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Magnesium citrate malate as a source of magnesium added for nutritional purposes to food supplements

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Abstract

The present scientific opinion deals with the assessment of the bioavailability of magnesium, from the proposed nutrient source, magnesium citrate malate (MgCM), when added for nutritional purposes to food supplements. MgCM is a mixed salt consisting of magnesium cations and citrate and malate anions, and with a magnesium content of 12–15%. MgCM is proposed to be used in food supplements that are intended to provide up to 300–540 mg/day magnesium. The data provided demonstrate that the production process results in batches of MgCM that comply with the product specifications and that the product is stable throughout its proposed shelf life. The human studies provided demonstrate that magnesium from MgCM is bioavailable. However, the extent of its bioavailability per se or compared to other magnesium sources cannot be established due to the lack of an appropriate magnesium source as a comparator in the studies provided or relevant kinetic data for magnesium. One publication provided in the dossier reported that supplementation with MgCM decreases calcium absorption, but this finding was not supported by publications on different magnesium salts and therefore the Panel could not draw conclusions from this finding. The Panel concludes that MgCM is a source from which magnesium is bioavailable, but the extent of its bioavailability cannot be established. The Panel notes that at the proposed maximum use levels of MgCM, the existing tolerable upper intake level for magnesium in nutritional supplements, water, or added to food and beverages (250 mg/day) is exceeded.

Keywords: magnesium citrate malate, magnesium, food supplement, nutrient source

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Summary

Following a request from the European Commission to the European Food Safety Authority (EFSA), the Panel on Nutrition, Novel Foods and Food Allergens (NDA) was asked to provide a scientific opinion on the nutrient source magnesium citrate malate (MgCM). The proposed nutrient source has already been included in the Union list of authorised novel foods according to Article 5 of Regulation (EC) 258/97. The present scientific opinion deals with the assessment of the bioavailability of the nutrient, magnesium, from the proposed nutrient source, MgCM, when added for nutritional purposes to food supplements.

The present evaluation is based on the data on MgCM provided by the applicant in the dossier submitted in support of its application, and on further information provided by the applicant upon request of the Panel on the identity of the substance, on the stability of the product and on the proposed use levels. Data on dietary intake of magnesium in the general population were extrapolated from the scientific opinion of the EFSA NDA Panel on dietary reference values for magnesium.

MgCM is a mixed salt consisting of magnesium cations and citrate and malate anions, and with a magnesium content of 12–15%. The Panel considers that the data provided do not allow confirming the molar ratio of all the components of the product as proposed by the applicant.

The data provided demonstrate that the production process results in batches of MgCM that comply with the product specifications and that the product is stable throughout its proposed shelf life.

MgCM is proposed to be used in food supplements that are intended to provide up to 300–540 mg/day magnesium. The Panel notes that at the proposed maximum use levels of MgCM the existing tolerable upper intake level (UL) of 250 mg/day for magnesium in nutritional supplements, water, or added to food and beverages is exceeded.

The information provided demonstrates that magnesium from MgCM is bioavailable. However, the extent of its bioavailability per se or compared to other magnesium sources cannot be established due to the lack of an appropriate magnesium source as a comparator in the studies provided or relevant kinetic data for magnesium.

One publication provided in the dossier reported that supplementation with MgCM decreases calcium absorption. Other studies investigating calcium absorption available in the literature, using different magnesium salts, have provided inconsistent results. Consequently, the Panel considers that no conclusions can be drawn from this finding.

The Panel concludes that MgCM is a source from which magnesium is bioavailable, but the extent of its bioavailability cannot be established. The Panel notes that at the proposed maximum use levels of MgCM, the existing UL for magnesium in nutritional supplements, water, or added to food and beverages is exceeded.

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1. Introduction

1.1. Background and Terms of Reference as provided by the European Commission

1.1.1. Background as provided by the European Commission

The European Union legislation lists nutritional substances that may be used for nutritional purposes in certain categories of foods as sources of certain nutrients.

