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Re-evaluation of tragacanth (E 413) as a food additive

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Abstract

The Panel on Food Additives and Nutrient Sources added to Food (ANS) provides a scientific opinion re-evaluating the safety of tragacanth (E 413) as a food additive. In the EU, tragacanth (E 413) has been evaluated by the Scientific Committee for Food (SCF, 1989) and by the Joint FAO/WHO Expert Committee on Food Additives (JECFA, 1987), who both allocated an acceptable daily intake (ADI) 'not specified' for this gum. Following the conceptual framework for the risk assessment of certain food additives, re-evaluated under Commission Regulation (EU) No 257/2010, the Panel considered that adequate exposure and toxicity data were available. Tragacanth (E 413) is unlikely to be absorbed intact and is partially fermented by intestinal microbiota. No adverse effects were reported in carcinogenicity studies at the highest dose tested and there is no concern with respect to the genotoxicity. Oral daily intake of a large amount of tragacanth up to 9,900 mg tragacanth/person per day (approximately equivalent 141 mg tragacanth/kg body weight (bw) per day) for up to 21 days was well tolerated in humans. The Panel concluded that there is no need for a numerical ADI for tragacanth (E 413) and that there is no safety concern for the general population at the refined exposure assessment of tragacanth (E 413) as a food additive at the reported uses and use levels.

Keywords: tragacanth (E 413), CAS Registry Number 9000-65-1, food additive

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Summary

Following a request from the European Commission, the EFSA Panel on Food Additives and Nutrient Sources added to Food (ANS) was asked to re-evaluate the safety of tragacanth (E 413) when used as a food additive.

Tragacanth (E 413) is authorised as food additives in the European Union (EU) according to Annex II to Regulation (EC) No 1333/2008 on food additives and it was previously evaluated by the EU Scientific Committee for Food (SCF) and the Joint FAO/WHO Expert Committee on Food Additives (JECFA), who both allocated an acceptable daily intake (ADI) 'not specified' for this gum.

The Panel was not provided with a newly submitted dossier and based its evaluation on previous evaluations and reviews, additional literature that became available since then and the data provided following public calls for data. Not all original studies on which previous evaluations were based were available for re-evaluation by the Panel.

Tragacanth is exclusively defined as a dried exudation obtained from the stems and branches of strains of *Astragalus gummifer* Labillardiere and other Asiatic species of *Astragalus* (family Leguminosae) (Commission Regulation (EU) No 231/2012).

Tragacanth (E 413) is authorised as a food additive in the EU under Regulation (EC) No 1333/2008 on food additives. Specific purity criteria on tragacanth (E 413) have been defined in Commission Regulation (EU) No 231/2012. The Panel noted that according to industry the average content of protein in the food additive is 2% while Anderson et al. (1989) indicated that this content can be between 0.5% and 3.4%. The Panel also noted some case reports of hypersensitivity reactions associated with tragacanth. The Panel considered that this hypersensitivity might be due to the tragacanth proteins and therefore their content should be reduced as much as possible.

Tragacanth is unlikely to be absorbed intact. In the absence of *in vivo* data and according to *in vitro* demonstration of fermentation of tragacanth by animal and human intestinal microorganisms, the Panel considered that tragacanth would be partially fermented during its passage through the large intestine by the action of the intestinal tract microflora. The rate of hydrolysis in the gastrointestinal tract in humans is unknown, but it is expected that the limited extent of hydrolysis of tragacanth would lead to the production of its fermentation products such as short-chain fatty acids which were considered of no safety concern by the Panel.

The acute toxicity of tragacanth in mice, hamsters, rats and rabbits is low.

The subchronic toxicity of tragacanth was investigated in mice for 13 weeks (Hagiwara et al., 1991). In all treated animals at all doses (except in females receiving 1,500 mg/kg body weight (bw) per day) slight but dose-related elevations of γ-glutamyl transpeptidase (GGT) levels were seen while squamous-cell hyperplasia of the forestomach occurred in males of all groups. In an additional study on males, given the highest dose of tragacanth for periods of up to 48 weeks demonstrated that these effects were not reproducible. The Panel noted that the increase in GGT levels was not confirmed by chronic studies performed by the same authors.

Based on the data available, the Panel considered that there is no concern with respect to the genotoxicity of tragacanth.

The Panel noted that in a long-term toxicity study tragacanth was not carcinogenic and no adverse effects were observed up to the highest dose tested.

The Panel considered that no adverse effects were observed in reproductive toxicity studies at doses up to 6% (equivalent to 5,400 mg tragacanth/kg bw per day), the highest dose tested. In the identically performed prenatal developmental tests with tragacanth by gavage in mice and hamsters (Food and Drug Res. Lab., 1972b), 1,200 mg/kg bw per day in mice and 900 mg/kg bw per day in hamsters (the highest doses tested), showed no dose-related developmental effects.

In a dietary study with tragacanth in humans, five male volunteers consumed 9,900 mg tragacanth (equivalent to 141 mg/kg bw per day) each day (Eastwood et al., 1984). The test substance was well tolerated and no adverse effects and no allergic reactions were observed. Tragacanth had no observed effects on clinical chemistry, haematological indices and urinalysis parameters. The intestinal transit time decreased, faecal fat concentration and wet and dry weights increased.

Tragacanth (E 413) is authorised in a wide range of foods. The Panel identified a possible brand loyalty to specific food categories (i.e. edible ices and other confectionery), and therefore, the Panel considered that the brand-loyal scenario covering the brand-loyal population was the more appropriate and realistic scenario for risk characterisation because it is assumed that the population would probably be exposed long-term to tragacanth (E 413) present at the maximum reported use level for one food category.

The refined estimates are based on 5 out of 70 food categories in which tragacanth (E 413) is authorised. The Panel considered that the uncertainties identified would, in general, result in an overestimation of the exposure to tragacanth (E 413) as a food additive in European countries for the refined scenario if it is considered that the food additive may not be used in food categories for which no usage data have been provided.

However, the Panel noted that given the information from the Mintel's Global New Products Database (GNPD), it may be assumed that tragacanth (E 413) is used in food categories for which no data have been provided by food industry. The main food categories, in term of amount consumed, not taken into account were cheeses, breakfast cereals, bread and rolls, fine bakery wares, meat products, processed fish, flavoured drinks, some alcoholic beverages (e.g. cider and perry, spirit drinks), snacks and desserts. According to the Mintel GNPD (Appendix B), in the EU market, bakery products, meat products, snacks and desserts are labelled with tragacanth (E 413) for limited number of products. Therefore, the Panel considered that if these uncertainties were confirmed, it would result in an underestimation of the exposure.

The Panel also noted that the refined exposure estimates are based on information provided on the reported level of use of tragacanth (E 413). If actual practice changes, this refined estimates may no longer be representative and should be updated.

Following the conceptual framework for the risk assessment of certain food additives re-evaluated under Commission Regulation (EU) No 257/2010 (EFSA ANS Panel, 2014), and given that:

- the safety assessment carried out by the Panel is limited to the reported uses (5 out of 70 food categories) and use levels;
- in the general population, the highest refined exposure assessments calculated based on the reported data from food industry were for toddlers (12–35 months) up to 6 mg/kg bw per day (brand-loyal scenario);
- tragacanth is unlikely to be absorbed intact and is partially fermented by intestinal microbiota;
- sufficient toxicity data were available;
- there is no concern with respect to the genotoxicity of tragacanth (E 413);
- no carcinogenic effects were reported at doses up to 6,120 and 9,120 mg/kg bw per day for male and female mice, respectively, the highest doses tested;
- oral daily intake of a large amount of tragacanth up to 9,900 mg (equivalent to 141 mg/kg bw per day) for 21 days was well tolerated in humans, without any undesirable effect being reported;

the Panel concluded that there is no need for a numerical ADI for tragacanth (E 413), and that there is no safety concern at the refined exposure assessment for the reported uses and use levels of tragacanth (E 413) as a food additive.

Due to the discrepancies observed between the data reported from industry and the Mintel database, where tragacanth (E 413) is labelled in more products than in food categories for which data were reported from industry, the Panel recommended collection of data of uses and use levels of tragacanth (E 413) including food supplements in order to perform a more realistic exposure assessment.

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1. Introduction

The present opinion document deals with the re-evaluation of tragacanth (E 413) when used as a food additive.

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

1.1.1. Background as provided by the European Commission

Regulation (EC) No 1333/2008 of the European Parliament and of the Council on food additives requires that food additives are subject to a safety evaluation by the European Food Safety Authority (EFSA) before they are permitted for use in the European Union (EU). In addition, it is foreseen that food additives must be kept under continuous observation and must be re-evaluated by EFSA.

For this purpose, a programme for the re-evaluation of food additives that were already permitted in the EU before 20 January 2009 has been set up under the Regulation (EU) No 257/2010[1]. This Regulation also foresees that food additives are re-evaluated whenever necessary in light of changing conditions of use and new scientific information. For efficiency and practical purposes, the re-evaluation should, as far as possible, be conducted by group of food additives according to the main functional class to which they belong.

The order of priorities for the re-evaluation of the currently approved food additives should be set on the basis of the following criteria: the time since the last evaluation of a food additive by the Scientific Committee on Food (SCF) or by EFSA, the availability of new scientific evidence, the extent of use of a food additive in food and the human exposure to the food additive taking also into account the outcome of the Report from the Commission on Dietary Food Additive Intake in the EU of 2001. The report 'Food additives in Europe 2000' submitted by the Nordic Council of Ministers to the Commission, provides additional information for the prioritisation of additives for re-evaluation. As colours were among the first additives to be evaluated, these food additives should be re-evaluated with a highest priority.

In 2003, the Commission already requested EFSA to start a systematic re-evaluation of authorised food additives. However, as a result of adoption of Regulation (EU) 257/2010, the 2003 Terms of References are replaced by those below.

1.1.2. Terms of Reference as provided by the European Commission

The Commission asks EFSA to re-evaluate the safety of food additives already permitted in the Union before 2009 and to issue scientific opinions on these additives, taking especially into account the priorities, procedures and deadlines that are enshrined in the Regulation (EU) No 257/2010 of 25 March 2010 setting up a programme for the re-evaluation of approved food additives in accordance with the Regulation (EC) No 1333/2008 of the European Parliament and of the Council on food additives.

1.2. Information on existing evaluations and authorisations

Tragacanth (E 413) is an authorised food additive in the EU according to Annex II and Annex III of Regulation (EC) No 1333/2008[2]. Specific purity criteria on tragacanth (E 413) have been defined in Commission Regulation (EU) No 231/2012.

Tragacanth has been evaluated by the Scientific Committee for Food (SCF) in 1988 (SCF, 1989). Evaluation of the toxicological evidence and limited present use of this gum, enabled the committee to establish an ADI "not specified" for this gum.

Tragacanth was evaluated by the Joint FAO/WHO Expert Committee on Food Additives (JECFA) in 1969, 1973, 1977, 1980, 1983, the latest evaluation was performed in 1985 (JECFA, 1987). Three toxicological monographs were prepared (JECFA, 1987). Based on the lack of adverse effects in the

[1] Commission Regulation (EU) No 257/2010 of 25 March 2010 setting up a programme for the re-evaluation of approved food additives in accordance with Regulation (EC) No 1333/2008 of the European Parliament and of the Council on food additives. OJ L 80, 26.3.2010, p. 19–27.

[2] Regulation (EC) No 1333/2008 of the European Parliament and of the Council of 16 December 2008 on food additives. OJ L 354, 31.12.2008, p. 16–33.

available toxicity database, an ADI 'not specified' was allocated by JECFA. In 2006, JECFA updated the specifications of tragacanth (JECFA, 2006a,b).

Tragacanth is one of the food additives that composed jelly mini-cups which were suspended in 2004 by the European Commission to be placed on the market and import (Commission Decision 2004/37/EC), following the measures taken and information provided by different Member States. Jelly mini-cups are defined as 'jelly confectionery of a firm consistence, contained in semirigid mini-cups or mini-capsules, intended to be ingested in a single bite by exerting pressure on the mini-cups or mini-capsule to project the confectionery into the mouth'.

In 2004, the EFSA Scientific Panel on Food Additives, Flavourings, Processing Aids and Materials in Contact with Food (AFC) prepared a scientific opinion on a request from the European Commission related to the use of certain food additives derived from seaweed or non-seaweed origin, including tragacanth (E 413) in jelly mini-cups (EFSA AFC Panel, 2004). The AFC Panel concluded that any of these gel-forming additives or of any other type that gave rise to a confectionery product of a similar size, with similar physical and/or physicochemical properties and that could be ingested in the same way as the jelly mini-cups, would give rise to a risk for choking (EFSA AFC Panel, 2004). The use of these additives in jelly mini-cups is not authorised in the EU. The use of these additives in jelly mini-cups is not authorised in the EU.[3]

Tragacanth has also been reviewed by the Nordic Council of Ministers (TemaNord, 2002), who concluded that no immediate re-evaluation of tragacanth was necessary.

