Original Article

Mineral composition of commonly consumed ethnic foods in Europe

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Abstract

Background: Ethnic foods are an integral part of food consumption in Europe contributing towards the overall nutrient intake of the population. Food composition data on these foods are crucial for assessing nutrient intake, providing dietary advice and preventing diseases.

Objective: To analyse selected minerals in authentic and modified ethnic foods commonly consumed in seven EU member states and Israel.

Design: A list of ethnic foods commonly consumed in selected European countries was generated, primary samples collected and composite sample prepared for each food, which were analysed for dietary minerals at accredited laboratories. Methods for sampling, analysis, data scrutiny and documentation were based on harmonised procedures.

Results: New data on 128 ethnic foods were generated for inclusion in the national databases of seven EU countries and Israel within the European Food Information Resource (EuroFIR), an EU Network of Excellence. The Na, K, Ca, P, Mg, Mn, Cl, Fe, Cu, Zn, Se and I contents of 39 foods is presented for the first time in this study.

Conclusion: The data will serve as an important tool in future national and international food consumption surveys, to target provision of dietary advice, facilitate implementation of policies and inform policymakers, health workers, food industry and researchers.

Keywords: *immigrant foods*; *ethnic foods*; *food composition data*; *micronutrients*; *minerals*; *analysis*

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Diet-related chronic diseases are responsible for two thirds of all deaths in the world (1) and it has been hypothesised that this might be due to intra-uterine programming linked to early micronutrient deficiencies. Furthermore, dietary intake of micronutrients is of public health concern due to the consequences of their deficiency in the diet and severe micronutrient-malnutrition (2). Dietary inadequacy of key minerals compared to D-A-CH (Germany, Austria and Switzerland) recommendations (3) have been reported for the European population, in particular lower intakes of Ca, Mg, Fe and I in female adolescents; lower intakes of Ca, Mg and Fe (women only) in adults and the elderly and lower iron intakes in girls (10–14 years age) (4). Calcium (Ca) and iron (Fe) are of greater concern due to difficulties in meeting increased requirements at certain stages in life, such as during pregnancy. Recent studies on the increased intakes of calcium, magnesium and potassium suggest that these are protective against unfavourable increases in serum lipid concentration (5), blood pressure (6, 7) and, therefore, the risk of coronary heart diseases (CHD) (8–10) which is the major cause of death worldwide, especially in developed countries (11).

Although ethnic foods are widely consumed in Europe, there is limited data on their composition. This makes it difficult to accurately estimate the nutrient intakes of the general population and, especially, of ethnic groups

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and migrants who are known to have higher incidences of nutrition-related problems. A cross-sectional study of black, Hispanic, and white men in Boston, USA demonstrated that the racial/ethnic heterogeneity affected bone mass and density through variations in body composition, diet, and socio-demographic factors (12).

Migrants also have higher rates of mortality and morbidity due to nutrition-related diseases when compared with the mainstream host population (13), as well as to the populations of their native country (14) which necessitates reliable data on ethnic diets. The objective of this study was, therefore, to analyse selected minerals in authentic[1] and modified[2] ethnic foods commonly consumed in seven EU member states and Israel; this was one of the objectives of the Ethnic Food Work Package within the EU's Sixth Framework Programme European Food Information Resource (EuroFIR) project. The most popular ethnic cuisines in European countries were identified as South Asian (for the UK), North African (France and Italy), Turkish and Pakistani (Denmark), Congolese (Belgium), Romanian (Italy), Mediterranean and Ethiopian (Israel), Latin American (Spain and Italy), Surinamese (The Netherlands) and Asian (Italy and Spain). The macronutrient composition of these foods has already been published (15).

Materials and methods

Prioritisation of commonly consumed ethnic foods

A list of ethnic foods commonly consumed in Belgium, Denmark, France, Israel, Italy, Spain, The Netherlands and the UK was generated and prioritised to ensure the data was representative according to criteria reported by Khokhar et al. (16). Factors considered in the prioritisation of foods included: the size and significance of ethnic populations in the partner countries; the records of foods in food consumption, national diet and nutrition surveys; the size of the national food industry; market retail share; sales from restaurants and takeaways, and diet-related risk factors in ethnic populations. The methods of sampling, analyses, data scrutiny and documentation were based on the harmonised procedures reported by Khokhar et al. (16). A total of 39 foods were analysed for minerals (Table 1).