The Commission has received a request for the evaluation of magnesium citrate malate as a source of magnesium added for nutritional purposes to food supplements. The relevant Union legislative measure is:

- Directive 2002/46/EC of the European Parliament and of the Council on the approximation of the laws of the Member States relating to food supplements.[1]

1.1.2. Terms of Reference as provided by the European Commission

In accordance with Article 29 (1)(a) of Regulation (EC) No 178/2002[2], the European Commission asks the European Food Safety Authority to provide a scientific opinion, based on its consideration of the safety and bioavailability of magnesium citrate malate as a source of magnesium added for nutritional purposes to food supplements.

1.2. Interpretation of the Terms of Reference

The applicant requests the inclusion of magnesium citrate malate as a source of magnesium in food supplements among the authorised substances included in Annex II of Directive 2002/46/EC.

The nutrient source has already been included in the Union list of authorised novel foods according to Article 5 of Regulation (EC) 258/97 (see Section 1.3.1). Following consultation with the European Commission, the Panel limited the present scientific opinion to the assessment of the bioavailability of the nutrient, magnesium, from the proposed nutrient source, magnesium citrate malate when added for nutritional purposes to food supplements.

1.3. Information on existing evaluations and authorisations

1.3.1. Magnesium citrate malate

A dossier requesting the use of magnesium citrate malate in food supplements was examined by the European Food Safety Authority (EFSA) in 2008. However, EFSA was unable to assess the bioavailability of the nutrient from this source due to the lack of appropriate information in the dossier (EFSA AFC Panel, 2008).

A substantial equivalence notification for magnesium citrate malate (MgCM) (manufactured by Dr Paul Lohmann GmbH KG) according to Article 3.4 of Regulation (EC) No 258/97 was accepted by the Food Safety Authority of Ireland (FSAI). MgCM was subsequently included in the Union list of authorised novel foods[3] based on its substantial equivalence to magnesium citrate (MgC) and magnesium malate (MgM). The opinion of the national competent authority confirming the substantial equivalence (FSAI, 2015) is without prejudice to the requirements set out in Directive 2002/46/EC as amended with regard to vitamins, minerals and their sources that may be used in food supplements within the European Union (EU).

1.3.2. Magnesium

The setting of a tolerable upper intake level (UL) for magnesium was considered by the European Commission Scientific Committee on Food (SCF) in 2001. The SCF concluded that osmotic diarrhoea

[1] Directive 2002/46/EC of the European Parliament and of the Council of 10 June 2002 on the approximation of the laws of the Member States relating to food supplements. OJ L 183, 12.7.2002, p. 51–57.

[2] Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety. OJ L 31, 1.2.2002, p. 1–24.

[3] Commission Implementing Regulation (EU) 2017/2470 of 20 December 2017 establishing the Union list of novel foods in accordance with Regulation (EU) 2015/2283 of the European Parliament and of the Council on novel foods.

was the critical effect for establishing a UL for magnesium and identified a no-observed-adverse-effect-level (NOAEL) of 250 mg/day of magnesium and an uncertainty factor of 1 for deriving a UL of 250 mg/day of magnesium for readily dissociable magnesium salts (e.g. chloride, sulfate, aspartate, lactate) and compounds, such as magnesium oxide, in nutritional supplements, water, or added to food and beverages. The UL does not include magnesium normally present in foods and beverages and it only applies to adults, including pregnant and lactating women, and children from 4 years onwards. No UL could be set for children aged 1–3 years due to lack of data (SCF, 2001).

In 2015, the EFSA Panel on Dietetic Products, Nutrition and Allergies (NDA) has defined dietary reference values for magnesium (EFSA NDA Panel, 2015) providing Adequate Intakes (AIs) that are summarised in Table 1.

