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Daily dietary lithium intake in Belgium using duplicate portion sampling

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Abstract For the first time, daily dietary lithium intake for adults in Belgium has been evaluated by duplicate portion sampling, the heating of the samples in a microwave oven and atomic absorption spectrometric determination of the element. The mean intake value for adults (8.6 ± 4.6 μg/day) is very low compared to the scarce literature data. Since the lithium requirement of humans and animals is still unknown, no comparison could be made with RDA values.

Key words Lithium intake · Duplicate portion sampling · Belgium

Introduction

Lithium (Li) is a trace element that appears to be essential for higher animals [1, 2]. However, although the element is widely used at pharmacological dosages in the treatment of various disorders [3, 4], its effect at normal nutritional levels has not yet received much attention.

Since no reference material with certified Li values could be traced, determination methods for Li are scarce [5–7] and not always checked for accuracy. Hence human Li intake levels are extremely variable, from less than 1 μg [8] to 2.5 mg/day [9].

Materials and methods

Sampling strategies. In order to obtain the dietary intake levels of trace elements, study designs that include collection and preparation of foods ready for consumption (by cooking) are thought to produce the most realistic and reliable results. Therefore, duplicated meals, beverages and provisions between meals were collected over 24-h periods in four different places in Belgium. The sampling was carried out for 7 days consecutively between February and October 1992. A detailed description of the meals provided daily to nearly 2000 consumers is presented elsewhere [10].

Samples and sample preparation. The food was passed through a simulated eating procedure using normal forks and knives. The different food items were sliced and inedible parts thrown away. The remaining parts were homogenized and the total amount of food and drinks weighed.

After homogenizing the food in a blender, of which different parts were Teflon coated, various aliquots of about 100 g were freeze-dried (GTL, Leybold, Heraeus). About 0.4 g of the lyophilized material was put into a Teflon vial of a polypropylene destruction bomb. Bidistilled water (1 ml), H_2O_2 (ultrapure, 250 μl) and HNO_3 (ultrapure, 65%, 2 ml) were added and the closed vessel was placed in a microwave digestion oven with a turntable. The destruction programme is described in a previous paper [11]. All analyses (lyophilization, destruction and measurement) were carried out in duplicate.

Analytical technique. A Perkin Elmer model 4100 ZL Zeeman atomic absorption spectrometer, equipped with a PE AS-70 autosampler, was used for all experiments. The manufacturer's recommendations for wavelength, spectral band width and lamp current parameters were followed. An adapted temperature programme for Li determination was used, as summarized in Table 1.

The destruction liquid was diluted twice and the calculated detection limit was 0.13 ppb on a wet weight basis. This means, after recalculation, 0.13 μg/100 g on a wet weight basis or an intake level of about 2.6 μg/day.

As matrix modification, the solution for injection was made 0.005 M with K_2HPO_4. Recovery of a $LiNO_3$ standard (Merck

Table 1 Temperature programme for the determination of lithium (Li)

Step	Temperature (°C)	Time(s)		Gas flow rate (ml/min)	Read
		Ramp	Hold		
1	110	1	20	250	
2	140	5	20	250	
3	950	10	20	250	
4	2100	0	7	0	*
5	2500	1	5	250	

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19506) at the levels of 1, 2 and 4 ppb was 105±2%. The relative standard deviation at the 10 ppb level ($n=10$) was 3%. Concentrations were calculated using external calibration and linear regression at levels of 1, 2 and 4 ppb. Linearity was checked and proved to be valid up to 50 ppb.

Results and discussion

Table 2 summarizes the daily Li intake at various sampling sites in Belgium. Mean intake ranged from 3.9 µg/day (Brussels) to 12.2 µg/day (Antwerp and Vilvoorde). The mean daily intake of all duplicate meals was 8.6±4.6 µg/day (range: 1.2–15.2 µg/day).

Day-to-day variation was greatest in the Liège region, where a variation in intake by a factor of more than five was observed. The lowest Li intake was found to occur in the Brussels area. This is in contrast to previous papers, where the Walloon part of the country (Liège) revealed the lowest intake and density of selenium [10], manganese [11], copper [12], calcium and magnesium [13], chromium [14], rubidium [15], iron [16] and recently also for zinc [17].

Table 3 reviews the scarce literature data relating to Li intake [8, 9, 18–20]. Values for Belgium are the lowest values observed for Li intake. A similar trend has been reported by Iyengar et al. [19].

For Japan [8] the intake level (<1 µg) is taken out of the abstract, while in the article a value of 3.3 µg/day is mentioned as the median value.

Owing to the different Li content of foodstuffs and beverages and to the different intake habits, the Li intake of adults varies considerably. The variation range was wider than in all other trace elements investigated.

