Original Article

Extent of error in estimating nutrient intakes from food tables versus laboratory estimates of cooked foods

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Individual cooked foods (104) and composite meals (92) were examined for agreement between nutritive value estimated by indirect analysis (E) (Indian National database of nutrient composition of raw foods, adjusted for observed moisture contents of cooked recipes), and by chemical analysis in our laboratory (M). The extent of error incurred in using food table values with moisture correction for estimating macro as well as micronutrients at food level and daily intake level was quantified. Food samples were analyzed for contents of iron, zinc, copper, β-carotene, riboflavin, thiamine, ascorbic acid, folic acid and also for macronutrients, phytate and dietary fiber. Mean percent difference in energy content between E and M was 3.07±0.6%, that for protein was 5.3±2.0%, for fat was 2.6±1.8% and for carbohydrates was 5.1±0.9%. Mean percent difference in vitamin contents between E and M ranged from 32 (vitamin C) to 45.5% (β-carotene content); and that for minerals between 5.6 (copper) to 19.8% (zinc). Percent E/M were computed for daily nutrient intakes of 264 apparently healthy adults. These were observed to be 108, 112, 127 and 97 for energy, protein, fat and carbohydrates respectively. Percent E/M for their intakes of copper (102) and β-carotene (114) were closer to 100 but these were very high in the case of zinc (186), iron (202), and vitamins C (170), thiamine (190), riboflavin (181) and folic acid (165). Estimates based on food composition table values with moisture correction show macronutrients for cooked foods to be within ± 5% whereas at daily intake levels the error increased up to 27%. The lack of good agreement in the case of several micronutrients indicated that the use of Indian food tables for micronutrient intakes would be inappropriate**.**

Key Words: micronutrient, error estimate, food tables, cooked foods' composition

Introduction

Evaluation of nutrient intakes is a prerequisite for determining dietary adequacy among individuals in nutrition and health surveys. Nutrient value data bases (mostly Food Composition Tables) usually provide information about nutrient contents of raw foods and some standardized marketed food items. Thus from the weight of raw and cooked items and the available Food Composition Tables, nutrient intakes can be computed. The accuracy of such estimates tends to be low on account of large variability in nutrient contents of ingredient raw foods, their amounts and cooking losses; especially in the case of micronutrients. Considering the importance of micronutrients in health and disease, precise assessment of their dietary levels is a prime consideration for clinicians and nutrition research workers**.** It is therefore worthwhile to know the relative bias of computed estimates with reference to the laboratory estimates of nutrient content in foodstuffs.

Many comparisons of nutrient intakes based upon laboratory analysis versus food table values have reported differences in energy, the macronutrients protein, lipids and carbohydrates[1,2] and the micronutrient minerals.[3,4] However few studies have assessed these discrepancies for vitamins.[5]

Estimates of nutrient intakes using different food composition tables often exhibit large variations. The relative biases for micronutrients estimated from British and American food tables are inconsistent.[6] Generally food composition tables provide limited reliability for the estimation of most nutrients in collective, prepared meals.[7] In a comparative study of 5 different European tables of food composition, the greatest differences were observed among micronutrients, especially vitamin B12, niacin, folic acid, calcium and particularly dietary fiber.[8]

Sources of variation for nutrient contents in cooked foods may be both actual and artifactual.[9] Natural variation in water and nutrient contents in raw food materials on the one hand, and differences in the number and proportion of ingredients of the recipe on the other, together make up the total variability in nutritive value of cooked foods. In developing countries like India, the number of processed foods in the market is comparatively less and often the exact proportion of ingredients and, therefore, nutrients in the processed food is not reported.

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There is a considerable lack of information about the nutrient content of cooked or processed foods that are commonly consumed in India. A similar situation probably obtains in many other countries. The present paper compares the nutrient assessment of cooked foods based on laboratory analysis with the computed nutrient contents based on nutritive values of raw foods obtainable from the Indian National Food Composition Tables[10] after correcting for moisture content. The interest has been one particularly of dietary micronutrient quality.

Methods

Food samples

In all, 104 commonly consumed food items such as preparations of cereals, legumes, vegetables and snacks were included in our study. Grains were brought from open market where material comes from different parts of India. Cereal preparations included unleavened pancakes made from wheat, rice, sorghum, pearl millet, finger millet, and maize, mix cereals, fried rolls of cereals, baked cereals and pressure-cooked rice. Legumes and pulse preparations like split red gram, split Bengal gram, split green gram, split black gram, whole green gram, lentil, moth beans, field beans, cow pea, green peas, soyabean, black beans, dried French beans and whole horse gram were pressure cooked. Vegetables were purchased from different local markets. Green leafy vegetables (GLV) viz.; Amaranthus g, amaranthus p, colocassia, spinach, fenugreek leaves, radish leaves, safflower leaves, coriander leaves, cabbage, onion stalk, salad, lettuce, were cooked either dry or in a curry form with onion or little amount of soaked or ground legumes. Other vegetables such as cauliflower, capsicum, French bean pods, egg plant, bottle gourd, bitter gourd, snake gourd, ridge gourd, ladies' finger, cluster beans, pumpkin, potato were cooked either in dry form or curry. Carrot, beat, onion, knolkol, tomato, radish, cucumber were prepared as raw or cooked salads. Snacks included food items such as steamed rice flakes with onion, wheat semolina steamed in sweet or salted form, steamed or pancake products of rice and split black gram (idli, dosa, uttapa), sandwich, deep fried products of potato, sago, split black gram, wheat flour with vegetable stuffing, and sweets.

92 composite meals, as commonly consumed during breakfast, lunch and dinner were chosen from the Indian National Nutrition Monitoring Bureau reports, and other literature[11-13] representing different parts of the world. Meals were comprised of a variety of cereals, legumes, vegetables, fruits, milk products, oils, sugar, leafy vegetables and ready to eat items from markets. Foods were prepared in the most traditional manner in each region. Rice and legumes were pressure-cooked. Vegetables were cooked in pans using oil and adding traditional spices, salt and jaggery (unrefined sugar) for taste. Other cereals were prepared in the form of Roti (unfermented pancakes using cereal flours). Meal samples were prepared by homogenizing the ingredient foods in the proportion in which they were consumed. Each of the food samples was homogenized in a blender. Homogenates were processed for analysis of individual nutrients. All the analyses were carried out in independent duplicate samples.