Sample collection and preparation

For the analysis of modified ethnic foods, primary samples were collected from various sources (supermarkets, takeaways, restaurants and ethnic food stores) with sample numbers ranging from 1 to 12 for each food. Authentic ethnic foods (up to 11 primary samples) were collected from households where they were prepared by members of relevant ethnic groups, and collected from different street market stalls, ethnic restaurants and specialist ethnic shops. Composite[3] samples for each selected food were analysed for dietary minerals.

Mineral analyses

The sodium (Na), potassium (K), calcium (Ca), phosphorus (P), magnesium (Mg), manganese (Mn), chloride (Cl), iron (Fe), copper (Cu), zinc (Zn) selenium (Se) and iodine (I) contents of the selected foods were determined using standardised methods based on CEN (European Committee for Standardisation) methods and/or UKAS-accredited methods at selected laboratories. These laboratories were accredited (ISO-17025), routinely participated in proficiency testing schemes (FAPAS) and complied with the Joint Code of Practice for Quality Assurance in Research. Appropriate guidelines (e.g. the use of appropriate equipment such as plastic, glass, stainless steel, rubber gloves, sodium-free detergents and distilled water for rinsing equipment) including those for preventing contamination of dietary samples with Fe, Zn or Cu, were strictly adhered to during sample preparation. The analytical methods are presented in Table 2.

Results

The mineral content of the selected foods was determined and reported per 100 g edible portion (Table 3). The most abundant minerals were Na, K, Ca, Mg, Fe, P and Cl, with Zn being present in small amounts. Overall, there were large variations in the mineral contents of the foods analysed, ranging from 4 mg (*frik*) to 3,207 mg (salted beef) for Na; 23 mg (Cantonese rice) to 710 mg (*harissa* sauce) for K; 5 mg (*sarmale*) to 579 mg (*biteku-teku*) for Ca; 6 mg (*chikwangue*) to 125 mg (*biteku-teku*) for Mg; 7 mg (*meloukhia* sauce) to 296 mg (*kebab*) for P; 89 mg (*frik*) to 2,712 mg (*brik*) for Cl; 0.4 mg (*mkayabo* and *chikwangue*) to 17.1 mg (*injera*) for Fe; <0.04 mg (salted beef, *chikwangue* and *mbinzo* worms) to 0.90 mg (*falafel*) for Cu; 0.1 mg (Cantonese rice, *sarmale* and *chikwangue*) to 6.4 mg (salted beef) for Zn; <1 mg (*brik, harissa* sauce and *meloukhia* sauce) to 11.2 mg (buttermilk) for Mn; 0 μg (*falafel*) to 23 μg (*injera*) for Se; and from <10 μg (*frik* and *meloukhia* sauce) to 44 μg (*harissa* sauce) for I. Such variation could be due to several factors, such as the processing and agronomic/cultivation conditions, but are also thought to involve different ingredients

[1]Authentic ethnic food: 'A food from countries other than the home market contribution to a different food culture than the traditional cuisine of the host country. Food may be adapted by combining local and imported ingredients and is prepared at home' (15).

[2]Modified ethnic food: 'A commercially-modified version of food as prepared in an immigrant country to suit the taste and preference of host country' (15).

[3]Primary samples were mixed to make a composite sample of approximately 2 kg and were stored at appropriate conditions. Details of sampling have been published (15, 16).

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Table 1. Description of selected ethnic foods commonly consumed in seven European countries and Israel