2. Data and methodologies

2.1. Data

The Panel on Food Additives and Nutrient Sources added to Food (ANS) was not provided with a newly submitted dossier. EFSA launched public calls for data[4,5] to collect information from interested parties and, if relevant, contacted risk assessment bodies.

The Panel based its assessment on information submitted to EFSA following the public calls for data, information from previous evaluations and additional available literature up to 22 March 2017. Attempts were made at retrieving relevant original study reports on which previous evaluations or reviews were based; however not always these were available to the Panel.

The EFSA Comprehensive European Food Consumption Database (Comprehensive Database[6]) was used to estimate the dietary exposure.

The Mintel's Global New Products Database (GNPD) is an online resource listing food products and compulsory ingredient information that should be included in labelling. This database was used to verify the use of tragacanth (E 413) in food products.

2.2. Methodologies

This opinion was formulated following the principles described in the EFSA Guidance on transparency with regard to scientific aspects of risk assessment (EFSA Scientific Committee, 2009) and following the relevant existing guidance documents from the EFSA Scientific Committee.

The ANS Panel assessed the safety of tragacanth (E 413) as a food additive in line with the principles laid down in Regulation (EU) 257/2010 and in the relevant guidance documents: Guidance on submission for food additive evaluations by the SCF (2001) and taking into consideration the Guidance for submission for food additive evaluations in 2012 (EFSA ANS Panel, 2012).

In the context of this re-evaluation, the Panel followed the conceptual framework for the risk assessment of certain food additives re-evaluated under Commission Regulation (EC) No 257/2010 (EFSA ANS Panel, 2014).

When the test substance was administered in the feed or in the drinking water, but doses were not explicitly reported by the authors as mg/kg bw per day based on actual feed or water consumption, the daily intake was calculated by the Panel using the relevant default values as indicated in the EFSA

[3] Annex II to Regulation (EC) No 1333/2008.
[4] Call for scientific data on food additives permitted in the EU and belonging to the functional classes of emulsifiers, stabilisers and gelling agents. Published: 22 November 2009. Available from: http://www.efsa.europa.eu/en/dataclosed/call/ans091123
[5] Call for technical data on certain thickening agents permitted as food additives in the EU – Extended Deadline: 31 December 2015. Available online: http://www.efsa.europa.eu/it/data/call/141219
[6] Available online: http://www.efsa.europa.eu/en/datexfoodcdb/datexfooddb.htm

Scientific Committee Guidance document (EFSA Scientific Committee, 2012) for studies in rodents or, in the case of other animal species, by JECFA (2000). In these cases, the daily intake is expressed as equivalent. When in human studies in adults (aged above 18 years), the dose of the test substance administered was reported in mg/person per day, the dose in mg/kg bw per day was calculated by the Panel using a body weight of 70 kg as default for the adult population as described in the EFSA Scientific Committee Guidance document (EFSA Scientific Committee, 2012).

Dietary exposure to tragacanth (E 413) from its use as a food additive was estimated combining food consumption data available within the EFSA Comprehensive European Food Consumption Database with the maximum levels according to Annex II to Regulation (EC) No 1333/2008[7] and/or reported use levels and analytical data submitted to EFSA following a call for data. Different scenarios were used to calculate exposure (see Section 3.3.1). Uncertainties on the exposure assessment were identified and discussed.

3. Assessment

3.1. Technical data

3.1.1. Identity of the substance

Tragacanth (E 413) is exclusively defined as a dried exudation obtained from the stems and branches of strains of *Astragalus gummifer* Labillardiere and other Asiatic species of *Astragalus* (family Leguminosae). It consists mainly of high molecular weight polysaccharides (galactoarabans and acidic polysaccharides) which, on hydrolysis, yield galacturonic acid, galactose, arabinose, xylose and fucose. Small amounts of rhamnose and of glucose (derived from traces of starch and/or cellulose) may also be present (Commission Regulation (EU) No 231/2012[8]). The substance has the CAS Registry Number 9000-65-1 and the EINECS Number 232-252-5.

The Panel noted that some publications describe tragacanth as a mixture of two components present as a mixed calcium, magnesium and potassium salt. The first component is tragacanthic acid, commonly known as bassorin, a water-swellable polymer. The second component is a water-soluble arabinogalactan polysaccharide known as tragacanthin (Weiping, 2000; Verbeken et al., 2003; Mayes, 2009). However, there seems to be a controversy on the composition of tragacanth that is also described as mixture composed of two major components: a water-insoluble fraction called bassorin and a water-soluble fraction called tragacanthin that is composed of tragacanthic acid (composed of D-galacturonic acid, D-xylose, L-fructose, D-galactose and other sugars) and arabinogalactan (Leung, 1980; Balaghi et al., 2011).

The ratio of the two fractions varies between species (Verbeken et al., 2003). It seems that the sugar composition of the tragacanth has a direct impact on the rheological behaviour of the gum. The sugar composition of several gums has been determined after acid hydrolysis and the monosaccharide content has been shown to vary between species. Verbeken et al. (2003) analysed the sugar composition in two Turkish *Astragalus* species and a high variability of the monosaccharide composition was also found by analysis of tragacanth from six Iranian *Astragalus* species (Balaghi et al., 2011), e.g. the content of arabinose ranges from 1% to 51%, galacturonic acid from 9% to 37%, xylose from 10% to 32%, glucose from 0% to 13%, fucose from 0% to 35%, galactose from 1% to 8% and less quantities of rhamnose.

Tragacanth also contains traces of starch and cellulosic materials and 3–4% protein content that is thought to play a part in the emulsification properties of the gum (Mayes, 2010).

The molecular weight of tragacanth (E 413) varies over a wide range and is reported to be approximately 800,000 g/mol (Commission Regulation (EU) No 231/2012).

Tragacanth has as synonyms tragacanth gum, tragant, bassora gum, goat's thorn and gum shiraz, among others.

Unground tragacanth occurs as flattened, lamellated, straight or curved fragments or as spirally twisted pieces 0.5–2.5 mm thick and up to 3 cm in length. It is white to pale yellow in colour but some pieces may have a red tinge. The pieces are horny in texture, with a short fracture. It is

[7] Commission Regulation (EC) No 1333/2008 of the European Parliament and of the Council of 16 December 2008 on food additives. OJ L 354, 31.12.2008, p. 16.

[8] Commission Regulation (EU) No 231/2012 of 9 March 2012 laying down specifications for food additives listed in Annexes II and III to Regulation (EC) No 1333/2008 of the European Parliament and of the Council. OJ L 83, 22.3.2012, p 1–295.

odourless and solutions have an insipid mucilaginous taste. Powdered tragacanth is white to pale yellow or pinkish brown (pale tan) in colour (Commission Regulation (EU) No 231/2012).

The substance is soluble in alkaline solutions and aqueous hydrogen peroxide solutions (Lewis, 1997).

Tragacanth is divided into two types, ribbon and flake. Ribbon exudates (5–10 cm long and 1–2 cm wide) are slightly opaque while the flakes (less than 5 cm thick) are dark in colour. There are physical and chemical differences between them and it was reported that a 1% (w/v) solution with ribbon tragacanth is three times more viscous than a 1% (w/v) solution with flake tragacanth (Mohammadifar et al., 2006). Viscosity is an important factor in determining tragacanth technological quality. The viscosity of a 1% (w/v) solution may range from 100 to 3,500 centipoise (cps), depending on the grade. The high viscosity of tragacanth solutions results from the molecular characteristics of the gum and these depend on the grade and physical form. Maximum viscosity is attained after 24 h at room temperature or after 2 h at 50°C. The viscosity is stable within the pH range of 2–10 (Wielinga, 2009).

Structural formulae with different molecular sequences of monosaccharides in tragacanth are proposed in the literature; however, the Panel noted that none of them could be considered representative.

An interested party (documentation provided to EFSA n. 8) has provided electronic microscopy data on particle shape and size for tragacanth 150 mesh. The micrographs provided indicate that it consists of angularly shaped grains with facets on the surface. Its morphology is closer to that of the karaya gum than the pulverised acacia gum. The gum tragacanth 150 mesh has a granulometry varying from 1 to 250 μm approximately. It seems divided into two populations of fairly balanced proportions: one for the finest particles mainly located between 10 and 50 μm, and the other for the bigger particle size ranging from 100 to 200 μm.

3.1.2. Specifications

The specifications for tragacanth (E 413) as defined in the Commission Regulation (EU) No 231/2012 and by JECFA (2006a) are listed in Table 1.

Table 1: Specifications for tragacanth (E 413) according to Commission Regulation (EU) No 231/2012 and JECFA (2006a)

	Commission Regulation (EU) No 231/2012	**JECFA (2006a)**
Definition	Tragacanth is a dried exudation obtained from the stems and branches of natural strains of *Astragalus gummifer* Labillardiere and other asiatic species of *Astragalus* (family Leguminosae). It consists mainly of high molecular weight polysaccharides (galactoarabans and acidic polysaccharides) which, on hydrolysis, yield galacturonic acid, galactose, arabinose, xylose and fucose. Small amounts of rhamnose and of glucose (derived from traces of starch and/or cellulose) may also be present	A dried exudation obtained from the stems and branches of *Astragalus gummifer* Labillardiere and other Asiatic species of *Astragalus* (Fam. Leguminosae); consists mainly of high molecular weight polysaccharides (galactoarabans and acidic polysaccharides) which, on hydrolysis, yield galacturonic acid, galactose, arabinose, xylose and fucose; small amounts of rhamnose and of glucose (derived from traces of starch and/or cellulose) may also be present
Description	Unground tragacanth gum occurs as flattened, lamellated, straight or curved fragments or as spirally twisted pieces 0.5–2.5 mm thick and up to 3 cm in length. It is white to pale yellow in colour but some pieces may have a red tinge. The pieces are horny in texture, with a short fracture. It is odourless and solutions have an insipid mucilaginous taste. Powdered tragacanth is white to pale yellow or pinkish brown (pale tan) in colour	The unground gum occurs as flattened, lamellated, straight or curved fragments or as spirally twisted pieces 0.5–2.5 mm thick and up to 3 cm in length; white to pale yellow, but some pieces may have a red tinge; the pieces are horny in texture, with a short fracture; odourless. The powdered gum is white to pale yellow or pinkish brown (pale tan) Items of commerce may contain extraneous materials such as pieces of bark which must be removed before use in food Unground samples should be powdered to pass a No. 45 sieve (355 M) and mixed well before performing any one of the following tests

	Commission Regulation (EU) No 231/2012	JECFA (2006a)
Identification		
Solubility	1 g of the sample in 50 mL of water swells to form a smooth, stiff, opalescent mucilage; insoluble in ethanol and does not swell in 60% (w/v) aqueous ethanol	1 g of the sample in 50 mL of water swells to form a smooth, stiff, opalescent mucilage; insoluble in ethanol and does not swell in 60% (w/v) aqueous ethanol
Microscopy	–	Examine microscopically a suspension of the sample in water. Numerous angular fragments with circular or irregular lamellae, starch grains up to 15 μm in diameter, and stratified cellular membranes, which turn violet in colour on the addition of iodinated zinc chloride solution, are visible
Precipitate formation	–	The samples give a precipitation reaction with a saturated aqueous solution of copper (II) acetate
Gum constituents	–	Identify arabinose, xylose, fucose, galactose and galacturonic acid as follows: Proceed as directed under Gum Constituents Identification using the following reference standards: arabinose, mannose, galactose, xylose, fucose, galacturonic acid and glucuronic acid. Arabinose, xylose, fucose, galactose and galacturonic acid should be present; mannose and glucuronic acid should be absent
Purity		
Test for Karaya gum	Negative. Boil 1 g with 20 mL of water until a mucilage is formed. Add 5 mL of hydrochloric acid and again boil the mixture for 5 min. No permanent pink or red colour develops	a) Boil 1 g of the sample with 20 mL of water until a mucilage is formed. Add 5 mL of hydrochloric acid and again boil for 5 min. No permanent pink or red colour develops b) Shake 0.2 g with 10 mL of ethanol (60%) in a 10-mL stoppered cylinder, graduated in 0.1 mL intervals. Any gel formed occupies not more than 1.5 mL c) Shake 1.0 g with 99 mL of water. Titrate the mucilage so formed with 0.01 M sodium hydroxide, using methyl red solution as indicator. Not more than 5.0 mL of 0.01 M sodium hydroxide is required to change the colour of the solution
Loss on drying	Not more than 16% (105°C, 5 h)	Not more than 16% (105°C, 5 h)
Total ash	Not more than 4%	–
Acid insoluble ash	Not more than 0.5%	Not more than 0.5% Boil the ash obtained as directed under sulfated ash above, with 25 mL of 3 M hydrochloric acid for 5 min, collect the insoluble matter on a tared crucible or ashless filter paper, wash with hot water, ignite, and weigh. Calculate the percentage of acid-insoluble ash from the weight of the sample

	Commission Regulation (EU) No 231/2012	JECFA (2006a)
Acid insoluble matter	Not more than 2%	Not more than 2% In a 250-mL round-bottomed flask, place 2.0 g of tragacanth and add 95 mL of methanol. Moisten the powder by swirling and add 80 mL of hydrochloric acid. Add a few glass beads of about 4 mm in diameter and heat under reflux in a water-bath for 3 h, shaking occasionally. Eliminate the glass beads and filter by suction the suspension while hot through a previously tared sintered-glass filter. Rinse the flask with a small quantity of water and pass the rinsings through the filter. Wash the residue on the filter with about 40 mL of methanol and dry at 110° to constant weight. Allow to cool in a desiccator and weigh. Calculate as percentage
Arsenic	Not more than 3 mg/kg	–
Lead	Not more than 2 mg/kg	Not more than 2 mg/kg
Mercury	Not more than 1 mg/kg	–
Cadmium	Not more than 1 mg/kg	–
Salmonella spp.	Absent in 10 g	Negative in 1 g
Escherichia coli	Absent in 5 g	Negative in 1 g
Sulfated ash	–	Not more than 4%
Acacia and other soluble gums	–	To 20 mL of a 0.25% (w/v) suspension of the sample in freshly boiled and cooled water add 10 mL of lead (II) acetate solution. A flocculent precipitate is produced. Filter, and to the filtrate add 10 mL of lead sub-acetate solution. The solution may become slightly cloudy but no precipitate is formed
Agar	–	To 4 mL of a dispersion (0.5% w/v) of the sample in water, add 0.5 mL of hydrochloric acid and heat on a boiling water bath for 30 min. Add a few drops of barium chloride solution (3.65% w/v). No precipitate is formed
Dextrin	–	Mount the sample in aqueous glycerol and examine under the microscope. The addition of 1% aqueous iodine solution does not reveal yellow-brown or purplish-red particles

The Panel noted that the European Pharmacopeia describes in addition to what is described in the EU regulation and by JECFA a test for methylcellulose contained as impurity (Eur. Pharm. 8th ed, 2014).

