Risiken erkennen – Gesundheit schützen

Lead and Cadmium from Ceramics

Updated Expert Opinion* No. 023/2005 of BfR from 26 March 2004

Opinion under review due to new toxicology data (22 November 2017)

The colour overglaze of ceramic dinnerware may contain heavy metals like lead and cadmium. Depending on whether the ceramics were fired at high or low temperatures and what kind of foods are stored in them for what periods of time, heavy metals may be transferred. Ingested by humans, these heavy metals can cause adverse health effects. Children are particularly at risk.

Vessels, from which lead and cadmium may be transferred, are described as articles from which a migration of lead or cadmium is possible. In order to prevent consumers being harmed by a lead or cadmium migration from ceramic vessels, maximum quantities of lead and cadmium transferred from ceramic articles were laid down on the European level in 1984. According to them, certain ceramic vessels may only transfer up to four milligrammes lead per litre. The Federal Institute for Risk Assessment (BfR) subjected the valid limits to a risk assessment. It was prompted to do this by the review of the European Directive on ceramic articles intended to come into contact with foodstuffs.

Risk assessment gets complicated by the fact that no adequate data are available on how many consumers come into contact with heavy metals and to what extent. However, there is no doubt about it that specific population-groups can have a larger dietary intake of heavy metals because of their eating habits and lifestyle. Therefore, additional exposure via migration of lead or cadmium from ceramics should be reduced to a minimum.

Regarding the valid limits of the EU the Provisional Tolerable Weekly Intake (PTWI) laid down by the World Health Organisation (WHO) may be considerably exceeded, depending on the calculation model. Particularly in view of the higher sensitivity of children, BfR recommends reducing the statutory limits for the migration of lead and cadmium from ceramic articles.

1 Subject matter of the assessment

BfR undertook a health assessment of the currently valid limits for the quantities of lead and cadmium transferred from ceramic articles. This was prompted by the review of the European Directive from 1984 on ceramic articles intended to come into contact with foodstuffs (84/500/EEC).

The Directive stipulates that the following limits for the quantities of lead and cadmium transferred from ceramic articles in the various categories (1 to 3) shall not be exceeded under defined test conditions:

Table 1: Limit values for the transfer of lead and cadmium from ceramic articles of daily use

Category	Description	Lead	Cadmium
1	Articles which cannot be filled and articles which can be filled, the internal depth of which, measured from the lowest point to the horizontal plane passing through the upper rim, does not exceed 25 mm	0.8 mg/dm^2	0.07 mg/dm^2
2	All other articles which can be filled	4.0 mg/l	0.3 mg/l

* Updated on 7 June 2005

3	Cooking ware, packaging and storage vessels with a capacity of more than three litres	1.5 mg/l	0.1 mg/l

The release volumes for lead and cadmium admissible according to the European Directive have been taken over into the German Ordinance on Commodities.

2 Result

The amount of lead transferred from ceramics into foodstuffs may be as much as 4 mg per litre if the food is stored in ceramic articles which transfer the full permitted amount of lead. Depending on the calculation model lead intake may, in some cases, considerably exceed the Provisional Tolerable Weekly Intake (PTWI), which has been derived toxicologically by WHO. Even if it is assumed that high exceedances of this kind do not occur either daily or lifelong this still constitutes an additional and, above all, an avoidable intake.

A comparable situation applies to cadmium but the extent of exceeding the PTWI is significant less than in the case of lead. However, because of their food habits and lifestyle, there are consumer groups and individual persons with cadmium-intakes almost use to full capacity of the PTWI. Every additional intake of cadmium should, therefore, be avoided.

BfR comes to the following conclusion: Adherence to the previous limits for the migration of lead and cadmium from ceramic articles into foodstuffs may result, in individual cases, in legally sanctioned intake levels which can no longer be considered safe, particularly in the case of lead. However, it has yet to be determined how many consumers are affected by high heavy metal intakes of this kind and how frequently they are affected.

BfR therefore recommends, particularly in view of the sensitivity of children, that the limit values for the transfer of lead and cadmium from ceramic articles into foodstuffs should be lowered.

3 Argument

3.1 Risk Assessment

3.1.1 Agent

For the characterisation of the elements, lead and cadmium, please refer to the international monographs (e.g. WHO, 1992; WHO, 1995; ATSDR, 1999a; ATSDR, 1999b).

