

# Proximate composition and dietary fibre content of various foods/rations processed to suit the Indian palate

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The proximate composition and dietary fibre contents of various processed foods either in ready-to-eat (RTE) or easy-to-reconstitute (ETR) form have been evaluated. The RTE foods included flavoured chapathy (unleavened bread), spiced potato chapathy and chikki (peanut candy), while the ETR foods contained items such as precooked dehydrated (PD) khichdi, PD vegetable pulav (rice based item), PD green gram dal curry, instant upma mix and instant halwa mix. Three different rations formulated out of these products have also been studied. Among the individual items studied, instant halwa and upma mixes have been found to be calorie dense (5400 kcal kg<sup>-1</sup> FW). The other items provided about 3000 to 4700 kcal kg<sup>-1</sup> FW. The rations, on the other hand, provided about 3500 kcal person<sup>-1</sup> day<sup>-1</sup>. All the food items except instant halwa mix were found to contain high amounts of insoluble and total dietary fibre (TDF). The rations were estimated to provide 60–70 g TDF person<sup>-1</sup> day<sup>-1</sup>.

## INTRODUCTION

Dietary fibre, an important ingredient in food (Spiller, 1986), comprises a diverse group of plant substances, celluloses, hemicelluloses, lignins and other non-starch/non-cellulosic polysaccharides which are of chemical and morphological complexity and are resistant to the action of enzymes of the human gastrointestinal tract. Since Trowell first introduced the dietary fibre hypothesis (Trowell, 1976), the importance of these unavailable carbohydrates in normal and therapeutic diets has been widely acknowledged by several authors (Kalsay, 1978; Schneeman, 1981; Kritchevsky, 1982; Vahouny & Kritchevsky, 1982; Spiller, 1986; Brand *et al.*, 1990). Generation of data therefore, on the profile of total dietary fibre (TDF) contents of various foods is warranted (Costa *et al.*, 1989; Hoagland, 1989; Indira & Kurup, 1989). Many investigators have measured the dietary fibre content of individual foods (Kalsay, 1978; Southgate, 1978; Herranz *et al.*, 1981; Englyst & Cummings, 1984; Prosky *et al.*, 1985; Anderson & Bridges, 1988; Plaami *et al.*, 1991; Renard & Thibault, 1991). Several others have reported the changes in the dietary fibre content and its profile encountered as a result of processing of foods (Herranz *et al.*, 1981; Johnston & Oliver, 1982; Herranz *et al.*, 1983; Varo *et al.*, 1983; Reistad and Hagen, 1986; Ring *et al.*, 1988; Marlett,

1991; Philips and Palmer, 1991; Valverde and Frial, 1991; Camire and Flint, 1992; Penner and Kim, 1992; Valverde *et al.*, 1992). However, reports regarding the dietary fibre content of foods processed to suit the Indian palate are sparse.

A wide range of processed foods, either in ready-to-eat (RTE) or easy-to-reconstitute (ETR) form, have been developed in our laboratory, especially for use by the Armed Forces operating in varied geographical and climatic areas. The crude fibre contents of some of these products have been reported (Ramanuja *et al.*, 1967). Crude fibre underestimates the contribution of dietary fibre from all foods and more so from cereals (Southgate *et al.*, 1976) as the methodology involves hydrolysis by acid and alkali. Moreover, it does not reveal the true picture of the components of dietary fibre, namely the insoluble and soluble dietary fibre which have more relevance in interpreting the beneficial effect of dietary fibre on the whole. The present study therefore aims to estimate total, insoluble and soluble dietary fibre contents of some of the RTE and ETR foods processed in our laboratory. Three different types of rations have been formulated incorporating the aforesaid processed foods to cater effectively for the nutritional needs of the Armed Forces. The dietary fibre content and its profile has been studied in these rations.

## MATERIALS AND METHODS

The various ration items employed for the present study together with their major constituents are listed in Table 1. The references cited against each of the products elucidate the processing techniques and method of reconstitution/use. The processes are also described here.

