Annex B

In this guide

Introduction

1. The information presented in this Annex should be read in conjunction with the main draft statement on the potential risk to human health of turmeric and curcumin supplements. It contains further detailed information on exposure data for turmeric in food and the presentation of trace element contamination from a recent survey.

Exposure from curcuminoids in food

2. The relative proportions and total concentration of curcuminoids within turmeric rhizomes vary depending on the variety grown and the conditions of cultivation (Li et al., 2011) (Table 1).

Table 1. Percentage composition of curcuminoids in turmeric powders and oleoresin extracts (adapted from Li *et al.*, 2011).

Curcuminoid	**Composition in turmeric powders (mean) (% dry weight)**	**Composition in turmeric oleoresin extracts (mean ± SD)** **(% dry weight)**
Curcumin	2.86	19.5 ± 2.07
Demethoxycurcumin	1.47	8.31 ± 1.13
Bisdemethoxycurcumin	1.36	6.22 ± 0.88
Total	5.69	34.0 ± 4.08

3. The EFSA ANS panel (2010) estimated dietary exposure to curcumin in children and adults using national consumption data with maximum permitted levels (MPLs) specified in Directive 94/36/EC (EC 1994) (tier 2 approach), and maximum reported use levels (tier 3 approach). Estimates of dietary exposure to curcumin obtained from these approaches are presented in Table 2.

4. For adults (> 18 years old), the EFSA ANS Panel (2010) estimated the exposure based on the UK consumption survey as the UK population is considered to be one of the highest consumers of soft drinks in Europe and individual food consumption data (UK National Diet and Nutrition Survey (NDNS), 2000-2001) are available (Tennant D., 2007, 2006). For children (1-10 years old), the Panel estimated exposure based on the Dietary Exposure Assessments for Children in Europe (EXPOCHI) project. The EXPOCHI project details individual food consumption data from eleven European countries (Belgium, France, the Netherlands, Spain, Italy, Finland, Sweden, Czech Republic, Cyprus, Greece and Germany). As the UK is not included in the EXPOCHI consortium, estimates for UK children (1.5 - 4.5 years old) were made by the Panel with the use of individual food consumption data (UK NDNS, 1992-1993) (Tennant D., 2007, 2006).

Table 2: Estimates of dietary exposure to curcumin in the UK adult population and in children from the EXPOCHI study and UK NDNS data.

Maximum permitted level (tier 2):	**UK adult exposure (> 18 years old) to curcumin (mg/kg bw/day)**	**Children (UK, 1.5 – 4.5 years & EXPOCHI, 1-10 years old) exposure to curcumin (mg/kg bw/day)**
Mean exposure	0.9	0.5-3.8
Exposure 95th or 97.5th %ile †	3.3	1.2-7.2
Maximum reported use levels (tier 3):	**UK adult exposure (> 18 years old) to curcumin (mg/kg bw/day)**	**Children (UK, 1.5 – 4.5 years & EXPOCHI, 1-10 years old) exposure to curcumin (mg/kg bw/day)**
Mean exposure	0.8 (1.0 *)	0.5-3.4 (0.7-3.6 *)
Exposure 95th or 97.5th %ile †	2.0 (2.6 *)	1.1-7.1 (1.6-7.6 *)

* Includes dietary exposure to curcumin from turmeric powder added to food as a spice and curry powder (see Table 3).

† For UK children and adults, mean consumption plus intake at the 97.5th percentile of ‘spirituous beverages’). For EU children, estimates are based on the EXPOCHI report, which gives the 95th percentile intake.

5. In tier 2, the main contributor to curcumin exposure from the UK adult diet was non-alcoholic flavoured drinks (46 %). The main contributors to the estimates of mean curcumin exposure for UK children, between 1.5 and 4.5 years old, (and children between 1 and 10 years old considered by the EXPOCHI consortium) were non-alcoholic beverages (13-55 %), fine bakery wares (e.g., biscuits, cakes, wafer) (12-43 %), desserts, including flavoured milk products (12-45 %), and sauces, seasonings, pickles, relishes, chutney and piccalilli (11-42 %).

6. In tier 3, the main contributor to curcumin exposure from the UK adult diet was non-alcoholic flavoured drinks (50 %). The main contributors to the estimates of mean curcumin exposure for UK children, between 1.5 and 4.5 years old, (and children between 1 and 10 years old considered by the EXPOCHI consortium) were fine bakery wares (e.g., biscuits, cakes, wafer) (13-47 %), desserts (including flavoured milk products) (13-52 %), non-alcoholic beverages (15-57 %) and sauces and seasonings (11-45 %).