Estimation of nutrient contents in the laboratory (M)

In all five independent replicates of each of the 246 foods were analysed in duplicates in the laboratory for nutrient contents. All the food items and meals were prepared and analysed in the laboratory for their nutrient contents. Nutrient contents and moisture of cooked foods and meals were measured by standard techniques of NIN manual.[14] β-carotene was estimated by spectrophotometry at 460 nm, after hydrolysis with alcoholic KOH and extraction in cyclohexane. Estimation of vitamin C was carried out using reduction of 2,6 dichlorophenol indophenol and reading at 520 nm. Thiamin was estimated flourometrically using excitation (364 nm) and emission (435 nm) filters after it's enzymatic liberation and conversion to thiochrome by oxidation with $K_3Fe(CN)_6$. Riboflavin was estimated flourometrically with excitation (436 nm) and emission (510 nm) filters.[14] Folic acid was estimated spectrophotometrically using the complex formation with N-1 Naphthyl Ethylene Diamine Dihydrochloride at 550 nm.[15] Contents of zinc, iron, copper of the cooked foods and meals were estimated by dry ashing and atomic absorption spectophotometry (UNICHEME, UK). Validation of the trace metal technique was done using biological standard (rice flour) obtained from NIES, Japan. Values observed by us were within ±5% of the expected value. These standards were run during estimation of the trace metals from foods. For the validation of vitamin contents, the marketed samples of vitamin supplements were used. Secondly, addition of known amount of pure vitamin in different food matrices and its recovery was also assessed during standardization of the techniques.

Levels of phytic acid degradation products (IP1, IP2, IP3, IP4, IP5 and IP6) were estimated by the method of Sandberg *et al*.[16] In brief, phytic acid and its degradation products were initially extracted from food samples in 3% trichloro acetic acid and the supernatant was subjected to ion exchange chromatography using Dowex 1x8 (200-400 mesh, Cl^- form) and gradient illution with 0 to 1 N HCl. The neutral detergent fiber, Acid detergent fiber and lignin were analysed by using the modified Van Soest detergent method using alpha amylase for reducing the interference of starch. Details are given elsewhere.[17,18]

Nutrient contents of some cooked foods are given in Appendix I along with an example illustrating the use of database for estimating nutrient intakes.

Estimation of nutrient contents by food composition tables (E)

Exact recipes were recorded for 104 food items. For each recipe, nutrient contents of raw ingredients were taken from the food table values from National database[18]. Using moisture content of the recipe as assessed in the laboratory, nutrient contents were computed for the cooked recipe. For example, consider a recipe containing 3 raw ingredients with respective amounts r1, r2 and r3 and observed percent moisture content as m. Dry part of the recipe = 100-m = d. Total raw weight =r1+r2+r3 = rt. Percent raw weight of each ingredient would be p1=(r1/rt)*100, p2=(r2/rt)*100, p3=(r3/rt)*100. From the food table, dry parts per 100 g of these three ingredients were noted as d1, d2, d3 respectively. The dry part in the recipe for each ingredient would be x1=p1*d1/100,

x2=p2*d2/100, x3=p3*d3/100 giving the total dry part on raw basis as dt=(p1*d1+p2*d2+p3*d3)/100. Let the ratio of observed to computed dry parts be k=d/dt. The nutrient value, say energy, for each ingredient be e1, e2, and e3 respectively. Then the total energy content of the cooked recipe can be computed as: Energy of the total recipe = k*(x1*e1/d1+x2*e2/d2+x3*e3/d3).
Similar calculations were performed for all nutrients.

Estimating nutrient intakes of healthy adults by both the methods

The nutrient contents of individual food items by both the methods were used to compute mean daily intakes of 264 healthy adults (20-45 yr). Their mean body mass index was 20.8±3.4 kg/m^2. Their dietary food intake was assessed by a semi quantitative Cooked Food Frequency Questionnaire (FFQ). The period of the FFQ was taken as one year to cover all seasonal fruits and vegetables. The FFQ covered 278 food items, which are commonly consumed in India. The questionnaire was administered by trained investigators by interview method. The details are already reported earlier.[19] Their mean energy intake was 2037±397 kcal/day, and mean protein intake was 52.0±9.4 g/day computed from the database of laboratory estimates of cooked food items.

Statistical Methods

Statistical analysis was performed using SPSS version 11.0 under Windows. Distributions of the nutrient contents over different foods were not normal. Therefore nonparametric tests viz.; Wilcoxon's matched pair signed rank test was used to compare the estimates by the two methods. To compare the two methods, limits of disagreement and intraclass correlation coefficient were used.[20-21]

Results

Table 1 gives macronutrient contents by the two methods. Variability in nutrient contents was more between the food groups than within the food group. Wilcoxon signed rank test indicated no significant difference between the methods M and E for energy and protein content for all the food groups (p>0.1). However fat content differed significantly except GLV. Carbohydrate content differed significantly in legumes and GLV groups (p<0.05). Average percent difference for energy content was 3.07±0.6% (95% confidence interval (1.91, 4.22)), for protein, 5.3±2.0%, (95% CI, (1.3, 9.2)); for fat 2.6±1.8% (95% CI:(-3.0, 8.3)); for carbohydrates 5.1±0.9% (95% CI: (3.3, 6.8)) indicating overestimation of macronutrients by E though statistically non-significant in case of energy and protein.

Tables 2a and 2b describe the micronutrient contents estimated by M and E respectively. Cereal preparations had similar contents of β-carotene and vitamin C. But all other micronutrients differed significantly between the two methods as shown by Wilcoxon signed rank test (Table 3, p<0.05). In case of legumes and pulses micronutrient contents except copper showed significant difference between the two methods. In GLV group, only folic acid contents were similar, all other micronutrients showed significant difference between the two estimates. In Other vegetable group, only β-carotene contents were similar but all other micronutrients showed significant difference between the two estimates. In snacks group, only folic acid contents were significantly different by the two methods. In case of composite meals group, all micronutrients except copper showed significant difference between the two estimates.

