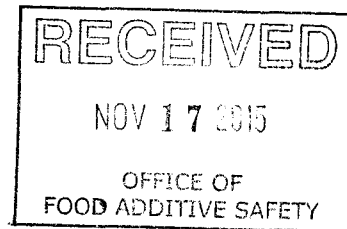




ORIGINAL SUBMISSION

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GRAS Notification for Isomaltodextrin (IMD)

Manufactured by Hayashibara Co., Ltd.

Prepared by

**Vanguard Regulatory Services, Inc.
1311 Iris Circle
Broomfield, CO 80020**

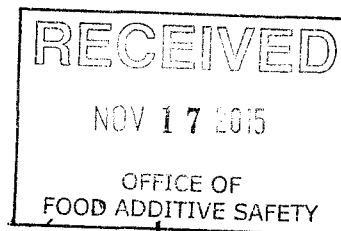
November 10, 2015

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GRN000610

November 10, 2015

Antonia Mattia, PhD, Director
Division of Biotechnology and GRAS Notice Review (HFS-225)
Office of Food Additive Safety
Center for Food Safety and Applied Nutrition
Food and Drug Administration
5100 Paint Branch Pkwy
College Park, MD 20740

Re: GRAS Notification for Isomaltodextrin (Resistant Dextrin)

Dear Dr. Mattia:

The attached GRAS Notification is submitted on behalf of our client, Hayashibara Co., Ltd., of Okayama, Japan, for Isomaltodextrin (IMD), which is a resistant dextrin, for use as a general food ingredient, and a dietary fiber ingredient in food. The document provides a review of the information related to the intended uses, manufacturing and safety of IMD.

Hayashibara Co., Ltd. (Hayashibara) has determined that IMD is generally recognized as safe (GRAS) based on scientific procedures under 21 CFR 170.30(b) and conforms to the proposed rule published in the *Federal Register* at Vol. 62, No. 74 on April 17, 1997. This GRAS determination has been evaluated by a panel of experts who are qualified by scientific training and experience to assess the safety of IMD under the conditions of its intended use in food. A copy of the Expert Panel's opinion is attached to this GRAS Notice. Hayashibara therefore would like to respectfully submit notice to the Agency that IMD, manufactured by Hayashibara is exempt from the premarket approval requirements of the Federal Food, Drug, and Cosmetic Act, because such use is GRAS.

IMD is a branched molecule consisting of only glucose molecules, which is derived from enzymatic hydrolysis and transglycosylation of food grade starch. It fits the

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chemical, physical and biologic properties of dextrin, maltodextrin, and similar substances, which have previously been determined to be GRAS. It is Hayashibara's judgment that IMD is *substantially equivalent* to these principally starch based food ingredients.

At a Pre-GRAS Notification meeting held with the Agency on April 28, 2015 a few comments were made by representatives of CFSAN. These included the comment that the Agency would like to receive information describing not only the properties that make IMD substantially equivalent to resistant dextrin and similar products, but also the differences. It is believed that the information provide in the attached GRAS Notice will provide the requested information. A second comment was that data should be provided that demonstrates the safety of the substances to which IMD is being compared as substantially equivalent. Again, it is believed that the safety information is included in the document.

All chemical, physical and analytical data, and additional information upon which the GRAS determination is based is available for FDA review and reproduction at a mutually convenient time at the office of Vanguard Regulatory Services, Inc., 1311 Iris Circle, Broomfield, CO 80020.

Hayashibara Co., Ltd. greatly appreciates the Agency's review of the submitted materials, and would be pleased to provide any additional information that the Agency needs to complete the review of this Notification.

Sincerely,

(b) (6)

Alan B. Richards, PhD
President, VRSI

Enclosures

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Section I. GRAS Exemption Claim

Vanguard Regulatory Services, Inc. on behalf of Hayashibara Co., Ltd. (Hayashibara), of Okayama, Japan submits this GRAS notification to the U.S. Food and Drug Administration in support of the determination by Hayashibara that their product termed Isomaltodextrin, is generally recognized as safe (GRAS) for use in food as a general food ingredient and a dietary fiber.

Hayashibara's determination of GRAS is based on scientific procedures, based on substantial equivalence to resistant and non-resistant dextrin and maltodextrin, and polydextrose, and pullulan. This submission is prepared in accordance with 21 C.F.R. § 170.30(b) and conforms to the guidance issued by the Food and Drug Administration (FDA) under proposed 21 C.F.R. §170.36, 62 Federal Register 18938 (April 17, 1997). The GRAS determination by Hayashibara has also been evaluated by an independent panel of experts qualified by scientific training and national and international experience to evaluate the safety of food and food ingredients, specifically Isomaltodextrin, under the conditions of its intended use in food. The analytical data, published studies, unpublished studies, and other relevant information that are the basis for this GRAS determination are available for the FDA to review and copy at mutually agreeable times at the offices of Vanguard Regulatory Services, Inc., 1311 Iris Circle, Broomfield, Co 80020. The references supporting the statements in this document will be included in the text as a superscript, and will be listed in Section VII.

The information covers the following areas:

- Chemical and physical structure of Isomaltodextrin (IMD).
- The process and raw materials used for the production of IMD.
- Specifications of IMD and its equivalence to other starch-based products.
- Technological properties of IMD.
- Intended uses and an estimation of consumption of IMD.
- Relevant safety data on previously GRASed dextrin/maltodextrin substances, polydextrose, pullulan, and safety data obtained from studies on IMD.
- Gastrointestinal tolerance of dextrin/maltodextrin substances, polydextrose, pullulan, and tolerance data obtained from studies on IMD.

An independent expert panel reviewed the information and data provided by Hayashibara, and examined other sources and concluded that Isomaltodextrin is

Section I: GRAS Exemption Claim

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GRAS for its intended uses. Hayashibara believes that the Agency will agree that the information provided will support the determination that IMD, manufactured by Hayashibara is GRAS for use as a general food ingredient, and as a dietary fiber in food. An extra copy of the GRAS Notice will be included so that it can be shared with the USDA for consideration for use in products under their purview. IMD is not intended to be reviewed for use in infant formula, at this time.

1. Notifier:

Hayashibara Co., Ltd.
675-1 Fujisaki, Naka-ku, Okayama 702-8006, JAPAN

All communications regarding this document should be addressed to:
Alan B. Richards, PhD
Vanguard Regulatory Services, Inc.
1311 Iris Circle
Broomfield, CO 80020
Office: (303) 464-8636
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2. Common or Usual Names:

Isomaltodextrin
Synonyms: Highly branched α -glucan, Dextrin, Resistant dextrin, Dietary fiber, Soluble fiber, Soluble dietary fiber

3. Applicable Conditions of Use:

Applications of IMD include use in foods as a general use direct additive and as a dietary fiber. The ingredient should be used under the conditions of current Good Manufacturing Practice.

Section II. General Introduction

Isomaltodextrin (IMD), the subject of this GRAS Notification, is a highly branched dextrin that is produced by enzymatic modification of cornstarch, tapioca or other starches.¹ IMD is highly water soluble, and has lower digestibility compared with many common dextrans/maltodextrans because it contains glucosidic linkages that are resistant to digestion.¹ Because of this resistance, IMD can be used as a soluble dietary fiber (see below), in addition to use as a general food ingredient when incorporated into processed food products.