Cuisine type and food name	Number and source of samples[a]	Description
France: North African (Maghreb); Strasbourg area		
Modified ethnic foods[b]		
Brik pastry sheet, baked	3 samples, supermarkets and grocery stores	Pastry sheet, baked
Harissa sauce	3 samples, supermarkets and grocery stores	Spicy sauce/paste
Buttermilk	3 samples, supermarkets and grocery stores	Fluid, cultured, low fat
Frik, dry	2 samples, supermarkets and grocery stores	Roasted crushed immature hard wheat, dry
Molokhia sauce	1 sample, supermarkets and grocery stores	Sauce made with dried Tossa Jute (*Corchorus olitorius* L.) leaves powder
Israel: Mediterranean and Ethiopian; Beer-Sheva, Tel-Aviv and Haifa		
Modified ethnic foods		
Falafel	12 samples, restaurants	Fried chick peas
Commercial soya patty	10 samples, supermarkets and grocery stores	Commercial vegetarian patty
Industrialised *hummus*	10 samples, supermarkets and grocery stores	Mashed chick peas
Authentic ethnic foods[c]		
Dark bread	10 samples, homemade	Common subsidize bread
*Injer*a	10 samples, homemade	Ethiopian pita
Spain: Latin American and Asian; Barcelona		
Modified ethnic foods		
Spring roll	8 samples, supermarkets and restaurants	Vegetable filled roll
Rice 3 delight	11 samples, supermarkets and restaurants	Cooked rice with peas, ham, shrimp, carrots and egg
Guacamole	3 samples, supermarkets and restaurants	Avocado puree
Mexican salsa	5 samples, supermarkets and restaurants	Tomato and chilli salsa
Authentic ethnic foods		
Ceviche	5 samples, homemade	Raw marinated fish or seafood in lemon juice
Denmark: Middle Eastern; Copenhagen		
Modified ethnic foods		
Dürüm rolls	4 samples, fast-food restaurants and takeaways	Flat bread with salad and strips of meat
Pita sandwich with *kebab*	4 samples, fast-food restaurants and takeaways	Pita bread with grilled kebab meat (normally lamb or beef) and salad
Sandwich with *kebab*	4 samples, fast-food restaurants and takeaways	Various types of bread with kebab and salad [typically lamb or beef]
Sandwich with *falafel*	4 samples, fast-food restaurants and takeaways	Various types of bread with falafel and salad
Kebab mix	4 samples, fast-food restaurants and takeaways	A mix of kebab, chips, salad and dressing
Italy: Asian, Latin American, Mediterranean and Romanian; Rome and Milan		
Modified ethnic foods		
Cantonese rice	5 samples, supermarkets and restaurants	Cooked rice with peas, vegetables, ham and egg
Nachos	9 samples, supermarkets and restaurants	Fried corn tortilla chips
Falafel	6 samples, supermarkets and restaurants	Broad bean and chickpea balls
Kebab	10 supermarkets and restaurants	'Rotating meat' lamb or beef grilled
Authentic ethnic foods		
Sarmale	4 samples, homemade	Cooked rolls of cabbage leaves with rice and meat
Netherlands: Surinamese; Zeist and The Hague		
Authentic ethnic foods		
Salted beef	3 samples, ethnic food store	Salt cured beef, boiled
Yellow split peas	1 sample, ethnic food store	Legumes, husked and split in half, boiled
Pomtayer	1 sample, ethnic food store	Roots of the tayer plant (*Xanthosoma sagittifolium*), prepared without fat
Tayer leaves	3 samples, market	Large green leaves of the tayer plant (*Xanthosoma sagittifolium*), prepared without fat

Table 1 (*Continued*)

Cuisine type and food name	Number and source of samples[a]	Description
Belgium: Congolese; Brussels		
Authentic ethnic foods		
Biteku-teku	6 samples, ethnic food store	Amaranthus leaves
Saka-saka	11 samples, ethnic food store	Cassava leaves
Chikwangue	5 samples, ethnic food store	Fermented cassava loaf
Mbinzo worms	5 samples, ethnic food store	Small black worms
Mkayabo	7 samples, ethnic food store	Dried and salted cod
UK: South Asian; London, Leeds and Birmingham		
Modified ethnic foods		
Chicken *bhuna*	10 samples, supermarkets, restaurants and takeaway	Medium spiced curry with tomato and onion, garlic and fresh coriander
Chicken *rogan josh*	12 samples, supermarkets	Chicken with a chilli, tomato and onion sauce
Aloo bombay	6 samples, supermarkets	Chunks of potato in a spicy, tomato and onion sauce
Authentic ethnic foods		
Rasmalai	9 samples, homemade and ethnic food stores	Milky dessert made with specialised milk powder, milk cream and cardamom
Lamb *kebab*	6 samples, homemade and ethnic food store	Patties made with spiced minced lamb

[a]Number of primary samples was based on the availability of a brand. EuroFIR criteria were used to collect commonly consumed foods which are important in the diet.
[b]A commercially-modified version of food as prepared in an immigrant country to suit the taste and preference of host country.
[c]A food from countries other than the home market contribution to a different food culture than the traditional cuisine of the host country. Food may be adapted by combining local and imported ingredients and is prepared at home.

in composite foods and recipes; for example, *falafel* examined in Israel and Italy showed different Na contents (853 mg *versus* 677, respectively). Lack of published mineral composition data in these ethnic foods precluded comparison of the data with that from other studies. However, the present data were determined at accredited laboratories and certified reference materials (CRMs) were used to ensure the validity and reliability of results obtained.