In general, vitamin contents were overestimated by the method E even after adjusting for moisture in cooked foods. Average percent difference for β-carotene content was 55.5±5.2% (95% confidence interval (44.8, 66.2)); for vitamin C 32.4±8.2% (95% CI:(16.0,48.9)); for riboflavin 41.6±4.4% (95% CI: (32.5,50.7)); for thiamin 36.7±6.9% (95% CI: (22.5,50.8)); for folic acid 27.8±8.2% (95% CI: (11.0,44.6)); for iron 11.3±2.8% (95% CI: (5.8,16.9)) zinc 19.8±4.7% (95% CI: (10.3,29.4)); and for copper 5.6±1.6% (95% CI: (2.4,8.7)).

Phytate and fiber contents by the two methods differed significantly by Wilcoxon signed rank test (Table 2c).

Intraclass correlations were high for macronutrients

Table 1. Macronutrient contents of cooked food items and meals by the two methods

Food group	Dry part (g)	Laboratory estimate				Computed			
		Energy (kcal)	Protein (g)	Fat (g)	CHO (g)	Energy (kcal)	Protein (g)	Fat (g)	CHO (g)
Cereal (n=23)	57.7±17.3	269±18	6.5±0.6	8.4±1.0	43.0±2.6	246±16	6.2±0.5	5.8±1.0	42.3±2.9
Legume (n=17)	17.4±6.6	77±7	2.7±0.3	1.8±0.2	12.6±1.2	78±7	3.2±0.4	3.3±0.3	8.9±1.0
GLV (n=16)	29.3±12.9	125±13	1.9±0.3	1.9±0.2	24.6±2.6	122±15	1.6±0.5	2.5±0.5	11.7±1.8
Other vegetable (n=21)	27.4±12.2	124±11	2.1±0.2	3.3±0.4	21.6±2.2	116±15	2.6±0.3	3.8±1.3	11.5±0.9
Snacks (n=27)	65.8±27.0	331±28	6.5±1.0	14.3±1.8	44.7±3.8	337±29	5.8±0.6	16.6±2.2	41.4±3.9
Meals (n=92)	25.6±5.5	110±2	3.3±0.1	1.9±0.1	20.5±0.5	106±2	3.1±0.1	1.8±0.1	19.9±0.6

Figures are mean± SE. Wilcoxon signed rank test indicated no significant difference between laboratory estimates and computed with observed moisture content for energy and protein for all the food groups. However fat differed significantly except beverages and GLV. Carbohydrates differed significantly in legumes and GLV groups.

Table 2a. Laboratory estimates of vitamin and mineral contents

Food group	β-carotene (μg)	Vitamin C (mg)	Riboflavin (μg)	Thiamin (μg)	Folic acid (μg)	Zinc (mg)	Copper (mg)	Iron (mg)
Cereal (n=23)	142±37	2.4±0.78	50.5±7.2	150±28	10.0±1.8	0.86±0.02	0.22±0.03	1.4±0.3
Legume (n=17)	109±11	3.5±0.8	21±5	18.2±3.7	5.1±0.9	0.46±0.07	0.16±0.02	0.60±0.09
GLV (n=16)	1599±381	10.6±2.0	15.8±3.4	39.4±5.3	17.0±3.7	0.3±0.1	0.05±0.02	0.6±0.1
Other vegetable (n=21)	205±66	8.3±1.6	30±8	48±10.8	7.8±1.1	0.21±0.04	0.06±0.01	0.39±0.09
Snacks (n=27)	140±27	3.6±0.7	47.2±9	118±20	4.7±1.2	0.62±0.12	0.25±0.03	2.0±0.52
Meals (n=92)	712±84	5.2±0.4	124±9	261±13	17.5±1.7	0.47±0.02	0.16±0.01	0.99±0.04

Table 2b. Computed estimates of vitamin and mineral contents

Food group	β-carotene (μg)	Vitamin C (mg)	Riboflavin (μg)	Thiamin (μg)	Folic acid (μg)	Zinc (mg)	Copper (mg)	Iron (mg)
Cereal (n=23)	216±102	3.2±1.1	97.4±12.5	199±23	20.6±3.2	1.3±0.1	0.34±0.04	2.5±0.35
Legume (n=17)	35±5.2	1.6±0.3	30.6±4	67.6±7.9	9.6±1.9	0.34±0.06	0.15±0.03	0.90±0.2
GLV (n=16)	2868±763	36.6±8.5	185±40	101.9±16.5	33.3±15.1	0.5±0.08	0.18±0.03	6.6±2.4
Other vegetable (n=21)	287±119	27.9±9.0	85.7±16.5	126.2±29.8	35.2±11.9	0.53±0.07	0.18±0.02	1.2±0.13
Snacks (n=27)	162±78	6.3±2.3	52.2±7.8	133±21	25.5±6.3	1.7±0.9	0.28±0.05	3.4±1.1
Meals (n=92)	156±17	4.1±0.4	50.2±1.9	93±4.1	11±0.6	0.58±0.02	0.15±0.01	1.2±0.06

Table 2c. Phytate and fiber contents by the two methods

	Laboratory estimate		Computed with moisture content	
Food group	Phytate-P (g)	Fiber (g)	Phytate-P (g)	Fiber (g)
Cereal (n=23)	124±16	7.1±1.1	339±41	4.9±0.7
Legume (n=17)	20.8±2.9	1.7±0.5	63.3±8.4	2.1±0.3
GLV (n=16)	14.9±3.7	2.0±0.6	48.7±11.8	2.3±0.4
Other vegetable (n=21)	7.5±1.0	1.0±0.2	28.4±4.6	1.8±0.3
Snacks (n=27)	46.4±6.5	8.3±2.0	110.5±22.8	3.7±1.2
Meals (n=92)	56.8±2.8	2.9±0.2	120±7.8	2.2±0.2

Figures are mean± SE. Phytate and fiber contents by the two methods differed significantly by Wilcoxon signed rank test.

Table 3. Significance of the difference between two estimates of micronutrients

	Cereal	Legume	GLV	Other vegetable	Snacks	Meals
Carotene	NS	*	*	NS	NS	*
Vitamin C	NS	*	*	*	NS	*
Riboflavin	*	*	*	*	NS	*
Thiamin	*	*	*	*	NS	*
Folic	*	*	NS	*	*	*
Zinc	*	*	*	*	NS	*
Copper	*	NS	*	*	NS	NS
Iron	*	*	*	*	NS	*

but were quite low for vitamins, minerals, phytates and fibers (Table 4). This suggests that food table values adjusted for moisture content of recipes can be used for energy and protein contents more so for composite meals but not for micronutrients.