The purpose of this GRAS Notification is to provide data and information in support of the determination that IMD is general recognized as safe (GRAS) for the intended use under current Good Manufacturing Practices in accordance with 21 CFR § 170.30(b) and conforms to the guidance issued by the Food and Drug Administration (FDA) under proposed 21 CFR § 170.36. This determination is based on scientific procedures using IMD's substantial equivalency to several other glucan substances that are GRAS and have been consumed in tremendous quantities by humans in the US for many years.

To support the claim of GRAS by scientific procedures using substantial equivalency, Hayashibara is providing background information in this introductory section on the structural and chemical nature of IMD that is believed to have direct implications on the safety of IMD and its substantial equivalence to other GRAS substances. The following paragraphs are intended to explain the direct equivalence to some of the most common food ingredients that are used in processed foods in the US and around the world. Discussion of these substances is problematic because the definitions of these substances are not universal, even within a country. Additionally some substances have become associated with particular manufacturing methods, which may not currently reflect on all the production methods used to produce the specific product.

A. Dextrin/Maltodextrin

Dextrin(s) is a group of food materials that have been used safely for many years in the US food industry. Dextrin is produced from starch that is broken down by various hydrolytic processes.²⁻⁴ Hydrolysis typically involves the use of acid and heat, but can also include the use of enzymes. Either physical/chemical or enzymatic hydrolysis results in a mixture of relatively low molecular weight starch, dextrans, maltodextrans, glucose syrups, and glucose.²⁻⁴ The relative structural composition depends on the amount of hydrolysis, and the type of purification processes that are used.²⁻⁴ Because dextrin is a hydrolytic product of starch, it contains almost exclusively D-glucose. It is partially to highly water soluble depending on the molecular weight and structure. These D-glucose molecules are most commonly linked together with α -1,4, or α -1,6 glycosidic linkages, but can include other linkages, again, depending on the manufacturing process.²⁻⁵ These substances can be highly to only slightly

digestible (see below). The dextrose equivalence (DE) of dextrin is usually considered to be 3-10, while starch has a DE of 0 and glucose is 100.⁴ If the dextrin is hydrolyzed further it is usually termed a maltodextrin with a DE of < 20, and is highly water soluble and completely digestible in the small intestine, having approximately 80% and 20% α -1,4 and α -1,6 glycosidic linkages, respectively.²⁻⁴ As mentioned, the division between dextrin and maltodextrin is not consistently applied, and so the terms are sometimes used interchangeably. Many texts simply use the term maltodextrin for substances with DE of 3 to less than 20.²⁻⁴ The US Tariff Schedule states that dextrans (HS 3505.10) have a DE of 10 or less. In the same section of that chapter it states that products (starch degradation) having a DE of > 10 are listed under HS 1702, which includes "Other sugars, including chemically pure lactose, maltose, glucose and fructose, in solid form".⁶ The term maltodextrin is not used. This custom's classification system is used by most countries in the world.

The empirical formula of all dextrin and maltodextrin is $(C_6H_{10}O_5)_n$. The typical glucosidic linkages in dextrin and maltodextrin are α -1,4 and α -1,6 linkages; however, other atypical linkages can be formed.^{2-5,7} Further, all preparations of dextrin or maltodextrin result in a highly heterogeneous mix of different molecule weights and branching configurations. DE's are reported as averages. As mentioned above, both dextrin and maltodextrin have been determined GRAS and used in the US and throughout the world for many years.

B. Resistant Dextrin and Maltodextrin

Resistant dextrin and resistant maltodextrin are subcategories of dextrin and maltodextrin, respectively, and have been sold as safe food ingredients for many years in Japan, the EU, and US. One type of dextrin (DE < 10) has been recently notified as GRAS.⁵ It was termed as both an "enzyme-modified dextrin", and a "resistant dextrin". The term "resistant" indicates that resistant dextrin or maltodextrin is to a greater extent partially resistant to enzymatic digestion in the small intestine of the human digestive tract. The resistant dextrin (DE $\leq$ 10) of the referenced GRAS Notification, as with other resistant dextrin products, is produced from acidified cornstarch or wheat starch using high temperature and low moisture (pyrolysis or dry roasting).⁵ The same process is used for producing a resistant maltodextrin product which has a higher DE (> 10 < 20).⁷ The process can be adjusted to form a higher amount of resistance in the dextrin and maltodextrin.^{5,7} As with other types of dextrin or maltodextrin, these products (enzyme-modified dextrin, resistant dextrin; resistant maltodextrin) are highly heterogeneous mixture of D-glucose polymers with molecular weights ranging from approximately 3,500 to 6,000 (resistant dextrin) or a mean of 2,000 (resistant maltodextrin), depending on the grade. This resistant dextrin/maltodextrin is then purified and concentrated to various extents using industry standard carbohydrate methods to produce various grades of the product. It is commonly spray dried. The product is a dextrin/maltodextrin of relatively low viscosity, high water solubility with

approximately 70% to > than 85% dietary fiber.^{5,7} Structural analysis of this resistant dextrin/maltodextrin shows linear and branched structures in which glucose residues are linked through α -1,2, α -1,3, β -1,2, β -1,3, and β -1,4 linkages, in addition to the common α -1,4 and α -1,6 dextrin linkages, or combinations of these.^{2-5,7} These and other similar products are already used in a wide variety of foods and as dietary fiber or bulking agents. There does not appear to be any FDA regulatory differentiation between non-resistant and resistant products. This is likely the result of a common production process for dextrin and maltodextrin that may or may not produce higher concentrations of non-digestible bonds.^{8,9} Modification of the process can result in a wide range of the percentage of resistant bonds.

The resistant dextrin/maltodextrin are being commercialized under 21CFR §184.1277 (dextrin), 21CFR 184.1444 (maltodextrin), GRAS 436 (resistant dextrin).^{5,8,9} There are additional "resistant" polyglucose products that are currently being sold into the US including 21CFR §172.841 (polydextrose), and GRAS Notice 099 (pullulan).^{10,11} As previously mentioned, all these products are manufactured from starch or other glucose-based sources using various methods, but result in substantially equivalent substances. These are recognized as safe for use under current good manufacturing practices.

