Pakistan J. Sci. Ind. Res. Vol. 19, No. 2, April 1976

SUPPLEMENTATION OF ROTI AND NAN WITH GRAM (CHICK PEA) FLOUR*

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(Received December, 23, 1975, revised June, 7, 1976)

Abstract. The effect of supplementation of roti and nan with 10, 15 and 20% levels of gram flour was studied. The protein content and protein quality of these products improved with the addition of gram flour. The effect of such supplementation on organoleptic qualities of roti was non-significant, while nans prepared with 15 or 20% gram flour were significantly more acceptable than control.

Roti and nan are the staple foods of Pakistanis. Both the products are prepared from wheat flour. Roti (an unleavened pancake like product) is almost invariably prepared from whole wheat flour called 'Atta' and Nan (a leavened pancake like product) is usually prepared from low extraction patent flour but in certain regions it is also prepared from whole wheat flour. The recipes for both products include a flour-water dough, in which, in some cases, small amount of common salt is added. The quantity and more particularly the quality of proteins in these products is rather low. On the other hand, there is a serious shortage of proteins in the diet of Pakistanis as evidenced by the Protein Committee Report[1] and it was recommended that supplementation of staple foods with protein rich materials should be considered. The present paper deals improvement of nutritive value of 'roti' and 'nan' when supplemented with varying levels of gram flour. In Pakistan gram flour is consumed in one form or the other. Gram flour alone or in admixture with flour from other legumes is blended with wheat flour and made into loaves 'missi roti' which are relished by all classes of people. Gram flour made into paste with water with the addition of spices when fried becomes a tasty snack 'packoray', roasted chick pea are also consumed as snack. Soup is made from split decorticated chick pea called 'dhal'. Gram (*Cicer arietinum*) is a protein-rich grain containing about 25% protein and is particularly rich in lysine which amino acid is deficient in cereals. Supplementation of white bread with different levels of gram flour was studied by Shehata and Fryer[2] who reported increase in PER with the addition of gram flour. Supplemental value of chick pea (*Cicer arietinum*) in cereal based foods has been reported by Phansalkar *et al.*[3] Ould Aoudia *et al.*[4] Hanafy *et al.*[5] and Adolph *et al.*[6]

Materials and Methods

The raw materials namely Atta, patent flour and gram flour• were purchased from market. 'Atta' was blended with O, 10, 15 and 20% gram flour for the preparation of roties and patent flour was blended with similar levels of gram flour for the preparation of nans. The blends were taken to a commercial baker who baked these products according to the following procedures.

Preparation of Roties. Different blends of atta and gram flour were separately kneaded into dough by the addition of water.†† A little amount of common salt was added. The dough was rested for about thirty minutes and was then divided into dough balls, weighing four ounces each. The balls were flattened and placed on a cloth pad and then pasted onto the walls of a preheated 'tanoor' (a conventional earthen oven) As soon as the roties had developed brown specks, these were removed from the tanoor.

Preparation of Nans. Different blends of patent flour and gram flour were separately mixed with small amounts of dehi•• (a youghart like product), starter (a fermenting dough piece from previous batch) and a small amount of salt. Each blend was then mixed to form a dough of proper development by the addition of water and was allowed to ferment for thirty minutes. Each dough was again kneaded for about ten minutes. The dough was then divided into dough balls weighing five ounces and proofed for thirty minutes after which period they were flattened with a rolling pin. These were then baked in a preheated tanoor, in the same manner as for roties.

Organoleptic Evaluation Roties and nans were evaluated organoleptically for colour, flavour, taste and eatability according to the scoring method.

* This work was submitted for M.Sc. thesis at Agriculture University, Lyallpur in 1973.

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• Decorticated chick pea are ground into flour, locally the gram flour is known as 'Baysen'.

†† In Pakistan no water absorption specifications for different flours are provided by the flour millers nor are performed by the commercial bakers. The housewife keeps on adding water little while kneading the dough until she feels that the desired consistency of the dough has reached. The same procedure is followed by the commercial bakers.

•• It is prepared by conventional methods. There are no specifications for its preparation. Hot milk is poured in earthen pots, when hand warm (no thermometer is used) a little quantity of curdled milk left from the previous day is added and left to ferment. No incubation time or temperature is maintained, just the experience counts.

TABLE 1. PROXIMATE ANALYSIS OF ATTA, GRAM FLOUR, AND DRIED 'ROTIES' CONTAINING DIFFERENT LEVELS OF GRAM FLOUR.