Figure 1 depicts ratios of estimates of nutrient intakes of adults from food tables (E) to those obtained by using cooked food database generated in the laboratory (M). The E/M ratios were close to 100 for calories, carbohydrates and copper but were higher for all other nutrients.

Discussion

A database of macro and micronutrient contents of 246 cooked foods has been generated. Of these, the contents of 104 individual cooked foods were compared with the estimated contents from the food composition tables tak-

Table 4. Comparison of two methods by limits of agreement and intraclass correlation coefficient

Nutrient	Intraclass correlation coefficient	Limits of agreement between two methods	
		Bias (dbar)	Random error SD
Energy	0.98	1.8	18.5
Protein	0.89	-0.11	1.61
Fat	0.87	-1.1	4.2
β-carotene	0.42	255	673
Vitamin C	0.30	-3.9	18.9
Riboflavin	0.10	4.1	72.9
Thiamin	0.20	50.3	140.2
Folic	0.15	-1.3	16.2
Iron	0.16	-0.97	3.8
Zinc	0.15	-0.28	1.7
Copper	0.61	-0.035	0.15
Phytate	0.30	-53.8	72.7
Fiber	0.66	0.38	2.1

ing into account the water content of the cooked foods. As evident from the results, the two estimates were closer for energy and protein, however most of the micronutrients showed a large difference in the range of 20 to 55% between the two estimates. Moreover, vegetable preparations exhibited larger variability than cereals suggesting that assessment of Indian food micronutrients need to be done in the laboratory. The intraclass correlation coefficient (ICC) was high for energy, protein and fat but for all other nutrients, phytates and dietary fiber the values of ICC were low and not statistically significant. These differences are reflected in the mean daily intakes of healthy adults (Fig 1).

Tables giving nutritive values for Indian cooked foods are presently not available. Our database can be used to compute the intakes of macro and micronutrients as well as phytate and dietary fiber. Cooking of items with multiple food ingredients differs largely because of relative proportions of the ingredients, especially oil and water; and also because of varietal differences in the nutrient contents of foods. Differences may also arise owing to different cooking processes, the time and the temperature; more so in case of micronutrients. For example, in preparation of vermicelli porridge (kheer), we have used cow's milk and vermicelli which were preboiled in water before adding milk and sugar. Another way of preparing the kheer is by adding fried vermicelli directly into buffalo's milk and sugar. This can lead to differences in nutrient contents of the same food item. Thus whenever recipes are not standard with respect to composition of ingredients and process, differences in nutrient contents are likely to occur. Moreover, as the number of ingredients in a recipe increases, the variability in estimates of contents further increases. For example in the case of *Misal* (see Appendix.), as many as 10 to 12 foods are separately prepared and mixed. As the proportion of rice flakes or puffed rice increases in the recipe, protein and fat contents vary to a large extent. Further, there was no association between number of ingredients and the error in nutrient contents indicating absence of a fixed bias in the estimates.

The purpose of the present study was to examine differences between the actual estimation of nutrients in cooked foods vs. computed values from Indian National Food Tables corrected for moisture content. Earlier we have analysed raw food samples of 22 rice types, 18 wheat types, 3 redgram, 2 bengalgram, and 9 different pulses for their mineral contents. Varietal differences for wheat and rice were significant only for zinc ($p<0.05$). Amongst raw vegetables, 27 fruit-root vegetables and 25 green leafy vegetables were analysed in three independent sets. Average values of all these foods agree well with National Nutritive value table giving mineral contents on raw basis. However vitamin contents for raw vegetables differed significantly ($p<0.05$).

Loss of micronutrients; especially vitamins, during cooking have been reported to the extent of 25 to 40%.[22] Another alternative to food tables is to use these estimates of cooking losses for computing dietary nutrient intakes. However there was a lack of relationship between observed laboratory value and the moisture adjusted food table value for micronutrients in the present database.

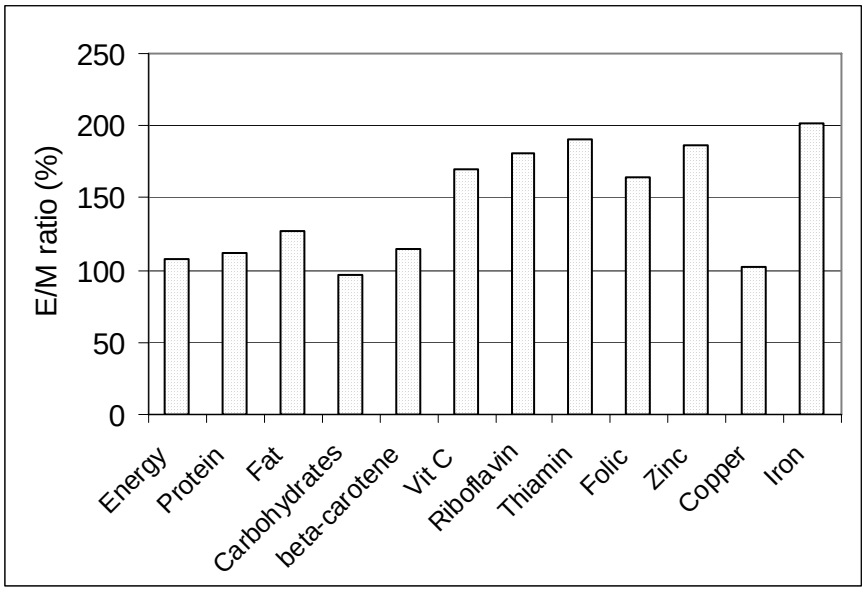

Figure 1. Ratio of nutrient intake estimates using food tables (E) to those measured in the laboratory (M)

Comparison of different food composition tables amongst themselves and that with chemical analysis revealed similarity in energy content estimates but differences in fat or carbohydrates.[1,2, 6, 8, 9] This is consistent with our findings that energy and protein contents by the two methods agree well. Our finding that micronutrient estimates exhibit more variation is also in line with the findings of others.[3-6]

In conclusion, food composition tables, after adjusting for moisture content, can be used for correct estimates of macronutrients. But, even with values generated in the laboratory, the micronutrient estimates will only allow a broad idea of dietary inadequacies.