C. Dietary Fiber –

Current FDA regulations do not include an established definition for dietary fiber although it is a common term and is required in food labeling.¹²⁻¹⁴ Dietary fiber is a nutritional expression that is not based on chemical or physical characteristics; however, both of these properties play a role in the determination of a substances inclusion in this group.³ In the last few years there has been a desire by the FDA to provide a definition.¹⁵ Essentially, dietary fiber is a carbohydrate or lignin that, when consumed in the human diet, is not or is partially digested by the hydrolytic enzymes in the small intestine. This is essentially the result of the substance being resistant, vis-à-vis, having chemical bonds or other physical characteristics that are "resistant" to this enzymatic hydrolysis. A dietary fiber can be either fully or partially fermented by gut bacteria in the large intestine, and/or excreted in the feces. It is accepted by most regulatory and scientific bodies in the world that dietary fibers have certain physiologic benefits in humans.^{13,14,16} There are also other terms that are used to describe characteristics of dietary fiber, which include water soluble/insoluble, viscous/non-viscous, and natural, intrinsic/added, extracted, and synthetic. The identification and amount of dietary fiber, for labeling purposes, is obtained using standardized analytical tests as listed by the AOAC (Association of Official Analytical Chemists).^{14,17} There are a number of analytic methods recognized by the FDA, that can be used to determine the fiber content.¹⁷

D. Isomaltodextrin (IMD) –

IMD is produced through the action of enzymes on cornstarch, tapioca or other starches.¹ Because the production process uses enzymes involved in α -

glucosyltransferase and α -amylase reactions, IMD is generally more homogeneous than other dextrin/maltodextrin and similar substances, but certainly still heterogeneous in nature.¹ It is a polymer composed exclusively of D-glucose with a average molecular weight of approximately 5,000. Another term for this type of substance is an α -glucan because it is made up only of glucose molecules attached together using α -glycosidic linkages, like the starch from which it is produced.³ Starch, maltodextrin, and pullulan are other examples of α -glucans. In brief, IMD is produced by first, enzymatic hydrolysis of starch, then two enzymes are used to produce the IMD structure, with a final α -amylase being used to assist filtration.¹ As with other dextrin/maltodextrin and resistant dextrin/maltodextrin substances, there are purification and concentration steps followed by spray drying. These processes are essentially used for all starch hydrolysate products from dextrin (DE 3-10) to glucose (DE 100), and high fructose corn syrup production. IMD is a dextrin of low viscosity, high water solubility, having a dietary fiber content of at least 80%.¹ IMD has both linear and branched structures created by α -1,4, α -1,6 and α -1,3 linkages, and combinations of these.¹ The combination of these linkages inhibits the amount of digestion by enzymes in the small intestine of humans, making IMD a resistant dextrin, and also a candidate dietary fiber.

In conclusion, structurally IMD is a type of dextrin (DE 3-10) and maltodextrin (DE < 20), which is produced by enzymatic hydrolysis and transglycosylation from food grade starch. It consists of only D-glucose units bound by α -glucosidic linkages that are found in all starches and in other commercialized resistant dextrin/maltodextrin products. IMD can, therefore be classified as a dextrin/maltodextrin and resistant dextrin/maltodextrin. Maltodextrin is defined in 21CFR 184.1444 as being produced by acid and enzymes, therefore IMD would be considered to be essentially GRAS under this section.⁹ While 21CFR §184.1277 only mentions that dextrin is produced by dry roasting, with or without processing aids such as acid; however, it has become common in the industry to use enzymes for this purpose.⁴ IMD generally meets the product specifications, but not all, for both dextrin and maltodextrin as found in the Food Chemical Codex (FCC, 2014).¹⁸⁻²⁰ While more specific information about the relationship of these substances will be provided, it is the opinion of Hayashibara that the chemical, structural and safety characteristics of IMD demonstrate that isomaltodextrin (IMD) can be considered generally recognized as safe, using scientific procedures being substantially equivalent to non-resistant and resistant dextrin/maltodextrin, pullulan and polydextrose, when used consistent with cGMP. This determination was reviewed by a panel of experts, qualified by their scientific training, and national and international experience to evaluate the safety of food and food ingredients (Appendix A).

Section III. Chemical Identity

**Section III: Chemical Identity, Structure, Manufacturing Processes,
Specifications, and Physicochemical Properties**

A. Common or Usual Names and Identity

Isomaltodextrin

B. Formal Names (IUPAC or Chemical Abstracts Names)

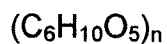
Chemical Abstracts Name: Dextrin

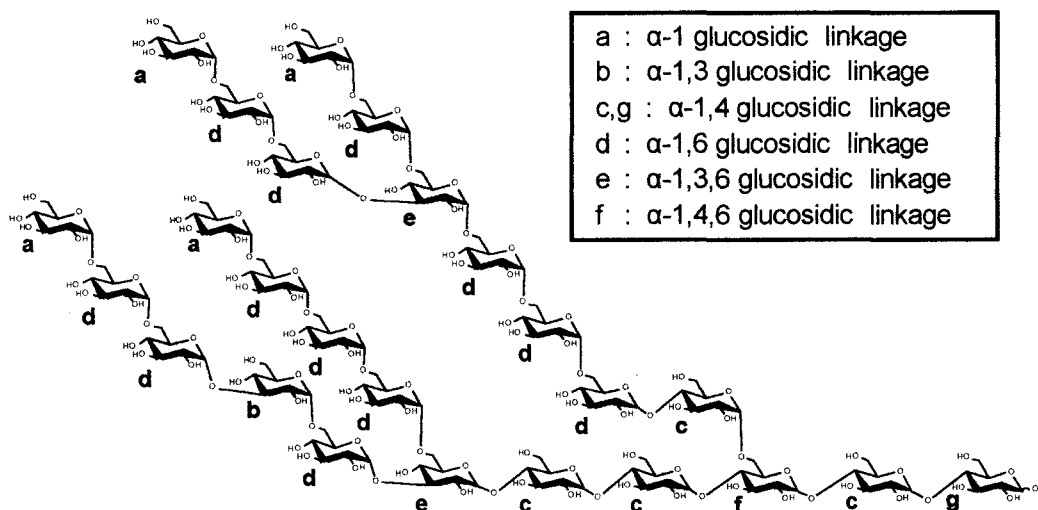
C. Synonyms, Other Common Names

1. Highly branched α -glucan
2. Dextrin
3. Resistant dextrin
4. Dietary fiber
5. Soluble fiber
6. Soluble dietary fiber

D. Chemical Formula, Structure and Molecular Weight

1. Empirical Formula



2. Structural Formula²¹

3. Molecular Weight

The weight average molecular weight is approximately 5,000. The number average molecular weight is approximately 2,500.²¹

E. Chemical Abstracts Service Registry Number (CAS Registry No.)

9004-53-9

F. Description

Isomaltodextrin (IMD) is white powder that is enzymatically produced from starch derived from corn, cassava, etc. IMD is comprised of only α -D-glucose. IMD includes more than 95% of α -glucans having a degree of polymerization more than 2. The molecular weight range is 500 – 10,000, the weight average molecular weight is approximately 5,000, and the number average molecular weight is approximately 2,500. The range of degree of polymerization is 3–62, and the mean degree of polymerization is 30. The dextrose equivalent is approximately 7. IMD includes approximately 17% of α -1 glucosidic linkages (nonreducing end group), 3% of α -1,3 glucosidic linkages, 19% of α -1,4

glucosidic linkages, 49% of α -1,6 glucosidic linkages, 7% of α -1,3,6 glucosidic linkages, and 5% of α -1,4,6 glucosidic linkages.^{1,21} All the bonds associated with IMD are alpha. These bonds result in a branched structure (2. above) like other dextrin/maltodextrin. Dietary fiber content in IMD measured by the Enzymatic-HPLC method (AOAC 2001.03) is approximately 80%.²²