Contents	Moisture %	Protein %	Crude fat %	Crude fibre %	Ash %
Atta (wheat flour)	11.54	11.63	1.30	1.90	1.74
0% gram flour roti	8.76	11.51	1.26	2.10	1.71
10% gram flour raw blend	10.52	12.88	1.45	2.23	1.80
roti	8.88	12.73	1.38	2.31	1.77
15% gram flour raw blend	10.69	13.68	1.69	2.54	1.85
roti	8.85	13.50	1.58	2.56	1.80
20% gram flour raw blend	10.63	14.36	1.90	2.76	2.00
roti	8.40	14.25	1.78	2.80	1.90
Gram flour	7.29	26.61	4.31	6.80	3.03

Values expressed on moisture free basis. Data represent an average of three determinations.

TABLE 2. PROXIMATE ANALYSIS OF PATENT FLOUR, GRAM FLOUR, AND DRIED 'NANS' CONTAINING DIFFERENT LEVELS OF GRAM FLOUR.

Contents	Moisture %	Protein %	Crude fat %	Crude fibre %	Ash %
Patent flour	10.75	10.60	0.35	0.71	0.52
0% gram flour nan	8.63	10.60	0.33	0.65	0.84
10% gram flour raw blend	10.07	12.25	0.70	1.24	0.74
nan	8.50	11.74	0.65	1.30	0.93
15% gram flour raw blend	10.22	12.42	0.98	1.56	0.85
nan	8.37	12.36	0.82	1.62	1.12
20% gram flour raw blend	10.09	13.22	1.09	1.91	1.10
nan	8.09	12.48	0.91	1.88	1.21
Gram flour	7.29	26.61	4.31	6.80	3.03

Values expressed on moisture free basis. Data represent an average of three determinations.

Preparation of Samples. Roti and nan samples were sliced and then dried at ambient temperature (97 ± 4°F) for about 60 hr. The dried samples were then ground in a laboratory Hammer Mill and were stored in polyethylene bags.

Analytical Methods. Samples were analysed for moisture, crude fat, crude fibre, total nitrogen and ash content according to methods 44-01, 30-25, 35-15, 46-12 and 08-01 respectively as described in Cereal Laboratory Methods of AACC.[7] Crude Protein of Atta, patent flour and blends, was calculated by multiplying total nitrogen by a factor of 5.7 and that of gram flour by multiplying with a factor of 6.25.

Amino Acid Content. The essential amino acids of the samples were determined microbiologically as described by Ford[8] employing *Streptococcus zymogenes* NCDO 592 for estimation of leucine, isoleucine, valine, arginine, methionine, histidine and tryptophan and *Leuconostoc mesenteroides* P60 for the estimation of lysine and phenylalanine. The organisms were obtained from National Collection of Dairy Organisms at the National Institute Research in Dairying, Shinfied, Reading.

Protein Efficiency Ratio Forty albino rats, weighing 40–50 g. each, were divided into ten groups of four each in such a way that average weight of each group was more or less the same. The rats were housed individually in wire mesh cages. Four rats were maintained on each diet. Five groups were given nan diets and the other five groups were fed roti diets. One drop of vitaminised oil, containing vitamins A, D, E, and K was also given to each rat every week. The rats were housed in an airconditioned room maintained at 23.8 ± 3°F. Feeding was continued over a period of 28 days. Food and water were provided *ad libidum*. Weekly records of weight gain and food intake were maintained Protein efficiency ratio was calculated by dividing the weight gain with the protein intake during the experimental period.

Results and Discussions

Proximate Composition. The data on the proximate composition of atta, raw blends and cooked roties are presented in Table 1. It was observed that gram flour contained 26.61% protein, 4.31% crude fat, 6.80% crude fibre and 3.03% ash, which were much higher than those of atta. Consequently, the addition of gram flour to atta at different levels caused corresponding increases in these constituents of the resulting blends. The addition of gram flour at 20% level resulted in a 2.73% increase in protein content, 0.6% increase in fat content, 0.86% increase in crude fibre and 0.26% inerease in ash contents in raw blend. Cooking had only slight and variable effect on the proximate composition.

The data on the proximate composition of patent flour, raw blends and nans are presented in Table 2. The protein, crude fat, crude fibre and ash contents of patent flour, as expected, were lower than those of 'atta'. The addition of gram flour resulted in significant increases in these constituents of the blends. Cooking of raw blends into nans showed non significant effect on these constituents

Amino Acid Contents. The results of microbioassay for essential amino acids of atta, raw blends of atta with gram flour and roties are presented in Table 3. The addition of 10, 15 and 20% gram flour corresponded to an increase of 0.08, 0.19 and 0.24% in the lysine content and 0.03,0.04 and 0.06% in the tryptophan content of roti. Similarly there was an increase of 0.11, 0.16 and 0.23% in the lysine content and 0.01, 0.05 and 0.07% in the tryptophan content of nans supplemented with 10, 15 and 20% gram flour respectively as shown by the data presented in Table 4. The losses of various amino acids during cooking or baking were insignificant. Mathews *et al.*[9] had reported only 4% loss of free lysine in the case of 'roties' which had been cooked after supplementation with lysine mono-hydrochloride at levels of 0.1–0.6%. Losses of lysine have, however, been reported to be as high as 10–15 by Ericson *et al.*[10] during baking of conventional white bread.