7. The exposure assessment in tier 3 does not take into account the use of turmeric as a spice in cooking. The estimated additional dietary exposure to curcumin through the use of turmeric spice in cooking was calculated by the EFSA ANS panel (2010) and is displayed in Table 3.

8. Because of the estimated exceedances of the ADI by 1 – 10-year-olds in the 2010 assessment, EFSA undertook a refined assessment of exposure to curcumin in the EU diet (EFSA, 2014). The refined assessment utilised consumption data from the Comprehensive European Food Consumption Database which contains data from EU Member States at the time of the assessment. Each age category was contributed to by a range of countries and consumption by the UK population was represented only in the “adult” category (18 – 60-years-old). The refined assessment also used additional data on curcumin levels reported to EFSA between 2010 and 2014.

9. Using this data, the 2014 assessment estimated exposure to curcumin under three different scenarios: Using maximum permitted levels; using reported use levels based on a “brand-loyal” scenario; and using reported use levels based on a “non-brand-loyal" scenario. The estimated exposures are displayed in table 4.

10. For children (no UK estimates), adolescents (no UK estimates), adults (UK estimates included), and the elderly (no UK estimates), the main food categories contributing to curcumin exposure in the 2014 assessment were flavoured drinks and fine bakery wares. For toddlers (no UK estimates), the main contributing food categories were flavoured fermented milk products and fine bakery wares. These food categories were the main contributors regardless of the exposure assessment scenario.

11. Overall, the curcumin exposures estimated in EFSA’s 2014 assessment were lower than those estimated in 2010. Whilst UK NDNS data for adult consumption of curcumin was included in the 2014 estimate as one of 15 consumption surveys, the UK data was the only survey considered in the 2010

estimate for adult exposures.

Table 3. Estimates of dietary exposure to curcumin from ingestion of spice added to food and curry powder in adults in children.

Exposure from spice added to food *	**Adult (18-64 years old) curcumin exposure (mg/kg bw/day)**	**Children (5-12 years old) curcumin exposure (mg/kg bw/day)**
Mean	0.1 (n = 66)	0.1 (n = 7)
97.5th %ile	0.3 (n = 66)	0.2 (n = 7)
Exposure from curry powder added to food *	**Adult (18-64 years old) curcumin exposure (mg/kg bw/day)**	**Children (5-12 years old) curcumin exposure (mg/kg bw/day)**
Mean	0.1 (n = 91)	0.1 (n = 21)
97.5th %ile	0.3 (n = 91)	0.3 (n = 21)

* The use of turmeric as a spice added to foods and used in home-made recipes was assessed using data from Irish adults (1379 adults, aged 18-64 years) and children (594 children, aged 5-12 years) (Harrington et al., 2001; IUNA (Irish Universities Nutrition Alliance), 2005). The dietary intake of curry powder was also considered, as turmeric powder is a widespread ingredient of this (approximately 30 % depending on the blend).

Table 4. Estimated exposures to curcumin in the EU population (from EFSA, 2014).

Maximum permitted levels	Toddlers (12 – 35 months) (mg/kg bw/day)	Children (3 – 9 years) (mg/kg bw/day)	Adolescents (10 – 17 years) (mg/kg bw/day)	Adults (18 – 64 years) (mg/kg bw/day)	The elderly (>65 years) (mg/kg bw/day)
Mean	0.9-3.9	0.9-3.2	0.3-1.6	0.3-1.1	0.1-0.6
High level	2.8-7.2	2.0-6.7	1.0-3.3	0.7-2.3	0.5-1.4
Refined scenario	n/a	n/a	n/a	n/a	n/a
Brand-loyal	n/a	n/a	n/a	n/a	n/a
Mean	0.4-2.0	0.6-1.6	0.2-0.9	0.2-0.6	0.1-0.4
High level	1.4-3.3	1.2-3.4	0.7-2.3	0.4-1.5	0.3-0.9
Non-brand-loyal	n/a	n/a	n/a	n/a	n/a
Mean	0.1-0.8	0.2-0.6	0.1-0.3	0.1-0.2	0.03-0.2
High level	0.5-1.2	0.5-1.2	0.2-0.7	0.2-0.5	0.1-0.4

Contamination of raw, ground turmeric and curcumin supplements

Heavy metals

Table 4. List of other trace elements (i.e. not including Pb, Hg, As or Cd) from turmeric product samples, where the concentration is greater than 5 x the mean concentration and the mean concentrations plus 2 x standard deviations for that product type.