Discussion

Macro- and micronutrient food composition data of commonly consumed ethnic foods in seven EU countries and Israel have been generated for the first time for

Table 2. List of analytical methods for dietary minerals analysis

Dietary mineral	Methods and references
Sodium	ICP-OES; ICP-AES; AES (A 08/09/77; PNTA0016), EAS; flame – atomic absorption spectroscopy after ashing (AOAC 965.09)
Potassium	ICP-OES; AES (A 08/09/77; PNTA0016), EAS; flame – atomic absorption spectroscopy (AOAC 965.09)
Calcium	ICP-OES; ICP-AES; SAA AAS (A 08/09/77), flame – atomic absorption spectroscopy (AOAC 965.09; PNTA0016)
Phosphorus	ICP-OES; ICP-AES; Colorimetric (A 08/09/77), spectrometric (PNTQ1025), UV absorption (AOAC 970.39), atomic absorption
Magnesium	ICP-OES; AAS (A 08/09/77), flame – atomic absorption spectroscopy (AOAC 965.09; PNTA0016)
Manganese	Graphite furnace – atomic absorption spectroscopy after microwave digestion (BS 14084)
Chloride	Potentiometry (NF ISO 5943, NF ISO 5725, NFV 05116, NFV04289, NF EN ISO 5810, ISO 1841-2, NF ISO 5943 mod)
Iron	ICP-OES; ICP-AES; AAS (Dir 78/993), ICP-MS; flame – atomic absorption spectroscopy (AOAC 965.09), graphite furnace AAS (PNTA0017)
Copper	ICP-OES; ICP-MS; AAS; graphite furnace AAS (PNTA0017)
Zinc	ICP-OES; ICP-AES; AAS (Dir 78/933/NF V76-113), ICP-MS; flame – atomic absorption spectroscopy (AOAC 965.09; PNTA0016)
Selenium	Hydride (PNTA0059), fluorescence; AAS; ICP-MS; graphite furnace – atomic absorption spectroscopy after microwave digestion (BS 14627)
Iodine	Colorimetric; bromation/titrimetry (AOAC 935.14)

Table 3. Mineral composition of authentic and modified ethnic foods (per 100 g edible portion)