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Appendix I. Laboratory estimates of Nutrient contents in cooked food items (Values are per 100 g cooked weight)

ID No	Food item	Water (g)	Energy (kcal)	Protein (g)	Fat (g)	CHO (g)	Ash (g)	Phytate-P (mg)	Fiber (g)	β-carotene (µg)	Vitamin C (mg)	B2 (µg)	B1 (µg)	Folic acid (µg)	Zinc (mg)	Copper (mg)	Iron (mg)
Beverages																	
1	Tea	86.2	63	0.9	1.3	11.0	0.1	-	-	3	0.2	20	10	1	0.01	0.07	0.01
2	Coffee	85.0	73	1.3	2.0	12.0	0.1	-	-	5	0.3	30	10	2	0.02	0.11	0.01
3	Whole Milk (buffalo's)	80.3	111	4.5	6.5	8.3	0.6	0	0	172	0	100	40	5	0.23	0.20	0.10
Cereal preparations																	
4	Unleavened whole wheat flour pan cake (Chapati)	34.7	305	8.0	9.2	47.5	0.7	63.1	10.0	40	1.6	44	105	19	0.74	0.31	1.94
5	Sorghum flour roti	31.2	280	6.0	1.7	60.2	0.8	60.5	10.0	72	1.6	67	228	13	0.78	0.23	2.30
6	Pearl millet (Bajara) flour roti	28.7	309	7.6	5.7	56.9	1.2	63.7	11.3	88	1.6	141	208	22	1.39	0.33	1.95
7	Rice flour roti	48.2	207	3.7	0.3	47.3	0.5	18.2	3.0	16	0.6	47	42	10	0.36	0.28	0.48
8	Maize flour roti	35.9	266	5.1	2.7	55.5	0.8	58.5	8.9	104	1	48	223	10	1.16	0.24	0.76
9	Finger millet (Ragi) flour roti	36.9	253	5.2	0.93	56.2	0.9	47.3	9.7	40	1.9	71	151	9	1.16	0.24	1.89
10	Shallow fried pan cake of roasted cereal and legume flours, spices, onion (Thalipet)	32.8	311	8.7	9.6	47.6	1.3	23.1	9.2	144	4.8	86	215	2	1.45	0.12	0.69
11	Potato stuffed whole wheat flour roti (Alu paratha)	55.5	205	4.9	6.0	41.8	0.6	20.7	7.8	45	4.7	70	190	12	0.56	0.05	1.30
12	Fenugreek-whole wheat flour roti (Methi paratha)	38.8	276	8.6	6.2	52.6	0.6	39.3	10.4	635	4.5	39	189	17	0.57	0.25	1.45
13	Deep fried pancake of whole wheat flour (Puri)	23.1	396	8.2	17.8	50.6	0.3	65.5	5.8	60	0	10	183	0	0.20	0.08	0.10
14	Mixture of bengalgram, jaggery stuffed in a wheat pan cake (Puran poli)	38.9	297	9.1	11.2	40.0	0.8	29.8	2.2	80	0	11	20	9	0.48	0.08	0.62
15	Plain rice	73.7	105	1.8	0.2	24.0	0.3	7.9	1.5	24	0.7	13	30	3	0.12	0.02	0.27
16	Rice cooked with vegetables, spices and vagar (Pulao)	62.2	171	3.3	4.6	29.0	0.9	7.4	4.2	56	1.8	55	180	1	0.19	0.13	0.38
17	Rice cooked with split green gram, oil, spices	80.2	90	3.0	2.4	14.1	0.4	6.8	1.3	64	2.2	13	35	3	0.45	0.20	0.59
18	Sweet rice	38.9	300	4.4	11.8	44.2	0.8	13.0	0.5	48	0	49	8	1	0.70	0.11	0.51
19	French millet (Warai)	79.5	96	1.5	3.1	15.6	0.3	0.0	9.7	15	5.1	2	66	-	0.17	0.09	0.57

