FOOD STANDARDS
Australia New Zealand
Te Mana Kounga Kai – Ahitereiria me Aotearoa

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[13–17]

Supporting document 1

Risk and technical assessment report (at Approval) – Application A1123

Isomalto-oligosaccharide as a Novel Food

Executive summary

FSANZ conducted a risk assessment on the request to permit isomalto-oligosaccharide (IMO) as a novel food for use as an alternative (lower energy) sweetener and bulk filler in a range of foods. This report contains a food technology report, a hazard assessment and a dietary exposure assessment.

The food technology assessment concluded that when IMO is used as an ingredient to replace sugars, mainly sucrose, in a food it meets the stated purposes of a bulk filler. According to the Applicant's reported composition of IMO (i.e. lower levels of mono- and di-saccharides than sucrose) and FSANZ's proposed specification for IMO, it could be used as a sweetener with approximately 60% sweetness compared to sucrose. The Applicant did not request a separate energy factor for IMO.

IMO has a history of safe use in humans (other than certain individuals with sucrase-isomaltase deficiency). IMO is not efficiently converted to glucose in the small intestine so the majority (~60–70%) of the ingested IMO is likely to pass unchanged into the colon. There is no evidence of adverse gastrointestinal effects (e.g. diarrhoea) in healthy humans up to a single bolus dose of 40 g, and IMO did not cause any abdominal symptoms (e.g. laxative effects) in any subjects at this level. In the absence of any identifiable hazard, an Acceptable Daily Intake (ADI) 'not specified' is considered appropriate. However, it is anticipated that IMO will be poorly tolerated by certain individuals with congenital or acquired sucrase-isomaltase deficiency.

A chronic dietary exposure assessment was not required due to the ADI of 'not specified' being assigned. The dietary exposure assessment (DEA) focused on a more acute or short term exposure and assessed two separate scenarios using consumption data (for day 1 only) from the most recent national nutrition survey for Australia i.e.:

- Scenario 1: IMO assumed to replace 50% of added sugars on a 1.6 gram for 1 gram basis in only those foods proposed by the Applicant
- Scenario 2: IMO assumed to replace 50% of added sugars on a 1.6 gram for 1 gram basis in all foods (excluding infant formula products, infant foods and formulated supplementary foods for young children).

The predicted dietary exposures were then compared to levels of IMO reported to be well tolerated in the literature i.e. a single dose (40 g) of IMO. Also, as the hazard assessment refers to a (cited) study that showed that a single dose of IMO of 1.5 g/kg bodyweight does not cause diarrhoea in humans, the predicted dietary exposures were also compared to this figure, for completeness.

For the food categories proposed by the Applicant (scenario 1), for all age groups assessed, the predicted mean dietary exposures to IMO over 24 hours were < 40 g IMO. For nearly all food categories containing added sugars with nominated exemptions (scenario 2), the predicted mean dietary exposures to IMO over 24 hours were < 40 g IMO for 2-8 years and 51 years and over; however, mean exposures were > 40 g IMO for those aged 9-50 years (up to 58 g/day). High consumers of IMO-containing foods may also exceed 40 g of IMO. However, due to the assumptions made in scenario 2, predicted exposures are conservative worst case scenarios and not considered realistic because the scenario is unlikely to reflect normal consumption patterns of IMO-containing foods. The Applicant suggests that no more than two foods containing IMO would likely be consumed per day, based on overseas market experience e.g. Canada.

In conclusion, as no threshold at which IMO may cause adverse effects has been identified for use in the assessment, IMO may be considered safe and suitable to be added to the food supply, noting that the addition of IMO to infant formula products, infant foods and formulated supplementary foods for young children was not intended (by the Applicant), so were excluded from the assessment.

Table of contents

1 Introduction

The Application is seeking permission for isomalto-oligosaccharides (IMOs) to be used as a novel food ingredient in food as an alternative sweetener and bulk filler. IMO is proposed to be an alternative to other carbohydrate bulk sweeteners such as sucrose, glucose, fructose and high fructose or maltose syrups, and an alternative bulk filler to fructo-oligosaccharides (FOS), inulin, polydextrose and dextrins.

The Applicant proposes to market IMO as a food ingredient in a number of food categories including carbonated beverages, sports and energy drinks, soy drinks, milk-based drinks, milk-based and non-milk-based meal replacement drinks, fruit juices, fruit-flavoured drinks, meal replacement bars, breakfast bars and confectionery.

1.1 Objectives of the assessment

The objectives of the risk and technical assessment were to assess whether permitting IMO as a novel food ingredient to a range of foods, as requested, is technologically justified and if it raised any public health and safety concerns. The key questions posed were:

1. When IMO is added to food to replace sucrose does it achieve the stated purpose of an alternative sweetener and bulk filler?
2. Are there any public health and safety concerns associated with the use of IMO as a novel food ingredient when it is added to food to replace sucrose?

2 Food technology assessment

2.1 Introduction and description of the substance

The food technology assessment aims to identify IMO via its chemical and physical properties and specifications; investigate analytical methods for its presence in food; and make an assessment against its proposed ‘stated’ purpose.

2.1.1 Identity

The Application provided information that identifies commercial IMO preparations as containing a mixture of sugar units (saccharides) linked together to form a blend of various oligosaccharides with the majority having chain lengths of three to seven monosaccharides. The Applicant’s IMO preparations (based on the monosaccharide glucose) are very similar to other commercial IMO preparations currently permitted and sold in other countries.

Figure 1 provides the chemical structures of some sugars contained in IMO showing structures with two, three and four saccharides units.

The term ‘oligosaccharide’ encompasses carbohydrates that are larger than simple disaccharides, but smaller than polysaccharides (greater than 10 units). Oligosaccharides are identified by the number of saccharide units they contain, using the term ‘degree of polymerisation’ (DP). A disaccharide consists of two saccharide units joined together and so has a DP of 2, abbreviated as DP2, while a trisaccharide is classed as DP3 and so on for other oligosaccharides. The majority of oligosaccharides in commercial IMO preparations consist of three to seven saccharide units but can contain up to nine, though there is also a moderate percentage of disaccharides, and a small percentage of glucose. The saccharide units are linked together by both α 1→4 and α 1→6 linkages in oligosaccharides but isomalto-oligosaccharides are linked by α 1→6 linkages alone.

The enzyme transglucosidase converts α 1→4 bonds to α 1→6 linkages, thus converting oligosaccharides to iso-oligosaccharides, as a final step in production.

Maltose is a disaccharide of two glucose units joined via a α-D-(1,4) linkage whereas its isomer, isomaltose, is joined by an α-D-(1,6) linkage. Typically IMOs are glucose oligomers with predominantly α-D-(1,6) linkages. Isomalto-oligosaccharides syrups typically contain a substantial amount of branched oligosaccharides such as isomaltose (DP2), isomaltotriose (DP3), isomaltotetraose (DP4) and isomaltopentaose (DP5). A 'branched' saccharide is defined as an oligosaccharide with glucose units linked by α-D-(1,4) linkages, but also by α-D-(1,6) linkages. For example, isomaltotriose is usually considered to be an indigestible branched DP3 saccharide.

The chemical structures and molecular formulas for some of the common saccharides found in IMO preparations are provided in Table 1 (adapted from the BioNeutra IMO application to the European Commission, 2008).

2.1.1.1 Differences between IMO and maltodextrins

The USA Code of Federal Regulations (CFR) provides a specific regulation for maltodextrin (i.e. section 184.1444 maltodextrin) in Title 21 (Food and Drugs). This regulation indicates that maltodextrin is a "non-sweet nutritive saccharide polymer that consists of D-glucose units primarily linked by [alpha]-1-4 bonds and that has a dextrose equivalent (DE) of less than 20". DE is derived from the DP:

$$DE = 100 \div DP.$$

Therefore a DE of less than 20 means an average DP of greater than 5.

Food Chemicals Codex (FCC) has specifications for maltodextrin.

Maltodextrin and IMO are produced from similar initial sources i.e. from starch, though the processing steps have some differences. The main differences in the chemical structures are that maltodextrins have α-D-(1, 4) linkages, whereas IMO has α-D-(1, 6) linkages between the glucose units. As the human digestive system effectively digests only α 1→4 linkages, maltodextrins can also be processed to convert a portion of the normal α 1→4 glycosidic linkages to other linkages. These other linkages render the molecules relatively resistant to human digestive processes. In this case they are termed resistant maltodextrins.

Such processing steps can include processing under high temperature and pressure such as during extrusion processing.

IMO and resistant maltodextrins both contain digestible and non-digestible saccharides. The DP1 to DP3 saccharides are likely to be digested in the small intestine, while the larger oligosaccharides would pass through the small intestine non-digested and subsequently undergo microbial fermentation in the large intestine (Health Canada 2012).

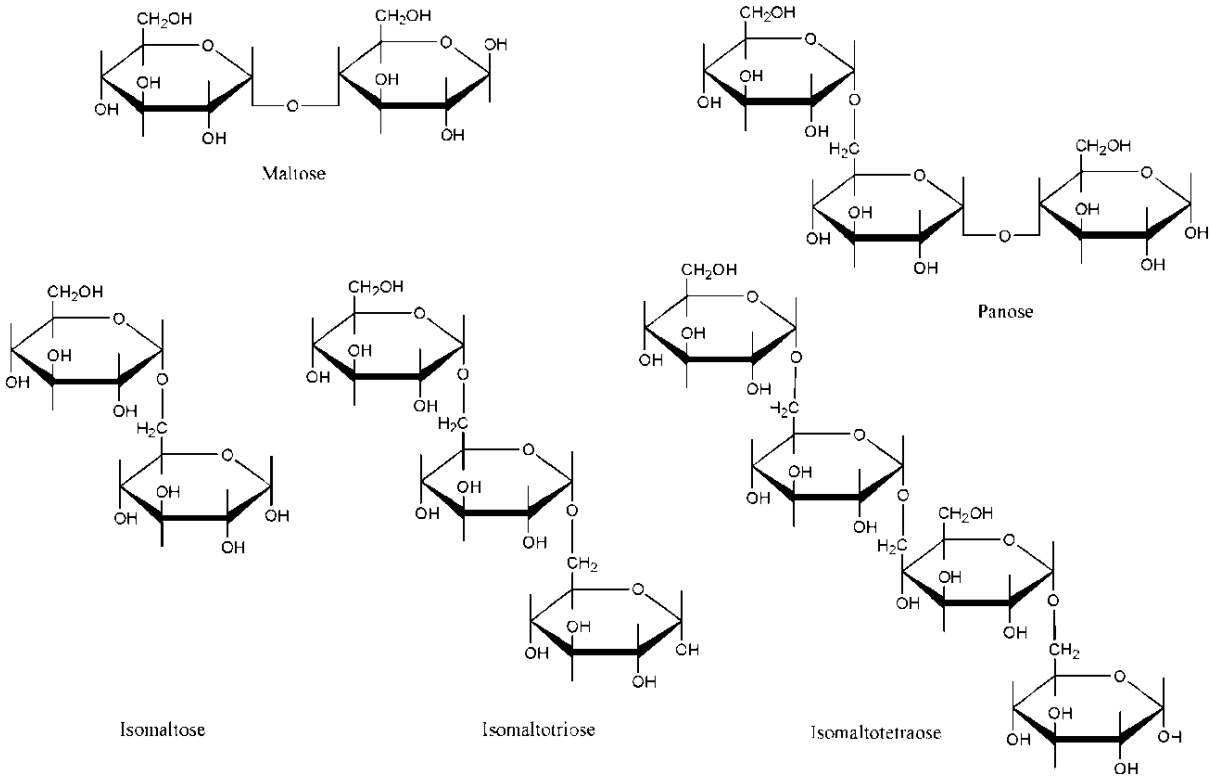

Figure 1: Chemical structure of various oligosaccharides that can be found in IMO; examples of DP2, DP3 and DP4 saccharides

2.1.2 Chemical names, identification and structure (adapted from BioNeutra 2008)

It is understood commercial preparations of IMO can be either a powder or syrup. The IMO powder is a white crystalline powder while the syrup is a transparent clear pale yellow coloured liquid. Both products have a sweetness of approximately 60% of sucrose (different numbers are found in references but the figure seems to be between 50–60%). The commercial IMO preparations contain greater than 90% various oligosaccharides and isomaltose and less than 5% glucose.

Table 1: **Chemical names, molecular formulas and Chemical Abstract Service (CAS) numbers for common isomalto-oligosaccharides in IMO preparations with different DPs**

Degree of polymerisation (DP)	Common name	Molecular formula	Chemical name	CAS #
1	Glucose	$C_6H_{12}O_6$	D-Glucose	50-99-7
2	Maltose	$C_{12}H_{22}O_{11}$	4-O-c-D-glucopyranosyl-D-glucose	69-79-4
	Isomaltose	$C_{12}H_{22}O_{11}$	6-O-c-D-glucopyranosyl-D-glucose	499-40-1
3	Maltotriose	$C_{18}H_{32}O_{16}$	O-c-D-glucopyranosyl-(1,4)-O-c-D-glucopyranosyl-(1,4)-D-glucose	1109-28-0
	Panose	$C_{18}H_{32}O_{16}$	O-c-D-glucopyranosyl-(1,6)-O-c-D-glucopyranosyl-(1,4)-D-glucose	33401-87-5
	Isomaltotriose	$C_{18}H_{32}O_{16}$	O-c-D-glucopyranosyl-(1,6)-O-c-D-glucopyranosyl-(1,6)-D-glucose	3371-50-4

Degree of polymerisation (DP)	Common name	Molecular formula	Chemical name	CAS #
4	Maltotetraose	$C_{24}H_{42}O_{21}$	O-c-D-glucopyranosyl-(1,4)-O-c-D-glucopyranosyl-(1,4)-D-glucose	34612-38-9
5	Maltopentaose	$C_{30}H_{52}O_{26}$	O-c-D-glucopyranosyl-(1,4)-O-c-D-glucopyranosyl-(1,4)-O-c-D-glucopyranosyl-(1,4)-O-c-D-glucopyranosyl-(1,4)-D-glucose	34620-6-3
6	Maltohexose	$C_{36}H_{62}O_{31}$	O-c-D-glucopyranosyl-(1,4)-O-c-D-glucopyranosyl-(1,4)-O-c-D-glucopyranosyl-(1,4)-O-c-D-glucopyranosyl-(1,4)-O-c-D-glucopyranosyl-(1 -4)-D-glucose	34620-77-4
7	Maltoheptaose	$C_{42}H_{72}O_{36}$	O-c-D-glucopyranosyl-(1,4)-O-c-D-glucopyranosyl-(1,4)-O-c-D-glucopyranosyl-(1,4)-O-a-D-glucopyranosyi-(1,4)-O-a-D-glucopyranosyl-1,4)-Oc-D-glucopyranosyl-(1,4)-D-glucopyranose	1980-14-9
8	Maltooctaose	$C_{48}H_{82}O_{41}$	O-c-D-glucopyranosyl-(1,4)-O-c-D-glucopyranosyl-(1,4)-O-c-D-glucopyranosyl-(1,4)-O-c-D-glucopyranosyl-(1,4)-O-c-D-glucopyranosyl-(1,4)-O-c-D-glucopyranosyl-(1,4)-O-c-D-glucopyranosyl-(1,4)-D-glucose	6156-84-9
9	Maltononaose	$C_{54}H_{92}O_{46}$	O-c-D-glucopyranosyl-(1,4)-O-c-D-glucopyranosyl-(1,4)-O-c-D-glucopyranosyl-(1,4)-O-c-D-glucopyranosyl-(1,4)-O-c-D-glucopyranosyl-(1,4)-O-c-D-glucopyranosyl-(1,4)-O-c-D-glucopyranosyl-(1,4)-O-c-D-glucopyranosyl-(1,4)-D-glucose	6471-60-9

Applicant's IMO profile

Appendix 13 of the Application contains a proposed specification for IMO and states that a maximum of 43% (range 20–43%) of the IMO preparation would be DP1 and DP2 as shown in Table 2.

Table 2: Ranges for Degree of Polymerisation of the Applicant's IMO preparation (taken from Appendix 13 of the Application)

Degree of polymerisation (DP)	Applicant's IMO Range (% w/w)	Main components
DP1	0–5	Glucose
DP2	20–38	Isomaltose, maltose
DP3	20–30	Isomaltotriose, maltotriose, panose
DP4	14–22	Isomaltotetraose
DP5	5–7	Isomaltopentaose
DP6	4–7	Isomaltohexaose
Other (≥DP7)	3–4	

2.1.3 Technological ('stated') purpose

IMO is being assessed as an ingredient, albeit a novel food ingredient, and not as a food additive. This is because it is proposed to be used at reasonably high concentrations in food and not to perform exclusively technological purposes in the food like a food additive. However, the Application has indicated that IMO will be marketed as a general food ingredient for use as an alternative (lower calorie) sweetener and bulk filler. These aspects are assessed in the section below.

2.1.4 Assessment of technological ('stated') purpose

2.1.4.1 Use as an alternative sweetener

IMO preparations have the relative sweetness of approximately 60% when compared to sucrose. IMO has been used as a partial replacement for sugars (mainly sucrose) in a number of countries. In this sense IMO is similar to other forms of oligosaccharides such as maltodextrin and resistant maltodextrin. Because of the relative sweetness, the Application indicates that IMO would likely be blended with other sweeteners to replace sucrose.

The Application provides a worked example where sugar was replaced with the appropriate amount of IMO to provide comparable sweetness (i.e. 1÷0.60 x sugar added) to a basic butter cake recipe (see Application appendices 2a) and 2b)). No other changes were made to the recipe. This example may be more theoretical than practical since other sweeteners, such as intense sweeteners are not used to replicate the bulk of sucrose, but the calculations are instructive as they highlight the potential impact of the change.

The Applicant's calculations replaced 156 grams of white sugar (sucrose) in a cake batter of 743 grams, with 260 grams of IMO in a cake batter of 836 grams in a serving size of 104 g in each case. The effect of IMO replacement for white sugar on the number of servings and change in sugars content are shown in Table 3. The calculation of total sugars has applied the definition of sugars given in Standard 1.1.2 – Definitions used throughout the Code (i.e. mono- and di-saccharides) that is also used in nutrition labelling to reflect the information available to consumers.

Table 3: Number of servings and total sugars in a cake baked with sucrose or IMO

Ingredient	Number of cake servings from recipe for cake batter	Total sugars/100 g
Sucrose	7	22.5 g
IMO	8	14.7 g

Based on this information, the direct replacement of sucrose by IMO would reduce the quantity of sugars in a food, assuming no other sugars have been used to correct for the change in sweetness. This is an approximate 34% reduction in total sugars content and highlights the impact of replacing sucrose with IMO as a lower disaccharide sweetener.

2.1.4.2 Use as a bulk filler

It is self-evident that using a larger quantity of IMO to replace sucrose means the final quantity of the food will also be greater. In this case the IMO acted as a bulk filler to increase the total volume of the final food. In Table 3 above, the number of cake servings of the same unit size increased from 7 to 8 using the cake batter recipe given above.

2.1.4.3 Conclusion of assessment of technological ('stated') purpose

In the presented example, IMO performs the technological purpose of both bulk filler, and a sweetener with less sugars (compared to sucrose) during cake production, using replacement levels linked to the lower sweetness levels of approximately 60% compared to sucrose.