It would be of interest to note that if consumption of wheat be taken at 400 g / person/day (it is generally agreed that wheat consumption in Pakistan is approximately 400 g./person/day) then the roties

TABLE 3. AMINO ACID COMPOSITION OF ATTA, RAW BLENDS, 'ROTIES' AND GRAM FLOUR (g/100 g)

Amino acids	0% GF*		10% GF blend		15% GF blend		20% GF blend		Gram flour
	Raw	Roti	Raw	Roti	Raw	Roti	Raw	Roti	
Tryptophan	0.09	0.10	0.14	0.13	0.18	0.14	0.19	0.16	0.21
Isoleucine	0.77	0.76	0.95	0.95	1.00	1.00	1.13	1.05	1.45
Leucine	0.97	0.97	1.08	1.04	1.15	1.10	1.18	1.15	1.53
Lysine	0.35	0.34	0.45	0.42	0.53	0.53	0.59	0.58	1.51
Methionine	0.20	0.20	0.21	0.21	0.25	0.24	0.26	0.20	0.25
Phenylalnine	0.65	0.64	0.76	0.75	0.86	0.84	0.94	0.95	1.65
Valine	0.61	0.58	0.67	0.65	0.72	0.71	0.79	0.75	1.36
Arginine	0.65	0.64	0.81	0.81	0.96	0.95	1.13	1.12	2.47
Histidine	0.32	0.32	0.36	0.35	0.38	0.36	0.44	0.42	0.85

*GF, Gram flour data represent an average of three determinations.

TABLE 4. AMINO ACID COMPOSITION OF PATENT FLOUR, RAW BLENDS, 'NANS' AND GRAM FLOUR (g/100 g)

Amino acids	0% GF*		10% GF blend		15% GF blend		20% GF blend		Gram flour
	Raw	Nan	Raw	Nan	Raw	Nan	Raw	Nan	
Tryptophan	0.07	0.07	0.10	0.08	0.14	0.12	0.16	0.14	0.21
Isoleucine	0.60	0.55	0.73	0.66	0.77	0.68	0.85	0.74	1.45
Leucine	0.87	0.81	1.03	0.95	1.09	0.99	1.14	1.00	1.53
Lysine	0.32	0.32	0.44	0.43	0.50	0.48	0.56	0.55	1.51
Methionine	0.19	0.19	0.19	0.21	0.21	0.20	0.25	0.24	0.25
Phenylalanine	0.75	0.74	0.86	0.83	1.04	0.99	1.19	1.09	1.65
Valine	0.53	0.48	0.60	0.53	0.64	0.60	0.67	0.61	1.36
Arginine	0.49	0.44	0.64	0.62	0.81	0.77	0.90	0.85	2.47
Histidine	0.26	0.26	0.34	0.33	0.36	0.34	0.38	0.35	0.85

*GF, Gram flour data represent an average of three determinations.

TABLE 5. FOOD INTAKE, PROTEIN INTAKE, CHANGE IN WEIGHT OF RAT AND PROTEIN EFFICIENCY RATIO OF ATTA AND ROTIES CONTAINING DIFFERENT LEVELS OF GRAM FLOUR.

Diet	Rat No.	Food intake (g)	Protein intake (g)	Change in wt. (g)	PER*	Average PER
Atta (wheat flour)	1	100.53	11.68	+15	1.28	
	2	104.95	12.19	+15	1.23	
	3	107.21	12.46	+16	1.28	
	4	102.75	11.94	+16	1.34	1.28
0% gram flour roti	1	125.01	14.41	+24	1.64	
	2	126.64	14.58	+23	1.57	
	3	130.84	15.05	+25	1.66	
	4	138.91	15.98	+27	1.68	1.63
10% gram flour roti	1	152.65	19.43	+33	1.70	
	2	137.39	17.49	+29	1.65	
	3	125.06	15.92	+27	1.69	
	4	130.55	16.61	+28	1.68	1.68
15% gram flour roti	1	154.13	20.81	+43	2.07	
	2	175.01	23.63	+49	2.07	
	3	130.88	17.67	+36	2.03	
	4	154.87	20.91	+44	2.10	2.07
20% gram flour roti	1	140.08	19.96	+41	2.05	
	2	163.84	23.32	+49	2.10	
	3	168.18	23.96	+52	2.17	
	4	161.85	23.05	+48	2.08	2.10

TABLE 6. FOOD INTAKE, PROTEIN INTAKE, CHANGE IN WEIGHT OF RAT AND PROTEIN EFFICIENCY RATIO OF PATENT FLOUR AND 'NANS' CONTAINING DIFFERENT LEVELS OF GRAM FLOUR.