1. Substantial Equivalence – Chemical and Physical

The claim of IMD being GRAS by scientific procedures of substantial equivalency to other dextrin and maltodextrin products is based upon the chemical and physical structures of these other commercialized products, and the demonstrated safety of these substances. It should be kept in mind that each of these products consists of a highly heterogeneous mixture of similar substances, with the same basic structure. As explained in the introductory section of this document, the difference between dextrin and maltodextrin in the US is more a regulatory differentiation than physical/structural. All these substances are branched molecules consisting of primarily glucose. It has become more common in chemical and academic circles to term all hydrolysates with a dextrose equivalence (DE) of less than 20 as maltodextrin, although dextrin also has a DE of less than 20, and they have different CAS numbers.^{4,8,9} The FDA has defined these two terms in the GRAS Notices as maltodextrin having a DE of less than 20, while dextrin has no associated DE.^{8,9} Text books usually include the lower limit of the DE as 3. A DE less than this is called acid-modified or thin-boiling starches.³ However, international trade has defined dextrin as a starch hydrosylate that has a DE of 10 or less, while the term maltodextrin is not even used.⁶ Regardless of the various classifications adopted, dextrin and maltodextrin are highly branched heterogeneous D-glucose polymers produced from starch by various hydrolytic methods.^{1-5,7-9}

Starch (cornstarch) contains exclusively glucose molecules that are attached by approximately 95% α -1,4 and 5% α -1,6 glucosidic linkages.²³ During the production process of IMD the linkages are rearranged, which results in a percentage of glucosidic linkages that are atypical or are formed

in a manner such that much of the molecules cannot be digested by the enzymes found in the small intestine.¹ This results in a subcategory of dextrin/maltodextrin called "resistant dextrin or maltodextrin". Resistant dextrin/maltodextrin are used commercially as general food ingredients, and can be considered dietary fiber if they meet the accepted criteria.^{3,4,13}

There are commercial resistant dextrin/maltodextrin products. They include "resistant dextrin", "resistant maltodextrin", polydextrose, and pullulan. Each of these substances, except polydextrose (see below), are formed by the hydrolysis of starch, which is partially branched (amylopectin). As with IMD the production process results in the formation of various atypical glucosidic bonds that can resist small intestinal enzymatic breakdown. When dextrin is produced the particular process conditions can result in a wide range of product characteristics. In addition to hydrolysis, repolymerization occurs and with it a wide range of glucosidic linkages, both alpha and beta.⁵ Additionally, the reducing end of resistant dextrin/maltodextrin usually contains a heat modified glucose, called levoglucosan. Therefore resistant dextrin and resistant maltodextrin do not completely consist of glucose, but contain a small amount of levoglucosan.

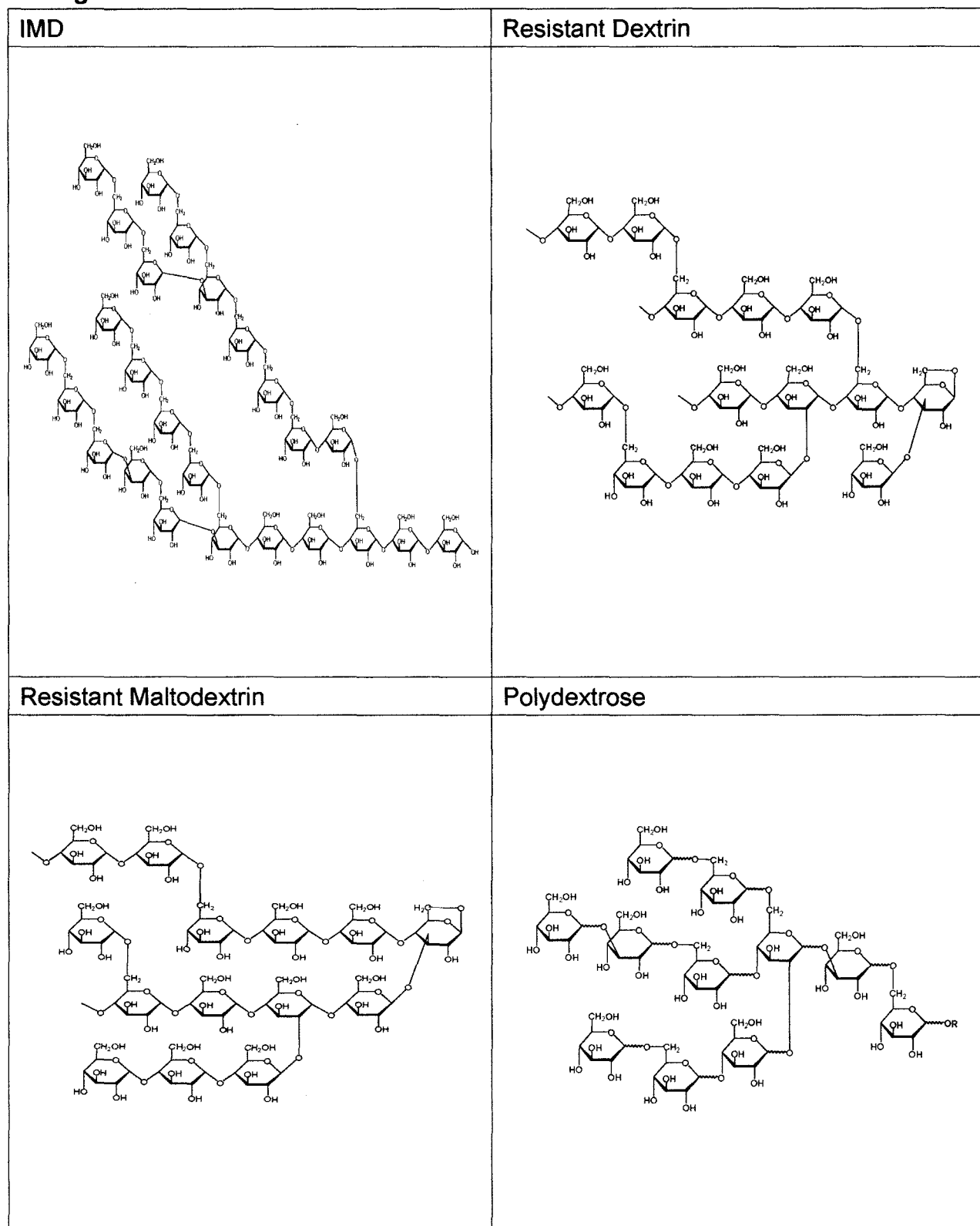
The production process of polydextrose is not via starch hydrolysis, but is a condensation of set concentrations of D-glucose, sorbitol and citric acid. This results in a branched resistant polyglucose, consisting of a relatively high proportion of 1-6 linkages, many being beta.²⁴ The reducing ends of the polyglucose molecules consist of a molecule of sorbitol, although a small fraction of these reducing ends are levoglucosan, like resistant dextrin/maltodextrin.