The protein content in seven Iranian commercial tragacanth samples varied from 0.5% to 3.4% (Anderson et al., 1989). The nitrogen content in 13 tragacanth samples varied between 0.17% and 0.58% (Anderson et al., 1985). Results for protein content (N × 6.25) in different tragacanth samples provided by industry (Documentation provided to EFSA n. 7) were all in the range between 1% and 3.6%. However, the Panel noted some case reports of hypersensitivity reactions associated with tragacanth (Section 3.5.7). The Panel considered that this hypersensitivity might be due to the tragacanth proteins and therefore their content should be reduced as much as possible.

Because of both the botanical origin and the polysaccharidic nature of gums, they can be a substrate of microbiological contamination and of field and storage fungal development. The latter has been recently demonstrated by the mycotoxin contaminations of gums (Zhang et al., 2014). In this respect, industry provided screening data for contamination of tragacanth by microorganisms and derived toxins (aflatoxins B1, B2, G1 and G2, deoxynivalenol, HT-2 Toxin, T-2 Toxin, ochratoxin A and patuline). An interested party (Documentation provided to EFSA n. 7) provided the following data on microbial contamination for five batches of tragacanth (E 413): total viable count (400–19,000 colony forming unit (cfu)/g), yeasts (10–100 cfu/g), moulds (10–100 cfu/g), Enterobacteriace (130–700 cfu/g),

coagulase-positive staphylococci (< 100 cfu/g), presumptive *Bacillus cereus* (< 100 cfu/g), *Salmonella* in 25 g (negative) and *Escherichia coli* in 5 g (negative). The interested party also provided analytical results for aflatoxins B1, B2, G1 and G2 from two different laboratories. According to the results from the first laboratory the content of aflatoxins B1, B2, G1 and G2 in two batches of tragacanth (E 413) was 1, < 0.1, 0.5 and < 0.1 μg/kg, respectively (limit of quantification (LOQ) 0.1 μg/kg). Results obtained in the second laboratory for five tested batches of E 413 were all below the LOQs (0.01 for one sample and 0.2 for four samples tested) (Documentation provided to EFSA n. 7).

The Panel noted that the differences in the microbiological criteria for tragacanth between the specifications given by the EU Regulation and those given by JECFA are not decisive. The Panel also noted that the microbiological specifications for polysaccharidic thickening agents, such as gums, should be harmonised and that for tragacanth criteria for total aerobic microbial count (TAMC) and total combined yeasts and moulds count (TYMC) should be included into the EU specifications as it is the case for other polysaccharidic thickening agents (e.g. alginic acids and its salts (E 400–E 404), agar (E 406), carrageenan (E 407), processed eucheuma sea weed (E 407a), xanthan gum (E 415), gellan gum (E 418)). TAMC and TYMC are also included as microbiological criteria in the specifications for tragacanth in the European Pharmacopeia (Ph. Eur. 8, 2014; Ph. Eur. 8.5, 2015).

In view of the botanical origin of tragacanth, limitations of possible contamination with pesticides should be considered. Industry (Documentation provided to EFSA n. 7) provided analytical data for organochlorine, organophosphorus, organonitrogen, pyrethroid, triazine, dicarboxamide and miscellaneous pesticides post-harvest fungicides. For all pesticides and fungicides, results were below the indicated quantification level. The Panel considered particularly necessary to pay attention on the compliance of tragacanth raw material to existing EU regulation on pesticides.

According to data provided (Documentation provided to EFSA n. 7) for five batches of tragacanth (E 413) tested, the content of lead, mercury, cadmium and arsenic were 0.02–0.07, 0.04–0.05, 0.01–0.06 and 0.01–0.04 mg/kg, respectively. The Panel noted that the levels of lead, mercury, cadmium and arsenic in the five batches analysed were all far below the levels as defined in the Commission Regulation (EU) No 231/2012 (Documentation provided to EFSA n. 2). The Panel noted that, according to the EU specifications for tragacanth (E 413), impurities of the toxic elements lead, mercury, cadmium and arsenic are accepted up concentrations of 2, 1, 1 and 3 mg/kg, respectively. Contamination at those levels could have a significant impact on the exposure to these metals, for which the intake is already close to the health-based guidance values or benchmark doses (lower confidence limits) established by EFSA (EFSA CONTAM Panel, 2009a,b, 2010, 2012a,b,c, 2014).

3.1.3. Manufacturing process

Tragacanth is the exudate from several species of *Astragalus* genus, comprising up to 2,000 species, which are found in Iran, Syria, Turkey and southwest Asia. Plants develop a mass of gum in the centre of the root, which swell in the summer heat. The plants are systematically tapped by making careful incisions in the tap root, or to a lesser extent, the dark branches of the plant. Tragacanth is obtained in two physical forms of different technological quality (ribbons are of high quality and flakes are of inferior quality). The best qualities are those with low microbiological contamination and showing higher viscosity in solution (Wielinga, 2009).

According to the industry (Documentation provided to EFSA n. 7), selected batches of raw exudates are mechanically ground to a fine powder, usually below 150 μm. Throughout the grinding process, foreign matter (mainly vegetable and mineral impurities) is removed by selective sieving, aspirating and density table separation. A heat treatment (flash air stream at about 90°C) can be applied on the granules prior to the pulverisation step in order to reduce the microbial content. Powdered grades may be blended together in order to achieve a product with consistent specifications. The finished tragacanth in powder form meets the EU and the specific end user specifications.

3.1.4. Methods of analysis in food

A gas chromatography method was evaluated for the determination of food grade gums (tragacanth, karaya, ghatti, carob, guar, Arabic and xanthan gum) in dairy products, salad dressings and meat sauces (Lawrence and Iyengar, 1985). The gum is isolated after extraction of fat, enzymatic degradation of starch and precipitation of protein. The polysaccharide is then hydrolysed with trifluoroacetic acid, and the resulting monosaccharides are converted to their aldonitrile acetate derivatives which are analysed by gas chromatography. The gums can be identified by the fingerprint patterns produced by their constituent neutral sugars. However, problems arise when gums are used

in combination with other gums as their component monosaccharides may interfere. Recoveries from the gums studies averaged 85% when spiked in various samples at concentrations of 0.25–0.50% (Lawrence and Iyengar, 1985).

3.1.5. Stability of the substance, and reaction and fate in food

A tragacanth solution is fairly stable over a wide pH range down to extremely acidic conditions at about pH 2 (Wielinga, 2009).

No further information on reaction in food was available in the literature.

3.2. Authorised uses and use levels

Maximum levels of tragacanth (E 413) have been defined in Annex II to Regulation (EC) No 1333/2008[9] on food additives, as amended. In this document, these levels are named maximum permitted levels (MPLs).

Currently, tragacanth (E 413) is an authorised food additive in the EU at *quantum satis* (QS) in all foods. Tragacanth (E 413) is included is included in the Group I of food additives.

Table 2 summarises foods that are permitted to contain tragacanth (E 413) and the corresponding MPLs as set by Annex II to Regulation (EC) No 1333/2008.

Table 2: MPLs of tragacanth (E 413) in foods according to the Annex II to Regulation (EC) No 1333/2008

Food Category number	Food category name	E-number/ group	Restrictions/exception	MPL (mg/L or mg/kg as appropriate)
01.3	**Unflavoured fermented milk products, heat-treated after fermentation**	Group I		*Quantum satis*
01.4	**Flavoured fermented milk products including heat-treated products**	Group I		*Quantum satis*
01.6.3	**Other creams**	Group I		*Quantum satis*
01.7.1	**Unripened cheese excluding products falling in category 16**	Group I	Except mozzarella	*Quantum satis*
01.7.5	**Processed cheese**	Group I		*Quantum satis*
01.7.6	**Cheese products (excluding products falling in category 16)**	Group I		*Quantum satis*
01.8	**Dairy analogues, including beverage whiteners**	Group I		*Quantum satis*
02.2.2	**Other fat and oil emulsions including spreads as defined by Council Regulation (EC) No 1234/2007 and liquid emulsions**	Group I		*Quantum satis*
02.3	**Vegetable oil pan spray**	Group I		*Quantum satis*
03	**Edible ices**	Group I		*Quantum satis*
04.2.1	**Dried fruit and vegetables**	Group I		*Quantum satis*
04.2.2	**Fruit and vegetables in vinegar, oil or brine**	Group I		*Quantum satis*
04.2.4.1	**Fruit and vegetable preparations excluding compote**	Group I		*Quantum satis*
04.2.5.4	**Nut butters and nut spreads**	Group I		*Quantum satis*
04.2.6	**Processed potato products**	Group I		*Quantum satis*
05.1	**Cocoa and Chocolate products as covered by Directive 2000/36/EC**	Group I	Only energy-reduced or with no added sugar	

Food Category number	Food category name	E-number/ group	Restrictions/exception	MPL (mg/L or mg/kg as appropriate)
05.2	**Other confectionery including breath freshening microsweets**	Group I	The substances listed under numbers E 400, E 401, E 402, E 403, E 404, E 406, E 407, 407a, E 410, E 412, E 413, E 414, E 415, E 417, E 418, E 425 and E 440 may not be used in jelly mini-cups, defined, for the purpose of this Regulation, as jelly confectionery of a firm consistence, contained in semirigid mini-cups or mini-capsules, intended to be ingested in a single bite by exerting pressure on the mini-cups or mini-capsule to project the confectionery into the mouth	*Quantum satis*
05.3	**Chewing gum**	Group I		*Quantum satis*
05.4	**Decorations, coatings and fillings, except fruit-based fillings covered by category 4.2.4**	Group I		*Quantum satis*
06.2.2	**Starches**	Group I		*Quantum satis*
06.3	**Breakfast cereals**	Group I		*Quantum satis*
06.4.2	**Dry pasta**	Group I	Only gluten free and/or pasta intended for hypoproteic diets in accordance with Directive 2009/39/EC	*Quantum satis*
06.4.4	**Potato Gnocchi**	Group I	Except fresh refrigerated potato gnocchi	*Quantum satis*
06.4.5	**Fillings of stuffed pasta (ravioli and similar)**	Group I		*Quantum satis*
06.5	**Noodles**	Group I		*Quantum satis*
06.6	**Batters**	Group I		*Quantum satis*
06.7	**Precooked or processed cereals**	Group I		*Quantum satis*
07.1	**Bread and rolls**	Group I	Except products in 7.1.1 and 7.1.2	*Quantum satis*
07.2	**Fine bakery wares**	Group I		*Quantum satis*
08.2	**Meat preparations as defined by Regulation (EC) No 853/ 2004**	E 413	Only preparations in which ingredients have been injected; meat preparations composed of meat parts that have been handled differently: minced, sliced or processed and that are combined together. Except *bifteki, soutzoukaki, kebap, gyros and souvlaki*	*Quantum satis*
08.3.1	**Non-heat-treated processed meat**	Group I		*Quantum satis*
08.3.2	**Heat-treated processed meat**	Group I	Except *foie gras, foie gras entier, blocs de foie gras, Libamáj, libamáj egészben, libamáj tömbben*	*Quantum satis*