3.1.2 Potential hazard

3.1.2.1 Lead

Adverse health effects to humans, caused by extreme lead intakes from food, which has been stored for longer periods in ceramic articles with a high transfer rate of lead, cannot be completely ruled out today either. For instance, there are reports on lead poisoning following the consumption of fruit juices which had been stored in lead transferring ceramic jugs. Acute lead poisoning manifests itself, amongst other things, through salivation, vomiting, intestinal colic, constipation and acute kidney failure. Children, in particular, may also suffer from brain damage.

The symptoms of mild lead poisoning tend to be rather non-specific like tiredness, headache and the onset of anaemia. Neurological disorders may also occur especially in developing organisms like foetuses, infants and small children. Chronic lead poisoning can manifest itself in a feeling of faintness, loss of appetite, nervousness, nausea and weight loss. Objectively measurable or observable changes, besides weight loss, are also paleness, muscular tremors and a weakness of the extensor muscles as well as the elevated excretion of delta-aminolaevulinic acid in urine, porphyrinuria, elevated lead count in blood, basophilic punctated erythrocytes and erythroblasts and a “lead line” on the teeth (grey-black staining of the gingival margins).

The Senate Committee for the Testing of Harmful Working Materials of the German Research Foundation (DFG) classifies lead and its inorganic compounds, aside from lead arsenate and lead chromate, in category 3B: “From *in vitro* or animal experiments there are indications of a carcinogenic effect which, however, do not suffice for classification in a different category. Further tests are needed in order to reach a definitive decision” (MAK [maximum workplace concentrations] and BAT [best available technology] List, 2003).

3.1.2.2 Cadmium

Cadmium poisoning initially manifests itself as massive, acute gastro-enteritis (vomiting, diarrhoea, heavy fluid loss) and leads to systemic changes (changes in the entire organism) like kidney failure, liver and heart damage as well as circulatory failure, often accompanied by very painful cramp (shock). At the same time, existing risk factors like protein, iron, calcium or vitamin D deficiency may markedly influence the action of cadmium. One tragic example for the fact that undernourished individuals can be particularly badly affected, was observed in the 1950s in conjunction with the outbreak of the so-called Itai-Itai (ouch-ouch) disease in Japan amongst older, undernourished women with several children.

In the case of sub-chronic and chronic oral exposure, kidneys are the main target organ both in humans and in experimental animals. At the same time, there are calcium losses from bones and elevated calcium excretion via the kidneys (ATSDR, 1999b). The first signs of cadmium poisoning are rather non-specific. The symptoms include tiredness, headache and the onset of anaemia as well as neurological disorders.

The heavy metal cadmium has a high accumulation potential in the organism. More than half of the cadmium accumulated in the body is concentrated in the liver and kidneys. Absorption (uptake) from the gastro-intestinal tract is normally given as on average 5%. Depending on the composition of food and supply status, there may, however, be individual fluctuations in the range of 1% to 20% (WHO, 1992). Once absorbed, cadmium is only excreted very slowly. Because of its long biological half life (kidneys and lungs 10-20 years, liver 5-10 years) the tissue of older people normally has a higher level of cadmium burden. The highest tissue concentrations are normally found in the renal cortex which can, therefore, also be used as the indicator organ for exposure estimation. However, after extreme cadmium exposure, the highest levels can be measured in the liver.

The Senate Commission for the Testing of Harmful Working Materials of the German Research Foundation (DFG) classifies cadmium and its bioavailable respirable compound fractions in category 2: “Substances which are deemed to be carcinogenic for man because, as a consequence of sufficient results from long-term animal experiments or indications from animal experiments and epidemiological studies, it can be assumed that they make a significant contribution to the risk of cancer” (MAK [maximum workplace concentrations] and BAT [best available technology] List, 2003).

In contrast to inhalative cadmium exposure, a carcinogenic potential could not be clearly identified up to now for oral exposure in man (Waalkes et al, 1992).

3.1.3 Exposure

Under certain conditions ceramic articles may transfer lead and cadmium into the foods stored in them in amounts which markedly exceed the limits laid down in the EC Ceramics Directive or the German Ordinance for Articles of Daily Use (Sheets, 1999).

However, not measured migration values (migration = transfer of harmful constituents into the food contained therein) have been used for this evaluation but the admissible migration values (limits) from the Ceramics Directive in order to establish “exposure scenarios”. On this basis it can be estimated whether the currently valid limits for the transfer of lead and cadmium from ceramic articles still offer sufficient protection to consumers:

A plate with a diameter of 20 cm and a depth of 1.5 cm (category 1) contains a volume of 471 ml. This plate has a surface (S) of 4.08 dm^2 which comes into contact with the food. For further considerations, a rounded up surface of 4 dm^2 is used.