Pullulan is a fermentation product, which uses a starch-derived syrup ($DE \geq 20$), to produce the substance. It is unique in that it is resistant to digestion (approximately 70%), even though it only contains α -1,4 and α -1,6 glucosidic linkages. However pullulan, like IMD, consists exclusively of D-glucose.¹¹

Figure III-1 shows the structure of IMD, resistant dextrin, resistant maltodextrin, polydextrose, pullulan and maltodextrin. All are commercial products, except IMD, and all consist of very similar branched structures, consisting almost exclusively of D-glucose (see above). Pullulan appears structurally different because it features a stair-step structure; however, by its empirical formula it is the same as the other glucose-based molecules. Maltodextrin has only α -1,4 and α -1,6 glucosidic bonds. It should be noted that each of these structures is an "average" or only part of the molecular structure because the production process of all these substances results in products that are highly heterogeneous in size and the structural way they are branched.

Table III-1 compares raw material, production methods, substance compositions, and other relevant features of IMD, resistant dextrin/maltodextrin, polydextrose and pullulan. Note that these are essentially similar to dextrin or maltodextrin. Pullulan is different in its average molecule weight and that it only has one reducing end per molecule; however, like the other molecules it is composed of glucose, and partially resistant to digestion. The commercially available resistant dextrin and resistant maltodextrin products are produced by essentially the same method. A principle reason that one is called dextrin and the other maltodextrin is because of their DE. As mentioned in the Introduction, dextrin has historically been considered by the industry and international customs as having a DE between 3 – 10, whereas maltodextrin has a DE of 11 to less than 20. Therefore, IMD would be considered to be a dextrin.

Figure III-1



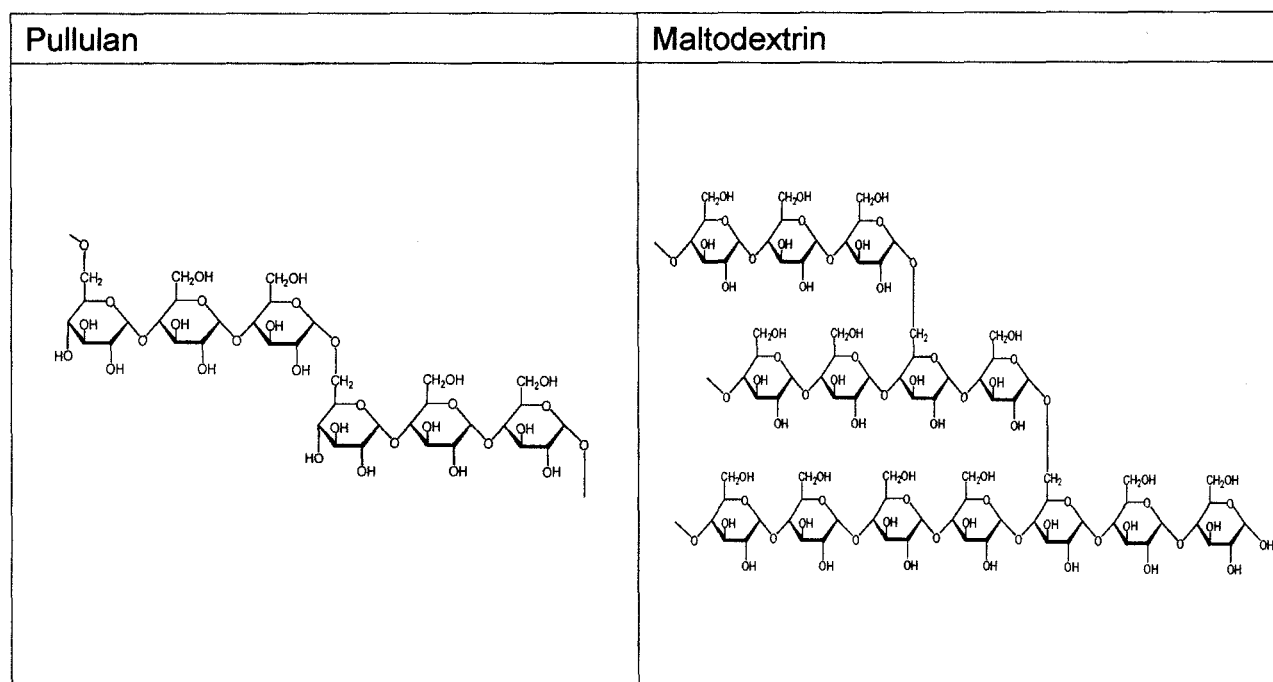


Table III-1

Products	IMD	Resistant Dextrin ^{1*}	Resistant Maltodextrin ²	Polydextrose ³	Pullulan ⁴
Raw Material	Starch	Starch	Starch	Glucose, Sorbitol, Citric acid	Starch syrup
Production Method	Enzymatic reaction	Pyrolysis, acid and enzyme treatment	Pyrolysis, acid and enzyme treatment	Dehydration synthesis	Fermentation
Composition	Glucose	Glucose, slight concentrations of Levoglucosan	Glucose, slight concentrations of Levoglucosan	Glucose, slight concentrations of Sorbitol and Levoglucosan	Glucose
Mw	≈ 5,000	4,000~6,000	≈ 2,000	1,500~2,000	≈ 200,000
DE	7	6	11	7	-
Dietary Fiber	≈ 83%	≈ 85%	85-95%	75-85%	≈ 70%

*References: 1. FDA, GRAS Notice No.436; 2. J Appl Glycosci, 49, 479-85 (2002); 3. Food Chem Tox, 42, 1531-42 (2004); FDA, GRAS Notice; No. 107 (withdrawn); 4. FDA, GRAS Notice No. 099

Table III-2 provides information about the types of bonds found in each molecule. It should be noted that it was only possible to obtain information

about the relative percentage of each specific type of bonds for IMD and pullulan. The specific bonding frequencies for the others were not found in the literature. The only two notable differences as compared to IMD are that resistant dextrin/maltodextrin and polydextrose contain beta bonds. However, the bonds that are found in IMD and pullulan are also common to these other three commercial products. The second difference is that these three substances contain a small portion of non-glucose molecules, while IMD and pullulan do not. There is no indication that differences in these glycosidic bonds would have any impact on the safety of these substances when consumed. Review of the safety and tolerability studies (see below) support this conclusion. All these substances are metabolized in essentially an identical manner in the human body. Hayashibara has concluded that the physical and chemical structures of these substances are chemically and structurally similar to make IMD substantially equivalent to resistant dextrin/maltodextrin, polydextrose and pullulan, all of which are considered as GRAS for their intended use.