Table 1: Summary of Adequate Intake values for magnesium (EFSA NDA Panel, 2015)

Age	Adequate Intake (mg/day)
7–11 months	80
1–3 years	170
4–6 years	230
7–17 years (F)	250
7–17 years (M)	300
≥ 18 years (F)[(a)]	300
≥ 18 years (M)	350

F: females; M: males.
(a): Including pregnant and lactating women.

1.3.3. Magnesium citrate

Magnesium salts of citric acid are authorised in the EU as sources of magnesium in food, food supplements, food for particular nutritional uses, food for special medical purposes, infant formulae, follow-on formulae, processed cereal-based food, baby food and total diet replacement for weight control, according to the respective legislative references.

1.3.4. Magnesium malate

Magnesium malate (MgM) is authorised as a source of magnesium in food supplements in the EU.

The EFSA AFC Panel (2006) assessed the safety of MgM and the bioavailability of Mg from this source, when added to food supplements as magnesium DL-malate trihydrate. The Panel concluded that the use of MgM as sources for Mg in food supplements was of no safety concern.

1.3.5. Calcium citrate malate

Calcium citrate malate is authorised in the EU as a source of calcium in food, food supplements, food for special medical purposes and food for particular nutritional uses, according to the respective legislative references.

The EFSA AFC Panel (2007) assessed calcium citrate malate as a source of calcium intended for use in food, food supplements and foods for particular nutritional uses. The Panel concluded that calcium from the proposed source was bioavailable and that there were no safety concerns at the maximum levels estimated in the opinion.

2. Data and methodologies

2.1. Data

The present evaluation is based on the data on magnesium citrate malate provided by the applicant in a dossier submitted in support of its application for the inclusion of the substance as a source of magnesium in food supplements. Upon request of the Panel, the applicant also provided further information on the identity of the substance, on the stability of the product and on the proposed use levels.

Data on dietary intake of magnesium in the general population were extrapolated from the scientific opinion of the EFSA NDA Panel on dietary reference values for magnesium (EFSA NDA Panel, 2015).

2.2. Methodologies

The assessment was conducted in line with the principles described in the EFSA Guidance on transparency in the scientific aspects of risk assessment (EFSA Scientific Committee, 2009) and following the relevant existing Guidance documents from the EFSA Scientific Committee.

The evaluation of bioavailability of the nutrient (magnesium) from the source (magnesium citrate malate) was conducted in line with the principles contained in the 'Guidance on safety evaluation of sources of nutrients and bioavailability of nutrient from the sources' (EFSA ANS Panel, 2018).

3. Assessment

3.1. Technical data

3.1.1. Identity of the substance

The proposed nutrient source, MgCM is a mixed salt consisting of magnesium cations and citrate and malate anions in a 5:2:2 molar ratio.

The applicant has provided the following information on the identity of the product:

- IUPAC name: penta-magnesium di-(2-hydroxybutanedioate)-di-(2-hydroxypropane-1,2,3-tricarboxylate)
- Molecular weight: 763.99 Da (in anhydrous form)
- Molecular formula: $Mg_5(C_6H_5O_7)_2(C_4H_4O_5)_2$

The product has been registered with CAS No 1259381-40-2.

The proposed nutrient source is an amorphous powder, colourless to whitish and easily soluble in water. The Panel considers that the product readily dissociates in water.

The applicant has provided a Fourier transform infrared spectroscopy (FT-IR) spectrum of MgCM identifying two characteristic absorption maxima corresponding to the hydroxyl and carboxyl groups; the applicant also provided a high-performance liquid chromatography-refractive index (HPLC-RI) chromatogram of MgCM showing the specific ratio of citric acid and malate in the product.

Upon request of the Panel, the applicant provided further information to support the characterisation of the product. These included high-performance liquid chromatography-electron spray ionization-mass spectrometric (HPLC-ESI-MS) analysis, and proton nuclear magnetic resonance (^{1}H-NMR) and carbon-13 NMR (^{13}C-NMR) spectra to further substantiate the chemical identity of MgCM, as well as a powder X-ray diffraction analysis to demonstrate the amorphous structure of MgCM.