$S = \pi \times 10^2 = 314\ cm^2 = 3.14\ dm^2$ (basic area) + $0.94\ dm^2$ (rim area) = $4.08\ dm^2$

When it comes to the current admissible values for lead and cadmium, this result means that a consumer who eats a plateful of food into which the entire permitted amount of lead or cadmium has migrated, takes in approx 3.2 mg lead (0.8 x 4) or 0.28 mg cadmium (0.07 x 4). One litre of a plate content of this kind could lead to an intake of 6.8 mg lead or 0.6 mg cadmium.

Consumption of a litre or 471 ml of the food stored in fillable articles from category 2, could, under comparable conditions, lead to an intake of only 4 mg and 1.88 mg lead and/or 0.3 mg and 0.14 mg cadmium.

Consumption of a litre of 471 ml product from appliances and vessels from category 3 could, under comparable conditions, lead to an intake of 1.5 mg and 0.71 ml lead and/or 0.1 mg and 0.047 ml cadmium.

For the following estimation of exposure we selected two models: in the first it is assumed that ceramic dinnerware is used once a week and in the second that it is used daily. Furthermore, two consumer groups are monitored: children with a body weight of 20 kg and adults with a body weight of 70 kg. Concerning the daily use of ceramic dinnerware, the PTWI (Provisional Tolerable Weekly Intake) was converted into a daily value in order to determine its daily exceedance. Strictly speaking, this is not permissible but has been used here in order for the purposes of an approximate illustration of the exceedance.

Table 2: Maximum possible lead intake from ceramics when the regulatory limits are exhausted compared to the PTWI*, concerning once weekly use of ceramics

Lead (Pb)	Maximum possible Pb intake from ceramics when exhausting regulatory limits	Exceedance of the PTWI (0.5 mg / week) referred to 20 kg body weight		Exceedance of the PTWI (1.75 mg / week) referred to 70 kg body weight	
		Factor	Percent	Factor	Percent
Category 1	(0.8 mg/dm² [1] and 6.8 mg/l [2]) 3.2 mg / plate (471ml)	6.4	540 %	1.83	83 %
Category 2	4 mg/l [1]	8	700 %	2.3	128 %
	1.88 mg / 471 ml [3]	3.76	276 %	1.07	7.4 %
Category 3	1.5 mg/l [1]	3	200 %	—	—
	0.71 mg / 471 ml [3]	1.42	42 %	—	—

*The PTWI value for cadmium (Provisional Tolerable Weekly Intake) was confirmed by JECFA in 2003 and is still 0.0007 mg/kg body weight and week. Here it is referred to a child weighing 20 kg and an adult weighing 70 kg.

[1] Migration permitted in accordance with Directive 84/500/EEC

[2] Result of the conversion described above of transfer mg/dm² to mg/l

[3] Reference amount with plate content (471 ml) for category 1

Table 3: Maximum possible cadmium intake from ceramics when the regulatory limits are exhausted compared to the PTWI*, concerning once weekly use of ceramics

Cadmium (Cd)	Maximum possible Cd intake from ceramics when exhausting regulatory limits	Exceedance of the PTWI (0.5 mg / week) referred to 20 kg body weight		Exceedance of the PTWI (1.75 mg / week) referred to 70 kg body weight	
		Factor	Percent	Factor	Percent
Category 1	0.07 mg/dm² [1] and 0.6 mg/l [2]				
	0.28 mg / plate (471 ml)	2	100 %	—	—
Category 2	0.3 mg/l [1]	2.14	114 %	—	—
	0.14 mg / 471 ml [3]	1	0 %	—	—
Category 3	0.1 mg/l [1]	—	—	—	—
	0.047 mg / 471 ml [3]	—	—	—	—

*The PTWI value for cadmium (Provisional Tolerable Weekly Intake) was confirmed by JECFA in 2003 and is still 0.0007 mg/kg body weight and week. Here it is referred to a child weighing 20 kg and an adult weighing 70 kg.