Legume preparations																	
20	Split redgram curry	84.9	68	2.5	1.7	10.7	0.2	2.9	0.8	200	2.5	8	16	3	0.17	0.14	0.29
21	Green gram	83.0	80	2.5	2.6	11.6	0.3	6.5	0.9	128	2.5	3	34	3	0.36	0.09	0.46
22	Split bengalgram sauce	89.0	50	2.0	3.5	5.3	0.1	4.6	1.5	152	1.6	12	12	3	0.24	0.10	0.27
23	Buttermilk with little engal gram flour curry (Kadhi)	90.1	41	0.8	3.7	4.5	0.1	0.4	0.1	168	5.1	12	14	3	0.07	0.03	0.08
24	Fresh peas curry	84.3	67	2.5	3.6	9.3	0.3	3.6	0.2	96	5.2	3	18	2	0.20	0.12	0.26
25	Sprouted moth beans	66.3	148	3.4	2.9	27.0	0.4	10.6	0.7	72	10.6	68	36	8	0.68	0.13	0.93
26	Field beans	80.1	86	3.0	1.8	14.4	0.6	2.4	1.7	88	0	25	6	2	0.38	0.03	0.25
27	Cow pea	81.0	80	2.1	3.6	12.9	0.4	6.3	1.2	80	2.6	15	18	4	0.19	0.17	0.36
28	French bean	86.8	56	2.1	2.9	8.0	0.2	5.4	0.9	64	0	7	4	2	0.18	0.03	0.18
29	Sprouted field beans	89.3	47	1.4	2.7	6.6	0.1	4.8	0.5	63	8.3	7	3	1	0.16	0.02	0.12
30	Big whole Bengal gram	87.3	62	1.9	2.5	8.1	0.2	5.8	1.0	156	0.8	13	13	8	0.12	0.08	0.15
31	Small whole Bengalgram	87.4	54	1.2	3.2	8.1	0.1	0.9	0.5	128	6.2	14	24	3	0.20	0.10	0.25
32	Horse bean	84.3	70	1.8	1.7	11.9	0.3	5.8	1.0	128	3.6	20	19	7	0.32	0.14	0.43
33	Soya bean	84.2	74	3.9	2.4	9.2	0.3	5.8	1.1	64	5.2	7	5	14	0.30	0.04	0.24
34	Lentil	68.6	142	6.5	4.0	20.1	0.8	13.3	9.4	62	5.4	7	60	7	0.55	0.11	1.01
Green leafy vegetable preparations																	
35	Cabbage dry	77.2	97	1.1	1.4	20.1	0.11	1.8	0.6	80	8.6	10	19	4	0.05	0.01	0.18
36	Red Amaranthus	75.2	107	1.1	1.8	21.7	0.2	2.4	0.7	2840	8.6	6	54	46	0.05	0.01	0.52
37	Fenugreek with bengalgram	70.2	129	3. 8	2.2	23.5	0.4	4.5	2.7	1240	16.8	53	30	8	0.34	0.20	0.60
38	Dill leaves	61.2	195	2.8	9.2	25.4	1.4	3.8	5.5	2240	10.1	17	43	17	1.65	0.03	2.37
39	Onion stalks	70.2	130	1.5	2.4	25.7	0.2	2.5	1.0	155	3.4	19	46	22	0.18	0.09	0.29
40	Spinach	72.8	117	1.5	1.9	23.6	0.3	3.0	0.3	3880	7	5	49	28	0.08	0.02	0.29
41	Raddish leaves	52.3	197	3.8	2.0	40.9	1.0	5.3	1.0	104	33.5	19	20	6	0.79	0.04	0.62
42	Hibiscus cann.	35.3	270	0.9	3.6	50.8	1.7	13.4	9.8	1960	8.4	2	3	5	0.18	0.00	0.30
43	Safflower leaves	83.4	74	1.8	1.6	12.9	0.2	1.4	1.7	3920	6.2	8	40	9	0.34	0.01	0.52
44	Corriander with bengalgram	70.7	132	3.8	3.7	20.9	0.8	11.6	2.4	340	2.5	40	30	18	0.18	0.03	0.30
45	Split redgram with Rumex ves	83.3	77	2.2	2.4	11.7	0.5	2.7	1.0	88	11.5	0	6	3	0.22	0.03	0.20
46	Amaranthus viridis	92.1	32	0.4	0.8	6.5	0.1	0.7	0.2	4880	26.7	6	11	3	0.10	0.03	0.87
47	Colocassisa with bengalgram	75.6	106	1.9	2.0	20.2	0.4	4.6	3.2	96	6.18	23	78	0.1	0.17	0.18	0.77
Other vegetable preparations																	
48	Field beans pods	78.3	88	2.1	1.5	17.9	0.2	2.6	0.1	80	2.5	25	2	3	0.16	0.02	0.12
49	Bitter gourd	70.2	150	2.7	6.3	20.6	0.2	2.6	1.6	112	36.5	43	61	18	0.06	0.01	0.30
50	Bottle gourd	75.8	109	2.7	2.6	18.7	0.2	1.4	0.3	112	7.2	24	57	12	0.12	0.01	0.22
51	Capsicum	74.9	113	2.3	2.6	19.9	0.3	1.4	0.6	320	20.5	30	53	13	0.12	0.02	0.25
52	Cauliflower	81.1	84	1.2	1.9	15.5	0.2	1.1	0.5	96	8.6	27	40	13	0.06	0.01	0.08

53	Cluster beans pods	74.1	117	2.4	3.0	20.1	0.4	2.4	0.3	96	32.9	12	29	7	0.08	0.03	0.13
54	French beans pods	80.6	87	1.4	2.0	15.9	0.1	2.2	0.7	640	3.5	6	37	11	0.08	0.01	0.16
55	Knolkhol (Brasica olaracia)	75.8	104	1.2	1.7	21.0	0.3	3.2	0.6	168	3	39	29	7	0.36	0.13	0.54
56	Ladies' finger	68.1	156	2.0	5.9	23.6	0.4	4.9	1.6	48	9.5	31	33	13	0.19	0.02	0.35
57	Red tomato ripe	77.4	107	2.6	3.9	15.2	0.9	0.8	-	327	8.2	14	39	4	0.18	0.13	1.65
58	Pumpkin	81.7	83	1.5	2.1	14.5	0.2	-	0.7	180	6.2	20	39	4	0.06	0.01	0.18
59	Ridge gourd	80.7	89	1.7	2.6	14.8	0.2	-	1.0	200	2.5	11	41	4	0.10	0.01	0.19
60	Snake gourd	85.6	64	1.4	1.5	11.4	0.1	0.9	0.2	320	4.6	10	29	2	0.08	0.04	0.10
61	Coccinia cordifolia	38.8	281	3.7	7.9	48.8	0.7	5.6	3.2	72	10.9	64	25	18	0.52	0.08	0.49
62	Ash gourd	77.9	99	1.7	2.2	18.0	0.2	-	0.3	155	1.2	22	48	7	0.14	0.01	0.26
63	Elephant Yam	78.4	98	1.6	2.6	17.2	0.2	2.8	0.7	128	0.6	9	23	4	0.12	0.03	0.14
64	Brinjal-onion	72.9	115	2.5	1.5	22.8	0.3	3.5	0.5	24	6.7	16	51	11	0.27	0.16	0.42
65	Fresh field beans	78.2	94	1.6	1.6	18.5	0.2	1.2	-	80	2.5	13	25	9	0.07	0.01	0.13
66	Mixed vegetables	78.9	116	2.0	6.4	12.5	0.2	4.7	1.5	160	2.9	21	47	17	0.21	0.13	0.42
67	Onion with bengal gram flour	15.4	371	7.7	7.8	67.4	1.7	-	2.5	80	3.8	65	15	7	0.90	0.07	0.92
68	Potato	70.9	133	3.7	3.6	21.5	0.3	2.5	0.9	80	9.5	9	16	7	0.19	0.09	0.30
69	Radish	70.9	130	2.3	3.0	23.5	0.3	3.9	0.8	80	4.5	26	30	20	0.08	0.01	0.17
70	Carrot	73.8	123	1.2	4.5	15.7	1.1	-	17.2	850	6.9	92	50	1	0.28	0.02	0.18
71	Cucumber	82.4	86	2.6	3.7	8.4	0.6	-	1.0	0	5.1	10	25	0	0.05	0.01	0.02
72	Beet	72.5	138	2.4	6.8	16.8	1.5	-	1.5	0	3.1	8	22	1	0.25	0.12	1.78
Salads																	
73	Carrot	75.6	111	2.8	3.7	16.7	1.3	-	0.8	1387	16.7	160	86	1	0.21	0.17	1.04
74	Tomato	83.7	75	2.0	2.4	11.0	0.2	-	0.2	687	11.6	23	110	1	0.01	0.00	0.07
75	Roasted brinjal, onion	72.0	136	1.6	5.2	21.0	0.3	-	0.6	161	6.1	100	230	15	0.22	0.01	0.83
76	Cabbage	82.6	74	0.9	0.9	15.0	0.1	-	0.3	96	8.5	8	17	4	0.04	0.01	0.09
77	Carrot, onion	48.3	234	2.0	5.8	43.0	0.6	-	0.9	976	4.8	16	18	4	0.62	0.02	0.27
78	Cucumber with curd	78.3	99	0.3	2.7	19.0	0.4	-	0.3	104	5	24	6	4	0.09	0.01	0.09
79	Onion	81.0	101	1.3	5.1	18.7	0.3	-	2.6	11	6.2	66	93	1	0.18	0.12	1.16
80	Knolkhol	68.3	106	1.7	3.2	23.0	1.4	-	0.4	52	16.1	48	80	1	0.23	0.16	1.27
81	Raddish	77.9	94	0.8	2.1	18.0	1.1	-	1.0	303	6.9	81	48	1	0.20	0.06	0.85
82	Beet	88.7	41	1.9	0.5	19.0	1.0	-	1.2	0	8	9	56	0	0.21	0.09	1.60
83	Fenugreek leaves	68.4	137	1.4	2.3	28.0	0.3	1.9	1.3	1331	8.6	9	35	22	0.09	0.04	0.50
84	Red amaranthus	75.9	103	1.2	1.5	21.0	0.1	2.4	1.0	3060	24.5	7	73	46	0.05	0.01	0.53
85	Spinach	69.4	131	1.7	1.8	27.0	0.2	3.5	0.9	3939	10.5	9	68	33	0.09	0.02	0.32
86	Lettuce leaves	80.0	84	1.0	1.0	18.0	0.1	-	-	800	3.5	10	16	8	0.06	0.02	0.18