The Panel considers that MgCM, the proposed nutrient source, is not fully characterised as the data provided do not allow confirming the molar ratio of all the components of the product as proposed by the applicant.

3.1.2. Manufacturing process

MgCM is manufactured in a one-step process. Equimolar amounts of food-grade citric acid and food-grade DL-malic acid are dissolved in water and an appropriate amount of a food-grade alkaline magnesium compounds (magnesium hydroxide, magnesium oxide or magnesium carbonate) is added. The resulting solution is filtered and spray-dried. The final product MgCM is marketed as an amorphous powder.

No impurities are expected in the final product due to the raw materials employed and the manufacturing process; this was confirmed by the applicant by HPLC-RI analysis.

The product is manufactured in a good manufacturing practice (GMP), DIN ISO EN 9001:2015 and FSSC 22000 certified manufacturing site in the context of a HACCP system.

The Panel considers that the production process is sufficiently described.

3.1.3. Compositional data

The applicant has provided the results of the analyses of three non-consecutive batches of MgCM (Table 2).

Table 2: Batch-to-batch analysis of MgCM

Parameter	Batch #1097718-1	Batch #1098848	Batch #1098791	Analytical method
Appearance, solid	Powder	Powder	Powder	Visual
Appearance solution (20%, H_2O)	Colourless to yellowish	Colourless to yellowish	Colourless to yellowish	Visual
Clarity solution (20%, H_2O)	Clear	Clear	Clear	Visual
Colour	White to yellowish-white	White to yellowish-white	White to yellowish-white	Visual
Identity	Conforms	Conforms	Conforms	FT-IR[(a)] spectra, comparison to reference standard
Magnesium content	12.6%	12.3%	12.9%	Complexometric titration with EDTA (Ph. Eur. 2011 or USP 37)
Ratio citrate: malate (peak areas)	1.61	1.56	1.57	HPLC-RI[(b)]
pH (20% solution)	5.2	5.1	5.2	Potentiometric
Loss on drying (120°C/4 h)	11.0%	12.2%	8.4%	Ph. Eur. 2014
Chloride	< 0.05%	< 0.05%	< 0.05%	British Pharmacopoeia 1973
Sulphate	< 0.05%	< 0.05%	< 0.05%	British Pharmacopoeia 1973
Zinc	< 10.0 ppm	< 10.0 ppm	< 10.0 ppm	AAS
Arsenic	< 3.0 ppm	< 3.0 ppm	< 3.0 ppm	Merckoquant® (Merck KGaA, Germany)
Lead	< 2.0 ppm	< 2.0 ppm	< 2.0 ppm	AAS[(c)]
Cadmium	< 1.0 ppm	< 1.0 ppm	< 1.0 ppm	AAS
Copper	< 10.0 ppm	< 10.0 ppm	< 10.0 ppm	AAS
Mercury	< 0.1 ppm	< 0.1 ppm	< 0.1 ppm	AFS[(d)]
Total aerobic count	< 2,000 CFU/g	< 2,000 CFU/g	< 2,000 CFU/g	Ph. Eur. 2014
Yeasts and moulds	< 200 CFU/g	< 200 CFU/g	< 200 CFU/g	Ph. Eur. 2014

MgCM: magnesium citrate malate; EDTA: ethylenediaminetetraacetic acid; CFU: colony forming unit.
(a): Fourier transform infrared spectroscopy.
(b): High-performance liquid chromatography with refractive index detection.
(c): Atomic absorption spectroscopy.
(d): Atomic fluorescence spectroscopy.

3.1.3.1. Stability of the substance and reaction and fate in food

The applicant proposes a shelf life of 36 months for the product.