Table III-2

Products/Linkages	IMD	Resistant Dextrin ^{1*}	Resistant Maltodextrin ²	Polydextrose ³	Pullulan ⁴
Non-Reducing end	✓ (17%)	✓	✓ (29%)	✓ (29%)	✓
α1,2 linkage	—	✓	✓	✓	—
α1,3 linkage	✓ (3%)	✓	✓	✓	—
α1,4 linkage	✓ (19%)	✓	✓	✓	✓ (67%)
α1,6 linkage	✓ (49%)	✓	✓	✓	✓ (33%)
β1,2 linkage	—	✓	✓	✓	—
β1,3 linkage	—	✓	✓	✓	—
β1,4 linkage	—	✓	✓	✓	—
β1,6 linkage	—	✓	✓	✓	—
Multi-branched structures (α1,3,6 bonding, etc)	✓ (12%)	✓	✓ (20%)	✓ (35%)	—

*References: 1. FDA, GRAS Notice No.436; 2. J Appl Glycosci, 49, 479-85 (2002); 3. Food Chem Tox, 42, 1531-42 (2004);

FDA, GRAS Notice; No. 107 (withdrawn); 4. FDA, GRAS Notice No. 099

G. Specifications For Raw Materials and Finished Product**1. Raw Materials**

The following substances are used in the manufacture of Isomaltodextrin (IMD) and are acceptable under Japan's Specifications and Standards for Food Additives under the Food Sanitation Act in Japan.²⁴

- a. Activated Carbon (2 kinds)
- b. Thermostable α -Amylase (EC 3.2.1.1)
- c. α -Amylase (EC 3.2.1.1)
- d. Calcium Carbonate
- e. Diatomaceous Earth (3 kinds)
- f. Hydrochloric Acid
- g. Ion Exchange Resin (3 kinds)
- h. Perlite
- i. Sodium Carbonate
- j. Sodium Hydroxide Solution
- k. Sodium Pyrosulfite
- l. Starch
- m. IMD Producing Enzymes
(α -Glucosyltransferase <AGT; EC 2.4.1.24> and α -Amylase <AMY; EC 3.2.1.1>)

2. Specifications of Raw Materials

The specification and grades of the raw materials used for the manufacture of IMD and the analytical methods were provided for the review of the IMD Expert Panel. Hayashibara analyzes all incoming raw materials periodically for compliance with their published specifications.

The use of the two food grade commercially available amylases used in the manufacture of IMD were reviewed in GRN 0045, and are consistent with 21 C.F.R. §184.1444 and the Federal Register, 60 No. 183, 48890-91 for the production of maltodextrin, and the use of an α -amylase was considered GRAS (GRN 000436) for use in the production of resistant

dextrin. The two α -amylases noted in G. 1. b. and c. above are found in the List of Existing Food Additives in Japan.²⁵

The two enzymes listed in G. 1. m., IMD Producing Enzymes (α -amylase and α -glucosyltransferase), are also allowed under the List of Existing Food Additives in Japan.²⁶ However, because these are produced by a novel organism, *Paenibacillus alginolyticus*, a non-toxicogenic, non-pathogenic soil bacteria, Hayashibara requested that one of the members of the Expert Panel, Dr. Michael Pariza, an internationally recognized expert on the safety of novel enzymes for use in food, provide an opinion on the safety of the organism and the two enzymes. His statement with the decision tree developed by Pariza and Johnson is found in Appendix B.²⁷ *Paenibacillus alginolyticus*, Nakamura strain, is deposited at ATCC and is categorized as biosafety level "1".²⁸ It is also classified as risk group "1" with no additional classification notes in the "German Classification of Prokaryotes (Bacteria and Archaea) into Risk Groups", and is not listed in the FDA Bad Bugs Book.^{29,30}

The concentration of protein was examined to assure the removal of the processing enzymes and other proteins that might have been associated with the starch. The amount of protein using a standard protein assay in 6 assayed lots was < 2.0 μ g/mL, which is below the limit of detection (Table III-3). Polyclonal ELISA's were developed, separately for the two standard α -amylases, and one for the IMD producing enzyme preparation. Results showed that there was < 0.5 ng/mL for the two commercial α -amylases, and < 2.0 ng/mL for the IMD production enzymes. The FCC protein specification for dextrin and maltodextrin are NMT 1.0%, and NMT 1.0 or 0.5% (depending on starch), respectively.^{19,20}

Hayashibara has concluded that the quality and safety of the raw materials are substantially equivalent to that used to produce currently available commercial dextrin/maltodextrin, resistant dextrin/maltodextrin, polydextrose and pullulan.

Table III-3 Results of a protein assay and three ELISA assays

	Protein assay ($\mu\text{g/mL}$)	ELISA assay (ng/mL)		
		Thermostable α -Amylase	IMD producing enzymes	α -Amylase
Lower detection limit	< 2.0	< 0.5	< 2.0	< 0.5
121220C1	< 2.0	< 0.5	< 2.0	< 0.5
130130C1	< 2.0	< 0.5	< 2.0	< 0.5
130720C1	< 2.0	< 0.5	< 2.0	< 0.5
130208T1	< 2.0	< 0.5	< 2.0	< 0.5
130208T2	< 2.0	< 0.5	< 2.0	< 0.5
130208T3	< 2.0	< 0.5	< 2.0	< 0.5

*IMD concentration of all samples is 5% (w/v).

H. Quantitative Composition of Isomaltodextrin

1. Product Specifications

Final food grade product specifications have been developed for IMD. IMD occurs as a white powder. All products contain not less than 95% IMD and not greater than 8.0% moisture. The residue on ignition is not greater than 0.1%. The pH of a 10% IMD solution ranges from 4.0 to 6.5. The dietary fiber content by AOAC 2001.03 is greater than 80% on a dry weight basis.²² The content of lead is not greater than 0.1 ppm and arsenic is not greater than 2 ppm. The total aerobic microbial limits do not exceed 300 CFU/g. Coliform organisms are negative. The yeast and mold limit do not exceed 100 CFU/g. Table III-4 lists the specifications for IMD and the analytical methods used.

Table III-4 Product Specifications for IMD

Variable	Specification	Analytical method
Appearance	White powder	General notices on Food additive in the Japan's Specifications and Standards for Food Additives
Purity	≥ 95%	Internal Company Method - HPLC validated method
Loss on drying	≤ 8.0%	General Tests and Assays in the FCC
Residue on ignition	≤ 0.1%	General Tests and Assays in the FCC
pH (10% solution)	4.0-6.5	JIS Z8802
Dietary fiber content	> 80%	AOAC 2001.03 – Enzymatic-HPLC Method
Lead	≤ 0.1 ppm	General Tests and Assays in the FCC
Arsenic (as As ₂ O ₃)	≤ 2 ppm	Arsenic Limit Test of Food additives in the Japan's Specifications and Standards for Food Additives
Viable count	≤ 300 CFU/g	Microbial test in Japan's Standard Methods of Analysis for Hygienic Chemists
Coliform organisms	Negative	Microbial test in Japan's Standard Methods of Analysis for Hygienic Chemists
Yeast and mold	≤ 100 CFU/g	Microbial test in Japan's Standard Methods of Analysis for Hygienic Chemists

Specifications for IMD are not completely comparable to those of FCC specifications for dextrin or maltodextrin, or resistant dextrin.^{5,16,17} Resistant dextrin also does not include all the FCC specifications.⁵ For the specifications that are similar, IMD meets or exceeds the limits of the FCC, and most of all the specifications for resistant dextrin.^{5,19,20} The specifications, where applicable, are also similar for polydextrose and pullulan.^{11,31} The specifications that are not used for IMD, but are included in the FCC specifications (dextrin and/or maltodextrin) are an iodine identification test, reducing sugar assay, chloride, sulfur dioxide, crude fat, and protein. For resistant dextrin, specification differences are mono- and di-saccharides, and protein. As part of the process of characterizing IMD Hayashibara performed a protein assay using the Bradford method and developed three ELISA assays to identify any residual protein, including enzymes, in the final product. The data demonstrates that there is virtually

no protein or enzyme residue remaining in the final IMD product. Both total protein and ELISA protein were below detectable limits ($< 2.0 \mu\text{g/mL}$ and $< 2.0 \text{ ng/mL}$, respectively; Table III-3). The reducing sugar assay and concentrations of mono- and di-saccharides, like protein, have been closely examined and data is supplied below (Table III-5). The mean reducing power (DE 7) was standardized with the other characteristics of IMD (Table III-1). IMD meets the FCC Maltodextrin specifications for total solids. Crude fat was tested and shown to meet the FCC Dextrin specification (NMT 1.0%).²⁰ An iodine reaction test is performed as one of the critical control points in the manufacturing process. Using the production method for IMD, as opposed to resistant dextrin and dextrin, there does not appear to be a rationale for testing for chlorine, and sulfur dioxide. It is Hayashibara's conclusion that the specifications of FCC dextrin and maltodextrin, and of resistant dextrin are substantially equivalent.