Diet	Rat No.	Food intake	Protein intake	Change in Wt.	PER*	Average PER
Patent flour	1	54.80	5.80	+5	0.86	
	2	47.43	—	—4	—	
	3	59.66	6.32	+5	0.79	
	4	46.77	—	0	—	0.81
0% gram flour nan	1	57.74	6.12	+6	0.99	
	2	90.72	9.61	+9	0.93	
	3	57.08	6.05	—3	—	
	4	60.49	6.41	+6	0.93	0.95
10% gram flour nan	1	80.85	9.45	+11	1.26	
	2	84.71	9.94	+12	1.30	
	3	75.19	8.82	+11	1.23	
	4	88.24	10.35	+13	1.26	1.26
15% gram flour nan	1	122.48	15.13	+20	1.32	
	2	140.61	17.38	+23	1.32	
	3	122.77	15.17	+21	1.38	
	4	114.70	14.17	+19	1.34	1.34
20% gram flour nan	1	151.10	18.85	+27	1.43	
	2	170.22	19.24	+27	1.40	
	3	143.40	17.89	+25	1.39	
	4	148.32	18.51	+26	1.40	1.40

*Weight gain per gram of protein intake.

TABLE 7.

Supplements	Organoleptic tests			
	Colour	Taste	Flavour	Eatability
Roties (gram flour)				
0%	5.4	7.3	7.3	7.0
10%	7.1	7.3	7.4	7.0
15%	7.3	7.3	7.0	7.4
20%	7.0	6.7	6.3	6.4
Nans (gram flour)				
0%	6.9	6.1	6.5	6.4
10%	7.2	6.6	6.8	7.1
15%	7.5	7.3	8.1	7.3
20%	6.8	6.9	7.1	7.4

Data represent average score of ten observations.
Range 1 poor to 10 good.

and nans prepared with 15 or 20% addition of gram flour, would provide the daily requirements of all the essential amino acids except methionine.

Biological Evaluation. The biological value of atta, patent flour, roti and nan was determined in terms of protein efficiency ratio (PER) and the data obtained are presented in Tables 5 and 6. The PER of atta and patent flour was observed to be 1.28 and 0.81 respectively. Atta being of higher rate of extraction, having better amino acid profile and higher protein content, would be expected to have better PER. Cooking of roti and baking of nan resulted in increases in PER. Such effect of cooking and baking has also been reported by Shayamala and Kennedy[11] and Chaudhry[12] to be due to destruction of antitrypsin factor in wheat. The supplementation of roti and nan with different levels of gram flour resulted in further improvement in PER. When roti was supplemented with 20% gram flour, the increased to 2.10 and in the case of nan supplemented with 20% gram flour, the PER was 1.40.

Shehata and Fryer[2] observed that PER of wheat flour and bread increased with the addition of chick pea flour. Murty and Austin[13] also reported that the nutritive value of wheat flour could be increased by blending with gram flour without affecting its palatability. The supplementation of both roti and nan with varying levels of gram flour resulted in corresponding improvement in weight gain of rats. Present results confirm the findings of Ould Aoudia *et al.*[4] who reported that when chick pea was added to bread wheat and barley diets, the daily weight gain of rats increased from less than 1 g to more than 1.3 g.

Organoleptic Evaluation. The addition of gram flour imparted yellow coloration to roties and nans, the intensity of which increased with increase in the level of gram flour. The organoleptic evaluation of roties showed nonsignificant effect on addition of gram flour on such attributes as colour, flavour, texture and eatability, Table 7. In case of nans, however, the judges showed a strong preference for the product with 15% gram flour, Table 7. Nans prepared with 15 or 20% gram flour were judged to be significantly more acceptable as compared to those prepared with the addition of 10 and 0% gram flour, with respect to their colour, flavour and texture. The strong preference was probably due to the beautiful golden brown colour of these nans.

Acknowledgements. The authors are thankful to Dr. S. M. Ali and Dr . A. F. M. Ehteshamuddin of PCSIR Laboratories, Lahore, for providing laboratory/animal house facilities, for valuable suggestions and for going through the manuscript.

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