To test for stability, the product packed in sealed plastic bags was stored in darkness at 25°C/60% relative humidity (RH), 30°C/65% RH and 40°C/75% RH for 3 months. All the parameters examined (% magnesium, loss on drying, colour, IR spectrum and taste) remained unchanged at the end of the test with the exception of the loss on drying which increased from 9.89% (starting material) to 12.27% upon storage at 40°C/75% RH.

The stability of powdered MgCM was also confirmed by a 36 months test conducted in darkness at 25°C and 60% RH. No degradation products were detected by HPLC-RI after 36 months of storage.

The applicant also performed a stability test on aqueous solutions with different concentrations of MgCM stored 6 days in darkness at room temperature. At 25% MgCM, fine sediment could be observed at the end of the test, while no changes were observed in solutions up to 20% MgCM.

The Panel considers that the data provided are sufficient to confirm stability of the product.

3.1.4. Specifications

The specifications for MgCM as proposed by the applicant are reported in Table 3.

Table 3: Specifications for MgCM as proposed by the applicant

Parameter	Value	Analytical method
Description	Powder	Visual
Assay Mg	12.0–15.0%	Titration with EDTA (Ph. Eur. 2011)
Ratio citrate: malate (peak areas)	1.28–1.65	HPLC-RI[(a)]
Loss on drying (120°C/4 h)	≤ 15%	Ph. Eur. 2014
Colour • solid • 20% solution	 • white to yellowish-white • colourless to yellowish	Visual
Clarity of solution (20%, H_2O)	Clear	Visual
pH (20%)	Approx. 6.0	Potentiometric
Chloride	≤ 0.05%	British Pharmacopoeia 1973
Sulphate	≤ 0.05%	British Pharmacopoeia 1973
Heavy metals		
Arsenic	≤ 3 ppm	Merckoquant® (Merck KGaA, Germany)
Lead	≤ 2 ppm	AAS[(b)]
Cadmium	≤ 1 ppm	AAS
Mercury	≤ 0.1 ppm	AFS[(c)]
Microbiology		
Total aerobic count	≤ 2,000 CFU/g	Ph. Eur. 2014
Yeasts/moulds count	≤ 200 CFU/g	Ph. Eur. 2014

MgCM: magnesium citrate malate; EDTA: ethylenediaminetetraacetic acid; CFU: colony forming unit.
(a): High-performance liquid chromatography with refractive index detection.
(b): Atomic absorption spectroscopy.
(c): Atomic fluorescence spectroscopy.

3.1.5. Methods of analysis in food

The applicant indicates that the following analytical methods are applicable for the analysis of MgCM and its degradation products in food supplements:

- FT-IR analysis for the identification of MgCM;
- Complexometric titration with EDTA for the determination of the magnesium content;
- HPLC-RI for the analysis of citrate to malate ratio and potential degradation products of these organic acids.

3.2. Proposed uses and use levels

The applicant proposes the use of MgCM as a food ingredient in food supplements as a source of magnesium.

Upon request of the Panel the applicant specified that MgCM is proposed to be used in food supplements at levels of 2.0–3.6 g/day, intended to provide 250–450 mg/day magnesium (assuming 12% Mg in MgCM). The applicant argues that the dose range indicated is based on the range of maximum magnesium daily intake from food supplements as regulated in different EU countries.

3.3. Exposure data

3.3.1. Dietary intakes of magnesium in the general population

The EFSA Scientific Opinion on dietary reference values for magnesium (EFSA NDA Panel, 2015) provides ranges of intake of magnesium from all sources, except food supplements and fortified foods, based on observed intakes in healthy populations in the EU. The ranges of average intake reported in the opinion are summarised in Table 4.