2.2 Analytical methods for detection

There are analytical methods available that can separate and analyse the individual oligosaccharides in the IMO preparation. High performance liquid chromatography (HPLC) is the analytical method of choice. The Application contains a HPLC analytical method (Appendix 14) that is claimed to separate, identify and quantify the IMOs from any other oligosaccharides that may be present in a food matrix.

2.3 Manufacturing method for isomalto-oligosaccharide

IMO is produced from starch via a series of controlled enzymatic steps, using different enzymes. These process steps are similar to the well-established processes used in the hydrolysis of starch and sugar to produce various sugar products. The source of starch for the IMO product is maize.

The starch derived from maize is hydrolysed using the enzymes, amylase and pullulanase to produce high maltose syrup. This syrup is further enzyme treated with transglucosidase to convert α 1→4 glycosidic linkages to α 1→6 glycosidic linkages.

Transglucosidase catalyses both hydrolytic and transfer reactions. The transfer occurs most frequently to hydroxyl group 6 of the glucose molecule, producing isomaltose from D-Glc, or panose [α-D-Glc-(1→6)-α-D-Glc-(1→4)-D-Glc] from maltose. As a result of transglucosidase reactions, the malto-oligosaccharides are converted into isomalto-oligosaccharides resulting in a class of oligosaccharides containing a high proportion of glucose moieties linked by α-D-1,6 glucosidic linkages.

Yeast is added to this saccharide syrup to ferment the easily fermentable mono and disaccharides leaving the other non-fermentable saccharides which are the components of the IMO preparation. The yeast cells are removed by filtration while the ethanol produced from the fermentation is removed by evaporation during subsequent purification and concentration steps. Purification and concentration includes decolouration using activated carbon and ion-exchange resins. As stated by the Applicant, all the enzymes and chemicals used in the IMO production are permitted processing aids and meet the identity and purity standards in Schedule 3.

The manufacturing process has been summarised as:

Starch + water → Starch slurry → Enzyme treatment (amylase and pullulanase) →

Liquescent starch → Further different enzyme treatment (transglucosidase) →

Saccharification → Decolouration (activated carbon) & filtration →

Desaltation & removal of proteins (ion exchange resin) → Concentration →

Drying → Final IMO product

The Application contains a schematic of the IMO production process which is provided in Figure 2.

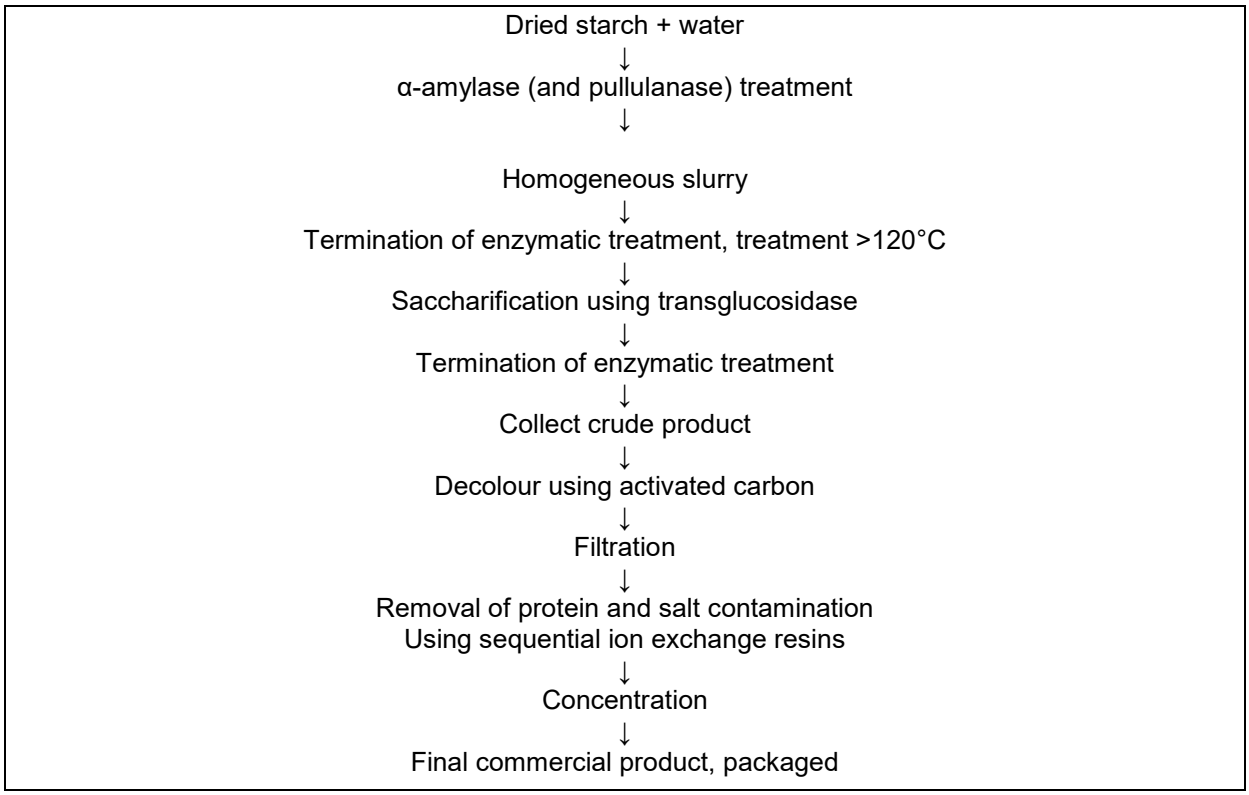

Figure 2: Schematic of production of IMO (adapted slightly from the Application)

2.3.1 Specification of isomalto-oligosaccharide

There are no specifications for IMO in Schedule 3 in the Code i.e. in any of the primary (section S3—2) or secondary sources (section S3—3) or the individual specifications sections S3—5 to S3—34. Therefore, a new individual specification for IMO is required for addition to Schedule 3.

The Applicant proposed an IMO specification in Appendix 13 of the Application as well as a product profile and a certificate of analysis for its commercial IMO preparation. The proposed specification suggested ranges for the different DPs (i.e. DP1 0–5%; DP2 20–38% etc.) for their IMO product. However, inclusion of such ranges is not appropriate for a regulatory specification that may not suit all possible IMO preparations, and serves no regulatory or safety purpose. Therefore, range limits for individual DPs within the IMO preparation were not included in the specification proposed by FSANZ for inclusion in the Code.

However, FSANZ proposed a requirement that at least 55% of the oligosaccharides present must have a degree of polymerisation of 3 or more, as the toxicological and nutritional assessment undertaken by FSANZ is based on the Applicant's IMO profile (Table 2).[1]

FSANZ proposed an IMO specification in the draft variation for the call for submissions (Attachment C).

[1] This % is based on the Applicant's figures for DP1 plus DP2 (43%), which leaves 57% as DP 3 and above. This was reduced slightly to 55% to allow some flexibility. This ensures the mono and disaccharides content is controlled to be kept as low as possible in the IMO product.

This was written in a comparable way to the specification for isomaltulose (section S3—15) for consistency in the Code, and included the following elements:

(a) chemical structure—IMO is a mixture of glucose oligomers with α 1→6 glycosidic linkages that include isomaltose, panose, isomaltotriose, isomaltopentaose and various branched oligosaccharides;
(b) description—a white crystalline powder or transparent clear pale yellow coloured syrup;
(c) IMO content (dry weight)—not less than 96% (powder) and not less than 75% (syrup);
(d) oligosaccharides—not less than 55% with a degree of polymerisation of 3 or more;
(e) glucose (dry weight)—not more than 5%;
(f) moisture—not more than 4% for the powder, not applicable for syrup;
(g) ash (dry weight)—not more than 0.3%.

Although proposed by the Applicant, FSANZ considered there was no need to include limits for lead and arsenic, as there are generic limits already set in the Code (section S3—4), and such small amounts in IMO are likely to make only a minor contribution to the food supply.

A submission in relation to the proposed IMO specification was received. This submission highlighted the need for consistency in domestic and international regulations, and alerted FSANZ to the draft Food Chemicals Codex (FCC) IMO specification, released in December 2016. Some aspects of the FCC draft specification are quite different to the specification proposed by FSANZ, and also to other international IMO specifications. However, it is important to note that the FCC specification is still in an early draft and will not be finalised before FSANZ needs to complete the assessment of A1123.

In response to the submission, FSANZ further considered the proposed IMO specification. Advice was sought from the Applicant, the submitter and another major supplier of IMO so that the final specification is robust, ensures the safety of food containing IMO, and that there are no unreasonable specification requirements that could be barriers to IMO producers in general.

As a result of the further consideration and consultation, FSANZ revised the proposed % content of IMO required in the preparation (dried powder). There is some variation in the IMO content required in international IMO specifications. Some IMO producers have a very pure product, including the Applicant who included two relevant documents in their Application; i.e. Appendix 13 proposed a draft specification of at least 98% IMO content, whereas Appendix 12 indicated various carbohydrate, glucose and IMO content. However, the majority of overseas specifications set a level of at least 90% IMO content (dried weight). Therefore, FSANZ's proposed content of at least 96% IMO has been amended to the generally accepted limit of at least 90% (dried weight), which provides greater consistency of specifications. The remaining 10% (or less) in the IMO preparations would include various other carbohydrates including glucose. The Applicant was consulted and advised of this amendment.

In addition, the Applicant also requested a change in the moisture content of IMO from 4% to 5%. The Applicant noted specifications from various IMO suppliers sourced recently indicate 4% may be too difficult to achieve. This level has also been amended in the FSANZ specification and was supported by the Applicant.

Therefore, to ensure greater consistency with domestic and international regulations, the amended specification (Attachment A) is:

(a) chemical structure—IMO is a mixture of glucose oligomers with α 1→6 glycosidic linkages that include isomaltose, panose, isomaltotriose, isomaltopentaose and various branched oligosaccharides;

(b) description—a white crystalline powder or transparent clear pale yellow coloured syrup;
(c) IMO content (dry weight)—not less than 90% (powder) and not less than 75% (syrup);
(d) oligosaccharides—not less than 55% with a degree of polymerisation of 3 or more;
(e) glucose (dry weight)—not more than 5%;
(f) moisture—not more than 5% for the powder, not applicable for syrup;
(g) ash (dry weight)—not more than 0.3%.

2.3.2 Stability of isomalto-oligosaccharide in food

IMO preparations have been determined to be stable over a wide pH range (2–10). Information in the Application indicates that IMO is stable (>99%) at pH 2 when stored for one year at 4°C, 25°C and 45°C.

No information has been provided or located that addressed the stability of IMO when added to food. However, IMO has been approved as an ingredient to be added to a wide range of foods in several countries for a number of years so there is an expectation that both the IMO suppliers and end users of IMO have a good understanding of how IMO can be added to different food matrices and its stability in such foods.

2.4 Food technology conclusion

IMO has been assessed as an ingredient, albeit a novel food ingredient, and not as a food additive. This is because it is proposed to be used at reasonably high concentrations in food and not to perform exclusively technological purposes in the food like a food additive. When IMO is used as a novel food ingredient, to replace sugars in the production of a food, it meets the stated purpose of a bulk filler. Based on the Applicant's reported composition of IMO (i.e. lower levels of mono- and di-saccharides) and FSANZ's proposed specification, it could be used as a sweetener with approximately 60% sweetness compared to sucrose.

There are currently no specifications for IMO within Schedule 3, so FSANZ has prepared a new specification (as above) for the Code. It is written in a similar way to the current specification for isomaltulose (section S3—15) for consistency in the Code. The FCC is included as a primary source listed in section S3—2 (1)(c), so if the draft IMO specifications were adopted by FCC in the future, they would be referenced in the Code as an alternative specification.

HPLC methods are available to identify and quantify the different oligosaccharides that make up an IMO preparation.

3 Hazard assessment

3.1 Scope of the current hazard assessment

The aims of the current assessment were to:

- review all of the available data on the toxicokinetics and toxicology of IMO to determine its safety as a novel food
- if appropriate, establish a health based guidance value for IMO.

3.2 Evaluation of submitted data

FSANZ has assessed the submitted evidence on the safety of IMO including studies on absorption, acute toxicity, repeat-dose toxicity, genotoxicity and human tolerance. The submitted data are considered suitable to assess the potential hazard of IMO.

Since the metabolic fate of carbohydrate polymers such as IMO is well known, toxicokinetic studies are considered to be unnecessary.

Studies in experimental animals include acute and chronic studies by appropriate routes of administration. No carcinogenicity studies have been conducted in animals.

This is not considered to be a significant omission because IMO, due to its molecular size and composition, is considered unlikely to be genotoxic. There is no evidence from subchronic and chronic repeat-dose studies that IMO is likely to cause neoplasia by a non-genotoxic mechanism. No developmental or reproductive toxicity studies have been conducted in animals, but this is also not a significant omission, because there is no systemic exposure to IMO other than glucose, short-chain fatty acids and hydrogen; i.e. normal products of dietary carbohydrates.

Studies in humans include single-dose and repeat-dose tolerance studies, and information on sensitive subpopulations, allergenic potential, and history of safe use.

3.3 Metabolism

IMO consists of both digestible and non-digestible saccharides.

In contrast to α-D-(1,4) glycosidic linkages, the α-D-(1,6) glycosidic linkages in IMO are not enzymatically hydrolysed by salivary or pancreatic α-amylase. However, digestion of short chain oligosaccharides, especially DP2 and DP3, by human sucrase-isomaltase complex and other hydrolytic enzymes does occur, albeit not very efficiently in the small intestine (Kaneko et al. 1995). This enzymatic hydrolysis releases glucose, which is absorbed into the systemic circulation. Since IMO is not efficiently converted to glucose in the small intestine, it is anticipated that the majority (~60–70%) of the ingested IMO will pass unchanged into the colon where microbial fermentation will give rise to short-chain fatty acids, hydrogen, carbon dioxide and methane (Goffin *et al.* 2011, Oku and Nakamura 2002, 2003).

3.4 Genotoxicity studies

As anticipated from IMO's molecular size and composition, no evidence of bacterial reverse mutations was found in an Ames test, using *Salmonella typhimurium* strains TA98, TA100, TA 1535, and TA 1537, and *Escherichia coli* strain WP2uvrA, with or without S9 fraction. IMO did not induce chromosomal aberration in Chinese hamster lung (CHL) cells (Kaneko *et al.* 1990).

3.5 Studies in Experimental Animals

3.5.1 Acute dose toxicity studies

Single-dose rat study (Kaneko et al. 1990)

The acute toxicity of IMO was investigated in 5-week old Jcl:Wistar male rats, ranging in bodyweight from 115 to 142 g. Rats, 6/dose, were given a 60% (w/w) solution of IMO-900 by oral gavage after overnight fasting. Dose levels were 16, 22, 31 or 44 g IMO/kg bw. Scheduled termination was after 14 days of observation.

There were two unscheduled deaths, both in rats in the 44 g/kg bw group and both occurring within 24 hours of dosing. Clinical signs at the high dose included polypnoea and prone position. Surviving rats recovered from these clinical signs within 24 hours. Diarrhoea was observed in the first 48 hours at 'moderate' and high dose levels.

On necropsy the rats that died within 24 hours had no specific lesions. There were no treatment-related changes in bodyweight gain in surviving rats, and no lesions at scheduled necropsies. The authors concluded that the acute LD50 of IMO is greater than 44 g/kg bodyweight.

The clinical signs described are consistent with the very large dose of IMO causing death by a physical rather than a toxicological mechanism. The highest administered dose in rats (44 g/kg bw) would be the equivalent of a 70 kg human receiving a bolus dose of 3 kg directly into the stomach.

3.5.2 Repeat dose tolerance studies

35-day dietary study in rats (Kaneko et al. 1992)

Groups of male Sprague-Dawley rats, 8/group, were fed diets containing different carbohydrates for 35 days, starting from 5 weeks of age. The control diet contained 60.7% (w/w) corn starch but the four test diets, contained 40.7% corn starch and 20% of either IMO, sucrose, maltose or fructo-oligosaccharide (FO). All other ingredients of the diets were the same. Parameters measured in the study included body weights, food intake, water intake, selected organ weights, serum and liver lipids, and maltase and isomaltase activities of jejunal mucosa. The organs weighed were liver, kidneys, stomach, small intestine, caecum, colon and retro-abdominal adipose tissue. Caecal contents were also weighed.

The rats fed the diet containing 20% IMO had significantly lower group mean final bodyweights and group mean bodyweight gain when compared to the group on the sucrose diet, although there were no significant differences in those parameters between the 20% IMO group and the control group, the 20% maltose group or the 20% FO group.

The group mean food intake of the 20% IMO group was 95% that of controls which was not a statistically significant difference. However, food utilisation efficiency of the 20% IMO group was significantly lower than that of controls (93%). Group mean relative liver weight of the 20% IMO group was not significantly lower than that of controls. The group mean serum triglyceride level of the 20% IMO group was significantly lower (74%) than that of the control group. However group mean levels for other lipid classes measured in serum and liver of the 20% IMO group were comparable to those of the control group. The activities of maltase and iso-maltase in the jejunal mucosa of the 20% IMO group were also comparable to those of controls.

It was concluded that the differences observed between the 20% IMO group and the control group were reversible metabolic adaptations and that there were no observed adverse effects of 20% IMO in the diet.

Although this study was not a toxicity study, the absence of observed toxicological effects in the measured parameters, at a high dietary concentration, is noteworthy. Food consumption was not stated and the dose of IMO consumed by the rats was not estimated.
Assuming a mean daily food consumption of 15 g at 5 weeks and 30 g at 10 weeks, and bodyweight for a typical male Wistar rat increasing from 125 at 5 weeks to 350 g at 10 weeks of age, daily intake is likely to be 3 g/rat at 5 weeks and 6 g/rat at 10 weeks, and 24 g/kg bw/day at 5 weeks declining to 17 g/kg bw/day at 10 weeks.

Five-week dietary study in rats (Sung et al. 2004)

Young male Sprague-Dawley rats, weighing approximately 190 g at study start, were assigned to five study groups of nine rats each. The group designations were control, IMO, fructooligosaccharide (FO), chicory inulooligosaccharide (CIO) and chicory inulin (CI).

The diets of the treatment groups were supplemented with IMO, FO, CIO and CI respectively at 6% w/w, partially replacing the sucrose content of the control diet. For the IMO group, the level of dietary supplementation with IMO was equivalent to 3 g IMO/kg bw/day. All diets, including the control diet, were high in cholesterol (1%) and contained equal amounts of other dietary components.

Rats were maintained on the diets for five weeks. Diets were provided *ad libitum* for the first week, and then proportionally to the food consumption of the FO group, which had the lowest food consumption in the first week.

Rats were individually housed under controlled conditions of temperature, humidity, and water was provided *ad libitum*. Body weights and food consumption were measured every two days. Faeces were collected over the last four days of the in-life phase; faecal weight and moisture content was measured, and faecal cholesterol, total steroid, triglyceride and bile acid contents were determined. Blood was collected from the abdominal aorta at termination and plasma levels of glucose, total cholesterol, HDL cholesterol, and triglycerides were determined. Liver was removed and weighed at termination and total cholesterol and triglycerides were determined in liver tissue.