Food Category number	Food category name	E-number/ group	Restrictions/exception	MPL (mg/L or mg/kg as appropriate)
08.3.3	**Casings and coatings and decorations for meat**	Group I		*Quantum satis*
09.2	**Processed fish and fishery products including molluscs and crustaceans**	Group I		*Quantum satis*
09.3	**Fish roe**	Group I	Only processed fish roe	*Quantum satis*
10.2	**Processed eggs and egg products**	Group I		*Quantum satis*
11.2	**Other sugars and syrups**	Group I		*Quantum satis*
11.4.1	**Table-top sweeteners in liquid form**	E 413		*Quantum satis*
11.4.2	**Table-top sweeteners in powder form**	E 413		*Quantum satis*
12.1.2	**Salt substitutes**	Group I		*Quantum satis*
12.2.2	**Seasonings and condiments**	Group I		*Quantum satis*
12.3	**Vinegars**	Group I		*Quantum satis*
12.4	**Mustard**	Group I		*Quantum satis*
12.5	**Soups and broths**	Group I		*Quantum satis*
12.6	**Sauces**	Group I		*Quantum satis*
12.7	**Salads and savoury-based sandwich spreads**	Group I		*Quantum satis*
12.8	**Yeast and yeast products**	Group I		*Quantum satis*
12.9	**Protein products, excluding products covered in category 1.8**	Group I		*Quantum satis*
13.2	**Dietary foods for special medical purposes defined in Directive 1999/21/EC (excluding products from food category 13.1.5)**	Group I		*Quantum satis*
13.3	**Dietary foods for weight control diets intended to replace total daily food intake or an individual meal (the whole or part of the total daily diet)**	Group I		*Quantum satis*
13.4	**Foods suitable for people intolerant to gluten as defined by Regulation (EC) No 41/2009**	Group I	Including dry pasta	*Quantum satis*
14.1.2	**Fruit juices as defined by Directive 2001/112/EC and vegetable juices**	Group I	Only vegetable juices	*Quantum satis*
14.1.3	**Fruit nectars as defined by Directive 2001/112/EC and vegetable nectars and similar products**	Group I	Only vegetable nectars	*Quantum satis*
14.1.4	**Flavoured drinks**	Group I		*Quantum satis*
14.1.5.2	**Other**	Group I	Excluding unflavoured leaf tea; including flavoured instant coffee	*Quantum satis*
14.2.3	**Cider and perry**	Group I		*Quantum satis*
14.2.4	**Fruit wine and made wine**	Group I		*Quantum satis*
14.2.5	**Mead**	Group I		*Quantum satis*

Food Category number	Food category name	E-number/ group	Restrictions/exception	MPL (mg/L or mg/kg as appropriate)
14.2.6	**Spirit drinks as defined in Regulation (EC) No 110/2008**	Group I	Except whisky or whiskey	*Quantum satis*
14.2.7.1	**Aromatised wines**	Group I		*Quantum satis*
14.2.7.2	**Aromatised wine-based drinks**	Group I		*Quantum satis*
14.2.7.3	**Aromatised wine-product cocktails**	Group I		*Quantum satis*
14.2.8	**Other alcoholic drinks including mixtures of alcoholic drinks with non-alcoholic drinks and spirits with less than 15% of alcohol**	Group I		*Quantum satis*
15.1	**Potato-, cereal-, flour- or starch-based snacks**	Group I		*Quantum satis*
15.2	**Processed nuts**	Group I		*Quantum satis*
16	**Desserts excluding products covered in categories 1, 3 and 4**	Group I		*Quantum satis*
17.1[(a)]	**Food supplements supplied in a solid form including capsules and tablets and similar forms, excluding chewable forms**	Group I		*Quantum satis*
17.2[(a)]	**Food supplements supplied in a liquid form**	Group I		*Quantum satis*
17.3[(a)]	**Food supplements supplied in a syrup-type or chewable form**	Group I		*Quantum satis*
18	**Processed foods not covered by categories 1 to 17, excluding foods for infants and young children**	Group I		*Quantum satis*

MPL: maximum permitted level.
(a): FCS 17 refers to food supplements as defined in Directive 2002/46/EC of the European Parliament and of the Council excluding food supplements for infants and young children.

According to Annex III, Part 1 of Regulation (EC) No 1333/2008, tragacanth (E 413) is also authorised as a carrier in food additives (in all food additives) with a maximum level in the products at QS.

In addition, according to Annex III, Part 2, Part 3, Part 4 and Part 5A of Regulation (EC) No 1333/2008, tragacanth (E 413) is also authorised as a food additive in food additives with a maximum level in all food additives preparations at QS, in food enzymes with a maximum level in the products (final food and beverages) at QS, in food flavourings with a maximum level in all flavourings at QS, and in nutrients (all nutrients) with a maximum level in all nutrients at QS.

3.3. Exposure data

3.3.1. Reported use levels or data on analytical levels of tragacanth (E 413)

Most food additives in the EU are authorised at a specific MPL. However, a food additive may be used at a lower level than the MPL. Therefore, information on actual use levels is required for performing a more realistic exposure assessment, especially for those food additives for which no MPL is set and which are authorised according to *QS*.

In the framework of Regulation (EC) No 1333/2008 on food additives and of Commission Regulation (EU) No 257/2010 regarding the re-evaluation of approved food additives, EFSA issued a public call[9] for occurrence data (usage level and/or concentration data) on tragacanth (E 413). In response to this public call, updated information on the actual use levels of tragacanth (E 413) in

[9] Call for food additives usage level and/or concentration data in food and beverages intended for human consumption. Published 27 March 2013. http://www.efsa.europa.eu/en/dataclosed/call/130327.htm

foods was made available to EFSA by industry. No analytical data on the concentration of tragacanth (E 413) in foods were made available by the Member States.

3.3.1.1. Summarised data on reported use levels in foods provided by industry

Industry provided EFSA with data on use levels (n = 81) of tragacanth (E 413) in foods for 68 out of the 70 food categories in which tragacanth (E 413) is authorised.

Updated information on the actual use levels of tragacanth (E 413) in foods was made available to EFSA by FoodDrinkEurope (FDE) and Association for International Promotion of Gums (AIPG).

Totally, 66 usage levels on tragacanth (E 413) referred to a niche product. Out of these, six usage levels on flavoured fermented milk products, edible ices, other confectionery and other alcoholic drinks were excluded from further analysis since other usage levels were available for these food categories.

The Panel noted that the AIPG is not food industry using gums in its food products but food additive producer. Usage levels reported by food additive producers should not be considered at the same level as those provided by food industry. Food additive producers might recommend usage levels to the food industry but the final levels might, ultimately, be different, unless food additive producers confirm that these levels are used by food industry. In all other cases, data from food additive producers will only be used in the MPL scenario in case of QS authorisation, when no data are available from food industry in order to have the most complete exposure estimates.

Appendix A provides data on the use levels of tragacanth (E 413) in foods as reported by industry (food industry and gum producers).

3.3.2. Summarised data extracted from the Mintel's Global New Products Database

The Mintel GNPD is an online database which monitors product introductions in consumer packaged goods markets worldwide. It contains information of over 2 million food and beverage products of which more than 900,000 are or have been available on the European food market. Mintel started covering EU's food markets in 1996, currently having 20 out of its 28 member countries and Norway presented in the Mintel GNPD.[10]

For the purpose of this Scientific Opinion, the Mintel GNPD[11] was used for checking the labelling of products containing tragacanth (E 413) within the EU's food products as the Mintel GNPD shows the compulsory ingredient information presented in the labelling of products.

According to Mintel, tragacanth (E 413) is labelled on products (n = 259) of Bakery, Dairy, Sauces & Seasonings, Processed Fish, Meat & Egg Products, Snacks, Meals & Meal Centers, Chocolate Confectionery, Desserts & Ice Cream, Hot Beverages, Sugar & Gum Confectionery, Savoury Spreads, Vitamins & Dietary Supplements, Other Beverages.

Appendix B presents the percentage of the food products labelled with tragacanth (E 413) between 2011 and 2016, out of the total number of food products per food subcategories according to the Mintel GNPD food classification. The overall percentage of food products labelled with tragacanth (E 413), considering the food subcategories with at least one food to which tragacanth (E 413) was added according to the label, was 0.06%.

3.3.3. Food consumption data used for exposure assessment

3.3.3.1. EFSA Comprehensive European Food Consumption Database

Since 2010, the EFSA Comprehensive European Food Consumption Database (Comprehensive Database) has been populated with national data on food consumption at a detailed level. Competent authorities in the European countries provide EFSA with data on the level of food consumption by the individual consumer from the most recent national dietary survey in their country (cf. Guidance of EFSA on the 'Use of the EFSA Comprehensive European Food Consumption Database in Exposure Assessment' (EFSA, 2011a). New consumption surveys recently[12] added in the Comprehensive database were also taken into account in this assessment.[8]

The food consumption data gathered by EFSA were collected by different methodologies and thus direct country-to-country comparisons should be interpreted with caution. Depending on the food category and the level of detail used for exposure calculations, uncertainties could be introduced owing

[10] Missing Bulgaria, Cyprus, Estonia, Latvia, Lithuania, Luxembourg, Malta and Slovenia.
[11] http://www.gnpd.com/sinatra/home/accessed on 22/9/2016.
[12] Available online: http://www.efsa.europa.eu/en/press/news/150428.htm

to possible subjects' underreporting and/or misreporting of the consumption amounts. Nevertheless, the EFSA Comprehensive Database represents the best available source of food consumption data across Europe at present.

Food consumption data from the following population groups: infants, toddlers, children, adolescents, adults and the elderly were used for the exposure assessment. For the present assessment, food consumption data were available from 33 different dietary surveys carried out in 19 European countries (Table 3).

Table 3: Population groups considered for the exposure estimates of tragacanth (E 413)

Population	Age range	Countries with food consumption surveys covering more than 1 day
Infants[(a)]	From 12 weeks up to and including 11 months of age	Bulgaria, Denmark, Finland, Germany, Italy, UK
Toddlers	From 12 months up to and including 35 months of age	Belgium, Bulgaria, Denmark, Finland, Germany, Italy, Netherlands, Spain, UK
Children[(a)]	From 36 months up to and including 9 years of age	Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Greece, Italy, Latvia, Netherlands, Spain, Sweden, UK
Adolescents	From 10 years up to and including 17 years of age	Austria, Belgium, Cyprus, Czech Republic, Denmark, Finland, France, Germany, Italy, Latvia, Spain, Sweden, UK
Adults	From 18 years up to and including 64 years of age	Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Netherlands, Romania, Spain, Sweden, UK
The elderly[(a)]	From 65 years of age and older	Austria, Belgium, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, Romania, Sweden, UK

(a): The terms 'children' and 'the elderly' correspond, respectively, to 'other children' and the merge of 'elderly' and 'very elderly' in the Guidance of EFSA on the 'Use of the EFSA Comprehensive European Food Consumption Database in Exposure Assessment' (EFSA, 2011a).

Consumption records were codified according to the FoodEx classification system (EFSA, 2011b). Nomenclature from the FoodEx classification system has been linked to the food classification system (FCS) as presented in Annex II of Regulation (EC) No 1333/2008, part D, to perform exposure estimates. In practice, FoodEx food codes were matched to the FCS food categories.

3.3.3.2. Food categories selected for the exposure assessment of tragacanth (E 413)

The food categories in which the use of tragacanth (E 413) is authorised were selected from the nomenclature of the EFSA Comprehensive Database (FoodEx classification system), at the most detailed level possible (up to FoodEx Level 4) (EFSA, 2011b).

Some food categories or their restrictions/exceptions are not referenced in the EFSA Comprehensive Database and could therefore not be taken into account in the present estimate. This may have resulted in an underestimation of the exposure. This was the case for 15 food categories (Appendix C).The food categories which were not taken into account are described below (in ascending order of the FCS codes):

- 01.6.3 Other creams;
- 01.7.6 Cheese products (excluding products falling in category 16);
- 02.3 Vegetable oil pan spray;
- 06.4.2 Dry pasta: only gluten free and/or pasta intended for hypoproteic diets in accordance with Directive 2009/39/EC;
- 06.4.4 Potato gnocchi: except fresh refrigerated potato gnocchi;
- 06.6 Batters;
- 06.7 Precooked or processed cereals;
- 08.2 Meat preparations; only preparations in which ingredients have been injected; meat preparations composed of meat parts that have been handled differently: minced, sliced or processed and that are combined together. Except *bifteki, soutzoukaki, kebap, gyros and souvlaki;*
- 08.3.3 Casings and coatings and decorations for meat;
- 12.1.2 Salt substitutes;

- 14.1.3 Fruit nectars, only vegetable nectars;
- 14.2.4 Fruit wine and made wine;
- 14.2.5 Mead;
- 14.2.7.2 Aromatised wine-based drinks;
- 14.2.7.3 Aromatised wine-product cocktails.

For the following food categories, the restrictions/exceptions which apply to the use of tragacanth (E 413) could not be taken into account, and therefore, the whole food category was considered in the exposure assessment. This applies to five food categories (Appendix C).This may have resulted in an overestimation of the exposure:

- 05.1 Cocoa and cocoa products, only energy-reduced or with no added sugar;
- 07.1 Bread and rolls, except products in 7.1.1 and 7.1.2;
- 08.3.2 Heat-treated processed meat, except foie gras, foie gras entier, blocs de foie gras, Libamáj, libamáj egészben, libamáj tömbben;
- 09.3 Fish roe, only processed fish roe;
- 14.1.5.2 Other, excluding unflavoured leaf tea; including flavoured instant coffee.