[1] Migration permitted in accordance with Directive 84/500/EEC

[2] Result of the conversion described above of transfer mg/dm² to mg/l

[3] Reference amount with plate content (471 ml) for category 1

Table 4: Maximum possible lead intake from ceramics when the regulatory limits are exhausted compared to the PTWI*, concerning once daily use of ceramics

Lead (Pb)	Maximum possible Pb intake from ceramics when exhausting regulatory limits	Exceedance of the PTWI (0.5 mg / week) referred to 20 kg body weight		Exceedance of the PTWI (1.75 mg / week) referred to 70 kg body weight	
		Factor	Percent	Factor	Percent
Category 1	(0.8 mg/dm² [1] and 6.8 mg/l [2]) 3.2 mg / plate (471ml)	45.7	4471 %	12.8	1180 %
Category 2	4 mg/l [1]	57.1	5614 %	16	1500 %
	1.88 mg / 471 ml [3]	27	2586 %	7.5	652 %
Category 3	1.5 mg/l [1]	21.4	2043 %	6	500
	0.71 mg / 471 ml [3]	10.1	914 %	2.8	184

*The PTWI value for cadmium (Provisional Tolerable Weekly Intake) was confirmed by JECFA in 2003 and is still 0.0007 mg/kg body weight and week. Here it is referred to a child weighing 20 kg and an adult weighing 70 kg.

[1] Migration permitted in accordance with Directive 84/500/EEC

[2] Result of the conversion described above of transfer mg/dm[2] to mg/l

[3] Reference amount with plate content (471 ml) for category 1

Table 5: Maximum possible cadmium intake from ceramics when the regulatory limits are exhausted compared to the PTWI*, concerning once daily use of ceramics

Cadmium (Cd)	Maximum possible Cd intake from ceramics when exhausting regulatory limits	Exceedance of the PTWI (0.5 mg / week) referred to 20 kg body weight		Exceedance of the PTWI (1.75 mg / week) referred to 70 kg body weight	
		Factor	Percent	Factor	Percent
Category 1	0.07 mg/dm² [1] and 0,6 mg/l [2]				
	0.28 mg / plate (471 ml)	14	40 %	4	300 %
Category 2	0.3 mg/l [1]	15	1400 %	4.29	329 %
	0.14 mg / 471 ml [3]	7	600 %	2	100 %
Category 3	0.1 mg/l [1]	5	400 %	1.43	43 %
	0.047 mg / 471 ml [3]	2.4	135 %	—	—

*The PTWI value for cadmium (Provisional Tolerable Weekly Intake) was confirmed by JECFA in 2003 and is still 0.0007 mg/kg body weight and week. Here it is referred to a child weighing 20 kg and an adult weighing 70 kg.

[1] Migration permitted in accordance with Directive 84/500/EEC

[2] Result of the conversion described above of transfer mg/dm[2] to mg/l

[3] Reference amount with plate content (471 ml) for category 1

3.1.3.1 Lead and cadmium intake from other sources

For lead the data are somewhat general. Representative quantitative data for specific population groups are only available in individual cases. In the USA dietary lead intake is given as between 5 and 11 µg per day. Up to 100 µg can be added from other sources. In the case of children living in a contaminated environment, intake occurs particularly via dust (Bolger et al, 1991; US-EPA, 1986 and 1989, ATSDR, 1999a). More exact data indicate a so-called typical normal dietary lead intake of 1 µg to 2 µg/kg body weight and week and a typically elevated lead intake of 2 µg to 4 µg/kg body weight and week. For children the possible lead intake from all sources in seven different countries is given as between 0.6 µg to 30 µg/kg body weight and week. Here, the possible lead intake from food for children in some countries was two to three times higher than for adults. Tap water continues to be another main source of lead (JECFA, 2000).

For cadmium the intake range in non-contaminated areas is given as between 10-14 µg per day. The daily dietary cadmium intake of the European population is between 14 and 57 µg per person whereby there are major fluctuations even within single Member States (SCF, 1995). More recent estimates by JECFA concerning average cadmium intake are more or less on the same scale. According to them around 40-60% of the PTWI of 7 µg/kg body weight a week, which has been confirmed in 2003, are exhausted. However, attention is drawn to the fact that high consumers ("total food consumption for high consumers") take in twice as much cadmium and may, therefore, exceed the PTWI (JECFA, 2003). For Germany total daily cadmium intake is estimated to be around 30-35 µg/person; in this respect 80% is taken in from food, 15% from drinking water and normally less than 1% from respiratory air (Schwarz et al., 1993). Around the same amount of cadmium can be taken in from average cigarette consumption. A 50 year-old non-smoker not exposed at work has a total cadmium body load of around 15 mg whereas a comparable smoker has a total body load of 30 mg (Stoeppler, 1991).