Dietary exposure to 6% IMO had no significant effects on bodyweight gain, food conversion, relative liver weight, plasma glucose, plasma cholesterol, liver cholesterol, liver triglyceride, faecal cholesterol, faecal total steroid, or faecal bile acids. Mean group faecal triglyceride was higher for all the treated groups than for the control group.

While this study was a tolerance study rather than a toxicity study, the absence of adverse effects at a high dietary exposure of 3 g/kg bw/day is informative to the hazard assessment.

Six-week dietary study in rats (Day and Chung 2004)

Young male Sprague-Dawley rats, approximately 8 weeks old and with a mean bodyweight of 270 g, were assigned to four groups, with 5 or 6 rats in each group. The control group were fed a standard rat chow. The treatment groups were fed rat chow supplemented with IMO to 5%, 10% or 20%. These diets were equivalent to 0, 5, 10 and 20 g IMO/kg bw/day. Rats were maintained on the diets for six weeks. Food intake and bodyweight were measured twice weekly. At scheduled termination, the weights of heart, spleen, kidney, lungs, caecum, brown adipose tissue and white adipose tissue were measured.

No significant differences were found in food intake, although there was a positive trend towards a dose-related increase in food intake. There was a dose-related increase in caecum weight, attributed to an increase in the population of bacteria responsible for fermentation. There was a dose-related decrease in abdominal fat.

No adverse effects of dietary exposure to IMO, at up to 20% of the diet, on weight gain, or organ weights, were reported. A dose-related increase in the weight of the caecum is likely to be physiological, reflecting the greater amount of fibre in the diet. The authors concluded that IMO-supplemented food is non-toxic and may reduce the deposition of fat.

This study was limited in scope of design and/or reporting. It appears that the IMO was added to the standard rat chow by weight rather than used as a substitute for other carbohydrates. Thus, the rats did not consume diets that were in other nutritional respects the same.

Rather, consumption of the IMO would have led to relatively lower consumption of other dietary components, e.g. lipids. This confounds interpretation of the decrease in abdominal fat. Haematology, clinical chemistry and histopathology were not conducted.

Twelve-month study of IMO administered in water to rats (Kaneko et al. 1990)

Male Wistar rats, five weeks old at the start of the study, were assigned to two groups of 32 rats/group. They were housed under standard controlled conditions, at two rats/cage for the first three months and 2 rats/cage thereafter to study termination at 12 months. Commercial rat feed was provided *ad libitum*. The control rats were supplied with tap water, while the treated group was provided with water in which an IMO powder had been dissolved at a rate of 3%.
The treated water was changed at 24 to 48 hour intervals, and water consumption was measured in both groups. Bodyweights were measured at 1, 3, 6, 9 and 12 months. At 1, 3, 6 and 12 months, eight rats/group were terminated for collection of cardiac blood and caecal contents, necropsy; determination of liver, kidney and spleen weights; and preservation of the jejunum for histopathology. In addition, histopathology was performed on liver, spleen and kidneys of six rats/group at the 12-month necropsy. Endpoints measured in blood were erythrocyte count, haemoglobin concentration, haematocrit, total leukocyte count, lymphocyte subset panel, and serum levels of AST, ALT, ALP, LDH, creatinine, BUN, uric acid, total cholesterol and triglycerides. Caecal contents were cultured in a range of non-selective and selective media to identify bacterial flora.

Water intake was similar between the two groups throughout the study, and the overall intake of IMO was estimated to be between 2.7 and 5.0 g/kg bw/day. The IMO group had a minimally (<4%) lower group mean bodyweight up to 6 months, but not thereafter. The treated rats terminated at 3 months had slightly higher group mean counts of all lymphocyte subsets than the controls, but there were no significant differences in lymphocyte counts between the two groups at later time points. There were very few statistically significant differences in haematological or serum chemistry values, and those observed were restricted to one time point each and therefore unlikely to be treatment-related. There were no significant differences in absolute or relative organ weights, and no treatment-related findings on gross necropsy or histopathology. Consistently, there were increased populations of *Bifidobacteria* and markedly suppressed populations of *Clostridia* in the caeca of treated rats compared to control rats.

The results of this study show that chronic intake of a high dose (2.7 to 5 g/kg bw/day) has no adverse effects in Wistar rats. Although IMO was administered in drinking water rather than in food, this study is informative to the hazard assessment. There is no reason to suppose that the food matrix would significantly alter the availability of such a high level of IMO to digestive and fermentation processes in the intestines, and administration in the water had the advantage that a high dose of IMO could be administered without reducing the intake of other nutrients in the diet.

3.5.3 Carcinogenicity studies

No carcinogenicity studies of IMO were available. Because there is no evidence that IMO is genotoxic or causes lesions associated with cellular proliferation, carcinogenicity studies are not considered to be essential.

3.5.4 Developmental toxicity studies

No developmental or reproductive studies of IMO were available. Because there is no systemic exposure to any xenobiotic, effects on developmental or reproductive parameters would not be anticipated.

3.5.5 Other studies in animals

Ten-day dietary study in rats (Ohta et al. 1993)

Male Sprague-Dawley rats were used in a series of three experiments to determine the effects of dietary oligosaccharides on absorption of calcium (Ca), magnesium (Mg) and phosphorus (P). Of the three experiments, only the third is summarised here because it was the only study that involved use of IMO. Rats, four weeks old and in the range 100–110 g bodyweight at the start of the study, were assigned to five groups. There were six rats in the control group and seven in each of the four treatment groups.

The control diet contained 10% sucrose w/w, of which 5% w/w was replaced with IMO, galactooligosaccharide (GOS), raffinose (RF) or FOS in the treatment groups. The diets contained the same levels of all other ingredients including Ca, Mg and P. The study duration was 10 days. Faecal and urinary excretion of Ca, Mg and P were measured over the last four days of the study. At the end of the study, rats were terminated for collection of the caecum.

The pH of the caecal contents, and concentrations of acetate, propionate, butyrate, D-lactate and L-lactate were measured. Inclusion of 5% w/w IMO in the diet had no effect on absorption of Ca, Mg or P. This was in contrast to GOS, RF and FOS, all of which enhanced absorption of the minerals. There was a significant correlation between mineral absorption and L-lactate concentration in the caecum.

This study was not a toxicology study and identified few endpoints of relevance to hazard assessment. The tolerability of 5% w/w IMO in the diet is consistent with other rat studies that show that this level of dietary IMO is not associated with adverse effects in rats.

Dietary study in diabetic rats (Chai and Rhee 2001)

Male Sprague-Dawley rats, weighing approximately 150 g at the start of the study, were assigned to five groups, 10/group. Two control groups were fed a rat diet without added oligosaccharides, while the three treatment groups were fed diets in which 10% of the starch in the control diet was replaced with 10% xylooligosaccharide (XO), IMO or FOS by weight. Groups were maintained on their respective diets for 4 weeks. After 4 weeks, diabetes was induced in the second control group and the three treatment groups by intravenous injection of 50 mg/kg bodyweight streptozotocin. All groups were then maintained on their respective diets for a further 4 weeks, after which they were terminated for collection of blood, weighing of selected organs, and determination of the activities of intestinal maltase, sucrase and lactase.

No significant differences were observed in group mean values for body weight, food intake, food utilization efficiency, or relative liver, kidney, and small intestine weights between IMO-treated and diabetic rats on the control diet. The group mean weight of the caecum, relative to body weight, was increased in the IMO diabetic rats when compared to the diabetic control rats.

The group mean blood glucose was significantly lower in the IMO group than in the diabetic control group at 1, 2 and 4 weeks after diabetes was induced, and the response to the glucose tolerance test was also significantly closer to that of the non-diabetic group. Group mean values in the IMO group for serum cholesterol and triglycerides were not significantly different to those of diabetic controls, and nor were activities of intestinal maltase, sucrase and lactase.

Data presented from this study are largely limited to measurements made after diabetes mellitus was induced by administration of streptozotocin, and are not representative of normal healthy animals. This limits the value of this study to the hazard assessment of IMO.

The inclusion of 10% IMO in the diet is not expressed in mg IMO/kg bw/day during the pre-streptozotocin phase of the study. It may be surmised by comparison with the study of Sung *et al.* (2004) that the IMO intake in this study was in excess of 3 g/kg bw/day, with no reported adverse effects.

3.6 Human tolerance studies

Single-dose study (Oku and Nakamura 2003)

Healthy young adult volunteers, nine men and 29 women, participated in an assessment of the digestibility of three oligosaccharides by measurement of breath hydrogen gas.

Subjects were selected for low lactase activity as determined by breath hydrogen gas after lactose ingestion, and for tolerance of ingestion of bolus doses of FOS at up to 30 g without developing diarrhoea. Overnight fasting prior to ingestion of the test substances, controlled diets of fully digestible carbohydrates, and prohibition of smoking, sleeping or vigorous exercise during the breath hydrogen measurement period were included in the study design to prevent confounding effects on breath hydrogen.

The test substances were FOS, galactosyl-sucrose (GS) and IMO (maximum percentage of oligosaccharides with DP ≤ 3 was 69.6%, see table in Appendix 1). Each test substance was consumed, dissolved in 150 mL of tap water, over less than two minutes. The different challenges were separated by 4 to 7 days to ensure complete elimination of the previous challenge. FOS and GS were tested at bolus doses of 10 and 20 g, whereas IMO was tested at 10, 20 and 40 g. In contrast to FOS and GOS, IMO did not cause a significant increase in breath hydrogen gas at 10 g or 20 g. A slight increase in breath hydrogen gas was observed following ingestion of 40 g IMO. Ingestion of ≥ 10 g FOS resulted in abdominal distention and borborygmi in all subjects, and flatulence in some subjects. Some subjects experienced the same symptoms following ingestion of 20 g GS. In contrast, IMO did not cause any abdominal symptoms in any subjects, even at a dose of 40 g. The authors concluded that IMO, unlike FOS and GS, is readily digested by enzymes in the small intestine. It may be more accurate to conclude that in contrast to FOS and GS, which are nondigestible carbohydrates, IMO is partially digestible in the small intestine.

It may be concluded from this study that IMO is well tolerated by healthy human subjects at a bolus dose of 40 g and is partially digestible in the small intestine. Because of the long 'wash-out' period between administrations, this is effectively a single-dose acute study at each dose level. The authors also cite an earlier study by Oku and Okazaki (1999)[2] that showed that a single dose of IMO of 1.5 g/kg bodyweight does not cause diarrhoea in humans[3].

Eight-day dietary study (Bouhnik et al. 2004)

The purpose of this study was to determine the bifidogenic potential of nondigestible carbohydrates (NDCHs). Participants were healthy volunteers of both sexes, between 18 and 54 years of age. IMO was used only in the first phase of this study, which was a pre-screening phase in which 64 volunteers were assigned to 8 groups of 8 subjects/group.

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2 Oku T and Okazaki M (1999). Effect of single and divided ingestion of the nondigestible oligosaccharide 'galactosyl-sucrose' on transitory diarrhoea and laxative threshold in normal female subjects. *Journal of Japan Society of Nutrition and Food Science* 52: 201-208. In Japanese.

3 The earlier study cited by Oku and Nakamura (2003), has not been reviewed by FSANZ because it is not in English. The study is also cited by Health Canada (See footnote 12 in the Approval Report).

The pre-screening phase was performed over 15 days, during which subjects consumed their normal daily diet, excluding any food products containing any of the NDCHs under study or any fermented dairy products containing viable bifidobacteria. From Day 8 to Day 15 of the study, the subjects consumed 5 g of placebo or a NDCH after both lunch and dinner. The NDCH consumed was short-chain FOS, soybean oligosaccharide, galactooligosaccharide, resistant starch, lactulose, long-chain inulin or IMO.

Digestive tolerance was evaluated daily by grading excess flatus, bloating, borborygmi and/or abdominal pain, and recording frequency and consistency of stool. Stools were collected for bacteriological analysis on Day 8 (prior to introduction of placebo or NDCH) and Day 15.

There were no significant differences in the frequency or severity of digestive symptoms between placebo and any of the seven test articles, and no instances of diarrhoea in any of the groups. IMO, together with long-chain inulin and lactulose, was assessed as being non-bifidogenic. In this study, 5 g of IMO twice daily for 8 days was well tolerated by eight healthy volunteers.

Ten- to 14-day dietary study (Kohmoto et al. 1988)

Two groups were used in this study. One group comprised six adult men ranging in age from 26 to 48 years, and the other group comprised five men and 13 women ranging in age from 50 to 93 years. The older group had been hospital patients and were described as ‘senile persons’. IMO 13.5 g/day, was administered in either 50 g coffee jelly or 70 g mizuyokan jelly. Mizuyokan jelly is based on red beans. The type of jelly in which the IMO was consumed was alternated every three days. The first, younger group consumed IMO in jelly for 10 days and the second group consumed it for 14 days.

None of the 24 subjects developed diarrhoea. Two people experienced an initial transient increase in flatulence, although it is not specified in which group the two people were, or which jelly they were consuming at the time.

This study was not primarily designed as a human tolerance study, but as a study of the bifidogenic potential of IMO. The method(s) of assessing gastrointestinal tolerance are not stated, and the results regarding gastrointestinal tolerance are mentioned, with little detail, only in the Discussion. However the findings indicate that 13.5 g/day of IMO for 10 to 14 days, administered once daily, resulted in minor transient gastrointestinal symptoms at most.

3.6.1 Other human studies

Four-week study of administration of IMO in water (Wang et al. 2001)

This study was conducted on 20 haemodialysis patients, eight men and 12 women, ranging in age from 44 to 80 years. The purpose of the study was to determine whether IMO was beneficial in the treatment of severe constipation and whether it had beneficial effects on the blood lipid profile. The IMO used in this study had a maximum percentage of oligosaccharides with DP ≤ 3 of 63% (see table, Appendix 1).

Both chronic constipation and hyperlipidaemia are common complications in haemodialysis patients, and to meet the inclusion criteria of this study, subjects had to have a history of chronic constipation, and to have not used laxatives for two weeks. IMO, 30 g/day, was consumed for four weeks in two daily doses of 15 g dissolved in warm water. All subjects completed the study and the majority of subjects reported that IMO had a beneficial effect on constipation.

However, there were statistically significant increases in the incidences of diarrhoea, abdominal distension, tormina, borborygmi and spasm, as compared to the two weeks before IMO was consumed and the four weeks after cessation of IMO consumption.

None of these adverse effects were so severe as to cause the patients to drop out of the study. IMO consumption led to decreased blood total cholesterol and triglycerides, and an increase in HDL-cholesterol.

This study was primarily a therapeutic efficacy study rather than a tolerance study, and was conducted in haemodialysis patients, presumably suffering from chronic renal insufficiency, and who suffered chronic constipation. Therefore the study is of limited relevance to the assessment of tolerance of IMO by healthy individuals.

However the results suggest that IMO is not as extensively digested in the small intestine as Oku and Nakamura (2003) concluded, because the gastrointestinal effects are consistent with undigested IMO reaching the large intestine in quantities exceeding the fermentation capacity of the large intestinal flora.

3.7 Sensitive human subpopulations

3.7.1 Infants

Breast milk contains 7 to 12 g/L oligosaccharides, a high level relative to other mammals (Boehm and Stahl 2007). More than 100 different oligosaccharides and oligosaccharide-like structures have been found in breast milk. It is therefore predicted that addition of oligosaccharide mixtures would be well tolerated by infants (Vandenplas 2002). The current Application does not include the addition of IMO to infant formula products[4], infant foods or to formulated supplementary food for young children.

3.7.2 Sucrase-isomaltase deficiency (Cohen 2016; review)

Deficiency of the intestinal enzyme sucrase-isomaltase results in inability to digest sucrose, maltose, isomaltose, isomaltulose or starch. Sucrase-isomaltase is a glycoprotein synthesized in enterocytes (epithelial cells) of the small intestine. Sucrase-isomaltase is transported to the apical cell surface of enterocytes lining the intestinal villi, and cleaved to its mature subunits, sucrase and isomaltase, by pancreatic proteases.

Congenital sucrase-isomaltase deficiency was first recognised in 1960, in children who presented with chronic diarrhoea, mild steatorrhoea, irritability, and vomiting after consuming sucrose. Chronic complications of the condition included dehydration, metabolic acidosis, failure to thrive, developmental delay, hypercalcaemia and renal calcinosis. Seven phenotypes are currently recognised. Some are inherited as autosomal recessive disorders while others show compound heterozygote inheritance. There is now strong evidence that heterozygous carriers experience some symptoms including diarrhoea, abdominal pain and bloating after consuming sucrose (Cohen 2016). The prevalence of congenital sucrase-isomaltase deficiency is estimated to be in the range of 0.05% to 0.2% in children of European descent (Geng et al. 2014).

There is some evidence that disorders that are associated with villous atrophy in the small intestine may represent examples of acquired or secondary sucrase-isomaltase deficiency.

[4] Since the Applicant indicated no intention for formulated supplementary food for young children or foods for infants to contain added IMO, FSANZ has taken “foods for infants” to include infant formula products.

Examples include coeliac disease, Crohn's disease, allergic enteropathy, sprue (tropical or non-tropical), and enteropathy secondary to chemotherapy or radiotherapy. The prevalence of acquired sucrase-isomaltase deficiency is unknown, and it may be underdiagnosed (Cohen 2016).

The mechanism in sucrase-isomaltase deficiency is that undigested sugar in the intestinal lumen causes osmotic diarrhoea. Children are more susceptible to this effect, because of the lower luminal capacity of the small intestine and also the shorter large intestine which reduces the opportunity for reabsorption of liquid. Consequently, some patients report that symptoms improve with age (Cohen 2016).

It can be reasonably predicted that individuals with congenital or acquired sucrase-isomaltase deficiency would be intolerant of IMO in the diet.

3.8 Potential for allergenicity

IMO is manufactured from maize, which is not one of the major allergenic foods.

3.9 History of safe human use

IMOs are naturally occurring components in honey, miso, sake and soy sauce and have therefore been consumed by humans, particularly in Asian countries, for hundreds of years. The annual per capita consumption of IMO in Japan from these sources has been estimated to be up to 100 g (~ 0.3 g/day) (BioNeutra 2008). It is anticipated that Australian and New Zealand diets will contain appreciably less IMO than the Japanese diet.

3.10 Discussion

The submitted data are considered adequate to define the hazard of IMO.

The IMO mixtures used in the studies cited in this Hazard Assessment were not all chemically identical. There were slight to moderate differences in the proportions of oligosaccharides of different degrees of polymerisation. Higher branched oligosaccharides in IMO may be resistant to both small intestinal digestion and large intestinal fermentation and will be passed in the faeces. Therefore, the proportion of these oligosaccharides in a given IMO mixture will affect the likelihood of effects on the large intestine. However, these differences are considered to be highly unlikely to make any difference to the safety of these products, because there is no systemic exposure to any substance other than normal products of intestinal digestion and fermentation; i.e. glucose and short-chain fatty acids respectively.

Comparison of the composition of the IMO mixtures used in some of the cited studies is presented in tabular form in Appendix 1.