Country/Organisation[a]	Food name	Na	K	Ca	Mg	P	Fe	Cu	Zn	Cl	Mn	Se	I
		mg										µg	
France/AFSSA	*Brik* pastry sheet, baked	1672	175	110	24	97	1.1	<1	<1.0	2712	<1	<5	18
	Harissa sauce	1122	710	78	47	63	3.1	<1	<1.0	1915	<1	<5	44
	Buttermilk	50	159	118	12	90	1.0	<1	1	139	11.2	<5	18
	Frik, dry	4.2	499	52	114	258	5.2	<1	3.6	89	3.6	<5	<10
	Meloukhia sauce	378	179	82	37	7	1.9	<1	<1.0	764	<1	<5	<10
Israel/BGU	*Falafel*	853	340	56	53	157	2.3	0.38	1.4	–	–	<18	–
	Dark bread	489	156	123	36	119	2.7	0.17	1.0	–	–	<18	–
	Commercial soy patty	548	255	133	46	172	3.5	0.24	2.3	–	–	<18	–
	Injera	12	249	90	102	200	17.1	0.47	2.0	–	–	23	–
	Industrialised *hummus*	472	205	45	71	164	1.9	0.35	1.4	–	–	<18	–
Spain/CESNID	Spring roll	516	162	41	15	143	0.9	0.10	0.5	–	–	<5	–
	Rice 3 delight	410	82	22	12	202	0.7	0.10	0.6	–	–	<5	–
	Guacamole	644	147	58	13	117	0.5	0.10	<0.5	–	–	<5	–
	Mexican salsa	663	294	27	17	73	0.6	0.10	<0.5	–	–	<5	–
	Ceviche	491	170	28	26	204	1.5	0.10	0.5	–	–	12	–
Denmark/DTU	*Dürüm* rolls	532	286	19	21	134	1.3	–	2.6	–	–	–	–
	Pita sandwich with kebab	365	231	25	18	102	1.1	–	1.7	–	–	–	–
	Sandwich with *kebab*	443	193	47	17	93	1.1	–	1.6	–	–	–	–
	Sandwich with *falafel*	382	236	45	29	96	1.1	–	0.7	–	–	–	–
	Kebab mix	545	472	17	27	154	1.5	–	2.1	–	–	–	–
Italy/INRAN	Cantonese rice	552	23	16	78	121	0.5	0.66	0.1	1151	–	1	–
	Nachos	462	201	47	62	144	1.2	0.10	1.2	1070	–	1	–
	Falafel	677	355	45	41	163	2.5	0.90	0.2	1016	–	0	–
	Kebab	849	531	22	32	296	1.6	0.12	3.8	1660	–	2	–
	Sarmale	707	27	5	22	10	0.5	0.93	0.1	1252	–	1	–
The Netherlands/RIVM	Salted meat	3207	40	15	16	135	1.6	<0.04	6.4	–	–	–	–
	Tayer leaves	122	541	354	39	61	1.0	0.10	1.3	–	–	–	–
	Pomtayer	17	606	51	49	105	1.0	0.30	0.5[b]	–	–	–	–
	Yellow split peas	6	309	20	31	140	1.1	0.11	0.9	–	–	–	–
Belgium/UGhent	*Mkayabo*	2533	64	190	40	–	0.4	0.04	3.7	–	–	–	–
	Saka-saka	<5	168	153	47	–	2.9	0.05	1.2	–	–	–	–
	Chikwangue	<5	75	8	6	–	0.4	<0.04	0.1	–	–	–	–
	Mbinzo worms	13	121	56	43	–	3.5	<0.04	3.7	–	–	–	–
	Biteku-teku	<5	131	579	125	–	1.3	0.04	0.6	–	–	–	–
UK/UL	Chicken *bhuna*	340	255	27	20	90	0.7	0.06	0.5	–	–	9	–
	Lamb *kebab*	528	410	30	32	175	2.5	0.15	3.2	–	–	19	–
	Aloo bombay	298	284	28	18	38	0.8	0.06	0.3	–	–	–	–
	Rasmalai	54	186	206	16	149	0.6	<0.06	0.9	–	–	–	–
	Chicken *rogan josh*	316	262	33	20	81	0.9	0.06	0.5	–	–	12	–

–, Implies nutrient not prioritised for analysis because the selected food was not expected to contain considerable amount of this nutrient and due to insufficient funding.

[a]University or Research Institute participated in the study.

[b]Value of raw *pomtayer* (as reported value from laboratory was judged to be too high to be accurate this value was derived from USDA data 2008).

inclusion in national food composition databases including new data on the dietary mineral presented in this paper. Some minerals considered of greater dietary significance including Na, Ca, Fe and Se ranged widely in these ethnic foods.

Sodium

The sodium content of *mkayabo* (dried and salted cod) and salted meat would be considered high because the amount of Na in 100 g edible portion (*mkayabo* 2.5 g, salted meat 3.2 g) in these foods exceeds the European recommendation (17) of <1.5 g/day (equivalent to 3.8 g of salt). Higher dietary intakes of Na exceeded the recommendation for both genders across 23 European countries as reported by Elmadfa (4). Furthermore, prolonged consumption of such foods could be an issue of concern since Na intake above the recommended value has been associated with high blood pressure and stiffening of arterial walls and, therefore, is a risk factor for CHD, which is a major cause of death in Europe (6, 18–21). Levels of Na can, however, be very variable due to other sodium-containing compounds such as mono-sodium glutamate (MSG) used in cooking or added by manufacturers.

Potassium

An adequate intake of potassium has been found to prevent high blood pressure and reduce the risk of stroke (22, 23). The low potassium content of the foods analysed may be considered critical in view of the UK recommendation of 3.5 mg/day (24). Thus, individuals who regularly consume these foods need to increase their daily intake of fruits and vegetables in order to meet their potassium needs.