In addition, for the following three food categories: FC 17.1, FC 17.2 and FC 17.3 Food supplements, in solid, liquid and syrup-type or chewable form, which were used only in the specific exposure scenario including food supplements, the restrictions which apply to the use of tragacanth (E 413) could not be taken into account, and therefore, the whole food category (FC 17) was considered in the exposure assessment.

For the refined scenario, one added food category was not taken into account because no concentration data were provided for this food category to EFSA (Appendix C). For the remaining food categories, the refinements considering the restrictions/exceptions as set in Annex II to Regulation No 1333/2008 were applied.

Overall, for the regulatory maximum level exposure scenario, 47 food categories were included, while for the refined scenarios, five food categories were considered in the present exposure assessment to tragacanth (E 413) (Appendix C).

3.4. Exposure estimate(s)

3.4.1. Exposure to tragacanth (E 413) from its use as a food additive

The Panel estimated chronic exposure to tragacanth (E 413) for the following population groups: infants, toddlers, children, adolescents, adults and the elderly. Dietary exposure to tragacanth (E 413) was calculated by multiplying tragacanth (E 413) concentrations for each food category (Appendix C) with their respective consumption amount per kilogram of body weight for each individual in the Comprehensive Database. The exposure per food category was subsequently added to derive an individual total exposure per day. These exposure estimates were averaged over the number of survey days, resulting in an individual average exposure per day for the survey period. Dietary surveys with only 1 day per subject were excluded as they are considered as not adequate to assess repeated exposure.

This was carried out for all individuals per survey and per population group, resulting in distributions of individual exposure per survey and population group (Table 3). On the basis of these distributions, the mean and 95th percentile of exposure were calculated per survey and per population group. The 95th percentile of exposure was only calculated for those population groups where the sample size was sufficiently large to allow this calculation (EFSA, 2011a). Therefore, in the present assessment, the 95th percentile of exposure for infants from Italy and for toddlers from Belgium, Italy and Spain were not included.

Exposure assessment to tragacanth (E 413) was carried out by the ANS Panel based on (1) maximum levels of data provided to EFSA (defined as the *maximum level exposure assessment scenario*); and (2) reported use levels (defined as the *refined exposure assessment scenario*) as provided by industry. Exposure scenarios can consider only food categories for which data were available to the Panel. These two scenarios are discussed in detail below.

These scenarios do not consider the consumption of food supplements (FC 17.1, FC 17.2 and FC 17.3) which are covered in an additional specific exposure scenario detailed below (*food supplements consumers only scenario*).

Certain foods for special medical purposes (FSMP) consumed in population groups of children, adolescents, adults and the elderly may be very diverse; they cannot be considered because of very limited information on consumption. Eating occasions belonging to the food categories 13.2, 13.3, 13.4 were therefore reclassified under food categories in accordance to their main component.

Considering that the food category 18 (processed foods not covered by categories 1 to 17, excluding foods for infants and young children) is extremely unspecific (e.g. composite foods), processed foods, prepared or composite dishes belonging to the food category 18 were reclassified under food categories in accordance to their main component. Therefore, FC 18 is not taken into account as contributor to the total exposure estimates.

A possible additional exposure from the use of tragacanth (E 413) as a carrier in food additives, as a food additive in food additives, food enzymes, flavourings and nutrients in accordance with Annex III to Regulation (EC) No 1333/2008 (Parts 1, 2, 3, 4 and 5A) was not considered in any of the exposure assessment scenarios in any of the exposure assessment scenarios, due to the absence of information on use levels.

3.4.1.1. Maximum level exposure assessment scenario

The regulatory maximum level exposure assessment scenario is based on the MPLs as set in Annex II to Regulation (EC) No 1333/2008 and listed in Table 2. As tragacanth (E 413) is authorised according to QS in all food categories, the maximum level exposure assessment scenario was estimated based on the maximum reported use levels provided by industry, excluding exposure via food supplements and FSMP, as described in the EFSA Conceptual framework (EFSA ANS Panel, 2014). The maximum reported use levels as used in this exposure scenario are listed in Appendix C.

The Panel considers the exposure estimates derived following this scenario as the most conservative as it is assumed that that the population group will be exposed to tragacanth (E 413) present in food at the maximum reported use levels over a longer period of time, and assuming that tragacanth (E 413) is only used in the food categories for which data were submitted by industry.

3.4.1.2. Refined exposure assessment scenario

The refined exposure assessment scenario of tragacanth (E 413) was based on reported use levels.

Appendix C summarises the concentration levels of tragacanth (E 413) used in the refined exposure assessment scenario. Based on the available data set, the Panel calculated two refined exposure estimates based on different model populations excluding exposure via food supplements and FSMP:

- The brand-loyal consumer scenario: It was assumed that a consumer is exposed long-term to tragacanth (E 413) present at the maximum reported use level for one food category. This exposure estimate is calculated as follows:
  - Combining food consumption with the maximum of the reported use levels for the main contributing food category at the individual level.
  - Using the mean of the typical reported use levels for the remaining food categories.
- The non-brand-loyal consumer scenario: It was assumed that a consumer is exposed long-term to tragacanth (E 413) present at the mean reported use levels in food. This exposure estimate is calculated using the mean of the typical reported use levels for all food categories.

3.4.1.3. Specific scenario: Consumers of food supplements

One additional scenario based on consumers only of food supplements (*food supplements consumers only scenario*) was also calculated. Exposure via food supplements was addressed in an additional exposure scenario, because the exposure via this source may deviate largely from the exposure via food and the number of food supplement consumers may be low. Due to these two factors, the potentially higher exposure to tragacanth (E 413) of food supplement users may not become evident in a whole population approach. Only usage data from food additive manufacturer were available, therefore only maximum level exposure scenario was calculated.

This scenario was estimated as follows:

- Consumers only of food supplements were assumed to be exposed to tragacanth (E 413) present at the maximum reported use levels provided by industry for all food categories.
- As food category 17 does not include food supplements for infants and toddlers (Regulation (EC) No 1333/2008), exposure to tragacanth (E 413) from food supplements was not estimated for these two population groups.

The maximum reported use levels as used in this exposure scenario are listed in Appendix C.

3.4.1.4. Dietary exposure to tragacanth (E 413)

Table 4 summarises the estimated exposure to tragacanth (E 413) from its use as food additive in six population groups (Table 3) according to the different exposure scenarios. Detailed results per population group and survey are presented in Appendix D.

Table 4: Summary of dietary exposure to tragacanth (E 413) from its use as food additive in the maximum level exposure assessment scenario and in the refined exposure scenarios, in six population groups (minimum–maximum across the dietary surveys in mg/kg bw per day)

	Infants (12 weeks–11 months)	Toddlers (12–35 months)	Children (3–9 years)	Adolescents (10–17 years)	Adults (18–64 years)	The elderly (≥ 65 years)
Maximum level exposure assessment scenario						
Mean	74–484	165–862	172–695	103–509	88–362	80–327
95th percentile	173–1587	352–1590	418–1226	246–891	196–713	171–571
Refined estimated exposure assessment scenario						
Brand-loyal scenario						
Mean	< 0.001–0.09	0.13–2.31	0.34–2.15	0.07–1.02	0.01–0.36	< 0.001–0.15
95th percentile	< 0.001–0.54	0.79–6.04	1.54–5.56	0.35–3.79	0.01–1.78	0.01–0.66
Non-brand-loyal scenario						
Mean	< 0.001–0.03	0.03–1.96	0.13–1.72	0.03–0.82	< 0.001–0.28	< 0.001–0.10
95th percentile	< 0.001–0.09	0.06–5.07	0.71–4.72	0.05–3.22	< 0.001–1.51	< 0.001–0.53

In the *maximum level exposure assessment scenario*, mean exposure to tragacanth (E 413) from its use as a food additive ranged from 74 mg/kg bw per day in infants to 862 mg/kg bw per day in toddlers. The 95th percentile of exposure to tragacanth (E 413) ranged from 171 mg/kg bw per day in the elderly to 1,590 mg/kg bw per day in toddlers.

In the *refined estimated exposure scenario*, in the *brand-loyal scenario*, mean exposure to tragacanth (E 413) from its use as a food additive ranged from < 0.001 mg/kg bw per day in infants and the elderly to 2.31 mg/kg bw per day in toddlers. The high exposure to tragacanth (E 413) ranged from < 0.001 mg/kg bw per day in infants to 6.04 mg/kg bw per day in toddlers. In the *non-brand-loyal scenario*, mean exposure to tragacanth (E 413) from its use as a food additive ranged from < 0.001 mg/kg bw per day in infants, adults and the elderly to 1.96 mg/kg bw per day in toddlers. The 95th percentile of exposure tragacanth (E 413) ranged from < 0.001 mg/kg bw per day in infants, adults and the elderly to 5.07 mg/kg bw per day in toddlers.

In the *maximum level exposure assessment scenario*, the main contributing food categories to the total mean exposure estimates were unflavoured fermented milk products, bread and rolls and soups and broths for infants, unflavoured fermented milk products, bread and rolls and flavoured drinks for toddlers and other children, bread and rolls and flavoured drinks for adolescents, bread and rolls, flavoured drinks and FCS 14.1.5.2 'other' (including tea, herbal and fruit infusions and coffee imitates beverages) for adults and bread and rolls and 'other' for the elderly.

The main contributing food categories in the *refined estimated exposure scenario*, in the *brand-loyal scenario* were edible ices and other confectionery for all population groups. In the *non-brand-loyal scenario*, the main contributing food categories were flavoured fermented milk products, other confectionery and sauces for infants, flavoured fermented milk products and other confectionery for toddlers, other confectionery for children and adolescents, other confectionery and alcoholic beverages for adults and the elderly.

The main food categories contributing to the exposure to tragacanth (E 413) are presented in Appendix E.

In the *food supplements consumers exposure scenario*, considering the maximum use levels for all food categories, mean exposure to tragacanth (E 413) from its use as a food additive ranged for children between 178 and 883 mg/kg bw per day and between 115 and 370 mg/kg bw per day for adults. The 95th percentile of exposure to tragacanth (E 413) ranged for children between 441 and 1,114 mg/kg bw per day and for adults between 246 and 755 mg/kg bw per day.

3.4.1.5. Uncertainty analysis

Uncertainties in the exposure assessment of tragacanth (E 413) have been discussed above. In accordance with the guidance provided in the EFSA opinion related to uncertainties in dietary exposure assessment (EFSA, 2007), the following sources of uncertainties have been considered and summarised in Table 5.

Table 5: Qualitative evaluation of influence of uncertainties on the dietary exposure estimate, excluding the *food supplements consumers only scenario*

Sources of uncertainties	Direction[(a)]
Uncertainties common for all assessments	
Consumption data: different methodologies/representativeness/underreporting/misreporting/no portion size standard	+/–
Use of data from food consumption survey of a few days to estimate long-term (chronic) exposure for high percentiles (95th percentile)	+
Correspondence of reported use levels and analytical data to the food items in the EFSA Comprehensive Food Consumption Database: uncertainties to which types of food the levels refer to	+/–
Uncertainty in possible national differences in use levels of food categories	+/–
Specific uncertainties for each assessment	
Concentration data: • levels considered applicable for all items within the entire food category • unclear representativeness of foods on the EU market	 + +/–
Consumption data considered in the refined exposure assessment: 0.6–63% of the amount (grams per body weight) corresponding to 5 food categories (out of 70 authorised food categories) taken into account	–
Food categories selected for the exposure assessment: exclusion of food categories due to missing FoodEx linkage (n = 15/70 food categories)	–
Food categories selected for the exposure assessment: inclusion of food categories without considering the restriction/exception (n = 5/70 food categories)	+
Food categories included in the exposure assessment: no additional data available for authorised food categories (n = 1/70 food categories)	–
Maximum level exposure assessment scenario: • exposure calculations based on the maximum reported use levels (reported use from industry) assuming tragacanth (E 413) is not used in the food categories for which no use levels were submitted • foods which may contain tragacanth (E 413) according to Annex III to Regulation (EC) No 1333/2008 not taken into account	 + –
Refined exposure assessment scenarios: • exposure calculations based on the maximum or mean levels (reported use from industry) • foods which may contain tragacanth (E 413) according to Annex III to Regulation (EC) No 1333/2008 not taken into account	 +/– –

(a): +, uncertainty with potential to cause overestimation of exposure; –, uncertainty with potential to cause underestimation of exposure.

Overall, the Panel considered that the uncertainties identified would, in general, result in an overestimation of the exposure to tragacanth (E 413) as a food additive in European countries for all exposure scenarios, assuming that the food additive is not used in the food categories for which no use levels were reported. This assumption of non-use was supported by the observation that tragacanth (E 413) is authorised as a Group I food additive all food categories (Table 1). Since, all these food categories correspond to the general Group I food additives authorisation, tragacanth (E 413) may not necessarily be used in some of these food categories, and may thus explain why reported use levels adequate for the refined exposure scenario of tragacanth (E 413) were only available for five food categories. The Panel noted that the information from the Mintel GNPD

supported the observation that due to its Group I authorisation, tragacanth (E 413) may not be used in all food categories in which it is authorised (Section 3.3.2). For three out of five food categories considered for the refined exposure assessment, the products labelled with tragacanth (E 413) were reported for also in the Mintel GNPD.

