skim milk powder g	Cottonseed protein concentrate g	Rapeseed protein concentrate g	Groundnut protein concentrate g	Vitamins[2] and mineral mixture g
Cottonseed protein concentrate + Skim milk powder (CPC+SMP)	880	50	23.0	—	—	15
Rapeseed protein concentrate + Skim milk powder (RPC+SMP)	878	50	—	25	—	15
Groundnut protein concentrate + Skim milk powder (GPC+SMP)	883	50	—	—	20	15
Skim milk powder (SMP)	853	100	—	—	—	15
None	968	—	—	—	—	—

1. Breads also contained: salt 12 g; yeast 10 g; sugar 10 g.
2. Composition per kg: Calcium phosphate 996 g; iron ammonium citrate 3.5 g; thiamin 80 mg; riboflavin 80 mg and niacin 340 mg.

TABLE 2.—ANALYSIS OF BREADS.

Protein* supplement	k cals g	Fat %	Protein %	Fibre %	Ash %	Carbo-hydrate %	Calcium mg/100g	Iron mg/100g
CPC+SMP	3.8	2.5	14.4	0.5	2.9	79.7	500	2.7
RPC+SMP	3.7	2.3	13.5	0.5	3.1	80.6	482	2.6
GPC+SMP	3.7	2.4	14.4	0.5	3.1	79.6	497	2.7
SMP	4.0	2.6	15.0	0.4	3.0	79.0	555	2.6
None	3.9	3.0	12.5	0.5	1.0	82.9	23	2.2

*For explanation of abbreviations see Table 1.

TABLE 3.—PROTEIN VALUES OF BREADS.

Protein supplement*	Protein cals%	N.P.U.$_{op}$ %	N.P.U.$_{st}$ %	NDp cals %
CPC+SMP	15.0	52	64	7.8
RPC+SMP	14.6	57	70	8.3
GPC+SMP	15.0	51	63	7.6
SMP	15.0	58	72	8.7
None	13.0	42	47	5.8

*For explanation of abbreviations see Table 1.

TABLE 4.—DIGESTIBILITY, FEED EFFICIENCY AND PROTEIN EFFICIENCY OF BREADS.

Protein supplement*	Digestibility	Feed efficiency	Protein efficiency
CPC+SMP	92	2.8	2.45
RPC+SMP	92	2.5	2.67
GPC+SMP		3.0	2.28
SMP	92	2.3	2.9
None	85	7.0	1.2

*For explanation of abbreviations see Table 1.

proteins have resulted in increase in protein utilization. This is clearly shown in NDp cal% values which have increased from a value of 5.8% in wheat bread to about 8% or more in breads containing blends of protein concentrates and skim milk powder. According to an FAO/WHO report[13] foods containing NDp cals %=8 are suitable for feeding infants. Hence these breads will be of special value in child feeding programmes.

There was no difference in the digestibility of various breads (Table 4). Maximum efficiency of feed and protein utilization was observed in rats fed on bread containing skim milk powder alone followed by those containing rapeseed protein concentrate, cottonseed protein concentrate and groundnut protein concentrate in decreasing order. Feed efficiency and protein efficiency of the wheat bread is much less than those of any of the breads containing protein concentrates. These observations further confirm the results of N.P.U. determinations.

Discussion

The above results have shown that breads fortified with protein concentrates, vitamins and minerals have a much higher nutritional value than that containing wheat flour alone. Although the protein value of bread containing skim milk powder is higher than those containing blends of skim milk powder and protein concentrates but the difference in protein value is not much. Thus it is possible to extend the supplies of skim milk powder and reduce the cost of these breads.

Fortification of leavened bread will be more effective than attempting to enrich the basic staple, e.g. wheat flour in Pakistan, which besides adding to the cost may not be practicable on a large scale for the time being. Distribution of the enriched bread on subsidized rate for feeding young children, sick or convalescents will be an important step towards ameliorating protein malnutrition in these groups.

The choice of the protein concentrate for enrichment purposes should be guided by the cost of the material which may differ from area to area. Rapeseed protein concentrate and groundnut protein concentrate have the advantage of being colourless powders while cottonseed protein concentrate possesses brown colour but it is used in such small quantities that it does not materially affect the appearance of the loaf. A bread containing higher protein content is possible and will be readily acceptable to a weaned infant who has not yet cultivated the taste and prejudices of the grown-up adult but the experience of public health

worker all over the world has shown that for successful implementation of a nutrition programme it is necessary to convince the parents first. So it is better to be content with a less nutritious product and high acceptability than a highly nutritious product with limited or no acceptability.

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