Calcium

Calcium is essential for bone development and prevention of osteoporosis (11, 17), and may also reduce the absorption of dietary fat thereby lowering serum total cholesterol and low-density lipoprotein cholesterol concentrations (8). The calcium content of the foods analysed in this study ranged widely between 5 mg (*sarmale*) and 579 mg (*biteku-teku*) per 100 g edible portion. Furthermore, the amount of calcium actually absorbed is dependent on individual vitamin D status and on the presence of binding substances, such as uronic acid, phytate and oxalate, in the food (25); in milk products its bioavailability is relatively higher.

Iron

According to a WHO report, over 2 million people in developed and developing countries have iron deficiency anaemia which leads to loss of productivity (26). Anaemia has been shown to be strongly linked to maternal mortality and premature child birth (27). In addition, iron deficiency, which is prevalent in ethnic groups, has also been reported in European countries (28). The reported prevalence ranged from 2.5 to 32% (29–32). Its bioavailability is low and is affected by dietary factors which could increase (presence of meat or fish or organic acids such as ascorbic acid, citric acid, lactic acid) or inhibit its availability (phytate, calcium, tannins, fibre, polyphenols in tea, coffee, bran), as well as the iron status of individuals (33); haem iron found only in meat and fish has a relatively high bioavailability (15–25%) (34). These data emphasise the need for appropriate dietary advice to be given to the population and especially to ethnic groups who tend to consume these food regularly and also have a higher incidence of anaemia (35, 36).

Selenium

Several functional roles of Se have been reported, including enzyme activity, decreasing the risk of CHD through its antioxidant effect (17, 37) and possibly offering protection against prostate cancer (38). Low intakes of Se in European countries especially in the UK have been reported (39) and increased consumption in the diet is encouraged. WHO recommends Se intakes of 40 μg/day for men and 30 μg/day for women (40). For Europe, the recommendation is 55 μg per day for both genders (41). *Injera*, an ethnic food from Israel, (after Israel) contained a great amount of Se (23 μg) and so may be considered as an excellent source of this mineral.

These data highlight potential health benefits of foods such as *injera* which contain higher amount of Fe than that of meat products and also high levels of selenium; however, there were several foods which were generally low in minerals presenting some concerns in populations regularly consuming these foods. The adequacy of intake must also take account of both the specific portion size of the food and its frequency of consumption in the daily diet, and not of the mineral contents in isolation. It is also important to underline that there are many factors, both dietary and physiological, that may influence mineral bioavailability.

There are substantial differences in the preparation of meals, eating habits, nutritional composition of the diets of migrants (including those of South Asian and black African-Caribbean origin) and Caucasians living in the UK and other European countries. Greater in-depth knowledge of these differences allied to reliable food composition data could help to explain both macronutrient and micronutrient intakes of these groups. For example, intakes of Ca and haem Fe have been found to be lower for South Asian children than for white European children. Similarly, African-Caribbean children have also been found to present lower intakes of Ca (42). Additionally, low intakes of iron among Moroccan and Turkish women have been found by their low iron status; prevalence of low iron status was highest among Turkish women (43). The diets of migrants showed both positive (macronutrients) and negative (micronutrients) differences in comparison with the mainstream European diets (43).

Conclusions

Ethnic foods are increasingly becoming popular in Europe and therefore will impact upon the overall nutrient intake of the population. As such, reliable information on their mineral content is crucial for assessing the intakes of the population and the provision of dietary advice for preventing the risk of deficiency and diet-related disease. These new food composition data on 39 prioritised ethnic foods (commercial and homemade) consumed by both the mainstream and ethnic population in Europe has been generated using harmonised methods, scrutinised for methodological and analytical errors and is made available through EuroFIR and national compilers for inclusion in the national databases. The new data have been documented for inclusion in national food composition databases in Belgium, Denmark, France, Italy, Spain, the Netherlands, UK and Israel, and is also available from EuroFIR.[4] In addition to the provision of dietary advice to both mainstream and ethnic populations, the validated data presented in the current study will serve as an important tool in future national and international food consumption surveys, inform policymakers, clinicians, dieticians, health professionals, food industry and epidemiological research.

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Conflict of interest and funding

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