As anticipated the acute oral LD50 of IMO in rats was not possible to measure (>44 g/kg bw).

Six repeat-dose animal studies were submitted, of which four were regarded as sufficiently informative to contribute to the Hazard Assessment. Chronic oral intake, through diet or in drinking water of 3 to 5 g IMO/kg bw/day, showed no observed adverse effects in rats.

No evidence of genotoxicity was found in a bacterial reverse mutation (Ames) test, or chromosomal aberration assay in CHL cells.

No carcinogenicity studies of IMO in experimental animals were available. A carcinogenicity study is not considered to be necessary because of the composition and molecular weight of the test material and the lack of any genotoxicity potential. No dose-related proliferative lesions were found in repeat-dose studies of up to 12 months' duration.

No reproductive or developmental toxicity studies of IMO in experimental animals have been reported. Reproductive or developmental toxicity is highly unlikely because the products of IMO digestion and fermentation that are absorbed into the systemic circulation are the same as those absorbed following digestion or fermentation of other dietary carbohydrates; i.e., glucose from small intestinal absorption and short-chain fatty acids from large intestinal fermentation.

Higher branched oligosaccharides that are present in small proportion in IMO can be confidently predicted, on the basis of the known fate of ingested carbohydrates, to be resistant to both digestion and fermentation and to be passed in the faeces, with no systemic exposure. It is noted that there is a history of consumption of IMOs by humans, particularly in Japan, for hundreds of years and therefore for multiple generations.

A single oral dose of 40 g IMO in water caused no effects in healthy human volunteers. IMO was well tolerated in repeat-dose studies at up to 13.5 g/day. It is unclear whether a transient increase in flatulence in a small minority of volunteers was due to IMO or other novel components of the diet, and in any case transient changes in intestinal gas production are common side effects of alterations in large intestinal flora in response to changes in the diet.

The available information in the scientific literature is not sufficient to identify a threshold at which IMO might cause diarrhoea in healthy individuals. There is also inadequate information to determine what difference, if any, on gastrointestinal function might result from consuming IMO multiple times in a day rather than as a single dose.

IMO can be reasonably predicted to be well tolerated by small children. However, in common with certain other sugars and carbohydrates, IMO is likely to be poorly tolerated by individuals with congenital or acquired sucrase-isomaltase deficiency. These individuals are likely to experience adverse gastrointestinal symptoms such as pain, diarrhoea and distension, and risk management strategies will be needed to manage the risk to these individuals.

3.11 Hazard assessment conclusions

The submitted data were considered suitable for hazard assessment of IMO. IMO is not efficiently converted to glucose in the small intestine so the majority (~60–70%) of the ingested IMO would likely pass unchanged into the colon where microbial fermentation will give rise to short-chain fatty acids, hydrogen, carbon dioxide and methane.

Toxicokinetic studies are not relevant to IMO because the only systemic exposures arising from IMO are normal products of carbohydrate digestion and fermentation in the small and large intestines respectively.

IMO shows no evidence of genotoxicity. An in vivo carcinogenicity study was not submitted which is considered acceptable because IMO is not genotoxic, systemic exposure to metabolites is limited to normal products of carbohydrate digestion and fermentation in the intestines, and there was no evidence of neoplastic or pre-neoplastic lesions in the repeat dose animal studies, which included a 12-month study in rats.

IMO is in practical terms nontoxic in laboratory rats, and because there is no systemic exposure to any xenobiotic, reproductive or developmental toxicity is not anticipated.

IMO has a multigenerational history of safe use in humans. There is no evidence of adverse effects in healthy humans at doses up to 40 g; it is well tolerated at this level. It is anticipated that IMO will be poorly tolerated by individuals with congenital or acquired sucrase-isomaltase deficiency, and risk management strategies will need to be developed to manage the risk to these individuals.

Based on the reviewed toxicological data, it was concluded that in the absence of any identifiable hazard, an Acceptable Daily Intake (ADI) 'not specified' is appropriate.

4 Dietary exposure assessment

4.1 Approach to predicting dietary exposure to IMO

Dietary exposure assessments require data on concentrations of the chemical of interest in food and food consumption data. The hazard assessment concluded that in the absence of an identifiable hazard for IMO, an ADI of 'not specified' was assigned, and therefore a chronic dietary exposure assessment was not required.

Furthermore, the available information in the scientific literature for various doses of IMO in the diet is not sufficient to identify a threshold at which IMO might cause acute effects such as diarrhoea or other adverse effects due to effects of IMO on the gastrointestinal system in healthy individuals.

However, a single (bolus) dose of 40 g/day is known to be well tolerated (Section 3.12 Hazard assessment). Therefore, the approach taken, was to undertake a screening/worst case acute dietary exposure assessment based on a sugars replacement scenario, and compare a single day intake of IMO from replacement of 50% of added sugars on a 1.6 gram for 1 gram basis (based on IMO relative sweetness of ~60% compared to sucrose) to dose levels of IMO tested in the studies in the literature.

Intakes of added sugars were recently estimated for the Australian population (ABS, 2016). It was determined that intakes of added sugars could be used to predict the dietary intake of IMO, assuming in the first scenario that IMO replaced 50% of added sugars on a 1.6 gram for 1 gram basis in the foods proposed by the Applicant, and in a second scenario, in nearly all foods except infant formula products, infant foods and formulated supplementary foods for young children. FSANZ notes that this 1.6 gram for 1 gram replacement model does not fully reflect the use of IMO as a bulk filler. The dietary exposure assessment was conducted using FSANZ's customised dietary modelling computer program, Harvest. A summary of the FSANZ approach to conducting dietary exposure assessments is at Appendix 2. A detailed discussion of the FSANZ methodology and approach to conducting dietary exposure assessments is set out in the Principles and Practices of Dietary Exposure Assessment for Food Regulatory Purposes (FSANZ 2009)[5].

[5] Further detailed information on conducting dietary exposure assessments at FSANZ is provided in *Principles and Practices of Dietary Exposure Assessment for Food Regulatory Purposes* (FSANZ 2009), available at http://www.foodstandards.gov.au/science/exposure/documents/Principles%20_%20practices%20exposure%20assessment%202009.pdf.

Additional modelling was conducted to assess if the proposed levels of use of IMO expressed in g/100 g provided by the Applicant for a list of proposed foods exceeded the threshold for triggering a laxative effect advisory statement for similar sugar substitutes (e.g. isomalt) of 25 g/100 g, as set out in Standard 1.2.3.

A further calculation was undertaken based on high consumption (P97.5) of selected foods to determine whether amounts consumed in 24 hours would result in dietary exposures to IMO that would exceed the well tolerated single bolus dose of 40 g IMO discussed in the hazard assessment section (Section 3.12).

Also, as the hazard assessment refers to a (cited) study by Oku and Okazaki (1999)[6] that showed that a single dose of IMO of 1.5 g/kg bodyweight does not cause diarrhoea in humans, the predicted dietary exposures were also compared to this figure.

4.1.1 Proposed foods and concentration data used

The Applicant proposes to replace on average, 50% of sucrose/sugar with IMO as a bulk filler in a number of food categories including carbonated beverages, sports and energy drinks, soy milks, milk-based drinks, meal replacement bars, breakfast bars and confectionery at levels up to 15 g IMO/serving. The Applicant's proposed concentrations of IMO to be added to foods for each food category are set out in Table 4.

For the purposes of predicting dietary exposure to IMO for the first scenario, each of the proposed food categories were mapped to equivalent 5 digit foods group levels from the 2011–13 Australian Health Survey Food and Supplement Classification (ABS 2014)[7]. A list of the 5 digit food groups mapped to the proposed food categories can be found in Appendix 3. For the purpose of calculating the amount for each food that would provide a single bolus dose, the concentration per 100 g/mL provided by the Applicant was used.

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6 Oku T and Okazaki M (1999). Effect of single and divided ingestion of the nondigestible oligosaccharide 'galactosyl-sucrose' on transitory diarrhoea and laxative threshold in normal female subjects. *Journal of Japan Society of Nutrition and Food Science* 52: 201-208. In Japanese. This study is also cited by Health Canada (See footnote 12 in the Approval Report). The report has not been reviewed by FSANZ because it is not in English.

7 2011–13 AHS Food and Supplement Classification is available on the Australian Bureau of Statistics website at http://www.ausstats.abs.gov.au/ausstats/subscriber.nsf/0/88E72D984242CC6ACA257CD200147EFA/$File/food and supplement classification.xls

Table 4: Proposed food categories and levels of use of IMO as specified in Appendix 2 of the Application

Standard 1.3.1 Category	Standard 1.3.1 Category Description	Product	Typical serve size (as stated by Applicant)	Typical Sucrose/Sugar (as stated by Applicant) [1]	IMO concentration based on 50% replacement sucrose/sugar [2]	Theoretical maximum IMO based on 50% replacement sucrose/sugar [3]
			g/mL	per 100 g/mL	per 100 g/mL	g/serve
1	**Dairy Products (excluding butter and butter fat)**					
1.1.2	Liquid milk products and flavoured liquid milk	Flavoured Milk	250	4.7	3.8	9.5
1.2.2	Fermented milk products and rennetted milk products	Cultured dairy products	250	5.0	4.0	10.0
3	**Ice cream & edible ices**	Other frozen dairy	45	6.7	5.3	2.4
4	**Fruits and Vegetables (including fungi, nuts, seeds, herbs and spices**					
4.3.4.1	Fruits & vegetable spreads(incl jams, chutneys & related)	Jams and jellies; chutneys and relishes	20	3.1	2.5	0.5
4.3.4.2	Low joule chutneys, jams & spreads	Jams and jellies; chutneys and relishes	20	26.9	21.5	4.3
5	**Confectionery**					
5.1	Chocolate & cocoa products	Chocolate	30	43.0	34.5	10.3
5.2	Sugar confectionery	Soft candy	15	39.2	31.5	4.7
6	**Cereals and Cereal products**					
6.3	Processed cereal & meal products	Ready-to-eat (RTE), Flaked, Extruded	40	7.3	5.9	2.4
7	**Breads and Bakery Products**					
7.1	Breads and bread related products	Bread	70	3.5 (total sugar)	2.8	2.0
7.1	Breads and bread related products	Sweet yeast leavened baked goods	60	14.9 (total sugar)	12.0	7.2
7.2	Biscuits, crackers, cakes, pastries & scones	Sweet biscuits	35	22.4	17.9	6.3
7.2	Biscuits, crackers, cakes, pastries & scones	Crackers	35	0.5 (total sugar)	0.4	0.1
7.2	Biscuits, crackers, cakes, pastries & scones	Rice Crackers	25	1.8 (total sugar)	1.4	0.4
7.2	Biscuits, crackers, cakes, pastries & scones	Cakes and muffins	60	4.3	3.4	2.0
7.2	Biscuits, crackers, cakes, pastries & scones	Cakes (commercial)	60	16.1	12.9	7.7
11	**Sugars, Honey and Related Products**					
11.4	Tabletop sweeteners	Table top sweeteners (IMO with intense sweeteners & IMO alone)	2	-	1.6	0.03

Standard 1.3.1 Category	Standard 1.3.1 Category Description	Product	Typical serve size (as stated by Applicant)	Typical Sucrose/Sugar (as stated by Applicant) [1]	IMO concentration based on 50% replacement sucrose/sugar [2]	Theoretical maximum IMO based on 50% replacement sucrose/sugar [3]
			g/mL	per 100 g/mL	per 100 g/mL	g/serve
13	**Food Intended for particular Dietary Uses**					
13.3	Formula meal replacements & formulated supplementary foods	Formulated meal replacement drinks prepared	54	17.8	14.2	7.8
13.3	Formula meal replacements & formulated supplementary foods	Formulated meal replacement mixes	35	49.1 (total sugar)	39.0	13.7
13.3	Formula meal replacements & formulated supplementary foods	Formulated meal replacement biscuits and bars	60	19.3 (total sugar)	15.4	9.3
13.3	Formula meal replacements & formulated supplementary foods	Formulated meal replacement dessert	46	8.9 (total sugar)	7.1	3.3
14	**Non-Alcoholic and Alcoholic Beverages**					
14.1.2.1	Fruit & vegetable juices	Fruit & vegetable juices	250	4.1	3.3	8.3
14.1.3	Water based flavoured drinks	Regular soft drinks	250	7.1	5.6	14.0
14.1.3	Water based flavoured drinks	Energy drinks	250	5.7	4.5	11.3
14.1.7.2	Soy beverage, flavoured	Flavoured soy milk	250	6.0 (total sugar)	4.8	12.0
20	**Mixed foods Commercial**					
20.2.1.1	Desserts, dairy [except ice cream]	Desserts	100	7.5	6.0	6.0
20.2.6.3.1	Dips, dairy or fat based	Sour cream based dips	30	4.4 (total sugar)	3.5	1.1
20.2.2.3	Cereal products, bars	Breakfast cereal bars (snack style)	60	10.5	8.4	5.0
20.2.2.3	Cereal products, bars	Cereal bars (muesli)	40	7.9	6.3	2.5
20.2.7.1	Mayonnaise	Mayonnaise	20	2.5 (total sugar)	2.0	0.4
20.2.8.2	Soups, dry mix	Soup mix	25	6.4	5.1	1.3
		Snackfoods Extruded (hot and cold), baked and fried	35	4.9 (total sugar)	3.9	1.4

[1] Typical sucrose or total sugar (g/100g or 100mL) based on NUTTAB 2010 or from NIPs
[2] IMO equivalence value calculated based on relative sweetness of IMO ~60% vs sucrose/sugar (1.6 g IMO for 1 g of sugar) and a 50% replacement of sucrose or sugar with IMO
[3] Value derived by calculation based on 50% replacement of sucrose or sugar with IMO and serve size
- Not stated by Applicant

4.1.2 Food consumption data used

Dietary exposure to IMO from the 50% replacement of added sugars on a 1.6 gram for 1 gram basis was predicted using food consumption data from the most recent national nutrition survey (NNS) for the Australian population only, as there are no reported added sugars intakes or an added sugars dataset for the New Zealand population available. However, daily total sugars intakes for Australia and New Zealand are similar for equivalent population age groups, with differences in mean intakes across age groups ranging between 8.5–10.4 g/person/day which would be within normal daily variance of total sugars intakes. Furthermore, the major food contributors to total sugars intakes were very similar for both populations.

The food consumption data used were as follows:

- **2011–12 Australian National Nutrition and Physical Activity Survey** (2011–12 NNPAS), a component of the 2011–13 Australian Health Survey (AHS): a 24–hour recall of 12,153 Australians aged 2 years and above, with a second 24–hour recall undertaken for 64% of respondents (ABS, 2014).

The consumption data for all foods as well as the foods proposed to be replaced with 50% IMO only were included in this dietary exposure assessment.

Unlike the published report on added sugars intakes, which reported usual intake of added sugars (using the two days of data and the National Cancer Institute (NCI) Method to estimate long term 'usual' intakes), this assessment was focused on acute dietary exposure. Acute exposures are assessed based on one meal or consumption over one day. Therefore, only day 1 data from the 2011–12 NNPAS were used for this assessment.

For the acute bolus dose assessment of exposures to IMO for high consumers of individual foods, the P97.5 consumption was derived from day 1 only of the NNPAS for consumers only. Calculations were undertaken for selected foods that exceed the proposed 25 g/100 g concentration level that could potentially trigger that laxative advisory statement (chocolate, soft candy and meal replacement) and those that were high contributors to added sugars intakes (e.g. soft drinks, flavoured milks) (ABS, 2016).

4.1.3 Food composition data used

FSANZ recently published the food composition data for added sugars as a part of AUSNUT 2011–13 (FSANZ 2016). This dataset was used in the added sugars intake estimates published by the ABS (ABS, 2016). These added sugars values were also used for this assessment.

4.1.4 Population groups assessed

The hazard assessment did not identify any population sub-groups for which there were specific safety considerations in relation to IMO. However, the hazard report indicated that in common with certain other sugars and carbohydrates, IMO is likely to be poorly tolerated by individuals with congenital or acquired sucrase-isomaltase deficiency. Specific at risk groups such as those with sucrose-isomaltase deficiency were not identifiable in the national nutrition data so could not be assessed separately. Therefore, the whole population was included in the assessment. The age/sex groups reported for the dietary exposure assessment were those used for Nutrient Reference Values (NRVs) as these are the groups for which nutrient intakes are usually reported.

Mean and percentile IMO exposures were derived for the age groups listed in Table 5.

Table 5: Population sub-groups used in this assessment

Country	Survey	Population surveyed	NRV age groups analysed
Australia	2011–12 NNPAS	2 years and over	2–3 years 4–8 years 9–13 years 14–18 years 19–30 years 31–50 years 51–70 years 71 years and over 2 years and over (All ages)

4.1.5 Assumptions in the dietary exposure assessment

Assumptions made in the dietary exposure assessment were:

- New Zealand population's consumption patterns for total sugars are similar to the Australian population and therefore it is considered that New Zealand IMO dietary exposures from replacing 50% of added sugars in nominated foods will be similar to those estimated for the Australian population.

- Where an IMO level of use has been proposed for a food category, an equivalent food group from the 2011–13 Australian Health Survey Food and Supplement Classification has been mapped to the proposed food, and therefore it was assumed that all foods in this group would contain IMO.

- Where the Applicant's proposed foods only have been used in the dietary exposure assessment (first scenario), only commercially manufactured foods have been included.

- Where nearly all food categories that contain added sugars have been used in the dietary exposure assessment (second scenario), every food in every category, including commercial and homemade foods, have been included. Infant formula products, infant foods and formulated supplementary foods for young children were not included.

The assumptions for both scenarios are likely to lead to a considerable over-estimate for IMO dietary exposure, as they assume that every food in every specified food category has replaced 50% of added sugars with an equivalent amount of IMO based on its sweetness of ~60% compared with added sucrose. This is more so for the second scenario that includes nearly all foods with added sugars.

4.2 Predicted dietary exposure to IMOs for Australia

Dietary exposure assessment results for IMO (50% replacement of added sugars on a 1.6 gram for 1 gram basis) were calculated for all 'respondents' and for 'consumers' only, that is, those people in the NNS who reported consuming foods containing added sugars (85.8% for the population 2 years and above). Population statistics (mean and 97.5th percentile predicted acute dietary exposure) for each population group assessed were derived from each individual's exposures. Exposures were reported on a gram per person per day, and a gram per kilogram body weight per day basis. Where results are derived on a body weight basis, each individual's body weight as recorded in the NNPAS was used.

Major dietary contributors to the dietary exposure to IMO were also assessed (also based on day 1 survey data only).

4.2.1 Predicted dietary exposures

4.2.1.1 Scenario 1 – IMO dietary exposure from proposed food categories only

The proportion of consumers of IMO (50% replacement of added sugars on a 1.6 gram for 1 gram basis) from the proposed foods categories to all survey respondents ranged between 82.2% and 95.5% for the population groups assessed.

Based on Day 1 consumption data, the predicted mean and P97.5 dietary exposure for consumers of IMO in the proposed food categories for Australian's ranged from 13.6–38.9 g/day and 49.8–129.4 g/ day respectively across the population sub-groups assessed (Table 6). Refer to tables set out in Appendix 4 for more detailed results. When expressed on a kilogram body weight basis, the predicted mean and P97.5 acute dietary exposures were 0.2–0.9 g/kg body weight/day and 1.0–3.4 g/kg body weight/day, respectively (Table 6).