Chatney																	
87	Garlic with dry coconut	5.9	562	5.6	37.2	51.3	-	-	-	23	2	70	30	12	-	-	-
88	Sesame	5.3	448	13.1	14.6	66.0	1.0	6.5	19.5	200	1.4	95	183	16	0.95	0.03	1.46
89	Mix split legumes	15.2	370	10.1	8.2	64.0	2.6	6.2	48.7	32	3.7	17	12	3	2.25	0.18	0.61
90	Coconut fresh, coriander	62.6	218	7.0	13.7	16.7	0.1	3.8	-	200	10.8	10	8	11	0.21	0.25	0.43
91	Mint	83.3	70	0.4	0.7	15.0	0.2	-	1.5	248	1.6	4	17	5	0.02	0.00	0.14
92	Peanut	5.9	460	16.0	17.1	60.0	0.5	9.2	42.6	160	0.6	104	202	38	0.96	0.53	1.26
Sweets and desserts																	
93	Sweet Curds (Srikhand)	57.7	213	3.9	9.0	29.0	0.4	-	2.3	310	5.0	33	19	8	0.40	0.23	0.43
94	Sweet Khoa balls (Gulabjam)	15.9	392	6.5	19.7	47.3	0.6	-	2.0	96	0.6	42	84	-	0.81	0.06	0.10
95	Sweet condensed milk (Basundi)	54.3	268	2.8	17.4	25.0	0.5	-	2.8	45	0.7	24	29	-	0.39	0.09	0.69
96	Balls of fried bengalgram flour, ghee, sugar (Motichur)	34.2	345	2.1	17.4	45.0	1.4	20.1	1.5	16	0.6	19	83	2	0.56	0.04	2.11
97	Balls of khoa with sugar (Pedha)	24.2	392	2.2	18.4	58.4	1.7	25.9	2.7	24	0.3	17	59	1	0.30	0.01	0.33
98	Ripe mango juice, khoa and sugar (Amba burfi)	15.6	392	5.6	11.7	65.9	1.1	11.5	3.7	100	1.7	31	62	1	0.24	0.14	0.25

Nutrient contents in Snacks. Values are per 100 g cooked weight

ID No	Food item	Water (%)	Energy (kcal)	Protein (g)	Fat (g)	CHO (g)	Ash (g)	Phytate-P (mg)	Fiber (g)	β-carotene (µg)	Vitamin C (mg)	B2 (µg)	B1 (µg)	Folic acid (µg)	Zinc (mg)	Copper (mg)	Iron (mg)
Snacks																	
99	Rice flakes with onion, chilli, coriander, coconut, lemon (Kanda pohe)	22.3	349	7.2	9.1	60	1.81	17.8	3.7	32	6.6	40	170	1	0.42	0.47	0.94
100	Roasted semolina steamed with sugar, ghee (Suji/shira)	48.1	263	2.1	11.5	38	0.63	7.9	1.1	80	2.8	0	17	6	0.30	0.31	1.25
101	Roasted semolina steamed with vagar, onion, chilli, ginger (Upama)	48.0	238	4.2	6.5	41	0.73	10.5	6.6	105	6.9	6	120	1	0.41	0.32	0.61
102	Fermented rice and split black-gram mixture (2:1) steamed with salt, eaten with coconut, chilli (Idli-chatni)	45.5	231	5.4	3.2	45	0.67	13.7	5.7	72	3.0	71	220	1	0.38	0.25	0.75
103	Fermented rice and split black-gram mix (3:1) shallow fried thin pan cake potato, onion, chilli, oil (Dosa)	39.5	260	6.0	4.1	50	0.71	15.3	5.4	76	11.6	71	200	1	0.39	0.46	0.79