### Ready-to-eat foods

#### Flavoured chapathy (unleavened bread)

The preservative mixture is dispersed in just enough water to enable the dough to be kneaded. Cumin (*Cuminum odorum* S.) oleoresin dispersed in about 50% of warm hydrogenated peanut (*Arachis hypogea* L.) oil is added to the mixture of wheat flour and whole milk powder and the dough is kneaded using the water containing the preservative mixture. Small portions of this dough were rolled into discs of about 15 cm diameter and baked on a hot plate (220–240°C) to obtain chapathies weighing about 40–50 g each. The remaining hydrogenated peanut oil was applied as uniformly as possible to both sides of the chapathies while baking. Immediately after baking, the chapathies (4 Nos) were packed in paper–aluminium foil (0.04 mm)–polyethylene laminate (PFP) pouches of 20 × 20 cm and heat-sealed. These were sterilized in-pack for 2 h at 90 ± 5°C.

#### Spiced-potato chapathy

All purpose wheat flour (Maida, 55–60% extraction rate) and cooked, peeled and mashed potatoes (*Solanum*

*tuberosum* L.) together with all other ingredients were kneaded (as described under flavoured chapathy) in the form of dough. Chapathies were baked, packed and sterilized in-pack as described above.

#### Chikki (Peanut Candy)

Sesame (*Sesamum indicum* L.) and peanut (*Arachis hypogea* L.) seeds were separately roasted to a golden brown colour. The peanut seeds were then crushed into small bits and dehusked. Both of these were thoroughly mixed with dehusked, roasted bengal gram (*Cicer arietinum* L.) dal. Crushed jaggery was dissolved in about one-third of its weight of water by warming on a low flame and filtering through a muslin cloth. The filtrate was concentrated (130–135°C) to a desired consistency, at which stage the mixture of roasted sesame, peanut and bengal gram dal was added and thoroughly mixed into a uniform mass. This was immediately transferred onto a suitable stainless-steel mould, and cut into uniform pieces, which were subsequently packed in PFP pouches.

### Easy-to-reconstitute foods

#### Precooked dehydrated (PD) khichdi, vegetable pulav and green gram dal curry

These three products have several major components in common, which can be processed on a large scale. These include PD rice, PD green gram (*Phaseolus aureus* R.) dal, fried onions (*Allium cepa* L.), potatoes, peas (*Pisum sativum* L.), curry powder and spice mix.

Table 1. List of various RTE and ETR foods and their major constituents

Items	Major constituents	Reference
Ready-to-eat (RTE) foods		
Flavoured		
chapathy (unleavened bread)	Whole wheat flour (90–95% extraction rate) 2kg; whole milk powder 40 g; hydrogenated peanut oil 10%; preservative mixture: citric acid 0.2%, cane sugar 3.0%, table salt 2.5%, sorbic acid 0.15% on wheat flour basis; flavouring agent: cumin oleoresin.	Rao <i>et al.</i> , 1966; Arya <i>et al.</i> , 1977.
Spiced potato chapathy	All purpose wheat flour (Maida:55–60% extraction rate) and cooked, peeled and mashed potatoes (ratio 1:1); hydrogenated peanut oil 10%; preservative mixture: citric acid 0.1%, table salt 2.25%, sorbic acid 0.15%; flavouring agent: cumin oleoresin.	Arya <i>et al.</i> , 1990.
Chikki (peanut candy)	Materials required for 4 kg of finished product: Gur (jaggery) 2.4 kg; roasted and dehusked peanut seeds 1.2 kg; roasted and dehusked bengal gram dal 0.8 kg; roasted sesame seeds 0.4 kg.	Vidyasagar <i>et al.</i> , 1964.
Pickle	Mixture of raw mangoes, gooseberries, lemon and ginger cut into small bits and preserved mainly in vinegar, salt and edible oil. (Obtained from trade in bulk and repacked in the laboratory)	
Easy-to-reconstitute (ETR) foods		
Precooked		
dehydrated (PD) khichdi	PD rice 45.0%; PD green gram dal 32.5%; hydrogenated peanut oil 22.0%; fried onion 3.5%; masala/spice mix 3.5%; table salt 4.5%.	Mathur <i>et al.</i> , 1972.
PD vegetable pulav	PD rice 64.0%; hydrogenated peanut oil 12.5%; fried onion 2.2%; fried potatoes 12.5%; fried peas 4.0%; masala/spice mix 1.8%; table salt 4.0%.	Mathur <i>et al.</i> , 1972.
PD green gram dal curry	P. D. green gram dal 66.0%; hydrogenated peanut oil 15.0%; fried onion 10.0%; curry powder 4.5%; table salt 4.5%.	Bhatia <i>et al.</i> , 1967.
Instant upma mix	Wheat semolina (medium particle size) 62.5%; hydrogenated peanut oil 31.25%; bengal gram dal 1.25%; black gram dal 0.63%; dehydrated carrots, potatoes, onion, french beans, coriander leaves and curry leaves 4.37%.	Premavalli <i>et al.</i> , 1987.
Instant halwa mix	Wheat semolina (fine particle size); hydrogenated peanut oil; sugar.	
Tea	Each PFP (Paper–aluminium foil–polyethylene) pouch contains whole milk powder 15 g, sugar 10 g and tea leaves 5 g in three separate polyethylene sachets. Reconstitution yields approximately 250 ml.	Arya & Thakur, 1986.