When comparing the predicted IMO dietary exposures to the well tolerated single bolus dose of up to 40 g IMO, and 1.5 g IMO /kg bodyweight/day provided in the literature (section 4.1), average (mean) consumers did not exceed either of these concentrations. However, predicted exposures for high consumers of IMO (P97.5) exceeded the 40 g single dose over the 24-hour period for all age categories. When looking at the consumption on a body weight basis, persons aged 2–30 years potentially exceeded the well tolerated single dose of 1.5 g/kg body weight/day at 1.9–3.4 g/kg body weight/day.

It is difficult to predict more specific dietary exposures to IMO given the broad range of food categories proposed to contain IMO by the Applicant. In reality it will be unlikely that all foods within each category will contain IMO and also unlikely that every consumer will select all of the foods that they consume to be the ones containing IMO on a given day. Therefore, the predicted exposures are conservative and not considered realistic because the scenario is unlikely to reflect normal consumption patterns of IMO-containing foods should permission for use be approved. The Applicant suggests that no more than two foods containing IMO would be consumed per day.

Table 6: Predicted acute dietary exposure to IMO for Australian consumers of *proposed foods only* with 50% IMO replacement of added sugar gram for gram, 2011-12 NNPAS, Day 1, by age

NRV Age group	Consumers as a % of respondents	Mean exposure		P97.5 exposure	
		g/day	*g/kg BW/day**	*g/day*	*g/kg BW/day**
2–3 years	94.3%	13.6	0.9	49.8	3.4
4–8 years	94.7%	22.1	0.9	73.5	3.0
9–13 years	95.5%	31.3	0.7	107.1	2.3
14–18 years	89.0%	38.9	0.6	127.3	2.2
19–30 years	84.7%	34.9	0.5	129.4	1.9
31–50 years	83.4%	26.3	0.3	107.4	1.4
51–70 years	82.2%	21.4	0.3	91.8	1.1
71 years & over	86.7%	17.8	0.2	74.1	1.0
2 years & over	**85.8%**	**26.6**	**0.4**	**110.1**	**1.9**

** Individual consumers' exposures are divided by their own body weight before deriving mean and P97.5 dietary exposures.*

4.2.1.2 Scenario 2 – IMO dietary exposure from all food categories

The proportion of consumers of IMO (50% replacement of added sugars on a 1.6 gram for 1 gram basis) from all foods categories except infant formula products, infant foods and formulated supplementary foods for young children, to all survey respondents ranged between 98.2% and 99.9% for the population groups assessed.

Using Day 1 consumption data, the predicted mean and P97.5 dietary exposure for consumers of IMO from all food categories (except those categories exempt) ranged from 26.2–58.3 g/ day and 85.9–184.6 g/ day respectively across the population sub-groups assessed (Table 7). Refer to Appendix 4 for more detailed results. On a body weight basis, the predicted mean and P97.5 acute dietary exposures to IMO were 0.3–1.0 g/kg body weight/day and 1.0–3.4 g/kg body weight/day, respectively (Table 7).

When comparing the predicted IMO dietary exposures to the well tolerated acute bolus dose of 40 g IMO and 1.5 g IMO /kg/body weight day, predicted mean exposures exceeded these for some age groups. For persons aged 9–50 years predicted mean dietary exposures ranged between 42.3–58.3 g/day, exceeding the acute bolus dose of 40 g 1MO; for young children aged 2-8 years their predicted mean dietary exposure of 1.7 g/kg body weight/day exceeded 1.5 g IMO /kg body weight/day. This is likely due to their smaller body weight and their higher food consumption per kilogram of body weight compared to adults (due to growth requirements). However, the hazard assessment concluded that IMO can be reasonably predicted to be well tolerated by small children.

Predicted acute dietary exposure to IMO for high consumers of IMO-containing foods (P97.5) exceeded both 40 g and 1.5 g IMO /kg/body weight/day for all age categories with levels ranging between 85.9–184.6 g/day and 1.6–5.4 g/kg body weight/day (Table 7). However, the information available in the scientific literature is insufficient to identify a threshold at which IMO might cause adverse effects such as diarrhoea in healthy individuals. This scenario includes a broader range of foods than those requested to contain IMO by the Applicant.

In reality, it is unlikely that all of the food categories included in this scenario will contain IMO should the permission for use be granted. Also, all foods within each category will be unlikely to contain IMO. Therefore, the predicted exposures are a conservative worst case scenario, and not considered realistic because the scenario is unlikely to reflect normal consumption patterns of IMO-containing foods were permission for use to be approved. As noted above, the Applicant suggests that no more than two foods containing IMO would be consumed per day. In addition, the Applicant notes that for organoleptic reasons i.e. matching the sweetness profile of sucrose, IMO is unlikely to be used alone (at the theoretical maximum sugar replacement level) in high sweetness products and instead is more likely to be used as a part of a blend of sweeteners.

Table 7: Predicted acute dietary exposure to IMO for Australian consumers of *all foods*[#] with 50% IMO replacement of added sugar gram for gram, 2011-12 NNPAS, Day 1, by age

NRV Age group	Consumers as a % of respondents	Mean exposure		P97.5 exposure	
		g/day	*g/kg BW/day**	*g/day*	*g/kg BW/day**
2–3 years	98.5%	26.2	1.7	85.9	5.4
4–8 years	99.6%	38.6	1.7	110.7	4.9
9–13 years	99.9%	51.2	1.2	141.8	3.7
14–18 years	99.6%	58.3	0.9	169.5	3.0
19–30 years	98.6%	52.4	0.7	184.6	2.7
31–50 years	98.8%	42.3	0.5	152.9	2.1
51–70 years	98.2%	34.0	0.4	131.6	1.7
71 years & over	98.4%	31.9	0.4	112.0	1.6
2 years & over	**98.8%**	**42.3**	**0.7**	**151.8**	**2.9**

** Individual consumers' exposures are divided by their own body weight before deriving mean and P97.5 dietary exposures.*
 # All foods except infant formula products, infant foods and formulated supplementary foods for young children.

4.2.2 Major food categories contributing to IMO dietary exposure

4.2.2.1 Scenario 1 – Percent Contribution of IMO from proposed food categories only

Major foods contributing to predicted IMO dietary exposure were calculated from consumers' total dietary exposure to IMO from the proposed food categories only (scenario 1).

Non-alcoholic beverages were major contributors to predicted IMO dietary exposures with 36.9% contribution (Table 8). Within this category, soft drinks were the highest contributor to total IMO exposures at 34.6%, followed by energy drinks at 2.2% and commercially prepared fruit juices at 0.1%. The cereal based products and dishes category was the next major contributor at 18.2%, with cakes and muffins contributing 10.8%, followed by milk products and dishes category with 17.7% and confectionery and cereal/nut/fruit/seed bars at 16.0%. See Appendix 5 for a full list of AHS food sub-categories.

Table 8: Major Food Group contributors to predicted IMO dietary exposure from *proposed food categories only* for Australians 2 years and over

AHS Food Group	% Contribution of IMO
Cereal based products and dishes	18.8%
Cereals and cereal products	5.8%
Confectionery and cereal/nut/fruit/seed bars	16.0%
Dairy & meat substitutes	<1%
Milk products and dishes	17.7%
Miscellaneous	<1%
Non-alcoholic beverages	36.9%
Savoury sauces and condiments	<1%
Snack foods	<1%
Soup	<1%
Special dietary foods	<1%
Sugar products and dishes	3.9%

4.2.2.2 Scenario 2 - Percent contribution of IMO from nearly all food categories

Major foods contributing to predicted IMO dietary exposure were calculated from consumers' total dietary exposure to IMO from all foods containing added sugar (scenario 2). Non-alcoholic beverages were major contributors to predicted IMO exposures with 35.1% contribution (Table 9), most likely due to the large volumes of these consumed. Within this category, soft drinks and flavoured mineral waters were the highest contributor to total exposures at 19.4%, followed by fruit and vegetable juices, and drinks at 6.2% and cordials at 5.4%. The cereal based products and dishes category was the next major contributor at 18.2%, followed by sugar products and dishes at 14.5%, milk products and dishes at 10.5% and confectionery and cereal/nut/fruit/seed bars at 9.7%. See Appendix 5 for a full list of AHS food sub-categories.

Table 9: Major Food Group contributors to predicted IMO dietary exposure from nearly *all food categories* for Australians 2 years and over

AHS Food Group	% Contribution of IMO
Alcoholic beverages	2.6%
Cereal based products and dishes	18.2%
Cereals and cereal products	3.4%
Confectionery and cereal/nut/fruit/seed bars	9.7%
Dairy & meat substitutes	<1%
Egg products and dishes	<1%
Fats and oils	0%
Fish and seafood products and dishes	<1%
Fruit products and dishes	1.2%
Legume and pulse products and dishes	<1%
Meat, poultry and game products and dishes	<1%
Milk products and dishes	10.4%
Miscellaneous	<1%
Non-alcoholic beverages	35.1%
Savoury sauces and condiments	2.7%
Seed and nut products and dishes	<1%
Snack foods	<1%
Soup	<1%
Special dietary foods	<1%
Sugar products and dishes	14.5%
Vegetable products and dishes	<1%

4.2.3 Comparison of proposed IMO levels of use against levels set in Standard 1.2.3

Standard 1.2.3 requires that foods containing certain substances (primarily polyols) above a threshold level (10 g/100 g or 25 g/100 g depending on the substance) must display a statement on the label to the effect that excess consumption can produce laxative effects. These requirements were established by Proposal P202 – Low Joule Foods. The requirement for a statement was based on evidence in humans demonstrating laxative effects from a single bolus dose of either 10 g or 25 g. The related polyol, isomalt is listed as a substance which requires an advisory statement at levels of or in excess of 25 g/100 g.

From the Applicant's proposed list of foods and levels of use of IMO as a bulk filler from 50% replacement of sugars expressed in g/100 g, there would be three foods that exceed the 25 g/100 g threshold for theoretically triggering a laxative effect advisory statement on labelling (Table 10).

Table 10: Proposed food categories and levels of use of IMO expressed in grams per 100 g/mL, which exceed 25 g/100 g

Std 1.3.1 Category	Std 1.3.1 Category Description	Product	IMO to replace 50% sucrose/sugar (per 100 g/mL)
5.1	Chocolate and cocoa products	Chocolate	34.5
5.2	Sugar confectionery	Soft candy	31.5
13.3	Formula meal replacements and formulated supplementary foods	Formulated meal replacement mixes	39.0

4.2.4 Potential exposure to IMO from high consumption of individual foods

To assess potential exposure to IMO from consumption of large amounts of a single food over 24 hours, high consumption amounts (P97.5 for consumers only) were determined for foods contributing significantly to predicted IMO dietary exposure and the 3 foods where an advisory statement could be triggered due to IMO concentrations. The resultant dietary exposure to IMO at this high level of consumption of a single food was calculated as was the amount of the food required to be consumed to reach the well tolerated acute single dose of 40 g IMO. A summary can be found in in Table 11 below (more detailed data are provided in Appendix 6).

Table 11: Predicted dietary exposure to IMO from high consumption of a single food over 24 hours and the amount needed to exceed well tolerated single bolus dose of 40 g IMO

Major foods contributing significantly to IMO exposure	Applicant's proposed concentration of IMO (g/100 g or mL)[1]	P97.5 consumption (g or mL/day)*	P97.5 exposure to IMO (g/day)*	Amount of single food to consume to reach bolus dose of 40 g IMO (g or mL)**
Soft drink	5.6	455–2080	25.5–116.5	715
Energy drink	4.5	1260–2100	56.7–94.5	890
Cake (commercial)	12.9	222–528	28.6–68.1	310
Flavoured milk	3.8	928–1640	35.3–62.3	1050
Chocolate	34.5	60–220	20.7–75.9	120
Soft candy	31.5	75–400	23.6–126.0	127

[1] IMO equivalence value calculated based on relative sweetness of IMO ~60% vs sucrose/sugar (1.6 g IMO for 1 g of sugar) and a 50% replacement of sucrose or sugar with IMO

* Range indicates the lowest and highest across the age/sex groups assessed. Does not include results from age/sex groups where there were not enough consumers to ensure a robust P97.5 consumption value.

** At the proposed concentration shown in column 2, as provided by the Applicant.

Of the major foods contributing to predicted IMO dietary exposure, and based on the Applicant's proposed use levels, high consumers (P97.5) of soft drinks, energy drinks, commercial cakes, flavoured milks, chocolate and soft candy alone would exceed the well-tolerated acute bolus dose of 40 g IMO over a 24 hour period for some of the population groups assessed.

Based on the amount of the food required to be consumed to reach the single bolus dose of 40 g IMO, it is possible that high consumers (P97.5) could reach or exceed this amount by consuming one or more of these foods in a single eating occasion or over 24 hours.

4.3 Dietary exposure assessment conclusion

FSANZ predicted IMO acute dietary exposure based on consumption data from the most recent national nutrition survey for Australia, assuming IMO replaced 50% of added sugars on a 1.6 gram for 1 gram basis for different food categories.

In the first scenario (proposed foods only), the predicted mean and P97.5 exposure for consumers of IMO ranged from 13.6–38.9 g/person/day and 49.8–129.4 g/person/day respectively across the age groups assessed. On a per kilogram body weight per day basis, the mean and P97.5 exposures were 0.2–0.9 g/kg body weight/day and 1.0–3.4 g/kg body weight/day, respectively. Predicted dietary exposures to IMO were less than the well-tolerated single dose of up to 40 g IMO and 1.5 g IMO /kg/bodyweight provided in the literature for mean exposures for all population groups assessed.

For high consumers (P97.5), predicted IMO exposure exceeded the 40 g single dose over 24 hours for all age categories. On a body weight basis, persons aged 2–30 years exceeded the well tolerated single dose of 1.5 g/kg body weight/day with predicted acute dietary exposures of 1.9–3.4 g/kg body weight/day.

In the second scenario considering nearly all foods containing added sugars, persons aged 9-50 years had predicted mean dietary exposures that exceeded the well tolerated single dose of 40 g IMO, ranging from 42.3–58.3 g/day; and young children aged 2–8 years exceeded 1.5 g IMO /kg body weight/day with a predicted mean exposure of 1.7 g/kg body weight/day. High consumers (P97.5) predicted acute dietary exposure to IMO exceeded both 40 g and 1.5 IMO /kg body weight/day over a 24 hour period for all age groups with levels ranging from 85.9–184.6 g/day and 1.6-5.4 g/kg body weight/day. However, there is insufficient scientific literature available to identify a threshold at which IMO may cause adverse effects such as diarrhoea in healthy individuals. The predicted exposures are conservative worst case scenario and not considered realistic because the scenario is unlikely to reflect normal consumption patterns of IMO-containing foods were permission for use to be approved. The Applicant suggests that no more than two foods containing IMO would be consumed per day.

Overall, the dietary exposure assessment indicated that in the first scenario that considered the proposed foods only, non-alcoholic beverages were the major contributor of predicted IMO dietary exposure with 36.8% contribution, followed by cereal based products and dishes at 18.8%, milk products and dishes at 17.7% and confectionery and cereal/nut/fruit/seed bars at 16.0%. In the second scenario considering nearly all foods containing added sugars with 50 % IMO replacement, non-alcoholic beverages were the major contributor of predicted IMO dietary exposure with 35.1% contribution, followed by cereal based products and dishes at 18.2%, sugar products 14.5%, milk products and dishes at 10.5% and confectionery and cereal/nut/fruit/seed bars at 9.7%.

Based on the Applicant's proposed use levels, major foods contributing to predicted IMO dietary exposure, and food potentially requiring an advisory statement, high consumers (P97.5) of soft drinks, energy drinks, flavoured milks, commercial cakes, chocolate and soft candy alone would exceed the well tolerated acute bolus dose of 40 g IMO over a 24 hour period for some of the population groups assessed. Hence, based on the amount of the food required to be consumed to reach the single bolus dose of 40 g IMO, it is possible that high consumers could reach or exceed this amount by consuming one or more of these foods in a single eating occasion or over 24 hours.

Given that no acute or chronic health based guidance values have been established for IMO that could be used for risk characterisation purposes, the dietary exposure assessment supports the conclusion that addition of IMO at the requested levels to the proposed food categories would not raise any public health concerns for the Australian and New Zealand populations (excluding certain individuals with sucrose-0isomaltase deficiency). In the acute dietary exposure assessment for nearly all foods, assuming that every food in every food category has replaced 50% of added sugars on a 1.6 gram for 1 gram basis with IMO, it is likely that IMO dietary exposure is considerably over-estimated. As no threshold at which IMO may cause adverse effects has been identified, IMO may be considered safe and suitable to be added to the food supply, noting the exclusion of infant formula products, infant foods and formulated supplementary foods for young children.

References

ABS (2016) National Nutrition and Physical Activity Survey, 2011–12, Consumption of added sugars. Australian Government, Canberra. http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/4364.0.55.011~2011-12~Main%20Features~Key%20Findings~1

ABS (2014) National Nutrition and Physical Activity Survey, 2011–12, Basic CURF. Australian Government, Canberra. http://www.abs.gov.au/AUSSTATS/abs@.nsf/Latestproducts/4324.0.55.002Main%20Features652011-12?opendocument&tabname=Summary&prodno=4324.0.55.002&issue=2011-12&num=&view=

ABS (2014) National Nutrition and Physical Activity Survey, 2011–12, Food and Supplement Classification. Australian Government, Canberra. http://www.ausstats.abs.gov.au/ausstats/subscriber.nsf/0/88E72D984242CC6ACA257CD200147EFA/$File/food and supplement classification.xls

BioNeutra Application for the Approval of IMO under regulation (EC) No 258/97 of the European Parliament and of the Council of 27th January 1997 concerning novel foods and novel food ingredients (2008).

Boehm G and Stahl B (2007) Oligosaccharides from Milk Journal of Nutrition 137: 847S-849S

Bouhnik Y, Raskine L, Simoneau G, Vicaut E, Neut C, Flourié B, Brouns F and Bornet FR (2004) The capacity of nondigestible carbohydrates to stimulate fecal bifidobacteria in healthy humans: a double-blind, randomized, placebo-controlled, parallel-group, dose-response relation study. *American Journal of Clinical Nutrition* 80: 1658-64

Chai Y-M and Rhee S-J (2001) Effects of Dietary Oligosaccharide on the Blood Glucose and Serum Lipid Composition in Streptozotocin-Induced Diabetic Rats. Journal of the Korean Society of Food Science and Nutrition 30(4): 710-716
(Korean with English Abstract; partial translation from Korean provided)

Code of Federal Regulations, US Food and Drug Administration, Title 21 – Food and Drugs, §184.1444 Maltodextrin, available at http://www.ecfr.gov/cgi-bin/text-idx?SID=394a4f97a63283f2de197a2fa5378aaf&mc=true&node=se21.3.184_11444&rgn=div8 Accessed on 29 August 2016

Cohen, SA (2016) Mini Review: The clinical consequences of sucrase-isomaltase deficiency. Molecular and Cellular Pediatrics 3(1): 5 http://molcellped.springeropen.com/articles/10.1186/s40348-015-0028-0

Day, DF Chung, C-H (Inventors), 2004. Isomaltooligosaccharides from Leuconostoc as Neutraceuticals. U.S. Patent and Trademark Office (USPTO); Washington, DC. U.S. Patent Application No. 20040235789, November 25, 2004.