2. Analysis of Multiple Lots

To demonstrate that Hayashibara is able to consistently manufacture IMD meeting the above proposed specifications, Hayashibara has analyzed 6 lots. The results are provided in Table III-6. The data shows that the product purity ranged from 97.4% to 98.6% (98.1 ± 0.45). The moisture ranged from 3.4% to 4.8% (4.03 ± 0.55). The residue on ignition ranged from 0% to 0.01% (0.00 ± 0.01). The pH of a 10% IMD solution ranged from 5.2 to 6.2 (5.85 ± 0.34). The dietary fiber content measured following the AOAC 2001.03 ranged from 86.5% to 90.8% (dwb; 88.5 ± 1.74).¹⁸ The contents of lead and arsenic were not greater than each proposed specification. Viable bacterial counts, and yeast and mold were within the limit, and the all lots were negative for coliform organisms.

Table III-5 Analyses of 6 Lots of IMD

Variables	Specifications	Lot No.					
		121220C1	130130C1	130720C1	130208T1	130208T2	130208T3
Appearance	White powder	White powder	White powder	White powder	White powder	White powder	White powder
Purity	≥ 95%	98.1	98.2	97.7	98.6	98.6	97.5
Loss on drying	≤ 8.0%	4.8	4.6	3.9	3.9	3.4	3.6
Residue on ignition	≤ 0.1%	0.01	0	0	0	0	0.01
pH (10% solution)	4.0-6.5	6.2	5.9	5.2	5.9	6.0	5.9
Dietary fiber content (dry weight basis; AOAC 2001.03)	>80%	87.5	87.4	86.5	90.4	90.8	88.5
Lead	≤ 0.1 ppm	≤ 0.1	≤ 0.1	≤ 0.1	≤ 0.1	≤ 0.1	≤ 0.1
Arsenic (as As ₂ O ₃)	≤ 2 ppm	≤ 2	≤ 2	≤ 2	≤ 2	≤ 2	≤ 2
Viable count	≤ 300 CFU/g	0	0	0	0	0	0
Coliform organisms	Negative	Negative	Negative	Negative	Negative	Negative	Negative
Yeast and mold	≤ 100 CFU/g	0	0	0	0	0	0

3. Identification of Mono- and Di-Saccharides

To identify the component mono- and di-saccharides, Hayashibara analyzed 6 lots of IMD. The results are provided in Table III-7. The data show that the components of mono-saccharide are glucose and fructose. The components of di-saccharide are isomaltose having α-1,6 glucosidic

bond, maltose having α -1,4 glucosidic bond, and nigerose (diglucose) having α -1,3 glucosidic bond.

Table III-6 Identification of Mono- and Di-Saccharides

Lot No.	Contents (%)					
	$\geq$ DP3	DP2 (Di-Saccharide)			DP1 (Mono-Saccharide)	
	IMD	Isomaltose	Maltose	Nigerose	Glucose	Fructose
121220C1	98.1	0.8	0.1	0.1	0.8	0.1
130130C1	98.2	0.8	0.1	0.1	0.8	0.0
130720C1	97.7	0.8	0.2	0.1	1.0	0.2
130208T1	98.6	0.6	0.1	0.1	0.6	0.0
130208T2	98.6	0.6	0.1	0.1	0.6	0.0
130208T3	97.5	0.8	0.3	0.2	1.1	0.1
Mean $\pm$ SD	98.1 $\pm$ 0.5	0.7 $\pm$ 0.1	0.2 $\pm$ 0.1	0.1 $\pm$ 0.0	0.8 $\pm$ 0.2	0.1 $\pm$ 0.1

4. Methods of Analysis

The methods for the analysis of each of the specification limits set for IMD, except for purity, are standard international methods as noted in Table III-4. Some general analytical methods in the Food Chemical Codex (FCC) have been adopted for the related specifications.³²⁻³⁴

5. Contaminants

The starting materials, cornstarch or other starches used, have been tested for the potential presence of over 250 different pesticide residues from pesticides commonly used in a broad range of crops in the U.S. and Asia. None of these pesticides were detected in any of the starch samples (below limits of detection).

IMD is tested for microbial contaminants using the microbial tests in Japan's Standard Methods of Analysis for Hygienic Chemists. As can be seen in Table III-6, where 6 lots were analyzed, the product is very clean.

Because of the use of enzymes produced from a novel bacteria, the IMD-producing enzyme preparation was tested for the presence of antibiotics. This analysis was performed by the Japan Food Research Laboratories, using the method of JECFA FAO/WHO Expert Committee on Food Additives "Combined Compendium of Food Additives Specifications". Three lots of the enzyme preparation were tested against the standard organisms of *Bacillus cereus* ATCC 2, *Bacillus circulans* ATCC 4516, *Serratia marcescens* ATCC 14041, *Escherichia coli* ATCC 11229, *Staphylococcus aureus* ATCC 6538 and *Streptococcus pyogenes* ATCC 12344. There was no indication of any antibiotic activity.

IMD was also tested for possible aflatoxin contamination. As with the antibiotic assays this analysis was performed by the Japan Food Research Laboratories. The analytical method used was SyokuAn No. 0916-2 "Analytical Methods for Aflatoxins" in Japan. The detection limit of these methods are < 1.0 µg/kg. No B1, B2, G1 or G2 aflatoxins were detected.