*PD rice*

Rice soaked in measured amounts of water for 1 h was cooked with 3% hydrogenated peanut oil (on weight of rice basis) at 16 psi for 20 min. Oil was added to obtain a free-flowing product. The cooked rice was dried at 60°C for 3–4 h in a Kilburn drier to a moisture level of 5% or less.

*PD green gram dal*

Green gram dal was soaked in water for 2 h and pressure-cooked at 10 psi for 10 min. The cooked dal was cooled to room temperature, mixed uniformly with a solution of papain in water (500 mg papain/kg dal) and dried in a Kilburn drier as above.

*Fried onions, potatoes and peas*

Raw onions, peeled and shredded were fried in hydrogenated peanut oil (onion:oil, 1:2) at 170°C for about 15 min to a final moisture level of 5% or less.

Potatoes were dressed, peeled and diced to obtain strips of one-quarter inch thickness. The strips were blanched in boiling water containing 0.125% KMS (potassium meta bisulphite) for 4–5 min. Excess blanching solution was drained off and the superficial water adhering to the material was removed by drying at 70°C for 3–4 min. The material was fried in hydrogenated peanut oil (Potatoes:Oil, 1:4) at 170°C for 10–15 min to a final moisture level of 5% or less.

Hulled fresh peas were soaked in 2% sodium carbonate solution for about 30 min and then washed with water until the washings were free from alkali. They were then blanched in boiling water containing 0.4% KMS, 0.1% magnesium oxide and 0.1% sodium bicarbonate for 4–5 min, drained, and dried at 70°C for 2–3 min to remove superficial moisture. The blanched material was fried in hydrogenated peanut oil as in the case of onion and potatoes.

The various products obtained finally by mixing these different items in the proportions given in Table 1 were packed individually in quantities of either 100 g

or 200 g in PFP pouches. The various components of curry powder/spice mix can be found in the references cited against them. PD khichdi, PD vegetable pulav and PD green gram dal curry have to be reconstituted before use by boiling the products in three volumes of water for 15 min followed by simmering for 10 min.

*Instant upma mix*

Bengal gram dal and black gram (*Phaseolus mungo* L.) dal were fried to a golden brown colour in hydrogenated peanut oil. The wheat semolina was added to this hot mix and heating continued with constant mixing until the contents reached a temperature of 130°C. The remaining constituents specified in Table 1 were added at this stage and heating was continued until the mixture reached 140°C. The material was cooled to room temperature and packed in quantities of 100 g each, in PFP pouches. To reconstitute, the product has to be cooked in 2 volumes of boiling water for 5–6 min.