Regarding *food supplements consumers only scenario*, the Panel considered that the uncertainties would result in an overestimation of the exposure to tragacanth (E 413) as a food additive, given that the calculations were based on consumers only of food supplements using maximum use levels recommended by food additive manufacturer and assuming a long term brand loyalty consumption of these food products on a daily basis.

In none of the exposure scenarios, the use of tragacanth (E 413) according to Annex III to Regulation No 1333/2008 was considered. Neglecting this source of exposure may have resulted in an underestimation of exposure to tragacanth (E 413) in all scenarios.

3.4.2. Exposure via other sources

Exposure to tragacanth due to the following use was not considered in this opinion.

3.4.2.1. Pharmaceutical uses

Tragacanth is used in pharmaceutical products mainly as technological excipient, e.g. as binder in tableting, suspending agent and thickener of suspensions (Verbeken et al., 2003; Sticher et al., 2015).

Tragacanth is used as a laxative in single dosages of approximately 3 g (Blaschek et al., 2014) and in that indication the daily dosage was given with approximately 10 g (Sticher et al., 2015). The action of tragacanth is described to be similar to karaya gum (Sticher et al., 2015). It swells in the intestine due to its high water binding properties and in this way stimulates the digestive tract. It is therefore described as a bulk forming laxative. As for all the other bulk forming laxatives it was pointed out that it has to be taken with an adequate amount of fluid (approximately 250–300 mL liquid per 3 g tragacanth) to prevent obstruction of the throat, oesophagus and ileus (Gruenwald et al., 2007; FDA, 2016).

From data provided by European Medicines Agency (EMA), information about the current medicinal usage of tragacanth and the usage as excipient in medicinal products was retrieved (Letter from EMA to EFSA, personal communication, May 2015, Documentation provided to EFSA n.6).

For tragacanth as an active ingredient, no authorised medicinal products exist within the EU.

In literature, it is pointed out, that sensitisation is possible, resulting in hypersensitivity.[13]

3.5. Biological and Toxicological data

Tragacanth has been reviewed for the use in food and cosmetics (LSRO/FASEB, 1972; CIR, 1987; JECFA, 1987; Anderson, 1988; TemaNord, 2002). The present opinion briefly reports the major studies evaluated in these reports. Additional information has been identified from a new literature search.

3.5.1. Absorption, distribution, metabolism and excretion

There is evidence that certain high molecular weight dietary polysaccharides such as gums, could be partially broken down in the large intestine of man. In addition to intermediate metabolites such as lactate, acrylate or fumarate, the main end products of this colonic anaerobic digestive process are short-chain fatty acids (SCFA) such as acetic, propionic and butyric acids, which are absorbed from the colon (Cummings and Englyst, 1987).

3.5.1.1. *In vitro* studies

Eleven *Bacteroides* species found in the human colon were surveyed for their ability to ferment mucins and plant polysaccharides including gums (Salyers et al., 1977a). Many of the *Bacteroides* strains tested were able to ferment a variety of plant polysaccharides, including amylose, dextran, pectin and gums. The ability to utilise mucins and plant polysaccharides varied considerably among the *Bacteroides* species tested. Tragacanth was shown to be mainly fermented by *Bacteroides ovatus* and in a lesser extent by *Bacteroides fragilis*.

[13] http://www.inchem.org/documents/jecfa/jecmono/v20je16.htm

A total of 154 strains from 22 species of *Bifidobacterium, Peptostreptococcus, Lactobacillus, Ruminococcus, Coprococcus, Eubacterium* and *Fusobacterium*, which are present in high concentrations in the human colon, were surveyed for their ability to ferment 21 different complex carbohydrates including gums. Among them, tragacanth was fermented by *Bifidobacterium longum* (Salyers et al., 1977b).

Fermentations of 10 polysaccharides including tragacanth, by species of the family Enterobacteriaceae (Klebsielleae and other gram-negative facultative *bacillia*) were examined by Ochuba and von Riesen (1980). Tragacanth was fermented by the nonmotile *Klebsiella* strains (*K. oxytoca and K. pneumoniae*), but not by the motile *Enterobacter* and *Serratia* strains. Tragacanth was also fermented by two species of *Proteus* and *Yersinia*. According to the authors, this study demonstrated the fermentation of tragacanth by enteric bacteria.

Adiotomre et al. (1990) investigated the effects of dietary fibres, including gums, on cecal fermentations by using fresh human microflora. Evolution of short-chain fatty acids and water-holding capacity after fermentation were also measured. Among other gums, tragacanth (E 413 grade) yielded a large amount of total SCFAs (67.4 vs 15.5 mmol/L for controls). The major SCFAs produced were acetic, propionic and butyric acids with smaller amounts of isobutyric, valeric and isovaleric acids. By contrast, the amount of water held by 1 g of the fermented residue was low in case of tragacanth.

Two hundred and ninety strains of 29 species of bifidobacteria of human and animal origin (mainly of faecal origin) were surveyed for their ability to ferment complex carbohydrates (Crociani et al., 1994). The substrates fermented by the largest number of species were D-galactosamine, D-glucosamine, amylose and amylopectin. Tragacanth was shown to be mainly fermented by *Bifidobacterium longum* strains.

3.5.1.2. *In vivo* study

Edwards and Eastwood (1995) investigated the caecal and faecal SCFAs and stool output in rats fed on diets containing non-starch polysaccharides, including tragacanth. The basal diet of male Wistar rats (n = 7) was supplemented or not with 50 g/kg of tragacanth for 28 days. Faeces were then collected over 2 days and caecal contents obtained post-mortem. Caecal and faecal wet and dry weights and SCFA were measured. Tragacanth had no significant effect on amount or concentration of caecal SCFA. However, tragacanth increased significantly the molar proportion of acetic and butyric acids in faeces and the faecal water.

Overall, tragacanth is unlikely to be absorbed intact. In the absence of *in vivo* data and according to *in vitro* demonstration of fermentation of tragacanth by animal and human intestinal microorganisms, the Panel considered that tragacanth would be partially fermented during its passage through the large intestine by the action of the intestinal tract microflora. The rate of hydrolysis in the gastrointestinal tract in humans is unknown, but it is expected that the limited extent of hydrolysis of tragacanth would lead to the production of its fermentation products such as SCFAs. Based on the available knowledge on the role of SCFA as end products of the fermentation of dietary fibres by the anaerobic intestinal microflora (Topping and Clifton, 2001; Den Besten et al., 2013), the Panel considered that their potential formation as fermentation products from tragacanth does not raise a safety concern.

3.5.2. Acute toxicity

The acute oral toxicity of tragacanth was tested in various species (i.e. mouse, rat, hamster and rabbit). The substance was given by gavage as a 25% suspension in corn oil. Five groups of 10 animals (five males and five females) were used per species. Information on strain is not available. All animals were observed for 14 days. The observed acute signs of toxicity were similar in all species and included ataxia, increased urination, soft stools, anorexia, muscle spasms, prostration and death. The LD_{50} values were equal to 10,300, 10,200, 8,800 and 7,200 mg/kg bw in mouse, rat, hamster and rabbit, respectively (Food and Drug Res. Lab., 1972a). The Panel noted that these LD_{50} values were obtained in animals receiving a single oral administration of tragacanth given as a suspension in corn oil.

3.5.3. Short-term and subchronic toxicity

The growth rate of newly weaned Sprague–Dawley rats (n = 10, sex not indicated) was not altered by feeding a diet containing 2% tragacanth (equivalent to 2,300 mg/kg bw per day) for 36 days (Vohra et al., 1979). The control group (n = 10) was fed with a diet containing 2% corn starch. The digestibility of the diet was not influenced by tragacanth.

The subchronic toxicity of tragacanth was investigated in mice by Hagiwara et al. (1991) in a study complying with the OECD guideline 408 (OECD, 1981). Groups of B6C3F1 mice (10 animals/sex per group) received a diet containing 0%, 0.625%, 1.25%, 2.5% and 5.0% tragacanth (equal to 0, 1,100, 2,100, 4,300 and 8,000 or 0, 1,500, 2,900, 5,800 and 12,500 mg/kg bw per day, in males and females, respectively) for 13 weeks. No deaths were observed in animals receiving dietary doses of tragacanth as high as 12,500 mg/kg bw per day administered for 13 weeks. No treatment-related effects regarding clinical signs, body or organ weights, and urinalysis or haematology data were observed. In all treated animals (except in females receiving 1,500 mg/kg bw per day) slight but statistically significant dose-related increase of γ-glutamyl transpeptidase (GGT) levels was seen. On gross observation, small, focally raised areas or nodules of the forestomach, which occurred as single or small numbers of lesions, were found in males of all groups, receiving respectively 1,100 (1 animal), 2,100 (1), 4,300 (2) and 8,000 (4) mg/kg bw per day. Histopathologically, these changes were diagnosed as squamous-cell hyperplasia, some being accompanied by slight ulceration or inflammation. The findings were further explored by the same authors in a subsequent carcinogenicity study described in Section 3.5.5.

3.5.4. Genotoxicity

3.5.4.1. *In vitro* studies

The genotoxicity studies listed below were previously cited in reviews (CIR, 1987; JECFA, 1987; Anderson, 1989). No new data on genotoxicity of tragacanth have been identified.

In the study by Litton Bionetics Inc. (1977), negative results for tragacanth were reported when assayed for gene mutation in the Ames test with *Salmonella* Typhimurium, tester strains TA1535, TA1537, TA1538, TA98 and TA100 and for mitotic gene conversion with *Saccharomyces cerevisiae,* tester strain D4, both in the absence and presence of exogenous mouse, rat and monkey liver S9 metabolism. Concentration levels of 11, 22 and 44 mg/mL and 12.5, 25 and 50 mg/mL for the Ames test and for the gene conversion assay, respectively, were used.

In the study by Green (1977), tragacanth was assessed for its mutagenicity in the reverse mutation assay using *S.* Typhimurium strains TA1530 and G-46 according to the method of Ames by the plate incorporation assay in the absence of rat liver S9 metabolism and for mitotic recombination in *S. cerevisiae* (strain D-3) in the absence of S9 metabolism only. Negative results were reported for both mutagenic and mitotic recombination capabilities. However, the Panel noted that the study shows significant weaknesses in the experimental design which include the use of a limited number of *S.* Typhimurium strains, the absence of treatment in the presence of S9 mix and no indication of concentration levels employed. On this basis the Panel considered this study not reliable for risk assessment.

Negative results were also reported for tragacanth when assayed for the analyses of chromosomal aberrations in anaphase in the human embryonic lung cells (WI-38) in the absence of S9 metabolism in one study (Litton Bionetics Inc., 1977) and at concentration-levels of 5, 50 and 500 μg/mL in the absence of S9 metabolism in another study (Green, 1977). However, the Panel considered these studies of limited relevance for risk assessment since they were performed in the absence of S9 metabolism and in one case (Green, 1977) the concentration levels employed were not reported. Furthermore, this assay using human embryonic lung cells in anaphase has not been validated and it is no longer employed for genotoxicity evaluations.

3.5.4.2. *In vivo* studies

In the study by Litton Bionetics Inc. (1972), tragacanth was assessed for its genotoxicity in the following in *vivo* assays:

1) Host mediated assay: Ten male ICR mice/group were dosed orally once (acute) or once daily for five consecutive days (subacute) with 30, 2,500 and 5,000 mg/kg bw tragacanth. The indicator organisms used were *S.* Typhimurium strains TA1530 and G46 for mutagenicity and *S, cerevisiae* strain D3 for mitotic recombination.
2) Chromosomal aberration assays: Five male Sprague–Dawley rats for each treatment group were dosed orally once (acute) or once daily for five consecutive days (subacute) with 30, 2,500 and 5,000 mg/kg bw tragacanth. In the acute treatment, sampling of bone marrow cells was performed at 6, 24 and 48 h from the last administration, while in the subacute study sampling was only performed 6 h after the last administration.

3) Dominant lethal assay: Ten male Sprague–Dawley rats/group were dosed orally once (acute) or once daily for five consecutive days (subacute) with 30, 2,500 and 5,000 mg/kg bw tragacanth. Following treatment, the male animals were sequentially mated to two females per week for 7 or 8 consecutive weeks in the subacute or acute treatment respectively. Total implants (live fetuses plus early and late fetal deaths), total dead (early and late fetal deaths), dead implants per total implants and pre-implantation loss (calculated as the difference between the total *corpora lutea* and total implant counts) were evaluated.

In conclusion, tragacanth was not mutagenic in *S.* Typhimurium strains TA1535, TA1537, TA97, TA98 and TA100 (Litton Bionetics Inc., 1977) and did not show substantial evidence for the induction of chromosome mutations in mammalian cells *in vitro* in the anaphase chromosome aberration test, although this assay has not been validated and it is not currently employed for genotoxicity testing (Green, 1977; Litton Bionetics Inc., 1977). Substantial negative results were also observed *in vivo* in the host-mediated assay in mice and the chromosomal aberration and dominant lethal assay in rats (Litton Bionetics Inc., 1972).