3.1.4 Risk Characterisation

Observations that the migration of both lead and cadmium from ceramic articles is lower when they are used frequently, are in principle correct and have been documented. However, it could also be shown that there are also ceramic articles that continue to transfer steady amounts into the food stored in them over longer periods despite frequent use (Sheets, 1997).

3.1.4.1 Lead

The clinically manifest lead poisoning described under 3.1.2 (persistent obstipation, anaemia and intestinal colic as well as neurological effects), as can still be observed today in conjunction with longer lasting use of ceramic articles with a high lead transfer into foodstuffs, is generally associated with blood lead concentrations of 80 µg/dl upwards. Values of this kind are achieved in conjunction with a daily lead intake of 3 to 5 mg (WHO, 1995; Schlatter Ch, 1975; Mahaffey KR, 1977).

Lead concentrations in the blood of 40 to 50 µg/dl generally lead to the subclinical, non-specific effects mentioned under 3.1.2 like tiredness, headache and the onset of anaemia, which can, however, also be clinically manifest in particularly sensitive individuals (WHO, 1977 and 1995; Schlatter Ch, 1975).

In the development phase the organism is particularly sensitive to lead. Elevated lead exposure can lead to irreversible neurological damage or disruptions of specific brain functions. Exact threshold values cannot be indicated up to now for effects of this kind. It is, however, generally accepted that for precautionary reasons the mean lead concentration in blood of 10 to 15 µg/dL should not be exceeded in infants or small children (WHO, 1977 and 1995). Since lead can reach the foetus via the placenta, this level should not be exceeded in pregnant women either.

Dietary lead intakes, meeting such blood lead levels, are given for children up to 6 years as 60 µg/day, for children from 7 years as 150 µg/day and for pregnant women as 250 µg/day.

For other healthy adults lead intake of 750 µg/day is indicated as safe and from the toxicological view point as tolerable. The PTWI for the lifelong intake of lead is currently 25 µg/kg body weight. This means that an adult (70 kg) should not take in more than 1.75 mg/day lead throughout his entire adult life, a child (20 kg) no more than 0.5 mg/week during childhood.

In contrast, the maximum permitted lead intake from food in ceramic articles in our calculation model can amount in an unrealistic, extreme case in category 1 to more than 3 mg, in category 2 up to 4 mg. However, when ceramic articles are used properly and as expected in daily life, it is unlikely that the theoretically possible migration will take place either daily in the fully permitted amount or lifelong. On the other hand, it must be borne in mind that vessels of this kind are used over longer periods for the storage of different types of food. In such cases from vessels leaching lead at the upper limit lead may be transferred on such levels into the food stored in them that the vessels can no longer be described as safe and should not be used.

3.1.4.2 Cadmium

Cadmium poisoning from foods, which have been stored over longer periods in ceramic articles with a high cadmium transfer into foodstuffs , is not to be expected when the currently valid statutory regulations are complied with. In the literature there were reports of acute poisoning which were triggered by foods with a high level of cadmium contamination (particularly through cadmium-contaminated beverages). However, only foods and beverages with a low pH were contaminated which had been stored for longer periods in cadmium-coated metal vessels.

When assessing additional cadmium intake from foods, which have been stored in ceramic vessels from which cadmium can be transferred, the following must be taken into account. Even when the average cadmium intake of the normal population is relatively low, a not negligible section of the overall population, depending on their food habits and lifestyle, already takes in cadmium amounts which come close to or even exceed the PTWI (SCF, 1995, JECFA, 2003). More recent studies would seem to indicate that even relatively low cadmium exposure increases, independently of its action on the kidney function, the risk of demineralisation of bones and promotes the development of osteoporosis (JECFA, 2003).

Tables 2-5 indicate that in the model considerations chosen here children in particular can take in lead amounts which lead to considerable exceedance of the PTWI. By contrast, the exceedance of the PTWI for cadmium obtained in these models is lower than in the case of lead.

3.2 Scope for Action / Measures

On the European level it should be pointed out that if the current regulations are maintained there may be specific cases of extremely elevated lead and cadmium intake. Up to now it has not, however, been possible to exactly estimate how many consumers take in elevated amounts of heavy metals or how frequently this happens. BfR, therefore, recommends, particularly with regard to the special sensitivity of children to lead, that the statutory limits for the migration of lead and cadmium from ceramic articles should be lowered.