*Instant halwa mix*

The major constituents going into halwa mix were wheat semolina, hydrogenated peanut oil and cane sugar, while the minor components include cashew nuts, raisins and cardamom. Wheat semolina was roasted to a golden brown colour in hydrogenated peanut oil (160–180°C). Cashew nuts, raisins and cardamom roasted separately were added to this hot mix together with powdered cane sugar, and heating was continued for another 1–2 min the sample was cooled, and packed in quantities of 100 g each, in PFP pouches. In order to reconstitute, the product has to be cooked in an equal volume of boiling water for 3–4 min.

**Rations**

The three different types of rations employed for the present study are compiled in Table 2. These rations, hereafter referred to as O, M and L have been formulated with a view to meet the nutritional demands of

**Table 2. Composition of O-, M-, and L- rations<sup>a</sup>**

Schedule	O-ration		M-ration		L-ration	
	Components <sup>b</sup>	Quantity per pack (g)	Components <sup>b</sup>	Quantity per pack (g)	Components <sup>b</sup>	Quantity per pack (g)
Bed-tea	Tea	30	Tea	30	Tea	30
Breakfast	PD Khichdi	200	Instant halwa mix	100	Instant halwa mix	100
	Pickle	25	Instant upma mix	100	Instant upma mix	100
	Tea	30	Tea	30	Tea	30
Snack	—	—	—	—	Chikki	50
Lunch	Flavoured chapathy	160 <sup>c</sup>	PD vegetable pulav	200	Tea	30
	PD green gram dal curry	100	Pickle	25	Spiced potato chapathy	200 <sup>c</sup>
Snack	Chikki	50	Chikki	50	Pickle	25
	Tea	30	Tea	30	Chikki	50
Dinner	PD veg pulav	200	PD khichdi	200	Tea	30
	Pickle	50	Pickle	50	PD khichdi	200
					Pickle	50

<sup>a</sup> Each ration is for one person for one day.

<sup>b</sup> Only one pack was used at a time.

<sup>c</sup> Each packet contains either four 40-g flavoured chapathies or four 50-g spiced potato chapathies.

Indian troops under field conditions. The rations are essentially reconstituted/prepared, as described by Prasad *et al.* (1991). In brief, the ETR foods were reconstituted as indicated under each food in the text and mixed thoroughly with the RTE components, except tea. In the case of tea, the sugar and milk powder components were directly added to the mixture while the tea leaves were boiled in about 100 ml water and only the extract was used. The mixture thus obtained was passed, several times, through a domestic meat mincer to obtain a homogeneous material which was subsequently used for the chemical analysis.

### Chemical analysis

#### Proximate composition

All the products except tea, were analysed in triplicate for their proximate composition using the AOAC method (AOAC, 1984). Samples of all the three rations were also analysed similarly.

#### Dietary fibre

The defatted residues of various ration items obtained during the course of the analysis of crude fat were finely powdered using a Waring Blender, to pass through a sieve of 100 mesh. This fine powder of each of the samples was utilised for the estimation of soluble (SDF), insoluble (IDF) and total dietary fibre (TDF) contents by the method of Asp *et al.* (1983).

## RESULTS AND DISCUSSION

The ration items employed for the study are referred to in Table 1. These items, either precooked and dehydrated (ETR-form) or preserved in the RTE state, are very useful to persons who are not accustomed to culinary practices and are especially meant for use by the Armed Forces during combat operations. The proximate composition of these foods are given in Table 3. PD khichdi and vegetable pulav, the traditional rice based items, provide about 440–455 kcal 100 g<sup>-1</sup>. The protein content of PD khichdi is higher due to the pres-