104	Fermented split Bengal gram powder steamed with vagar, garlic, chilli, ginger, coriander (Dhokla)	78.9	109	4.2	5.1	11.4	0.35	8.4	3.5	480	5.9	25	66	17	0.46	0.16	0.62
105	Colocasia leaves with bengal gram flour, tamarind, spices jaggery, sesame, steamed, shallow fried (Aluwadi)	52.1	197	6.0	1.9	39.2	0.97	9.0	6.3	5920	43.5	168	53	41	1.95	0.07	1.51
106	Bread with mix vegetables (pavbhaji)	76.2	106	2.1	2.4	18.9	1.54	5.4	2.2	280	5.2	12	38	17	0.18	0.03	0.23
107	Fermented split blackgram balls, deep fried, chatny (Meduwada)	48.3	272	4.8	13.5	32.9	0.5	14.8	5.7	96	5.8	31	194	0	0.40	0.25	0.56
108	Potato, split bengalgram flour, garlic, ginger, chilli (Potatowada)	41.8	316	4.5	17.3	35.5	0.88	19.4	5.1	117	6.3	32	133	0.73	0.43	0.25	0.59
109	Stuffed pan cake with split greengram (Kachori)	31.3	330	5.6	12.0	49.9	1.1	22.5	4.4	28	7.2	40	39	0	0.26	0.14	0.67
110	Sago potato, roasted peanut, chilli (Sagowada)	47.4	257	3.9	10.0	37.7	0.9	11.8	8.0	416	3.9	29	116	1	0.26	0.16	0.29
111	Refined wheat flour fries with potato, peas, spices (Samosa)	47.6	261	3.8	10.9	37.0	0.6	13.4	6.7	480	9.9	28	89	0	0.15	0.01	0.86
112	Vegetable cutlet (potato, beet, onion, peas, French beans)	38.5	340	5.7	19.5	35.5	0.8	-	0.9	35	0.5	5	61	0	0.46	0.25	3.20
113	Deep fried balls of onion in bengalgram flour (Pakoda)	58.7	208	5.5	9.0	26.4	0.5	5.9	3.0	64	5.8	8	58	5	0.33	0.29	0.45
114	Mixture of rice flakes, onion, sprouts, bengalgram fries, potato, coriander (Misal)	70.5	131	2.1	3.2	23.6	0.6	6.1	1.2	24	9.2	1	11	0	0.12	0.10	0.30
115	Cereal-legume fries, spices, sesame (Bakarwadi)	3.6	442	13.1	12.1	70.2	1.0	31.5	12.3	80	2.6	91	364	1	0.83	0.66	1.18
116	Split Blackgram flour , chilli, pepper fries (Papad)	3.3	386	11.1	2.3	80.4	2.9	0	0.0	24	0	16	50	0	0.68	0.41	6.06
117	Split bengalgram flour, red chilli fries (Shev)	3.9	506	9.9	25.7	58.7	1.7	0.0	-	72	0.5	40	322	1	0.79	0.40	8.19
118	Fried legumes, peanut, red chilli, spices (Pharsan)	3.6	617	14.1	46.2	36.1	0.8	0.0	15.6	47	0	52	181	0	0.83	0.34	6.45
119	Soaked Sago steamed with roasted peanut, ghee and cumin seeds (Sago khichadi)	70.7	146	2.5	6.2	20.0	0.5	3.2	2.7	340	2.8	34	52	14	0.14	0.01	0.22
120	Amaranth seed and jaggery cake (Rajgeerawadi)	1.5	484	7.9	18.6	71.3	0.7	0.5	9.7	13	0	43	47	-	0.68	0.53	11.84
121	Grated sweet potato, peanut, ghee (Ratalakis)	57.2	200	2.3	8.4	28.8	3.3	0.1	0.6	1	3	29	59	-	0.38	0.10	1.48

- indicates value not available. Words in brackets indicate local names.

Calculation of a sample day's consumption of vitamins:

Food item name	Quantity consumed	Weight (g)	β-carotene (μg)	Vitamin C (mg)	Riboflavin (μg)	Thiamin (μg)	Folic acid (μg)
Milk	1 cup	125	200	1.25	125	50	2.5
Methi paratha	2	60	381	2.72	23.4	113.4	10.2
Rice	1 bowl	100	24	0.70	13	30	3
Redgram curry	Half bowl	45	36	0.36	4.95	3.15	4.05
Total		330	641	5.03	166.35	196.55	19.75

The above calculation is based on the assumption that eg, moisture content in your methi paratha and the one given in the table are same with same proportion of ingredients. You can correct at least for the difference in moisture contents by computing moisture content of your cooked food item as follows:

Recipe: Methi paratha.

1. Weigh the raw ingredients of your recipe. Total raw weight is 250 g. Prepare paratha and again weigh. Now total cooked weight is 380 g.
2. The difference in the two weights will give you the moisture content of your recipe = 380-250 = 130 g.
3. Percent moisture of the recipe =(130/380)*100 = 34.21
4. Dry part of your recipe per 100 g cooked weight = 100-34.21=65.79
5. Mositure of Table value for Methi paratha =38.8 Dry part = 100- 38.8 = 61.2
6. Correction Factor for computing nutrients in your recipe= your recipe's dry part/ Table value dry part= 65.79/61.2=1.075
7. To compute vitamin C content in your recipe multiply by this factor to the table value = 4.53*1.075 = 4.87 Likewise you can compute any nutrient for your recipe.
8. This calculation will give you a closer estimate about the nutrient contents in your recipe. However differences in raw ingredients between two recipes would not be accounted.

Original Article

Extent of error in estimating nutrient intakes from food tables versus laboratory estimates of cooked foods

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以食物成分表及實驗室分析熟食估計營養素攝取量之誤差程度

使用間接分析(E)(印度國家生鮮食物營養素成分資料庫，已校正烹調後水分含量)及我們實驗室做的化學分析(M)來評估煮熟食物單項(104)和混合餐食(92)的營養素值的一致性。我們將使用食物成分表，來評估每日攝取量之巨量及微量營養素會引起誤差的校正水分予以量化。我們分析食物樣本中的鐵、鋅、銅、β-胡蘿蔔素、核黃素、硫胺、抗壞血酸、葉酸及巨量營養素、植酸和膳食纖維。在 E 和 M 之間熱量平均相差 3.07±0.6%、蛋白質 5.3±2.0%、脂質 2.6±1.8%及醣類 5.1±0.9%。在 E 和 M 之間維生素平均差異從 32(維生素 C)到 45.5%(β-胡蘿蔔素)；而礦物質從 5.6(銅)到 19.8%(鋅)。計算 264 名健康成人每日營養素攝取量 E/M 百分比。熱量、蛋白質、脂質及醣類分別為 108、112、127 及 97。他們的銅(102)及β-胡蘿蔔素(114)攝取 E/M 百分比接近一百，而鋅(186)、鐵(202)及維生素 C(170)、硫胺(190)、核黃素(181)及葉酸(165)卻相當高。使用經校正水分的食物成分表後，顯示熟食的巨量營養素誤差在± 5%，而每日攝取量誤差則增加至 27%。多個微量營養素的評估一致性欠佳，顯示使用印度的食物成分表評估微量營養素攝取量並不恰當。

關鍵字：微量營養素、誤差估計、食物成分表、熟食食物組成。