FSANZ (2009) Principles and practices of dietary exposure asessment for food regulatory purposes. Report prepared by Food Standards Australia New Zealand, Canberra. http://www.foodstandards.gov.au/publications/Pages/Principles-and-Practices-of-Dietary.aspx

FSANZ (2014). AUSNUT 2011–13 – Australian Food Composition Database. Australian Government, Canberra
http://www.foodstandards.gov.au/science/monitoringnutrients/ausnut/pages/default.aspx

FSANZ (2016). AUSNUT 2011-13 – Food Nutrient Database. Australian Government, Canberra
http://www.foodstandards.gov.au/science/monitoringnutrients/ausnut/ausnutdatafiles/Pages/foodnutrient.aspx

Geng L, Li D-Y, Ou W, Yang Q, Fang T, Chen P, Yang M and Gong S (2014). Congenital sucrase-isomaltase deficiency: an underdiagnosed disease in Chinese children. BMC Pediatrics 14:11 doi: 10.1186/1471-2431-14-11

Goffin D, Delzenne N, Blecker C, Hanon E, Deroanne C and Paquot M (2001). Will Isomalto-Oligosaccharides, a Well-Established Functional Food in Asia, Break through the European and American Market. The Status of Knowledge on these Prebiotics. Critical Reviews in Food Science and Nutrition 51(5): 394- 409 http://dx.doi.org/10.1080/10408391003628955

Health Canada (2012) Novel Food Information – Isomalto-oligosaccharide (VitaFiber™), available at http://www.hc-sc.gc.ca/fn-an/gmf-agm/appro/isomalto-oligosaccharide-eng.php. Accessed on 30 August 2016.

Hodge HC and Sterner JH (1949) Tabulation of toxicity classes. American Industrial Hygiene Association Quarterly 10(4):93-6.

Kaneko T, Kohmoto T, Fukui F, Akiba T, Suzuki S, Hirao A, Nakatsuru S and Kanisawa M (1990) Acute and chronic toxicity and mutagenicity studies on isomaltooligosaccharides, and the effects on peripheral blood lymphocytes and intestinal microflora. Shokuhin Eiseigaku Zasshi 31(5): 394-403
(Japanese with English Abstract; partial translation from Japanese provided)

Kaneko T, Kohmoto T, Kikuchi H, Fukui F, Shiota M, Yatake T, Takaku H and Iino H (1992). Digestibility of isomaltooligosaccharides by rats and effects on serum lipids. Nippon Nōgeikagaku Kaishi 66(8): 1211-1220
(Japanese with English Abstract; partial translation from Japanese provided)

Kaneko T, Yokoyama A and Suzuki M (1995). Digestibility characteristics of isomaltooligosaccharides in comparison with several saccharides using the rat jejunum loop method. Bioscience, Biotechnology, and Biochemistry 59: 1190-1194

Kohmoto T, Fukui F, Takaku H, Machida Y, Arai M and Mitsuoka T (1988) Effect of isomaltooligosaccharides on human fecal flora. Bifidobacteria and Microflora 7(2): 61-69

Ohta , Osakabe N, Yamada K, Saito Y and Hidaka H (1993) Effects of Fructooligosaccharides and Other Saccharides on Ca, Mg and P Absorption in Rats. Nippon Eiyō Syokuryō Gakkaishi 46: 123-129
(Japanese with English Abstract; partial translation from Japanese provided)

Oku T and Nakamura S (2002). Digestion, absorption, fermentation, and metabolism of functional sugar substitutes and their available energy. Pure and Applied Chemistry 74(7): 1253-1261.

Oku T and Nakamura S (2003) Comparison of digestibility and breath hydrogen gas excretion of fructo-oligosaccharide, galactosyl-sucrose, and isomalto-oligosaccharide in healthy human subjects.. European Journal of Clinical Nutrition 57: 1150-1156

Sung H-Y, Jeoung H-J, Choi Y-S, Cho S-H and Yun J-W (2004) Effects of chicory inulin and oligosaccharides on lipid metabolism in rats fed a high-cholesterol diet. Journal of the Korean Society of Food Science and Nutrition 33(2): 305-310
(Korean with English Abstract; partial translation from Korean provided)

United States Pharmacopeial Convention (2014) Food Chemicals Codex. 9th ed, United States Pharmacopeial Convention, Rockville, MD, Steviol glycosides.
http://online.foodchemicalscodex.org/online/pub/index?fcc=10&s=0&oYr=2016&oMo=6&oDa=1

Vandenplas Y (2002). Oligosaccharides in infant formula. British Journal of Nutrition 87(Suppl.2): S293-S296

Wang H-F, Lim P-S, Kao M-D, Chan E-C, Lin L-C and Wang N-P (2001) Use of Isomalto-oligosaccharide in the Treatment of Lipid Profiles and Constipation in Hemodialysis Patients. Journal of Renal Nutrition 2: 73-79

Appendix 1: Composition of IMO mixtures used in some cited studies

Composition of IMO mixtures used in some cited studies																
Reference (alphabetical)	DP1 (%)		DP2 (%)			DP3 (%)				DP4 (%)		DP5 (%)		DP6 (%)		Other (%)
	Glu	Fru	M	IsoM	O	P	M	IsoM	O	M	IsoM	M	IsoM	M	IsoM	
Day & Chung 2004	<0.2		6.9			28.4	-	-	-	36.7		19.1		7.4		1.2 IMO
Kaneko *et al.* 1990 (acute study)	-	-	52.5			25.4				15.2						-
Kaneko *et al.* 1990 (chronic study)	-	-	38.0			25.2				23.7						-
Kaneko *et al.* 1992	-	-	-	34.4	-	12.2	-	14.7	-	-	16.2	-	-	-	-	10.6 IMO
Kohmoto *et al.* 1988	1.8	-	5.1	48.8	3.7	6.9	-	16.9	1.6	15.2						
Oku & Nakamura 2003	3.8	-	4.5	22.8	13.1	11.6	0.9	16.7	-	17.7		7.2		1.7		-
Wang *et al*. 2001	20.9	0.5	15.4	12.0	-.	29.1	3.9	2.6	-	3.2	9.9	-		-		2.5% Dex
DP = Degree of polymerization, Glu = glucose, Fru = fructose. M = malto-, IsoM = isomalto-, O = other, P = panose. Dex = dextrose																

Appendix 2: Dietary Exposure Assessments at FSANZ

A dietary exposure assessment is the process of estimating how much of a food chemical a population, or population sub group, consumes. Dietary exposure to food chemicals is estimated by combining food consumption data with food chemical concentration data. The process of doing this is called 'dietary modelling'.

Dietary exposure = food chemical concentration x food consumption

FSANZ's approach to dietary modelling is based on internationally accepted procedures for estimating dietary exposure to food chemicals (FSANZ 2009). Different dietary modelling approaches may be used depending on the assessment, the type of food chemical, the data available and the risk assessment questions to be answered. In the majority of assessments FSANZ uses the food consumption data from each person in the national nutrition surveys to estimate their individual dietary exposure. Population summary statistics such as the mean exposure or a high percentile exposure are derived from the ranked individual person's exposures from the nutrition survey.

An overview of how dietary exposure assessments are conducted and their place in the FSANZ Risk Analysis Process[8] is on the FSANZ website.

FSANZ has developed a custom-built computer program 'Harvest' to calculate dietary exposures. Harvest is a newly built program and replaces the program 'DIAMOND' that had been used by FSANZ for many years. Harvest has been designed to replicate the calculations that occurred within DIAMOND using a different software package. Harvest was used for this assessment to extract the exposure data for added sugars in foods for Australian consumers.

Further detailed information on conducting dietary exposure assessments at FSANZ is provided in *Principles and Practices of Dietary Exposure Assessment for Food Regulatory Purposes* (FSANZ 2009)[9].

A2.1 Food consumption data used

The most recent food consumption data available were used to estimate IMO exposures for the Australian population. The national nutrition survey (NNS) data used for these assessments were:

The 2011–12 Australian National Nutrition and Physical Activity Survey (2011–12 NNPAS)

The design of this survey and key attributes are set out below. Further information on the national nutrition surveys[10] used to conduct dietary exposure assessments is available on the FSANZ website.

A2.1.1 2011–12 Australian National Nutrition and Physical Activity Survey (2011–12 NNPAS)

The 2011–12 Australian National Nutrition and Physical Activity Survey (NNPAS) undertaken by the Australian Bureau of Statistics is the most recent food consumption data for Australia.

8 http://www.foodstandards.gov.au/science/riskanalysis/Pages/default.aspx
9 http://www.foodstandards.gov.au/publications/Pages/Principles-and-Practices-of-Dietary.aspx
10 http://www.foodstandards.gov.au/science/exposure/Pages/dietaryexposureandin4438.aspx

This survey includes dietary patterns of a sample of 12,153 Australians aged from 2 years and above. The survey used a 24-hour recall method for all respondents, with 64% of respondents also completing a second 24-hour recall on a second, non-consecutive day. The data were collected from May 2011 to June 2012 (with no enumeration between August and September 2011 due to the Census). Day 1 24-hour recall data for respondents were used for this assessment. These data were weighted for use in the calculation. Consumption and respondent data from the survey were incorporated into the Harvest program from the Confidentialised Unit Record Files (CURF) data set (ABS 2014).

A2.2 Limitations of dietary exposure assessments

Dietary exposure assessments based on 2011–12 NNPAS food consumption data provide the best estimation of actual consumption of a food and the resulting estimated dietary exposure assessment for the Australian population aged 2 years and above. However, it should be noted that NNS data do have limitations.

As there are no reported added sugars intakes available for the New Zealand population, an additional limitation is the assumption that added sugars intakes and the major food contributors to added sugar intakes in the New Zealand population would be similar to those in the Australian population, based on the available data for total sugar intakes.

Further details of the limitations relating to dietary exposure assessments undertaken by FSANZ are set out in the FSANZ document, *Principles and Practices of Dietary Exposure Assessment for Food Regulatory Purposes* (FSANZ 2009).

Appendix 3: Mapping of proposed foods to the 2011-13 AHS classifications

The 2011–13 AHS Food and Supplement Classification Groups at the 5 digit level mapped to the proposed food categories*

Food Group or Code	Description	Applicant's proposed foods
11	**Non-alcoholic beverages**	
113	Fruit and vegetable juices, and drinks	
11301	Fruit juices, commercially prepared	Fruit juices
11303	Fruit juices, fortified	
11304	Vegetable juices	Vegetable juices
11306	Fruit and vegetable juice blends	
11309	Fruit drink, prepared from dry powder	Beverages made up from powdered beverage pre-mix
115	Soft drinks, and flavoured mineral waters	
11501	Soft drinks, non-cola	Regular Soft drinks
11502	Soft drinks, non-cola, intense sweetened	
11503	Soft drinks, cola	
11504	Soft drinks, cola, intense sweetened	
116	Electrolyte, energy and fortified drinks	
11603	Energy drinks	Energy drinks
11604	Energy drinks, intense sweetened	
12	**Cereals and cereal products**	
122	Regular breads, and bread rolls (plain/unfilled/untopped varieties)	Bread
12201	Breads, and bread rolls, white, mandatorily fortified	
12202	Breads, and bread rolls, white, additional voluntary fortification	
12203	Breads, and bread rolls, white, not stated as to fortification	
12204	Breads, and bread rolls, mixed grain, mandatorily fortified	
12206	Breads, and bread rolls, mixed grain, not stated as to fortification	
12207	Breads, and bread rolls, wholemeal and brown, mandatorily fortified	
12208	Breads, and bread rolls, wholemeal and brown, additional voluntary fortification	
12209	Breads, and bread rolls, wholemeal, not stated as to fortification	
12210	Breads, and bread rolls, rye, mandatorily fortified	
12212	Breads, and bread rolls, rye, not stated as to fortification	
12213	Breads, and bread rolls, gluten free	
12214	Breads, and bread rolls, not stated as to major flour or fortification	
123	English-style muffins, flat breads, and savoury and sweet breads	
12305	Sweet breads, buns and scrolls, uniced, unfilled	Sweet yeast leavened baked goods
12306	Sweet breads, buns and scrolls, iced and/or filled	
125	Breakfast cereals, ready to eat	Ready-to-eat (RTE), Flaked, Extruded
12501	Breakfast cereal, corn based	
12502	Breakfast cereal, corn based, fortified	
12503	Breakfast cereal, rice based	
12504	Breakfast cereal, rice based, fortified	
12505	Breakfast cereal, wheat based	
12506	Breakfast cereal, wheat based, fortified, sugars ≤20 g/100g	
12507	Breakfast cereal, wheat based, fortified, sugars >20 g/100g	
12509	Breakfast cereal, wheat based, with fruit and/or nuts, fortified, sugars ≤25 g/100g	
12510	Breakfast cereal, wheat based, with fruit and/or nuts, fortified, sugars >25 g/100g	
12511	Breakfast cereal, mixed grain	
12512	Breakfast cereal, mixed grain, fortified, sugars ≤20 g/100g	
12513	Breakfast cereal, mixed grain, fortified, sugars >20 g/100g	
12514	Breakfast cereal, mixed grain, with fruit and/or nuts	
12515	Breakfast cereal, mixed grain, with fruit and/or nuts, fortified	
12516	Breakfast cereal, other	

Food Group or Code	Description	Applicant's proposed foods
13	**Cereal based products and dishes**	
131	Sweet biscuits	Sweet biscuits
13101	Sweet biscuits, plain or flavoured including short bread varieties	
13102	Sweet biscuits, plain with fruit or nuts	
13103	Sweet biscuits, with jam, marshmallow or other sugar-based filling	
Food Group or Code	**Description**	**Applicant's proposed foods**
13104	Sweet biscuits, cream-filled	
13105	Sweet biscuits, chocolate-coated, chocolate chip	
13106	Sweet biscuits, chocolate-coated, chocolate or cream filled	
13107	Sweet biscuits, other toppings	
132	Savoury biscuits	Crackers & Rice Crackers
13201	Savoury biscuits, wheat based, plain, energy ≤1800 kJ per 100 g	
13202	Savoury biscuits, wheat based, plain, energy >1800 kJ per 100 g	
13203	Savoury biscuits, rye based	
13204	Savoury biscuits, rice based (includes rice cakes)	
13205	Savoury biscuits, corn based	
133	Cakes, muffins, scones, cake-type desserts	
13301	Cakes and cake mixes, chocolate	Cakes (commercial)
13302	Cakes and cake mixes, sponge	
13303	Cakes and cake mixes, other types	
13304	Muffins, cake type, and muffin mixes	Muffins
19	**Milk products and dishes**	
192	Yoghurt	Cultured dairy products
19201	Yoghurt, natural, regular fat and high fat (>4 g/100g fat)	
19202	Yoghurt, natural, reduced fat	
19203	Yoghurt, natural, skim and non-fat	
19204	Yoghurt, flavoured or added fruit and/or cereal, high fat (>4 g/100g fat)	
19205	Yoghurt, flavoured or added fruit, full fat	
19206	Yoghurt, flavoured or added fruit with added cereal, full fat	
19207	Yoghurt, flavoured or added fruit, reduced fat	
19208	Yoghurt, flavoured or added fruit, low fat or skim, sugar sweetened	
19209	Yoghurt, flavoured or added fruit, low fat or skim, intense sweetened	
19210	Yoghurt, drinks, buttermilk	
19211	Yoghurt, added nutrients or other substances	
19212	Yoghurt, unspecified fat	Other frozen dairy
195	Frozen milk products	
19501	Ice cream, tub varieties, fat content >10 g/100 g	
19502	Ice cream, tub varieties, fat content 4 - 10 g/100 g	
19503	Ice cream, tub varieties, fat content <4 g/100 g	
19504	Ice cream, individual bar, stick and cone varieties, fat content >10 g/100 g	
19505	Ice cream, individual bar, stick and cone varieties, fat content 4 - 10 g/100 g	
19506	Ice cream, individual bar, stick and cone varieties, fat content <4 g/100 g	
19507	Frozen yoghurts, all types	
19508	Frozen dairy desserts, other	
196	Custards	Desserts
19601	Custard, fat content ≥ 4 g/100 g	
19602	Custard, fat content <4 g/100 g	
197	Other dishes where milk or a milk product is the major component	
19701	Dairy desserts, smooth or gelatin-based dairy desserts	Desserts
198	Flavoured milks and milkshakes	
19801	Milk, coffee/chocolate flavoured and milk-based drinks, full fat	Flavoured milk
19802	Milk, other flavoured and milk-based drinks, full fat	
19803	Milk, coffee/chocolate flavoured and milk-based drinks, reduced fat	
19804	Milk, other flavoured and milk-based drinks, reduced fat	
19805	Milk, other flavoured and milk-based drinks, not stated as to fat	
19806	Milk-based fruit drinks	

Food Group or Code	Description	Applicant's proposed foods
20	**Dairy & meat substitutes**	
202	Dairy milk substitutes, flavoured	
20201	Soy-based beverage, regular fat, flavoured	Flavoured soy milk
20202	Soy-based beverage, reduced fat, flavoured	
21	**Soup**	
212	Dry soup mix	Soup mix
21201	Dry soup mix containing meat, poultry or seafood	
21202	Dry soup mix, vegetable only	
23	**Savoury sauces and condiments**	
232	Pickles, chutneys and relishes	
23201	Fruit-based pickles, chutneys and relishes	Chutney and relishes
Food Group or Code	**Description**	**Applicant's proposed foods**
233	Salad dressings	
23301	Mayonnaise and cream-style dressings, full fat	Mayonnaise
23302	Mayonnaise and cream-style dressings, reduced or non-fat	
235	Dips	
23501	Dairy based dips	Sour cream based dips
26	**Snack foods**	
263	Extruded or reformed snacks	
26301	Extruded snacks	Snackfoods extruded (hot & cold), baked and fried
27	**Sugar products and dishes**	
272	Jam and lemon spreads, chocolate spreads, sauces	
27201	Jams and conserves, sugar sweetened	Jams and jellies
27202	Jams and conserves, reduced sugar	
28	**Confectionery and cereal/nut/fruit/seed bars**	
281	Chocolate and chocolate-based confectionery	
28101	Chocolate (plain, unfilled varieties)	Chocolate
28102	Chocolate-based confectionery with nut fillings or additions	
28103	Chocolate-based confectionery with other fillings or additions	
28104	Carob or yoghurt and carob or yoghurt-based confectionery	
283	Muesli or cereal style bars	
28301	Muesli and cereal style bars, no fruit	
28302	Muesli and cereal style bars, with fruit and/or nuts	Breakfast cereal bars
28303	Muesli and cereal style bars, added coatings or confectionery	
28304	Muesli bar, with fruit or fruit paste filling	Cereal bars
284	Other confectionery	
28401	Lollies and other confectionery, sugar sweetened	
30	**Special dietary foods**	
301	Formula dietary foods	
30101	Biscuit and bar meal replacement	Formulated meal replacement biscuits & bars
30102	Meal replacement and similar prepared beverages	Formulated meal replacement drinks prepared
30103	Meal replacement and similar dry powders	Formulated meal replacement mixes
31	**Miscellaneous**	
312	Intense sweetening agents	Table top sweeteners
31201	Intense sweeteners	

* This matching of NNPAS classifications with requested food groups provides a guide to what foods are included in the dietary exposure assessment on a general level. More specific matching was done down to the individual foods at the 8-digit level as required.