ence of green gram dal as a component. The PD green gram dal by itself provides about 450 kcal 100 g<sup>-1</sup> and is generally used along with chapathies (unleavened bread) which contribute about 320 kcal 100 g<sup>-1</sup>. Spiced potato chapathy provides about 320 kcal 100 g<sup>-1</sup>. Instant halwa mix and upma mix, items based on wheat semolina (*Triticum aestivum*) are the richest sources of calories (approx. 540 kcal 100 g<sup>-1</sup>) which is derived from the hydrogenated oil employed in their preparation. Instant halwa mix is a sweet dish, while the upma mix is a savoury preparation containing vegetables like carrots (*Daucus carota*), french beans (*Phaseolus vulgaris*), potatoes, onion, etc. Chikki (peanut candy) a jaggery-based product is also a good source of protein and calories. The high protein and fat content is due to the presence of peanut and sesame seeds. Pickle, although used in small quantities and generally as a side dish, is a good source of calories, mainly due to the large amounts of oil used in its preparation.

Studies carried out by our laboratory (Viswanathan *et al.*, 1991) with the Indian troops engaged in simulated combat operations, both at sea level and at high altitude, showed that pack rations of the type used herein, which provided nearly 3500 kcal person<sup>-1</sup> day<sup>-1</sup> (normal energy pack rations) are best suited for the purpose. The O, M and L rations have been formulated based on the findings of these studies. The components of these three rations are given in Table 2. These rations provide, respectively, 3396, 3490 and 3488 kcal person<sup>-1</sup> day<sup>-1</sup> (calculated from the data given in Table 3). This energy is derived from 80–90 g of protein, 136–156 g of fat and 455–480 g of carbohydrates.

The soluble, insoluble and total dietary fibre contents of different foods are given in Table 4. The IDF and TDF contents of flavoured chapathy are very much higher than the values for spiced potato chapathy. The soluble fibre contents are, however, similar. The TDF content of spiced potato chapathy is much lower than that of flavoured chapathy (54.37 vs 86.35 g kg<sup>-1</sup> dry wt). The TDF content of chapathy is dependent mainly on the extraction rate of wheat flour used. As the extraction rate increases the TDF increases, almost to the levels found in the whole grain. As already indicated in the methodology, flavoured chapathies were prepared

Table 3. Proximate composition (g kg<sup>-1</sup> FW) of various processed foods

Product	Moisture	Crude protein	Crude fat	Carbohydrates	Crude fibre	Ash	Calories
PD khichdi	46.1	129.3	197.2	564	18.2	45.3	4548
PD vegetable pulav	43.2	90.1	164.3	649	18.6	35.2	4434
PD green gram dal curry	43.6	162.7	186.4	538	24.3	44.8	4481
Instant halwa mix	18.0	63.1	278.3	616	2.1	22.1	5223
Instant upma mix	32.1	91.3	319.1	514	18.8	25.2	5291
Flavoured chapathy	274.1	77.2	81.3	536	13.2	18.4	3184
Spiced potato chapathy	240.1	82.5	68.5	579	10.1	20.2	3261
Chikki (peanut candy)	33.2	155.4	185.4	590	14.6	21.6	4649
Mixed pickle	537.1	18.1	286.2	44	29.2	85.1	2825
O-ration	708.6	36.2	42.3	181	16.6	15.0	1251
M-ration	682.2	31.3	61.2	194	17.2	14.2	1452
L-ration	573.0	49.3	56.4	283	22.1	16.7	1835

PD, precooked and dehydrated; FW, fresh weight.

from 95% extraction wheat flour while spiced potato chapathies have been prepared by combining maida (55–60% extraction rate wheat flour) and cooked, peeled and mashed potatoes in the ratio 1:1. Both maida and peeled potatoes contribute less to the insoluble fraction of fibre of spiced potato chapathy compared to the contribution made by 95% extraction rate wheat flour in the case of flavoured chapathy. This possibly explains the differences in the IDF and TDF contents between these products.