Overall, the Panel noted that, although the available *in vitro* and *in vivo* studies are limited, no genotoxic activity has been observed for tragacanth. In addition, considering the chemical structure of tragacanth and its negligible absorption, the Panel considered that there is no concern with respect to the genotoxicity of tragacanth (E 413).

3.5.5. Chronic toxicity and carcinogenicity

In order to further explore the relevance of squamous-cell hyperplasia observed in the forestomach during the 90-day study (Hagiwara et al., 1991), the nature of the gross lesions reported was investigated in groups of 30 male mice fed at the dietary level of 5.0% tragacanth (equal to about 8,000 mg/kg bw per day) for periods of up to 48 weeks; 20 males served as controls. No deaths were observed in animals receiving dietary doses of tragacanth as high as 8,000 mg/kg bw per day administered for 48 weeks. There were no treatment-related increases of plasma GGT levels at weeks 24 and 48. Although squamous-cell hyperplasias were seen in 2 out of 10 mice in the treated group at week 24, none of these proliferative lesions were apparent at week 48, after either chronic exposure or 24 week on basal diet. These lesions were considered by the authors to be of a non-neoplastic nature, since no atypic epithelium was found histopathologically. Furthermore, the number of cells undergoing DNA synthesis in forestomach epithelium as determined by 5-bromo-2'deoxyuridine incorporation into nuclei was comparable to control at weeks 24 and 48. According to the authors, the oral toxicity of tragacanth to $B6C3F_1$ mice was negligible (Hagiwara et al., 1991). The Panel agreed with this conclusion.

$B6C3F_1$ mice (50 animals of each sex per group) were fed a diet containing 0%, 1.25% or 5% tragacanth (equal to 0, 1,487 and 6,121, and 0, 1,988 and 9,120 mg/kg bw per day for males and females, respectively) for 96 weeks followed by a recovery period of 10 weeks (Hagiwara et al., 1992). The animals were observed daily for abnormalities. Individual bodyweights and feed and water consumption were recorded. Urine parameters were examined and extensive haematological and blood biochemistry determinations were carried out at the end of the study period after week 106 (sacrifice of the animals). At necropsy, gross observations were made followed by detailed examinations of the luminal stomach surfaces. Brain, thymus, heart, spleen, liver, kidneys, adrenals, testes or ovaries were weighed and examined histopathologically. No treatment-related clinical signs or adverse effects on survival rate, urinalysis, haematology, blood biochemistry and organ weights were observed. The detailed gross observation at necropsy revealed lesions of the forestomach in both sexes of treated and control animals (discoloured spots, focal raised areas or focal nodules occurring randomly as single lesions or in small numbers).

Squamous cell hyperplasia in the forestomach was found in both sexes of treated and control animals with squamous cell papilloma observed in one male and two females of the high-dose group. In one female of the 5% group, a squamous cell carcinoma was observed. These differences from controls were not statistically significant. Moreover, the Panel noted that, generally, tumours in the forestomach of rodents are not of relevance for human risk assessment. A significant ($p < 0.05$) decrease in the incidence of hepatocellular carcinomas was reported in the male mice of the highest dose group. As compared to controls, the incidence of hepatocellular adenomas in the females of both treatment groups was slightly lowered and the combined incidences of hepatocellular adenomas and carcinomas in the females of the 1.25% group showed a significant reduction. No significant differences ($p < 0.05$) from controls were observed in the incidences of other types of tumour. The

Panel identified no-observed-adverse-effect-levels (NOAELs) of 6,120 and 9,120 mg/kg bw per day for males and females, respectively, the highest doses tested.

Overall, the Panel noted that in a long-term toxicity study tragacanth was not carcinogenic and no adverse effects were observed up to the highest dose tested.

3.5.6. Reproductive and developmental toxicity

All reproductive and developmental toxicity studies have been previously evaluated by JECFA (1987).

3.5.6.1. Reproductive toxicity studies

Groups of 50 male and 50 female Osborne-Mendel rats (approximately 21 days of age) were maintained on diets containing 0, 0.006, 0.06, 0.6, or 6.0% ppm tragacanth gum (equivalent to 5.4, 54, 540 and 5,400 mg/kg bw per day, respectively) (Graham et al., 1985, unpublished study, Documentation provided to EFSA n. 5). No maternal fertility or developmental data or description of the reproduction study was available to the Panel. Only the pathology report was available.

As reported by JECFA (1987), after 13 weeks on the test diets, the rats were bred to produce an F_1 generation. The offspring were weaned at day 21 and placed on their respective diets. The animals in the F0 generation were maintained on the test diets for a total period of 27 weeks. Groups of 50 male and 50 female rats of the F_1 generation were maintained on the test diets for approximately 20 weeks. During the course of the study, body weights and feed intake were measured. Reproduction data included the fertility index, total number of progeny, average litter size of pregnant females, total number of liveborn, viability index, survivors to days 4 and 21, weaning index at birth, and weaning weights.

In the F_1 generation, particularly in the males, lower body weights were observed. Haematological measurements showed no compound-related effects. Only minor effects were noted in the various clinical chemistry parameters. Reproduction data were comparable for test and control animals. Histological studies did not show any compound-related effects. Enlarged livers were noted in the 6% group, but the enlargement was not associated with any significant change in liver composition or with histological changes. The ATP/ADP ratio in liver preparations for F_0 animals was markedly decreased, but this effect was not observed in F_1 animals.

3.5.6.2. Developmental toxicity studies

Several developmental toxicity studies of tragacanth were conducted in Wistar rats, CD1 mice, golden hamsters and Dutch belted rabbits (Food and Drug Res. Lab., 1972b). Animals were administered different doses of tragacanth suspended in anhydrous corn oil by gavage; the control groups sham-treated. Body weights were recorded at regular intervals during gestation and all animals were observed daily for appearance and behaviour. All dams were subjected to caesarean section, and the numbers of implantation sites, resorption sites, live and dead fetuses, and body weight of live fetuses were recorded. All fetuses were examined grossly for external abnormalities, one-third underwent detailed visceral examinations and two-thirds were stained and examined for skeletal defects.

Mice (20/group) were treated once daily from day 6 to day 15 of gestation with doses of 12, 56, 210, 1,200 mg tragacanth/kg bw per day (Food and Drug Res. Lab., 1972b). The administration of up to 1,200 mg tragacanth/kg bw per day pregnant mice for 10 consecutive days had no treatment-related effect on the number of implantation sites or on maternal and fetal survival. The number of abnormalities observed in the soft and skeletal tissues in the offspring of tragacanth treated dams did not differ from the number occurring in the fetuses of vehicle-treated controls.

Rats (20–24/group) were treated once daily from day 6 to day 15 of gestation with doses of 12, 56, 210, 1,200 mg tragacanth/kg bw per day (Food and Drug Res. Lab., 1972b). The administration of up to 210 mg tragacanth/kg bw per day to pregnant rats for 10 consecutive days had no treatment-related effect on the number of implantation sites or on maternal and fetal survival. The number and type of abnormalities observed in the soft and skeletal tissues derived from this group of dams did not differ from the number occurring in the fetuses of vehicle-treated controls. However, in a group of dams exposed at 1,200 mg/kg bw per day, significant maternal toxicity occurred with the loss of 5 of 20 pregnant rats. Death was accompanied by severe diarrhoea and urinary incontinence with anorexia. At autopsy, marked petechial haemorrhages were observed in the mucosa of the small intestine. The surviving dams appeared normal and bore normal fetuses. The number of implantation sites and the number of the live fetuses were not affected. The authors concluded that tragacanth was not teratogenic in rats under the conditions of the study. The Panel agreed with this conclusion.

Hamsters (20/group) were treated once daily from day 6 to day 10 of gestation with doses of 9, 42, 185 and 900 mg tragacanth/kg bw per day (Food and Drug Res. Lab., 1972b). The administration of up to 900 mg tragacanth/kg bw per day to pregnant hamsters for five consecutive days had no treatment-related effect on the number of implantation sites or on maternal and fetal survival. The number of abnormalities observed in the soft and skeletal tissues in the offspring of tragacanth treated dams did not differ from the number in the fetuses of vehicle-treated controls.

Rabbits (10–13/group) received daily doses of 7, 33, 150 and 700 mg tragacanth/kg bw per day from day 6 to day 18 of gestation (Food and Drug Res. Lab., 1972b). The administration of up to 33 mg tragacanth/kg bw per day to pregnant rabbits for 13 consecutive days had no treatment-related effect on the number of implantation sites or on maternal and fetal survival. However, in two groups of dams exposed at 150 and 700 mg/kg bw per day, significant maternal toxicity occurred with the loss of 6 and 9 of 15 pregnant rabbits, respectively. Death was accompanied by severe diarrhoea and urinary incontinence with anorexia. At autopsy, marked petechial haemorrhages were observed in the mucosa of the small intestine. The surviving dams appeared normal and bore normal fetuses. The number of implantations and the survival of the live pups were not affected. The author concluded that tragacanth was not teratogenic in rabbits under the conditions of the study. The Panel noted that it is not possible to draw this conclusion as at the highest dose levels tested (150 and 700 mg/kg bw per day) only 7 or 5 does were pregnant at caesarean section at gestation day 29 (6 or 9 animals died or aborted).

According to the Panel, the identically performed tests with tragacanth in mice, rats, hamsters and rabbits by the Food and Drug Research Lab. reported in a limited way (Food and Drug Res. Lab., 1972b) cover the organogenesis period of the reproductive cycle. The outcome of these prenatal developmental toxicity studies shows no dose-related developmental effects at doses, which are not maternal toxic or lethal. However, the Panel noted that there was a repeated unexplained maternal mortality at the high dose levels in different animals tested (rats and rabbits). The Panel noted that JECFA considered in its evaluation of tragacanth, that 'maternal toxicity observed in rats and rabbits, at the highest levels tested, may have been due to the mode of administration (suspended in corn oil), rather than to any innate toxicity of the gum' (JECFA, 1987). The Panel agreed with this statement and considered these studies not suitable for the evaluation of risk assessment.

Overall, the Panel considered that no adverse effects were observed in the reproductive toxicity studies at doses up to 6% (equivalent to 5,400 mg tragacanth/kg bw per day), the highest dose tested. In the identically performed prenatal developmental tests with tragacanth by gavage in mice and hamsters (Food and Drug Res. Lab., 1972b), 1,200 mg/kg bw per day in mice and 900 mg/kg bw per day in hamsters (the highest doses tested) showed no dose-related developmental effects.

3.5.7. Hypersensitivity, allergenicity and food intolerance

3.5.7.1. Human studies

A few cases of hypersensitivity reactions to tragacanth have been reported. The clinical manifestations of allergy resulting from ingestion of a mixture of tragacanth, karaya, and Arabic gums in sensitive subjects have been reported to include bronchial asthma, urticaria, angioedema, vasomotor rhinitis, and gastrointestinal problems (Gelfand, 1949). Allergic reactions were also occasionally observed after ingestion of tablets formulated with tragacanth (Brown and Crepea, 1947; Rubinger et al., 1978). The patients were also positive to pollens in skin test. The authors suggested that before ascribing sensitivity reactions to the main ingredient (the gum), other constituents should also be investigated.

3.5.7.2. Animal study

Mice ([(C57BL/6JxDBA/2)F1]BDF_1, n = 6–8/group) were immunised intradermally with tragacanth in Freund's adjuvant then serum antibody levels were measured with an enzyme-linked immunosorbent assay (ELISA) and delayed hypersensitivity responses by a footpad swelling test (Strobel et al., 1986). Tragacanth caused delayed-type hypersensitivity and induced antibody responses. However, the authors demonstrated that the purified gum is less immunologically reactive than the crude one, in addition, non-specific inflammation (likely due to contaminants in the gum) was also reported.

Overall, the available information is sparse. However, there is no indication of a specific concern for hypersensitivity/intolerance regarding the use of tragacanth gum as a food additive.

3.5.8. Other studies

3.5.8.1. Animal studies

In a study by Anderson et al. (1984), groups of five male Wistar rats (initial weight 40–60 g) were given diets containing 0% (control), 0.5%, 1.5%, 2.5% and 3.5% of tragacanth for 91 days (equivalent to 0.40, 1.2, 2.0 and 2.8 g/kg bw per day, respectively[14]). At autopsy, the liver and heart of all animals were examined microscopically and material was retained for electron microscopy and for microsomal cytochrome P450 assays. There were no detectable abnormalities in any of the organelles in the heart and the liver specimens. All histopathological observations showed normal tissues. The data from the assays of the microsomal protein and cytochrome P450 content of the livers gave no indication for an inductive effect of tragacanth.