Appendix 4: Predicted dietary exposure to IMO in g/day and g/kg body weight/day

Scenario 1: Predicted daily exposure to IMO in grams per person (IMO replacement of 50% of added sugars on a 1.6 g for 1 g basis) from *proposed foods categories* in the Australian population

2011–12 NNPAS	NRV Age Group	% Consumers of IMO from proposed foods only	Daily intake of IMO from selected foods only (g/day) (50% replacement of added sugar)							
			Respondents				Consumers			
			Mean	P90	P95	P97.5	Mean	P90	P95	P97.5
Persons	2–3 years	94.3%	12.7	31.1	39.2	49.8	13.6	32.4	40.1	49.8
	4–8 years	94.7%	20.9	48.7	58.7	72.2	22.1	49.3	60.5	73.5
	9–13 years	95.5%	29.8	64.7	84.6	105.6	31.3	66.7	85.8	107.1
	14–18 years	89.0%	34.7	82.5	104.7	120.2	38.9	86.6	106.4	127.3
	19–30 years	84.7%	29.5	78.6	97.8	128.9	34.9	85.2	108.2	129.4
	31–50 years	83.4%	21.7	58.4	81.5	107.4	26.3	66.6	87.5	107.4
	51–70 years	82.2%	17.5	47.2	65.8	87.7	21.4	52.1	70.4	91.8
	71 years & over	86.7%	15.2	37.4	51.1	72.7	17.8	41.6	56.1	74.1
	2 years & over	**85.8%**	**22.7**	**59.0**	**81.5**	**104.5**	**26.6**	**64.7**	**86.9**	**110.1**
Males	2–3 years	93.2%	12.1	28.4	35.6	38.0	13.2	30.8	37.4	40.1
	4–8 years	94.5%	21.8	51.0	57.5	69.2	23.1	51.5	58.7	69.2
	9–13 years	96.5%	31.4	72.3	103.6	138.7	32.5	73.0	103.6	138.7
	14–18 years	86.3%	39.5	97.1	117.0	140.6	45.7	99.2	119.8	145.9
	19–30 years	84.7%	34.3	86.6	111.3	131.6	40.5	92.3	118.5	137.7
	31–50 years	83.2%	25.7	70.4	98.9	117.9	31.1	77.6	106.0	120.5
	51–70 years	82.6%	20.4	54.5	74.9	93.9	24.8	62.2	83.9	101.3
	71 years & over	87.7%	18.4	49.3	65.5	81.8	21.2	51.6	72.7	92.4
	2 years & over	**85.9%**	**26.2**	**68.8**	**93.2**	**117.6**	**30.6**	**74.9**	**97.8**	**120.5**

2011–12 NNPAS	NRV Age Group	% Consumers of IMO from proposed foods only	Daily intake of IMO from selected foods only (g/day) (50% replacement of added sugar)							
			Respondents				Consumers			
			Mean	P90	P95	P97.5	Mean	P90	P95	P97.5
Females	2–3 years	95.5%	13.4	34.2	49.4	52.6	14.0	34.8	49.4	52.6
	4–8 years	94.8%	19.9	43.4	63.0	74.7	21.0	43.9	63.0	77.1
	9–13 years	94.5%	28.3	62.3	71.0	83.6	29.9	63.0	71.0	85.8
	14–18 years	91.7%	29.8	76.3	85.1	102.2	32.4	76.5	85.7	104.7
	19–30 years	84.8%	24.6	61.4	93.4	110.1	29.1	65.5	95.4	124.4
	31–50 years	83.6%	17.8	47.3	67.0	84.9	21.5	52.7	70.7	87.0
	51–70 years	81.8%	14.7	37.7	52.1	72.1	18.1	42.6	58.8	79.9
	71 years & over	85.8%	12.6	31.0	41.7	49.8	14.9	32.8	44.1	50.0
	2 years & over	**85.8%**	**19.3**	**49.1**	**67.4**	**86.9**	**22.6**	**53.3**	**71.6**	**92.2**

Scenario 1: Predicted daily exposure to IMO in grams per kilogram of body weight (IMO replacement of 50% of added sugars on a 1.6 g for 1 g basis) from Applicant's *proposed food categories* in the Australian population

2011–12 NNPAS	NRV Age Group	% Consumers of IMO from proposed foods only	Daily intake of IMO from selected foods only (g/kg body weight/day) (50% replacement of added sugar)							
			Respondents				Consumers			
			Mean	P90	P95	P97.5	Mean	P90	P95	P97.5
Persons	2–3 years	94.3%	0.8	2.1	2.6	3.4	0.9	2.1	2.7	3.4
	4–8 years	94.7%	0.9	2.0	2.4	3.0	0.9	2.0	2.4	3.0
	9–13 years	95.5%	0.7	1.5	1.9	2.3	0.7	1.5	2.0	2.3
	14–18 years	89.0%	0.6	1.3	1.7	2.1	0.6	1.4	1.7	2.2
	19–30 years	84.7%	0.4	1.1	1.5	1.9	0.5	1.2	1.6	1.9
	31–50 years	83.4%	0.3	0.7	1.0	1.3	0.3	0.8	1.1	1.4
	51–70 years	82.2%	0.2	0.6	0.8	1.1	0.3	0.6	0.9	1.1
	71 years & over	86.7%	0.2	0.5	0.7	1.0	0.2	0.6	0.8	1.0
	2 years & over	**85.8%**	**0.4**	**1.0**	**1.4**	**1.8**	**0.4**	**1.1**	**1.5**	**1.9**
Males	2–3 years	93.2%	0.8	1.9	2.3	2.4	0.8	1.9	2.4	2.4
	4–8 years	94.5%	0.9	2.1	2.5	3.0	1.0	2.1	2.6	3.0
	9–13 years	96.5%	0.7	1.6	2.2	2.8	0.8	1.6	2.2	3.0
	14–18 years	86.3%	0.6	1.4	1.7	2.6	0.7	1.6	1.8	2.9
	19–30 years	84.7%	0.4	1.2	1.5	1.8	0.5	1.2	1.6	1.9
	31–50 years	83.2%	0.3	0.8	1.1	1.4	0.4	0.9	1.2	1.4
	51–70 years	82.6%	0.2	0.6	0.9	1.1	0.3	0.7	1.0	1.2
	71 years & over	87.7%	0.2	0.6	0.9	1.1	0.3	0.7	0.9	1.2
	2 years & over	**85.9%**	**0.4**	**1.2**	**1.5**	**1.9**	**0.5**	**1.2**	**1.6**	**2.1**
Females	2–3 years	95.5%	0.9	2.2	3.1	3.7	0.9	2.2	3.4	3.7
	4–8 years	94.8%	0.8	1.9	2.3	3.0	0.9	2.0	2.3	3.0
	9–13 years	94.5%	0.7	1.4	1.6	1.9	0.7	1.5	1.7	1.9
	14–18 years	91.7%	0.5	1.3	1.6	1.7	0.6	1.3	1.6	1.7
	19–30 years	84.8%	0.4	1.0	1.4	1.9	0.5	1.1	1.5	1.9
	31–50 years	83.6%	0.3	0.7	0.9	1.2	0.3	0.7	1.0	1.3
	51–70 years	81.8%	0.2	0.5	0.7	1.0	0.3	0.6	0.8	1.0
	71 years & over	85.8%	0.2	0.5	0.7	0.8	0.2	0.5	0.7	0.9
	2 years & over	**85.8%**	**0.4**	**0.9**	**1.4**	**1.7**	**0.4**	**1.0**	**1.4**	**1.8**

Scenario 2: Predicted dietary exposure to IMO in grams per person (IMO replacement of 50% of added sugars on a 1.6 g for 1 g basis) from nearly *all foods categories* in the Australian population (except infant formula products, infant foods and formulated supplementary foods for young children)

2011–12 NNPAS	NRV Age Group	% consuming added sugars	Daily intake of IMO from all foods (g/day) (50% replacement of added sugar)							
			Respondents				Consumers			
			Mean	P90	P95	P97.5	Mean	P90	P95	P97.5
Persons	2–3 years	98.5%	25.8	51.4	72.8	85.9	26.2	51.5	72.8	85.9
	4–8 years	99.6%	38.4	77.1	93.8	110.7	38.6	77.1	93.8	110.7
	9–13 years	99.9%	51.2	98.5	116.7	141.8	51.2	98.5	116.7	141.8
	14–18 years	99.6%	58.1	120.7	146.0	169.5	58.3	121.0	147.3	169.5
	19–30 years	98.6%	51.6	110.7	146.6	184.5	52.4	112.4	147.9	184.6
	31–50 years	98.8%	41.7	97.1	129.5	152.9	42.3	97.4	129.8	152.9
	51–70 years	98.2%	33.3	74.1	74.1	130.3	34.0	74.2	102.4	131.6
	71 years & over	98.4%	31.4	68.0	85.2	112.0	31.9	68.3	87.3	112.0
	2 years & over	**98.8%**	**41.8**	**93.6**	**123.7**	**151.5**	**42.3**	**94.3**	**124.6**	**151.8**
Males	2–3 years	98.2%	26.0	50.1	58.1	85.9	26.5	50.1	63.4	85.9
	4–8 years	100.0%	41.8	90.1	98.1	119.0	41.8	90.1	98.1	119.0
	9–13 years	100.0%	53.5	108.9	136.4	175.2	53.5	108.9	136.4	175.2
	14–18 years	99.3%	65.7	137.7	163.1	198.4	66.2	137.7	163.1	198.4
	19–30 years	98.5%	60.4	125.5	163.4	234.7	61.3	126.1	167.5	234.7
	31–50 years	98.8%	49.5	115.4	146.5	176.9	50.1	116.5	146.6	177.0
	51–70 years	97.9%	37.4	81.8	109.0	150.7	38.2	82.3	110.1	150.7
	71 years & over	99.0%	36.3	76.2	98.5	148.8	36.6	76.2	98.5	148.8
	2 years & over	**98.8%**	**48.0**	**108.0**	**141.5**	**169.8**	**48.6**	**108.0**	**141.8**	**170.4**
Females	2–3 years	98.8%	25.6	62.0	73.1	93.0	25.9	62.0	73.1	93.0
	4–8 years	99.2%	34.8	68.6	84.4	100.1	35.1	68.6	84.4	100.1
	9–13 years	99.8%	48.8	85.9	105.1	116.7	48.9	85.9	105.1	116.7
	14–18 years	100.0%	50.3	102.0	124.9	146.0	50.3	102.0	124.9	146.0
	19–30 years	98.7%	42.5	94.2	130.5	149.6	43.1	96.5	130.5	149.6
	31–50 years	98.7%	34.0	77.0	104.1	125.0	34.5	77.0	104.6	125.0
	51–70 years	98.5%	29.4	65.6	88.8	118.1	29.9	65.6	92.1	118.1
	71 years & over	97.9%	27.4	61.1	75.3	87.9	28.0	61.1	75.3	89.8
	2 years & over	**98.8%**	**35.7**	**78.2**	**102.5**	**127.7**	**36.1**	**79.0**	**103.2**	**128.1**

Scenario 2: Estimated dietary exposure to IMO in grams per kilogram of body weight (IMO replacement of 50% of added sugars on a 1.6 g for 1 g basis) from nearly *all food categories* in the Australian population (except infant formula products, infant foods and formulated supplementary foods for young children)

2011–12 NNPAS	NRV Age Group	% consuming added sugars	Daily intake of IMO from all foods (g/kg body weight/day) (50% replacement of added sugar)							
			Respondents				Consumers			
			Mean	P90	P95	P97.5	Mean	P90	P95	P97.5
Persons	2–3 years	98.5%	1.7	3.5	4.4	5.4	1.7	3.6	4.4	5.4
	4–8 years	99.6%	1.6	3.2	4.0	4.9	1.7	3.2	4.1	4.9
	9–13 years	99.9%	1.2	2.4	3.0	3.7	1.2	2.4	3.0	3.7
	14–18 years	99.6%	0.9	1.8	2.4	3.0	0.9	1.8	2.4	3.0
	19–30 years	98.6%	0.7	1.6	2.2	2.7	0.7	1.6	2.2	2.7
	31–50 years	98.8%	0.5	1.2	1.7	2.1	0.5	1.2	1.7	2.1
	51–70 years	98.2%	0.4	0.9	1.3	1.7	0.4	1.0	1.3	1.7
	71 years & over	98.4%	0.4	1.0	1.3	1.6	0.4	1.0	1.3	1.6
	2 years & over	**98.8%**	**0.7**	**1.7**	**2.3**	**2.9**	**0.7**	**1.7**	**2.3**	**2.9**
Males	2–3 years	98.2%	1.6	3.2	3.9	5.4	1.7	3.2	3.9	5.4
	4–8 years	100.0%	1.8	3.6	4.3	4.9	1.8	3.6	4.3	4.9
	9–13 years	100.0%	1.3	2.7	3.4	4.0	1.3	2.7	3.4	4.0
	14–18 years	99.3%	1.0	2.1	3.0	3.5	1.0	2.1	3.0	3.5
	19–30 years	98.5%	0.8	1.7	2.3	2.8	0.8	1.7	2.3	2.8
	31–50 years	98.8%	0.6	1.3	1.7	2.2	0.6	1.3	1.7	2.2
	51–70 years	97.9%	0.4	1.0	1.3	1.8	1.8	1.0	1.3	1.8
	71 years & over	99.0%	0.5	1.0	1.4	2.0	0.5	1.0	1.4	2.0
	2 years & over	**98.8%**	**0.8**	**1.8**	**2.5**	**3.1**	**0.8**	**1.8**	**2.5**	**3.1**
Females	2–3 years	98.8%	1.7	4.0	4.5	5.7	1.7	4.0	4.5	5.7
	4–8 years	99.2%	1.5	2.9	3.3	4.9	1.5	2.9	3.3	4.9
	9–13 years	99.8%	1.1	2.1	2.6	3.1	1.2	2.1	2.6	3.1
	14–18 years	100.0%	0.9	1.7	2.1	2.5	0.9	1.7	2.1	2.5
	19–30 years	98.7%	0.7	1.5	2.0	2.5	0.7	1.5	2.0	2.5
	31–50 years	98.7%	0.5	1.1	1.6	2.0	0.5	1.1	1.6	2.0
	51–70 years	98.5%	0.4	0.9	1.2	1.6	0.4	0.9	1.2	1.7
	71 years & over	97.9%	0.4	0.9	1.2	1.6	0.4	1.0	1.2	1.6
	2 years & over	**98.8%**	**0.7**	**1.6**	**2.1**	**2.6**	**0.7**	**1.6**	**2.1**	**2.6**

Appendix 5: Contribution of food groups to predicted IMO dietary exposure

Scenario 1 – Proposed food groups only

Food group*	Contribution to IMO exposure (%)
Cereal based products and dishes	18.8
Cakes, muffins, scones, cake-type desserts	10.8
Cakes and cake mixes, chocolate	3.4
Cakes and cake mixes, other types	3.4
Cakes and cake mixes, sponge	1.9
Muffins, cake type, and muffin mixes	2.1
Savoury biscuits	<1
Sweet biscuits	7.6
Cereals and cereal products	5.8
Breakfast cereals, ready to eat	5.3
English-style muffins, flat breads, and savoury and sweet breads	<1
Sweet breads, buns and scrolls, iced and/or filled	<1
Sweet breads, buns and scrolls, uniced, unfilled	<1
Regular breads, and bread rolls (plain/unfilled/untopped varieties)	<1
Confectionery and cereal/nut/fruit/seed bars	16
Chocolate and chocolate-based confectionery	10.4
Chocolate (plain, unfilled varieties)	3.8
Chocolate-based confectionery with nut fillings or additions	1.8
Chocolate-based confectionery with other fillings or additions	4.7
Muesli or cereal style bars	1.5
Muesli and cereal style bars, added coatings or confectionery	<1
Muesli and cereal style bars, no fruit	<1
Muesli and cereal style bars, with fruit and/or nuts	<1
Muesli bar, with fruit or fruit paste filling	<1
Other confectionery	4.1
Lollies and other confectionery, sugar sweetened	4.1
Dairy & meat substitutes	<1
Dairy milk substitutes, flavoured	<1
Soy-based beverage, reduced fat, flavoured	<1
Soy-based beverage, regular fat, flavoured	<1
Milk products and dishes	17.7
Custards	<1
Flavoured milks and milkshakes	4.6
Frozen milk products	8.4
Frozen dairy desserts, other	<1
Frozen yoghurts, all types	<1
Ice cream, individual bar, stick and cone varieties, fat content <4 g/100 g	<1
Ice cream, individual bar, stick and cone varieties, fat content >10 g/100 g	1.3
Ice cream, individual bar, stick and cone varieties, fat content 4 - 10 g/100 g	<1
Ice cream, tub varieties, fat content <4 g/100 g	<1
Ice cream, tub varieties, fat content >10 g/100 g	4.5
Ice cream, tub varieties, fat content 4 - 10 g/100 g	<1

Food group*	Contribution to IMO exposure (%)
Other dishes where milk or a milk product is the major component	<1
Dairy desserts, smooth or gelatin-based dairy desserts	<1
Yoghurt	3.7
Miscellaneous	<1
Intense sweetening agents	<1
Non-alcoholic beverages	36.9
Electrolyte, energy and fortified drinks	2.2
Energy drinks	2.2
Energy drinks, intense sweetened	0
Fruit and vegetable juices, and drinks	<1
Fruit and vegetable juice blends	0
Fruit drink, prepared from dry powder	<1
Fruit juices, commercially prepared	<1
Fruit juices, fortified	0
Vegetable juices	<1
Soft drinks, and flavoured mineral waters	34.6
Soft drinks, cola	20.2
Soft drinks, cola, intense sweetened	0
Soft drinks, non-cola	14.4
Soft drinks, non-cola, intense sweetened	0
Savoury sauces and condiments	<1
Dips	<1
Dairy based dips	<1
Pickles, chutneys and relishes	<1
Fruit-based pickles, chutneys and relishes	<1
Salad dressings	<1
Mayonnaise and cream-style dressings, full fat	<1
Mayonnaise and cream-style dressings, reduced or non-fat	<1
Snack foods	<1
Extruded or reformed snacks	<1
Extruded snacks	<1
Soup	<1
Dry soup mix	<1
Special dietary foods	<1
Formula dietary foods	<1
Biscuit and bar meal replacement	<1
Meal replacement and similar dry powders	<1
Meal replacement and similar prepared beverages	<1
Sugar products and dishes	3.9
Jam and lemon spreads, chocolate spreads, sauces	3.9
Jams and conserves, reduced sugar	<1
Jams and conserves, sugar sweetened	3.8
Grand Total	100