When it comes to laying down new limits for heavy metal migration from ceramic articles, the following considerations could be taken into account:

- The maximum admissible transferred amounts should not exceed the PTWI in conjunction with once-weekly use without taking into account intake from other sources. Since it is unlikely that ceramic articles with high heavy metal migration are used exclusively lifelong, the intake from other sources can be ignored.

or

- The maximum admissible transferred amounts should not exceed the value which results from the conversion of the PTWI to daily intake (daily use), again without taking into account intake from other sources.

Based on these considerations, corresponding limits would have to be laid down. Tables 6 and 7 indicate which limits meet the above requirements.

Table 6: Limits for the transfer .of lead from ceramic articles which would not lead to an exceedance of the PTWI without taking into account heavy metal contents from other sources

Lead (Pb)	Limit when the PTWI is complied with (once weekly use)		Limit when the PTWI is complied with (daily use)	
Target group	Child (PTWI: 0.5 mg) referred to 20 kg body weight	Adult (PTWI: 1.75 mg) referred to 70 kg body weight	Child (PTWI: 0.07 mg)* referred to 20 kg body weight	Adult (PTWI: 0.25 mg)* referred to 70 kg body weight
Category 1 Amount consumed 471 ml	0.125 mg/dm^2	0.437 mg/dm^2	0.0175 mg/dm^2	0.0625 mg/dm^2
Category 2 Amount consumed 1l	0.5 mg/l	1.75 mg/l	0.07 mg/l	0.25 mg/l
Category 3 Amount consumed 1l	0.5 mg/l	1.75 mg/l	0.07 mg/l	0.25 mg/l

* Value which results from the conversion of the PTWI to daily intake.

Table 7: Limits for the transfer of cadmium from ceramic articles which do not lead to an exceedance of the PTWI without taking into account heavy metal contents from other sources

Cadmium (Cd)	Limit when the PTWI is complied with (once-weekly use)		Limit when the PTWI is complied with (daily use)	
Target group	Child (PTWI: 0.14 mg) referred to 20 kg body weight	Adult (PTWI: 0.49 mg) referred to 70 kg body weight	Child (PTWI: 0.02 mg)* referred to 20 kg body weight	Adult (PTWI: 0.07 mg)* referred to 70 kg body weight
Category 1 Amount consumed 471 ml	0.035 mg/dm^2	0.123 mg/dm^2	0.005 mg/dm^2	0.0175 mg/dm^2
Category 2 Amount consumed 1l	0.14 mg/l	0.49 mg/l	0.02 mg/l	0.07 mg/l
Category 3 Amount consumed 1l	0.14 mg/l	0.49 mg/l	0.02 mg/l	0.07 mg/l

* Value which results from the conversion of the PTWI to daily intake.

Finally, it should be pointed out that it is technically possible to manufacture products with far lower heavy metal transfer. This has been confirmed by studies on lead and cadmium transferred from ceramic articles which were determined between 1998 and 2001 by the Test Agency for Commodities Lüneburg and submitted by the Test Agency Braunschweig. The results are presented in Tables 8 and 9.

Table 8: Test results from 1998 to 2001 for lead transferred from ceramic articles

Type of article	Number of Samples		Lead transfer
	Absolute	Percentage	
Category 1: total 145 samples	3	2 %	> 0.8 mg/dm^2
	16	11 %	0.05 – 0.8 mg/dm^2
	28	19 %	n.d.* (0.01 – 0.05 mg/dm^2)
	98	68 %	n.i.** (< 0.01 mg/dm^2)
Category 2: total 512 samples	1	0.2 %	> 4 mg/l
	8	2 %	1 – 4 mg/l
	55	11 %	0.1 – 1 mg/l
	41	8 %	0.05 – 0.1 mg/l
	13	2 %	n.d.* (0.002 – 0.005 mg/l)
	394	77 %	n.i.** (< 0.01 mg/l)

* n.d. not determinable

** n.i. not identifiable

Table 9: Test results from 1998 to 2001 for cadmium transfer from ceramic articles

Type of article	Number of Samples		Cadmium transfer
	Absolute	Percentage	
Category 1: total 89 samples	2	2 %	> 0.07 mg/dm²
	12	14 %	0.005 – 0.07 mg/dm²
	9	10 %	n.d.* (0.002 – 0.005 mg/dm²)
	66	74 %	n.i.** (< 0.002 mg/dm²)
Category 2: total 513 samples	1	0.2 %	> 0.3 mg/l
	16	3 %	0.005 - 0,3 mg/l
	9	2 %	n.d.* (0.002 – 0.005 mg/l)
	487	95 %	n.i.** (< 0.002 mg/l)

* n.d. not determinable

** n.i. not identifiable

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