Sample code	Sample type	Element	Concentration (mg/kg)	Mean concentration of product type (mg/kg)	Increased fold change from mean
TU03	Supplement	Titanium	281	29	9.7
TU03	Supplement	Niobium	0.16	0.023	7.0
TU06	Supplement	Molybdenum	1.9	0.21	9.0
TU06	Supplement	Uranium	0.57	0.079	6.6
TU06	Supplement	Tin	0.16	0.025	6.4
TU07	Supplement	Thallium	0.10	0.012	8.3
TU07	Supplement	Caesium	0.09	0.014	6.4
TU07	Supplement	Zinc	38	7.3	5.2
TU07	Supplement	Barium	50	9.8	5.1
TU10	Powder	Tungsten	0.039	0.0072	5.4
TU12	Supplement	Copper	114	8.6	13.3
TU15	Supplement	Yttrium	4.1	0.56	7.3

TU15	Supplement Antimony	0.24	0.033	7.3
TU15	Supplement Palladium	0.11	0.019	5.8
TU15	Supplement Lanthanum	1.3	0.23	5.7
TU15	Supplement Calcium	323,000	63,913	5.1
TU17	Supplement Beryllium	0.124	0.016	7.8
TU17	Supplement Antimony	0.19	0.033	5.8

Table 5. Summary of exposure of each of the trace elements from Table 4 for an adult taking the supplement as advised on the label, alongside comparison of a Health Based Guidance Value (HBGV) if applicable.

Element	**Concentration (mg/kg)**	**Advised consumption of supplement (g/day)**	**Exposure from product* (µg/kg bw/day)**	**HBGV or other reference value (µg/kg bw day)**	**HBGV reference**
Titanium	281	0.42	1.69	n/a	n/a
Niobium	0.16	0.42	0.0010	n/a	n/a
Molybdenum	1.9	0.35	0.010	26 (TUI)	(Institute of Medicine (US) Panel on Micronutrients, 2001)

Uranium	0.57	0.35	0.0029	0.6 (TDI)	(WHO, 2012)
Tin	0.16	0.35	0.00080	2 (p-TDI)	(FAO/WHO, 2004)
Thallium	0.10	0.92	0.0013	0.01 (p-RFD)	(EPA, 2009)
Caesium	0.09	0.92	0.0012	n/a	n/a
Zinc	38	0.92	0.50	1000 (TDI)	(FAO/WHO, 1982)
Barium	50	0.92	0.66	200 (TDI)	(SCHER, 2012)
Tungsten #	0.039	7	0.0022	n/a	n/a
Copper	114	1	1.6	70 (ADI)	(EFSA, 2022)
Yttrium	4.1	4.7	0.28	145.5 (TDI)	(Kowalczyk et al., 2022)
Antimony	0.24	4.7	0.016	6	(WHO, 2003)
Palladium	0.11	4.7	0.0074	n/a	n/a
Lanthanum	1.3	4.7	0.087	51.3 (TDI)	(Kowalczyk et al., 2022)
Calcium	323,000	4.7	21,733	35,714 (TUI) **	(SCF, 2003)

Beryllium	0.124	0.3	0.00053	2	(WHO, 2009)
Antimony	0.19	0.3	0.00081	6	(WHO, 2003)

* Assumes a 70Kg adult consumes the supplement as stated on the label.
** Assumes a 70Kg adult to derive the TUI.
# Tungsten concentration from a spice powder not a supplement. A conservative estimate of 4g per day if consumed as a supplement has been used for the exposure calculations.
TUI = Tolerable Upper Intake.
TDI = Tolerable Daily Intake.
p-RFD = Provisional Reference Dose.
ADI = Acceptable Daily Intake.
n/a = not applicable.

List of Abbreviations and Technical terms

ADI	Acceptable Daily Intake
ANS Panel	Scientific Panel on Food Additives and Nutrient Sources Added to Food
As	Arsenic
Cd	Cadmium
EFSA	European Food Safety Authority
EU	European Union
EXPOCHI	Exposure Assessments For Children In Europe
g	gram

HBGVs	Health-Based Guidance Values
Hg	Mercury
kg bw/day	Kilogram Bodyweight per Day
mg	Milligram
MPL	Maximum Permitted Levels
NDNS	National Diet and Nutrition Survey
p-RFD	Provisional Reference Dose
Pb	Lead
SD	Standard Deviation
TDI	Tolerable Daily Intake
TUI	Tolerable Upper Intake
µg	Microgram
UK	United Kingdom

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