* Major group in bold, sub-group indented and not bold

Scenario 2: Nearly all food groups (except infant formula products, infant foods and formulated supplementary foods for young children)

Food group*	Contribution to IMO exposure (%)
Alcoholic beverages	2.6
Beers	0
Cider and perry	0
Other alcoholic beverages	2.6
Spirits	0
Wines	0
Cereal based products and dishes	18.2
Batter-based products	<1
Cakes, muffins, scones, cake-type desserts	9.9
Mixed dishes where cereal is the major ingredient	1.7
Pastries	1.2
Savoury biscuits	<1
Sweet biscuits	4.6
Cereals and cereal products	3.4
Breakfast cereals, hot porridge style	<1
Breakfast cereals, ready to eat	2.9
English-style muffins, flat breads, and savoury and sweet breads	<1
Flours and other cereal grains and starches	0
Pasta and pasta products (without sauce)	0
Regular breads, and bread rolls (plain/unfilled/untopped varieties)	<1
Confectionery and cereal/nut/fruit/seed bars	9.7
Chocolate and chocolate-based confectionery	5.6
Fruit, nut and seed-bars	<1
Muesli or cereal style bars	<1
Other confectionery	3
Dairy & meat substitutes	<1
Cheese substitute	0
Dairy milk substitutes, flavoured	<1
Dairy milk substitutes, unflavoured	<1
Dishes where meat substitutes are the major component	<1
Meat substitutes	<1
Soy-based ice confection	<1
Soy-based yoghurts	<1
Egg products and dishes	<1
Dishes where egg is the major ingredient	<1
Eggs	0
Fats and oils	0
Butters	0
Dairy blends	0
Margarine and table spreads	0
Other fats	0
Plant oils	0
Unspecified fats	0
Fish and seafood products and dishes	<1
Crustacea and molluscs (excluding commercially sterile)	<1
Fin fish (excluding commercially sterile)	0
Fish and seafood products (homemade and takeaway)	<1
Mixed dishes with fish or seafood as the major component	<1
Other sea and freshwater foods	0

Food group*	Contribution to IMO exposure (%)
Packed (commercially sterile) fish and seafood	<1
Fruit products and dishes	1.2
Berry fruit	<1
Citrus fruit	<1
Dried fruit, preserved fruit	<1
Mixed dishes where fruit is the major component	<1
Mixtures of two or more groups of fruit	<1
Other fruit	<1
Pome fruit	<1
Stone fruit	<1
Tropical and subtropical fruit	<1
Legume and pulse products and dishes	<1
Mature legume and pulse products and dishes	<1
Mature legumes and pulses	<1
Meat, poultry and game products and dishes	<1
Beef, sheep and pork, unprocessed	<1
Mammalian game meats	0
Mixed dishes where beef, sheep, pork or mammalian game is the major component	<1
Mixed dishes where poultry or feathered game is the major component	<1
Mixed dishes where sausage, bacon, ham or other processed meat is the major component	<1
Organ meats and offal, products and dishes	0
Poultry and feathered game	<1
Processed meat	<1
Sausages, frankfurts and saveloys	<1
Milk products and dishes	10.4
Cheese	<1
Cream	<1
Custards	<1
Dairy milk (cow, sheep and goat)	<1
Flavoured milks and milkshakes	2.5
Frozen milk products	4.5
Other dishes where milk or a milk product is the major component	<1
Yoghurt	2.1
Miscellaneous	<1
Chemical raising agents and cooking ingredients	0
Essences	0
Herbs, spices, seasonings and stock cubes	<1
Intense sweetening agents	<1
Yeast, and yeast vegetable or meat extracts	<1
Non-alcoholic beverages	35.1
Coffee and coffee substitutes	<1
Cordials	5.4
Electrolyte, energy and fortified drinks	2.3
Fruit and vegetable juices, and drinks	6.2
Other beverage flavourings and prepared beverages	1.1
Soft drinks, and flavoured mineral waters	19.4
Tea	<1
Waters, municipal and bottled, unflavoured	<1
Savoury sauces and condiments	2.7
Dips	<1
Gravies and savoury sauces	2

Food group*	Contribution to IMO exposure (%)
Pickles, chutneys and relishes	<1
Salad dressings	<1
Stuffings	0
Seed and nut products and dishes	<1
Nuts and nut products	<1
Seeds and seed products	<1
Snack foods	<1
Corn snacks	<1
Extruded or reformed snacks	<1
Other snacks	<1
Potato snacks	<1
Soup	<1
Canned condensed soup (unprepared)	<1
Dry soup mix	<1
Soup, commercially sterile, prepared from condensed or sold ready to heat	<1
Soup, homemade from basic ingredients	<1
Soup, not commercially sterile, purchased ready to eat	<1
Soup, prepared from dry soup mix	<1
Special dietary foods	<1
Formula dietary foods	<1
Biscuit and bar meal replacement	<1
Meal replacement and similar dry powders	<1
Meal replacement and similar prepared beverages	<1
Sport and protein prepared beverages	<1
Sport and protein, dry powders	<1
Supplementary and medical foods dry powders	<1
Supplementary and medical foods prepared beverages	<1
Sugar products and dishes	14.5
Dishes and products other than confectionery where sugar is the major component	1.5
Jam and lemon spreads, chocolate spreads, sauces	2.4
Sugar, honey and syrups	10.6
Vegetable products and dishes	<1
Cabbage, cauliflower and similar brassica vegetables	0
Carrot and similar root vegetables	0
Dishes where vegetable is the major component	<1
Leaf and stalk vegetables	0
Other fruiting vegetables	<1
Other vegetables and vegetable combinations	0
Peas and beans	0
Potatoes	<1
Tomato and tomato products	<1
Grand Total	**100**

* Major group in bold, sub-group indented and not bold

Appendix 6: Predicted dietary exposure to IMO from high consumption (P97.5) of individual foods (Applicant's use levels)

Chocolate
IMO concentration based on 50% replacement of added sugar = 34.5 g/100 g/mL

Sex	NRV Age Group	Number of Consumers	P97.5 Consumption g/day	P97.5 exposure to IMO over 24 hrs g/day
Females	2–3 years	30	n/a	n/a
	4–8 years	79	110.0	38.0
	9–13 years	87	110.0	38.0
	14–18 years	86	200.0	69.0
	19–30 years	220	125.0	43.1
	31–50 years	309	135.0	46.6
	51–70 years	215	200.0	69.0
	71 years & over	77	80.0	27.6
	2 years & over	**1103**	**157.5**	**54.3**
Males	2–3 years	25	n/a	n/a
	4–8 years	67	80.0	27.6
	9–13 years	85	220.0	75.9
	14–18 years	56	160.0	55.2
	19–30 years	140	90.0	31.1
	31–50 years	277	200.0	69.0
	51–70 years	189	200.0	69.0
	71 years & over	79	60.0	20.7
	2 years & over	**918**	**200.0**	**69.0**

n/a – indicates insufficient consumer numbers (less than 39) to allow for the derivation of a robust 97.5th percentile consumption

Soft Candy
IMO concentration based on 50% replacement of added sugar = 31.5 g/100 g/mL

Sex	NRV Age Group	Number of Consumers	P97.5 Consumption g/day	P97.5 exposure to IMO over 24 hrs g/day
Females	2–3 years	14	n/a	n/a
	4–8 years	45	83.0	26.1
	9–13 years	38	n/a	n/a
	14–18 years	35	n/a	n/a
	19–30 years	50	190.0	59.9
	31–50 years	126	100.0	31.5
	51–70 years	101	152.0	47.9
	71 years & over	32	n/a	n/a
	2 years & over	**441**	**100.0**	**31.5**
Males	2–3 years	18	n/a	n/a
	4–8 years	43	91.3	28.8
	9–13 years	48	74.8	23.6
	14–18 years	32	n/a	n/a
	19–30 years	57	400.0	126.0
	31–50 years	102	125.0	39.4
	51–70 years	53	90.0	28.4
	71 years & over	25	n/a	n/a
	2 years & over	**377**	**143.0**	**44.9**

n/a – indicates insufficient no. consumers (less than 39) to derive a robust 97.5th percentile consumption

Formulated meal replacement mixes
IMO concentration based on 50% replacement of added sugar = 39 g/100 g/mL

Sex	NRV Age Group	Number of Consumers	P97.5 Consumption g/day	P97.5 exposure to IMO over 24 hrs g/day
Females	2–3 years	–	–	–
	4–8 years	–	–	–
	9–13 years	–	–	–
	14–18 years	–	–	–
	19–30 years	2	n/a	n/a
	31–50 years	6	n/a	n/a
	51–70 years	4	n/a	n/a
	71 years & over	–	–	–
	2 years & over	**12**	n/a	n/a
Males	2–3 years	–	–	–
	4–8 years	–	–	–
	9–13 years	–	–	–
	14–18 years	–	–	–
	19–30 years	–	–	–
	31–50 years	1	n/a	n/a
	51–70 years	4	n/a	n/a
	71 years & over	–	–	–
	2 years & over	**5**	n/a	n/a

– indicates not consumed

n/a – indicates insufficient consumer numbers (less than 39) to derive a robust 97.5th percentile consumption

Soft drinks (excludes flavoured mineral waters)
IMO concentration based on 50% replacement of added sugar = 5.6 g/100 g/mL

Sex	NRV Age Group	Number of Consumers	P97.5 Consumption g/day	P97.5 exposure to IMO over 24 hrs g/day
Females	2–3 years	8	n/a	n/a
	4–8 years	81	455.0	25.5
	9–13 years	129	930.8	52.1
	14–18 years	134	830.0	46.5
	19–30 years	386	1311.0	73.4
	31–50 years	479	1200.0	67.2
	51–70 years	249	1230.0	68.9
	71 years & over	66	816.6	45.7
	2 years & over	**1531**	**1170.0**	**65.5**
Males	2–3 years	10	n/a	n/a
	4–8 years	65	765.0	42.8
	9–13 years	151	1300.0	72.8
	14–18 years	183	1840.0	103.0
	19–30 years	495	1725.0	96.6
	31–50 years	602	1590.0	89.0
	51–70 years	353	2080.0	116.5
	71 years & over	66	2000.0	112.0
	2 years & over	**1926**	**1800.0**	**100.8**

n/a – indicates insufficient consumer numbers (less than 39) to allow for the derivation of a robust 97.5th percentile consumption

Energy drinks
IMO concentration based on 50% replacement of added sugar = 4.5 g/100 g/mL

Sex	NRV Age Group	Number of Consumers	P97.5 Consumption g/day	P97.5 exposure to IMO over 24 hrs g/day
Females	2–3 years	–	–	–
	4–8 years	–	–	–
	9–13 years	0	n/a	n/a
	14–18 years	5	n/a	n/a
	19–30 years	34	n/a	n/a
	31–50 years	6	n/a	n/a
	51–70 years	1	n/a	n/a
	71 years & over	–	–	–
	2 years & over	**47**	**761.3**	**34.3**
Males	2–3 years	–	–	–
	4–8 years	–	–	–
	9–13 years	1	n/a	n/a
	14–18 years	8	n/a	n/a
	19–30 years	58	2100.0	94.5
	31–50 years	35	1260.0	56.7
	51–70 years	7	n/a	n/a
	71 years & over	1	n/a	n/a
	2 years & over	**110**	**1260.0**	**56.7**

– indicates not consumed

n/a – indicates insufficient consumer numbers (less than 39) to allow for the derivation of a robust 97.5th percentile consumption

Fruit and vegetable juices (commercial only)
IMO concentration based on 50% replacement of added sugar = 3.3 g/100 g/mL

Sex	NRV Age Group	Number of Consumers	P97.5 Consumption g/day	P97.5 exposure to IMO over 24 hrs g/day
Females	2–3 years	36	n/a	n/a
	4–8 years	78	756.0	24.9
	9–13 years	93	735.0	24.3
	14–18 years	74	945.0	31.2
	19–30 years	144	913.5	30.1
	31–50 years	227	761.25	25.1
	51–70 years	139	945.0	31.2
	71 years & over	67	756.0	24.9
	2 years & over	**857**	**761.3**	**25.1**
Males	2–3 years	40	913.5	30.1
	4–8 years	96	626.0	20.7
	9–13 years	92	756.0	24.9
	14–18 years	84	1050.0	34.7
	19–30 years	191	1050.0	34.7
	31–50 years	223	1102.5	36.4
	51–70 years	194	945.0	31.2
	71 years & over	69	735.0	24.3
	2 years & over	**988**	**1050.0**	**34.7**

n/a – indicates insufficient consumer numbers (less than 39) to allow for the derivation of a robust 97.5th percentile consumption

Cakes (Commercial only)
IMO concentration based on 50% replacement of added sugar = 12.9 g/100 g/mL

Sex	NRV Age Group	Number of Consumers	P97.5 Consumption g/day	P97.5 exposure to IMO over 24 hrs g/day
Females	2–3 years	23	n/a	n/a
	4–8 years	56	280.0	36.1
	9–13 years	70	280.0	36.1
	14–18 years	41	297.0	38.3
	19–30 years	124	390.0	50.2
	31–50 years	204	330.0	42.6
	51–70 years	167	330.0	42.6
	71 years & over	78	264.0	34.1
	2 years & over	**763**	**330.0**	**42.6**
Males	2–3 years	17	n/a	n/a
	4–8 years	60	222.0	28.6
	9–13 years	61	326.0	42.1
	14–18 years	21	n/a	n/a
	19–30 years	84	440.0	56.8
	31–50 years	155	396.0	51.1
	51–70 years	154	330.0	42.6
	71 years & over	80	528.0	68.1
	2 years & over	**633**	**354.0**	**45.7**

n/a – indicates insufficient consumer numbers (less than 39) to allow for the derivation of a robust 97.5th percentile consumption

Muffins
IMO concentration based on 50% replacement of added sugar = 3.4 g/100 g/mL

Sex	NRV Age Group	Number of Consumers	P97.5 Consumption g/day	P97.5 exposure to IMO over 24 hrs g/day
Females	2–3 years	2	n/a	n/a
	4–8 years	20	n/a	n/a
	9–13 years	17	n/a	n/a
	14–18 years	12	n/a	n/a
	19–30 years	23	n/a	n/a
	31–50 years	62	326.0	11.1
	51–70 years	25	n/a	n/a
	71 years & over	16	n/a	n/a
	2 years & over	**178**	**326.0**	**11.1**
Males	2–3 years	8	n/a	n/a
	4–8 years	16	n/a	n/a
	9–13 years	15	n/a	n/a
	14–18 years	13	n/a	n/a
	19–30 years	34	n/a	n/a
	31–50 years	44	326.0	11.1
	51–70 years	28	n/a	n/a
	71 years & over	7	n/a	n/a
	2 years & over	**165**	**326.0**	**11.1**

n/a – indicates insufficient consumer numbers (less than 39) to allow for the derivation of a robust 97.5th percentile consumption

Sweet Biscuits (commercial)
IMO concentration based on 50% replacement of added sugar = 17.9 g/100 g/mL

Sex	NRV Age Group	Number of Consumers	P97.5 Consumption g/day	P97.5 exposure to IMO over 24 hrs g/day
Females	2–3 years	58	216.8	38.8
	4–8 years	139	55.4	9.9
	9–13 years	144	156.0	27.9
	14–18 years	82	113.5	20.3
	19–30 years	176	144.0	25.8
	31–50 years	326	80.0	14.3
	51–70 years	283	66.0	11.8
	71 years & over	206	71.6	12.8
	2 years & over	**1412**	**87.5**	**15.7**
Males	2–3 years	64	69.0	12.4
	4–8 years	135	174.6	31.3
	9–13 years	141	93.0	16.6
	14–18 years	72	187.5	33.6
	19–30 years	153	334.0	59.8
	31–50 years	320	100.0	17.9
	51–70 years	287	133.0	23.8
	71 years & over	132	89.8	16.1
	2 years & over	**1304**	**150.0**	**26.9**

Flavoured milk
IMO concentration based on 50% replacement of added sugar = 3.8 g/100 g/mL

Sex	NRV Age Group	Number of Consumers	P97.5 Consumption g/day	P97.5 exposure to IMO over 24 hrs g/day
Females	2–3 years	4	n/a	n/a
	4–8 years	29	n/a	n/a
	9–13 years	40	928.0	35.3
	14–18 years	54	1390.5	52.8
	19–30 years	54	1484.59	56.4
	31–50 years	69	1060.0	40.3
	51–70 years	36	n/a	n/a
	71 years & over	11	n/a	n/a
	2 years & over	**298**	**1390.5**	**52.8**
Males	2–3 years	6	n/a	n/a
	4–8 years	29	n/a	n/a
	9–13 years	42	944.0	35.9
	14–18 years	33	n/a	n/a
	19–30 years	90	1209.8	46.0
	31–50 years	110	1640.0	62.3
	51–70 years	48	1272.0	48.3
	71 years & over	13	n/a	n/a
	2 years & over	**371**	**1272.0**	**48.3**

n/a – indicates insufficient consumer numbers (less than 39) to allow for the derivation of a robust 97.5th percentile consumption

Frozen milk products
IMO concentration based on 50% replacement of added sugar = 5.3 g/100 g/mL

Sex	NRV Age Group	Number of Consumers	P97.5 Consumption g/day	P97.5 exposure to IMO over 24 hrs g/day
Females	2–3 years	23	n/a	n/a
	4–8 years	69	174.0	9.2
	9–13 years	114	264.0	14.0
	14–18 years	66	316.3	16.8
	19–30 years	117	407.0	21.6
	31–50 years	191	316.3	16.8
	51–70 years	162	254.0	13.5
	71 years & over	95	178.0	9.4
	2 years & over	**838**	**287.0**	**15.2**
Males	2–3 years	20	n/a	n/a
	4–8 years	96	275.5	14.6
	9–13 years	114	330.0	17.5
	14–18 years	62	275.0	14.6
	19–30 years	153	481.3	25.5
	31–50 years	210	320.0	17.0
	51–70 years	201	390.5	20.7
	71 years & over	99	310.5	16.5
	2 years & over	**956**	**358.0**	**18.9**

n/a – indicates insufficient consumer numbers (less than 39) to allow for the derivation of a robust 97.5th percentile consumption

Yoghurt (commercial only)
IMO concentration based on 50% replacement of added sugar = 4.0 g/100 g/mL

Sex	NRV Age Group	Number of Consumers	P97.5 Consumption g/day	P97.5 exposure to IMO over 24 hrs g/day
Females	2–3 years	67	260.0	10.4
	4–8 years	78	350.0	14.0
	9–13 years	63	312.0	12.5
	14–18 years	40	312.0	12.5
	19–30 years	176	340.0	13.6
	31–50 years	321	408.0	16.3
	51–70 years	326	350.0	14.0
	71 years & over	98	363.0	14.5
	2 years & over	**1169**	**350.0**	**14.0**
Males	2–3 years	42	520.0	20.8
	4–8 years	87	520.0	20.8
	9–13 years	52	260.0	10.4
	14–18 years	20	354.1	14.2
	19–30 years	115	780.0	31.2
	31–50 years	223	364.0	14.6
	51–70 years	141	520.0	20.8
	71 years & over	59	327.6	13.1
	2 years & over	**739**	**490.0**	**19.6**