We did not analyse various foods, but from the literature it is known that milk and eggs were the Li-richest foodstuffs, while also beer and water can deliver much Li. All cereal products, peas and beans are Li-poor [1]. The Li requirement of humans and animals still remains unknown.

Since Li is effective in a proportion of bipolar patients, and as an adjunct in acute depression, it is important to determine whether the patient is a 'lithium responder' [4]. The very low intake of Li makes the danger of toxicity only dependent on the prophylactic dose and not the supplemental intake by food. Therefore the phenomenon of Li withdrawal requires more attention since food cannot compensate for this element.

Table 2 Daily Li intake (µg) at various sampling sites

Location	Li concentration (ng/100 g; wet weight)	Daily Li intake (µg)	
		Mean±SD	Range
Royal Military Academy (Brussels)	163±62	3.9±1.3	1.2–5.2
University Hospital (Antwerp)	506±212	12.2±1.1	10.2–13.7
Military Service Quarter (Maj. Houssiau, Vilvoorde)	566±152	12.2±3.6	7.1–15.2
University Hospital (Liège)	321±176	6.4±3.5	2.0–11.6

Table 3 Literature data on daily Li intake (µg)

Country	Sampling technique	Population	Daily intake x±SD (range)	Ref.
Belgium	Duplicate diets	Four different areas (healthy people)	8.6±4.6	This study
Canada	Analysed data; household food survey	Average diets	21.6	18
Germany	Duplicate diet	Seven men	(182–546)	1
(DDR)		Seven women	(220–532)	1
Italy	Fifteen total diets	25–30 years (♂)	27.8±8.2 (16.2–44.6)	19
Japan	Duplicate portion, food tables	Non-smoking adults (♀)	<1[a]	8
Spain	Twenty total diets	25–30 years (♂)	53.5±25.3 (10.9–104.7)	19
Turkey	Six total diets	25–30 years (♂)	39.3±10.3 (29.3–50.9)	19
UK	–	Adults	107	20
USA	Five total diets	25–30 years (♂)	37.4±14.6 (25–62)	19

[a] Median value

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References

1. Anke M, Groppel B, Kronemann H, Gruen M (1983) In: Anke M, Baumann W, Braeumlich H, Brueckner CC (eds) Lithium. Proc 4th Spurenelement Symposium, Karl-Marx-Universität, Leipzig, pp 58–65
2. Anke M, Arnhold W, Groppel B, Krause U (1991) In: Schauzer GN, Klippel KF (eds) Lithium in biology and medicine. VCH, Weinheim, pp 147–167
3. Moncrieff J (1997) Br J Psychiatry 171:113
4. Cookson J (1997) Br J Psychiatry 171:120
5. Evans WH, Read JI (1985) Analyst 110:619
6. Ohta K, Itoh S-I, Mizuno T (1991) Talanta 38:325
7. Genyuan Y, DeXuan X, Ruixiang (1995) Analyst 120:1657
8. Shimbo S, Hayase A, Murakami M, Hatai I, Higashika K, Moon C-S, Zhang Z-W, Watanabe T, Iguchi H, Ikeda M (1996) Food Additives Contam 13:775
9. Schrauzer GN, Shrestha KP (1991) In: Schrauzer GN, Klippel KF (eds) Lithium in biology and medicine. VCH, Weinheim, pp 189–203
10. Robberecht H, Hendrix P, Van Cauwenbergh R, Deelstra H (1994) Z Lebensm Unters Forsch 199:251
11. Robberecht H, Hendrix P, Van Cauwenbergh R, Deelstra H (1995) Z Lebensm Unters Forsch 199:446
12. Van Cauwenbergh R, Hendrix P, Robberecht H, Deelstra H (1995) Z Lebensm Unters Forsch 200:301
13. Hendrix P, Van Cauwenbergh R, Robberecht H, Deelstra H (1995) Z Lebensm Unters Forsch 201:213
14. Van Cauwenbergh R, Hendrix P, Robberecht H, Deelstra H (1996) Z Lebensm Unters Forsch 203:203
15. Hendrix P, Van Cauwenbergh R, Robberecht H, Deelstra H (1997) Z Lebensm Unters Forsch 204:165
16. Van Cauwenbergh R, Hendrix P, Robberecht H, Deelstra H (1997) Z Lebensm Unters Forsch 205:401
17. Hendrix P, Van Cauwenbergh R, Robberecht H, Deelstra H (1998) Z Lebensm Unters Forsch 206:222
18. Clarke WB, Gibson R (1988) J Food Compos Anal 1:209
19. Iyengar GV, Clarke WB, Downing RG, Tanner JT, Parr RM (1991) J Trace Elem Electrolytes Health Dis 5:125
20. Parr RM, Crawley H, Abdulla M, Iyengar GV, Kumpulainen J (1992) Human dietary intakes of trace elements: a global literature survey mainly for the period 1970–1991. (Nahres-12) IAEA, Vienna