Table 4: Ranges of average intake of magnesium in Europe (EFSA NDA Panel, 2015)

Age	Range of average intake (mg/day)
7–11 months	72–120 (4)
1–3 years	153–188 (5)
3–10 years	184–281 (7)
10–18 years (F)	213–384 (7)
10–17 years (M)	257–344 (7)
≥ 18 years (F)	232–357 (9)
≥ 18 years (M)	264–439 (9)

F: females; M: males.
Between brackets the number of surveys on which the range is based.

3.3.2. Intake of magnesium from the use of MgCM as a nutrient source in food supplements

The applicant assumes that MgCM as a source of magnesium will replace some of the already authorised magnesium sources in food supplements. Therefore, the applicant assumes that the intake of magnesium would not increase as result of the market introduction of MgCM.

The applicant proposed that MgCM may be used in food supplements at levels of 2.0–3.6 g/day MgCM; this would correspond to a maximum intake of magnesium of 300–540 mg/day (assuming 15% Mg in MgCM, the upper end of the range of Mg content proposed in the specifications).

The Panel notes that the proposed maximum use levels of MgCM exceeds the existing UL of 250 mg/day (SCF, 2001) for magnesium established for readily dissociable magnesium salts and compounds like magnesium oxide in nutritional supplements, water, or added to food and beverages.

3.4. Biological data

In its assessment of calcium citrate malate as a source of calcium (EFSA AFC Panel, 2007), the AFC Panel considered that malate and citrate are expected to be dissociated from calcium in the gastrointestinal tract, and assumed that citrate and malate are available for absorption as calcium citrate and calcium malate salts in the intestinal tract. In the same opinion, the Panel reported that citric acid and D(+)-malate are metabolised without difficulty as intermediates in the tricarboxylic acid cycle (WHO, 1974) and that for malate there is no clear evidence for a need to distinguish between the enantiomers when malate is used in food (SCF, 1990).

The Panel considers that MgCM is readily soluble in water and that after ingestion, solid MgCM is then expected to dissolve and dissociate into the respective ions.

3.4.1. Absorption, distribution, metabolism and excretion

3.4.1.1. Bioavailability of magnesium from magnesium citrate malate

The applicant provided three publications where MgCM was used as a test item. The Panel notes that MgCM used in these three studies may not have been identical to the product under assessment.

The first publication is a controlled trial that assessed magnesium citrate calcium malate as a source of Mg and Ca when given to eight pre- and eight postmenopausal women (Ubbink et al., 1997). The study demonstrates the bioavailability of Mg from the source based on the urinary excretion rates of Mg, but the lack of a proper control and the limited reporting does not demonstrate whether the bioavailability of Mg from this source is higher or lower than from other sources of Mg.

The second publication (Basso et al., 2000a) reports on a uncontrolled study where 20 healthy female subjects with low erythrocyte Mg (less than 1.97 mmol/L), which the authors infer to be subclinical Mg deficient, were given K/Na citrate malate for 4 weeks followed by MgCM (up to 250 mg/day) for 4 weeks. The MgCM used in the study was given in sachets containing the equivalent of 125 mg elemental magnesium complexed with citric acid (2.06 g) and malic acid (1.41 g) each. Two sachets were taken. The study was designed to test the efficacy of Mg supplementation on Ca turnover and not to examine Mg metabolism or bioavailability. ^{45}Ca absorption was measured at the start and end of the MgCM supplementation. The authors reports that Ca absorption was statistically significantly decreased (23.5%) by supplementation with MgCM, but there were no changes in markers of collagen turnover. Whether the

observed effect of MgCM supplementation on Ca absorption is related to the Mg or to MgCM is not discussed in the paper. An increase in plasma and urine Mg concentration was observed (5.3% and 31.1%, respectively), but there was no change in the only body pool measured, i.e. erythrocyte Mg concentration.

The third publication (Basso et al., 2000b) examined the validity of erythrocyte Mg as an indicator of Mg status. The Panel notes that the study did not add any new information on the bioavailability of Mg from MgCM.