The IDF and TDF contents of products like PD khichdi, vegetable pulav, and green gram dal curry, and of instant upma mix are also higher. However, these values are lower in the case of instant halwa mix and peanut candy. The very low content of IDF and TDF of instant halwa mix is expected, because of the fact that the product contains wheat semolina, sugar and hydrogenated peanut oil as the major constituents. All the products examined for the dietary fibre profile, except pickle, have been subjected to various processing treatments, including thermal treatment. Processing/thermal treatments such as cooking, baking, frying, extrusion, etc., that involve formation of non-enzymatic browning (NEB) compounds, have been found to increase the apparent fibre content of foods (Van Soest, 1965). The brown Maillard polymers, being insoluble and indigestible substances with the physical properties of lignin, contribute to the insoluble fibre fraction and, as a result, the TDF values appear higher (Schaller, 1978). This eventually explains the apparently higher IDF and TDF values observed in our products.

Amongst the three types of rations studied, O ration appears to contain more IDF and TDF than the other two rations, which contain nearly identical amounts of

various fractions of fibre. It can be seen from Table 2 that the ration breakfast contains PD khichdi and pickle, while the other two rations contain instant halwa mix and upma mix. The contribution of PD khichdi and pickle to the TDF content of O ration is calculated to be about 40.5 g, while the other two rations derive only 9.76 g from instant halwa and upma mix. The contribution made by the various other components of each of the rations being almost similar, the above difference arising out of the breakfast items explains the higher TDF content of O ration.

Although fibre remains an important constituent of food, it cannot be considered as an essential nutrient. Furthermore, it is difficult to ascertain the necessary daily requirement for so varied a substance as fibre. However, in view of the increasing importance of dietary fibre in human nutrition, the United States Food and Drug Administration and the National Advisory Committee in Great Britain have both recommended a dietary fibre intake of 20–35 g day<sup>-1</sup> (NAC, 1983; Pilch, 1987). The rations studied hitherto have been calculated to provide about 60–70 g TDF person<sup>-1</sup> day<sup>-1</sup> (Table 2), which is nearly double the recommended values.

There are some unclear and controversial reports that high fibre intake may have a negative effect on the bioavailability of some nutrients, especially minerals. This subject has of late been extensively reviewed by Torre *et al.* (1991), who conclude that there are clearly many unresolved questions on the effects of high fibre diets on mineral availability. In a study (Prasad *et al.*, 1991) carried out in the authors' laboratory with growing albino rats, it was found that the O ration, with highest TDF content, had a good growth-promoting value and was as good as the standard casein diet. However, it is desirable to evaluate all three rations for their effects on mineral bioavailability.

Table 4. Soluble, insoluble and total dietary fibre contents (g kg<sup>-1</sup> DW)<sup>a</sup> of processed foods and rations

Processed foods/rations	Dietary fibre		
	Soluble	Insoluble	Total
PD khichdi	8.22 (10)	70.66 (90)	78.88
PD vegetable pulav	6.18 (8)	70.35 (92)	76.53
PD green gram dal curry	18.44 (19)	80.43 (81)	98.87
Instant halwa mix	8.82 (26)	24.69 (74)	33.51
Instant upma mix	26.54 (31)	59.92 (69)	86.46
Flavoured chapathy	22.56 (26)	63.79 (74)	86.35
Spiced potato chapathy	22.78 (42)	31.59 (58)	54.37
Chikki (peanut candy)	15.27 (27)	42.40 (73)	57.67
Pickle mixed	21.44 (22)	77.43 (78)	98.87
O-ration <sup>b</sup>	10.79 (11)	83.93 (89)	94.72
M-ration <sup>c</sup>	15.11 (19)	66.41 (81)	81.52
L-ration <sup>d</sup>	13.04 (16)	69.37 (84)	82.41

<sup>a</sup> Values are means of a minimum of three and a maximum of six replicates.

<sup>b</sup> Provides 70 g TDF person<sup>-1</sup> day<sup>-1</sup>.

<sup>c</sup> Provides 59 g TDF person<sup>-1</sup> day<sup>-1</sup>.

<sup>d</sup> Provides 62 g TDF person<sup>-1</sup> day<sup>-1</sup>.

Figures in parentheses indicate values expressed as a percent of total dietary fibre.

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