Wistar albino rats (99–120 g) were fed a diet containing 4% tragacanth (equivalent to 4,700 mg/kg bw per day) daily for 45 days according to Anderson et al. (1986). The number of rats in the study was not stated. No abnormalities in organelles were observed within cells of the jejunum, ileum, or caecum of rats by transmission electron microscopy. Additionally, neither inclusions nor other pathological changes were detected. It was concluded by the authors that no remarkable ultrastructural differences occurred between experimental and control rats.

3.5.8.2. Human data

A dietary study with tragacanth was undertaken in humans (Eastwood et al., 1984). After a 7-day control period, five male volunteers consumed each day 9,900 mg tragacanth (equivalent to 141 mg/kg bw per day) for 21 days. The test substance was well tolerated; no adverse effects and no allergic reactions were observed. The authors noted that the daily intake of tragacanth during the study was significantly greater than the estimated amount normally ingested as a food additive. Tragacanth had no observed effects on clinical chemistry, haematological indices, urinalysis parameters, glucose and insulin levels, serum cholesterol, triglycerides and phospholipids, breath hydrogen and methane concentrations. All parameters remained unchanged. The intestinal transit time decreased, faecal fat concentration and wet and dry weights increased, but these changes were considered by the authors to be only of nutritional and physiological interest.

3.6. Discussion

Tragacanth is exclusively defined as a dried exudation obtained from the stems and branches of strains of *Astragalus gummifer* Labillardiere and other Asiatic species of *Astragalus* (family Leguminosae) (Commission Regulation (EU) No 231/2012).

Tragacanth (E 413) is authorised as a food additive in the EU under Regulation (EC) No 1333/2008 on food additives. Specific purity criteria on tragacanth (E 413) have been defined in Commission Regulation (EU) No 231/2012. The Panel noted that according to industry the average content of protein in the food additive is 2% while Anderson et al. (1989) indicated that this content can be between 0.5% and 3.4%. The Panel also noted some case reports of hypersensitivity reactions associated with tragacanth. The Panel considered that this hypersensitivity might be due to the tragacanth proteins and therefore their content should be reduced as much as possible.

Tragacanth is unlikely to be absorbed intact. In the absence of *in vivo* data and according to *in vitro* demonstration of fermentation of tragacanth by animal and human intestinal microorganisms, the Panel considered that tragacanth would be partially fermented during its passage through the large intestine by the action of the intestinal tract microflora. The rate of hydrolysis in the gastrointestinal tract in humans is unknown, but it is expected that the limited extent of hydrolysis of tragacanth would lead to the production of its fermentation products such as short chain fatty acids which were considered of no safety concern by the Panel.

The acute toxicity of tragacanth in mice, hamsters, rats and rabbits is low.

The subchronic toxicity of tragacanth was investigated in mice for 13 weeks (Hagiwara et al., 1991). In all treated animals at all doses (except in females receiving 1,500 mg/kg bw per day) slight but dose-related elevations of GGT levels were seen while squamous-cell hyperplasia of the forestomach occurred in males of all groups. In an additional study on males given the highest dose of tragacanth for periods of up to 48 weeks demonstrated that these effects were not reproducible. The

[14] EFSA guidance on selected default values. EFSA Journal 2012;10(3):2579 [32 pp.].

Panel noted that the increase in GGT levels was not confirmed by chronic studies performed by the same authors.

Based on the data available, the Panel considered that there is no concern with respect to the genotoxicity of tragacanth.

The Panel noted that in a long-term toxicity study tragacanth was not carcinogenic and no adverse effects were observed up to the highest dose tested.

The Panel considered that no adverse effects were observed in reproductive toxicity studies at doses up to 6% (equivalent to 5,400 mg tragacanth/kg bw per day), the highest dose tested. In the identically performed prenatal developmental tests with tragacanth by gavage in mice and hamsters (Food and Drug Res. Lab., 1972b) 1,200 mg/kg bw per day in mice and 900 mg/kg bw per day in hamsters (the highest doses tested), showed no dose-related developmental effects.

In a dietary study with tragacanth in humans, five male volunteers consumed 9,900 mg tragacanth (equivalent to 141 mg/kg bw per day) each day (Eastwood et al., 1984). The test substance was well tolerated and no adverse effects and no allergic reactions were observed. Tragacanth had no observed effects on clinical chemistry, haematological indices and urinalysis parameters. The intestinal transit time decreased, faecal fat concentration and wet and dry weights increased.

To assess the dietary exposure to tragacanth (E 413) from its use as a food additive, the exposure was calculated based on (1) maximum levels of data provided to EFSA (defined as the maximum level exposure assessment scenario) and (2) reported use levels (defined as the refined exposure assessment scenario, brand-loyal and non-brand-loyal consumer scenario).

Tragacanth (E 413) is authorised in a wide range of foods. The Panel identified a possible brand loyalty to specific food categories (i.e. edible ices and other confectionery), and therefore, the Panel considered that the brand-loyal scenario covering the brand-loyal population was the more appropriate and realistic scenario for risk characterisation because it is assumed that the population would probably be exposed long-term to tragacanth (E 413) present at the maximum reported use level for one food category.

A specific exposure assessment scenario taking into account the consumption of food supplements for consumers only was also performed to estimate exposure for children, adolescents, adults and the elderly as exposure via food supplements may deviate largely from that via food, and the number of food supplement consumers may be low depending on populations and surveys.

The refined estimates are based on 5 out of 70 food categories in which tragacanth (E 413) is authorised. The Panel considered that the uncertainties identified would, in general, result in an overestimation of the exposure to tragacanth (E 413) as a food additive in European countries for the refined scenario if it is considered that the food additive may not be used in food categories for which no usage data have been provided.

However, the Panel noted that given the information from the Mintel's GNPD, it may be assumed that tragacanth (E 413) is used in food categories for which no data have been provided by food industry. The main food categories, in term of amount consumed, not taken into account were cheeses, breakfast cereals, bread and rolls, fine bakery wares, meat products, processed fish, flavoured drinks, some alcoholic beverages (e.g. cider and perry, spirit drinks), snacks and desserts. According to Mintel GNPD (Appendix B), in the EU market, bakery products, meat products, snacks and desserts are labelled with tragacanth (E 413) for limited number of products. Therefore the Panel considered that if these uncertainties were confirmed, it would result in an underestimation of the exposure.

The Panel noted that the exposure to tragacanth (E 413) from its use according the Annex III (Part 1, 2, 3, 4 and 5A) was not considered in the exposure assessment.

The Panel also noted that the refined exposure estimates are based on information provided on the reported level of use of tragacanth (E 413). If actual practice changes, this refined estimates may no longer be representative and should be updated.

Conclusions

Following the conceptual framework for the risk assessment of certain food additives re-evaluated under Commission Regulation (EU) No 257/2010 (EFSA ANS Panel, 2014), and given that:

- the safety assessment carried out by the Panel is limited to the reported uses (5 out of 70 food categories) and use levels;
- in the general population, the highest refined exposure assessments calculated based on the reported data from food industry were for toddlers (12–35 months) up to 6 mg/kg bw per day (brand-loyal scenario);

- tragacanth is unlikely to be absorbed intact and is partially fermented by intestinal microbiota;
- sufficient toxicity data were available;
- there is no concern with respect to the genotoxicity of tragacanth (E 413);
- no carcinogenic effects were reported at doses up to 6,120 and 9,120 mg/kg bw per day for male and female mice, respectively, the highest doses tested;
- oral daily intake of a large amount of tragacanth up to 9,900 mg (equivalent to 141 mg/kg bw per day) for 21 days was well tolerated in humans, without any undesirable effect being reported;

the Panel concluded that there is no need for a numerical ADI for tragacanth (E 413), and that there is no safety concern at the refined exposure assessment for the reported uses and use levels of tragacanth (E 413) as a food additive.

4. Recommendations

The Panel recommended that the European Commission considers lowering the current limits for the toxic elements (lead, cadmium, mercury and arsenic) in the EU specification for tragacanth (E 413) in order to ensure that tragacanth (E 413) as a food additive will not be a significant source of exposure to those toxic elements in food. The Panel noted that currently detected levels of these toxic elements were far below those defined in the European Commission specifications and therefore the current limits could be lowered.

The Panel recommended that the European Commission considers harmonising the microbiological specifications for polysaccharidic thickening agents, such as gums, and including criteria for TAMC and TYMC into the EU specifications of tragacanth (E 413).

The Panel considered that no threshold dose can be established for allergic reactions. Therefore, it is advisable that exposure to eliciting allergens, such as proteinaceous compounds, is avoided as much as possible and therefore the Panel recommended that their content should be reduced as much as possible.

Due to the discrepancies observed between the data reported from industry and the Mintel database, where tragacanth (E 413) is labelled in more products than in food categories for which data were reported from industry, the Panel recommended collection of data of uses and use levels of tragacanth (E 413) including food supplements in order to perform a more realistic exposure assessment.

Documentation provided to EFSA

1) Pre-evaluation document prepared by Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V. August 2012.
2) Riemser Arzeinmittel AG, 2010, Stoffliche Übersicht zu einem Antrag zur Aufnahme in die Empfehlungen des BfR [Substance overview for petitions for the inclusion in the BfR recommandations], 31 May 2010.
3) Association for International Promotion of Gums (AIPG), 2010. Data submitted to EFSA, March 2010.
4) Association for International Promotion of Gums (AIPG). Data submitted to EFSA, August 2013.
5) Graham, S.L., Friedman, L., & Garthoff, L. (1985). The subchronic effects of gum tragacanth on F0 and F1 generation Osborn-Mendel rats. Unpublished report of the Food and Drug Administration. Submitted by AIPG, August 2013.
6) European Medicines Agency (EMA) communication to EFSA request in 4 May 2015, for information on a certain group of substances used as food additives, June 2015.
7) Association for International Promotion of Gums (AIPG). Data submitted to EFSA, December 2015.
8) Association for International Promotion of Gums (AIPG). Data submitted to EFSA, 2016.
9) AIPG (Association for International Promotion of Gums), 2014. Data on usage levels of Tragacanth (E 413) in foods in response to the EFSA call for food additives usage level and/or concentration data in food and beverages intended for human consumption (Batch 3). Submitted to EFSA on 8 October 2014.
10) FDE (FoodDrinkEurope), 2015. Data on usage levels of Tragacanth (E 413) in foods in response to the EFSA call for food additives usage level and/or concentration data in food and beverages intended for human consumption (Batch 3). Submitted to EFSA on 29 November 2015.

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Abbreviations

ADI	acceptable daily intake
AFC	EFSAFormer Panel on Additives, Flavourings, Processing Aids and Materials in Contact
AIPG	Association for International Promotion of Gums
ANS Panel	EFSA Panel on Food Additives and Nutrient Sources added to Food
AOAC	Association of Official Agricultural Chemists
CAS	Chemical Abstracts Service
CFU	colony-forming unit
EINECS	European Inventory of Existing Commercial Chemical Substances
ELISA	enzyme-linked immunosorbent assay
EMA	European Medicines Agency
FAO	Food and Agriculture Organization
FCS	Food Classification System
FDA	Food and Drug Administration
FDE	FoodDrinkEurope
FSMP	foods for special medical purposes
GNPD	Global New Products Database
HDL	high-density lipoprotein
JECFA Joint FAO/WHO	Expert Committee on Food Additives
LD_{50}	lethal dose
LOQ	limit of quantification
MPL	maximum permitted level
NDA	EFSA Panel on Dietetic Products, Nutrition and Allergies

NOAEL	no-observed-adverse-effect-level
OECD	Organisation for Economic Co-operation and Development
QS	*quantum satis*
SCF	Scientific Committee for Food
SCFA	short-chain fatty acids
TAMC	total aerobic microbial count
TLC	thin-layer chromatography
TYMC	total combined yeasts and moulds
WHO	World Health Organization

Appendix A – Summary of the reported use levels (mg/kg or mg/L as appropriate) of tragacanth (E 413) provided by industry

Appendix A can be found in the online version of this output ('Supporting information' section): https://doi.org/10.2903/j.efsa.2017.4789

Appendix B – Number and percentage of food products labelled with tragacanth (E 413) out of the total number of food products present in the Mintel GNPD per food subcategory between 2011 and 2016

Appendix B can be found in the online version of this output ('Supporting information' section): https://doi.org/10.2903/j.efsa.2017.4789

Appendix C – Concentration levels of tragacanth (E 413) used in the maximum level exposure scenario, the refined exposure assessment scenarios and food supplements consumers only scenario (mg/kg or mL/kg as appropriate)

Appendix C can be found in the online version of this output ('Supporting information' section): https://doi.org/10.2903/j.efsa.2017.4789

Appendix D – Summary of total estimated exposure of tragacanth (E 413) from its use as a food additive for the maximum level exposure scenario and the refined exposure assessment scenarios per population group and survey: mean and 95th percentile (mg/kg bw per day)

Appendix D can be found in the online version of this output ('Supporting information' section): https://doi.org/10.2903/j.efsa.2017.4789

Appendix E – Main food categories contributing to exposure to tragacanth (E 413) using the maximum level exposure scenario and the refined exposure assessment scenarios (> 5% to the total mean exposure)

Appendix E can be found in the online version of this output ('Supporting information' section): https://doi.org/10.2903/j.efsa.2017.4789