Based on all the information provided, the Panel concludes that Mg from MgCM is bioavailable. However, the extent of its bioavailability per se or compared to other magnesium sources cannot be established due to the lack of an appropriate magnesium source as a comparator in the studies provided or relevant kinetic data for magnesium. Furthermore, the Panel cannot conclude whether MgCM used in these studies is equivalent to the proposed nutrient source.

3.5. Discussion

The present scientific opinion deals with the assessment of the bioavailability of the nutrient, magnesium, from the proposed nutrient source, MgCM, when added for nutritional purposes to food supplements.

MgCM is a mixed salt consisting of magnesium cations and citrate and malate anions, and with a magnesium content of 12–15%. The Panel considers that the data provided do not allow confirming the molar ratio of all the components of the product as proposed by the applicant.

The applicant has submitted analytical results from three batches of MgCM demonstrating compliance with the proposed specifications and provided data demonstrating the stability of the product.

MgCM is proposed to be used in food supplements that are intended to provide up to 300–540 mg/day magnesium. The Panel notes that at the proposed maximum use levels of MgCM the existing UL of 250 mg/day for magnesium in nutritional supplements, water, or added to food and beverages (SCF, 2001) is exceeded.

The information provided demonstrates that magnesium from MgCM is bioavailable. However, the extent of its bioavailability per se or compared to other magnesium sources cannot be established due to the lack of an appropriate magnesium source as a comparator in the studies provided or relevant kinetic data for magnesium.

One publication has reported that supplementation with MgCM decreases calcium absorption. The Panel notes that other studies (Spencer et al., 1994; Martini, 1999) investigating calcium absorption, using different magnesium salts, have provided inconsistent results. Consequently, the Panel considers that no conclusions can be drawn from this finding.

4. Conclusions

The Panel concludes that MgCM is a source from which magnesium is bioavailable, but the extent of its bioavailability cannot be established.

The Panel notes that at the proposed maximum use levels of MgCM, the existing UL of 250 mg/day for magnesium in nutritional supplements, water, or added to food and beverages (SCF, 2001) is exceeded.

Documentation provided to EFSA

1) Mandate received from the European Commission on 22 December 2017, under Commission Regulation (EC) 258/1997 referring to the commission request for a scientific opinion on magnesium citrate malate added for nutritional purposes to food supplements submitted by Dr. Paul Lohmann GmbH KG.
2) Technical dossier received from the European Commission on 24 January 2018, for 'Application for the inclusion of Magnesium Citrate Malate in Annex II of Directive 2002/46/EC'.
3) Additional data provided on 12 July 2018. Submitted by Dr. Paul Lohmann GmbH KG in response to a request from EFSA.

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Abbreviations

AAS	atomic absorption spectroscopy
AFC Panel	Panel on Food Additive, Flavourings, Processing Aids and Materials in Contact with Food
AFS	atomic fluorescence spectroscopy
AI	adequate intake
^{13}C-NMR	carbon-13 nuclear magnetic resonance
CAS	Chemical Abstracts Service
CFU	colony forming unit

FSAI	Food Safety Authority of Ireland
FT-IR	Fourier transform infrared spectroscopy
GMP	good manufacturing practice
^{1}H-NMR	proton nuclear magnetic resonance
HACCP	hazard analysis and critical control points
HPLC-ESI-MS	high-performance liquid chromatography-electron spray ionisation-mass spectrometry
HPLC-RI	high-performance liquid chromatography-refractive index
IUPAC	International Union of Pure and Applied Chemistry
MgC	magnesium citrate
MgCM	magnesium citrate malate
MgM	magnesium malate
NDA Panel	Panel on Nutrition, Novel Foods and Food Allergens (before July 2018 named as Panel on Dietetic Products, Nutrition and Allergies)
NOAEL	no-observed-adverse-effect level
RH	relative humidity
SCF	Scientific Committee on Food
UL	tolerable upper intake level
yo	year old