I. Manufacturing Process, Enzyme Function, and Quality Control

1. Introduction

Starch syrups were originally produced by acid and heat hydrolysis which resulted in products with highly heterogeneous components.²⁻⁴ As enzymology developed it was understood that various enzymes could be used to breakdown starch in both specific and general ways. Other enzymes could use these hydrolytic products to make very specific end products, if desired. Hayashibara was the first company in the world to use enzymes commercially to hydrolyze starch and produce an exceptionally high purity glucose in 1958. Ten years later Hayashibara scientist developed an enzymatic process to produce maltose directly from starch.³⁵ The purity was high enough that it could be crystallized and processed to

make a product almost 99% pure.^{35,36} This product subsequently allowed for the development of crystalline maltitol, which is used in the food industry as a major polyol for confectionaries.^{37,38} Hayashibara has continued to innovate and in 1995 resulted in the production of a commercially viable trehalose product of high purity, which was submitted and granted GRAS Notice status in 2000.³⁹ The purification process for most all these starch hydrolysates, both heat/acid and enzymatic are standard methods.^{1,2,5,21,35,39}

Many saccharides that are vital to the food, cosmetic and pharmaceutical industries are manufactured from starch by enzymatic reactions.^{2,3} In general, enzymatic synthesis results in high yields of the target substances. To date a method exclusively using enzyme technology for the manufacture of a water-soluble resistant dextrin or dietary fiber, has not been developed. Hayashibara, using its years of enzymatic expertise, screened thousands of isolates of soil bacteria to identify bacterial enzymes that could produce water-soluble resistant dextrin/dietary fiber from starch.¹

2. Manufacture Process

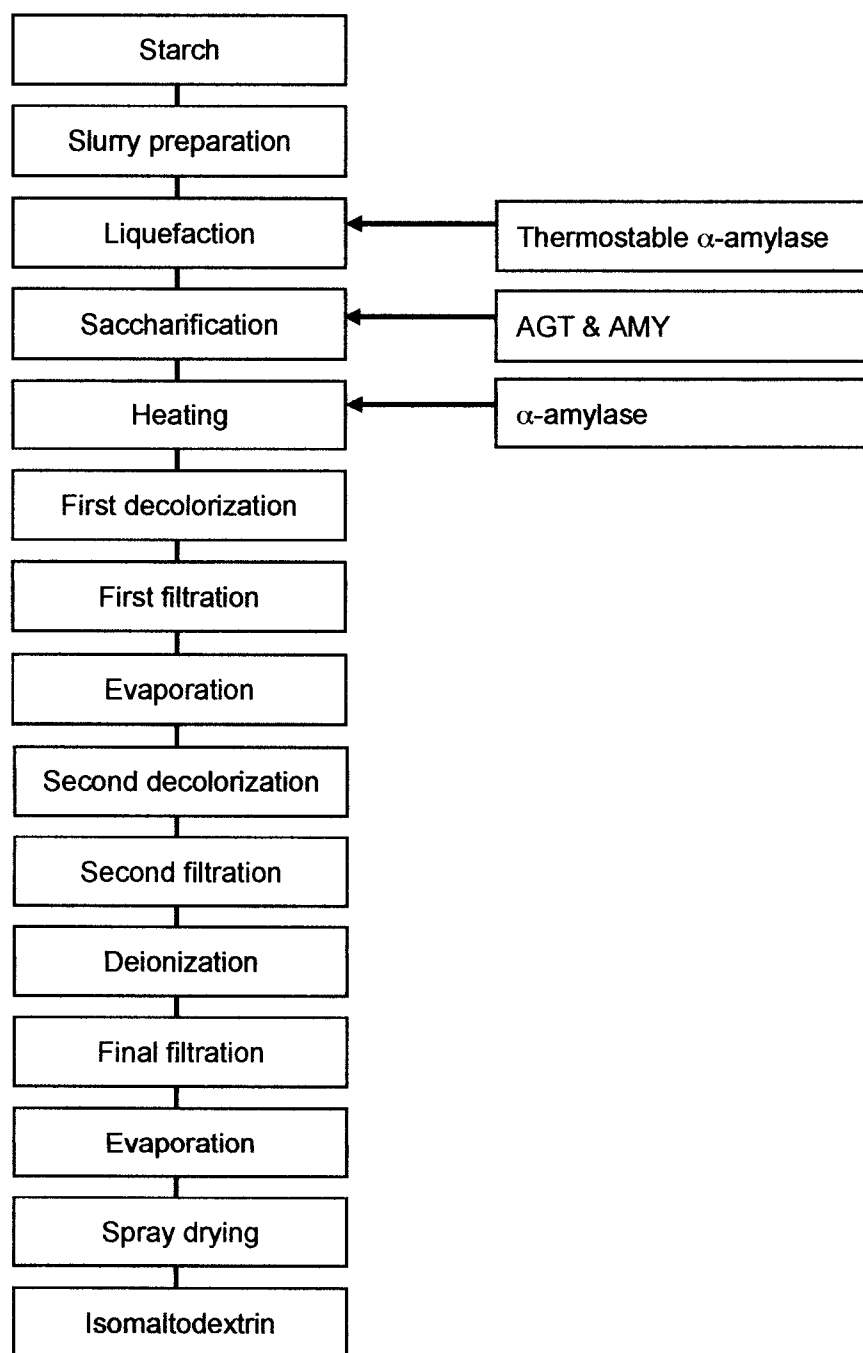
This section includes a detailed description of the novel production process developed and patented by Hayashibara to manufacture IMD from starch.^{1,21,40} Various food grade starches (cornstarch, tapioca, potato starch, sweet potato starch, etc.) can be used as the starting raw material. Because some of the information is confidential specific values and amounts will be deleted. If the FDA needs more specifics related to the production process, Hayashibara would be pleased to discuss this with the Agency. The technology of Hayashibara includes the use of two IMD producing enzymes discovered by scientists at Hayashibara.^{1,21} Following this section which describes the production process, the next section will provide information about the mechanisms by which the unique enzyme system synthesizes the IMD molecules. It should be noted that all ingredients are suitable for the food production (Section III. G. 1. and 2.) and there are a variety of critical control points (Section III. I. 4.) used to assure the quality of the product during production. A diagram of the production process is

provided in Figure III-2 below.

- a. The first step in the production process is the suspension of starch to produce a starch slurry with a concentration of XX% to XX%. The pH is adjusted to XX to XX.
- b. Thermostable α -amylase is added to the starch slurry and heated to XX°C to XX°C for liquefaction. This enzyme cleaves amylose and amylopectin chains into shorter units. After liquefaction, the added enzyme is inactivated by heat-treatment to XX°C to XX°C. The solution is then cooled to XX°C to XX°C and the pH is adjusted to XX to XX in preparation for the next production step.
- c. The IMD producing enzymes, α -glucosyl transferase and α -amylase, are added to the liquefied starch. These enzymes are responsible for the saccharification of the liquefied starch into IMD.²⁹ The specific activities of the IMD producing enzymes are discussed in the introduction above
- d. The IMD-producing enzymes are inactivated by heating to XX°C to XX°C.
- e. The pH is adjusted to XX to XX for the subsequent reaction. To hydrolyze the unreacted starch and dextrin, another α -amylase is added. This enzyme cleaves the unreacted amylose and amylopectin chains into shorter units, which make the filtration process much more efficient.
- f. The added α -amylase is inactivated by decreasing the pH of the solution to XX to XX.
- g. The solution is then decolorized with activated carbon at XX°C to XX°C.
- h. The activated carbon and other insoluble substances are removed by filtration at XX°C to XX°C.

- i. The solution is concentrated by evaporation and then decolorized with activated carbon at XX°C to XX°C.
- j. The activated carbon and other insoluble substances are removed by filtration at XX°C to XX°C.
- k. Salts and proteins are then removed in a 2-step procedure using twin-bed ion exchange resins, followed by a mixed-bed ion exchange procedure.
- l. The odorous substances and insoluble substances are removed by filtration with pre-coated activated carbon.
- m. The filtrate is concentrated by evaporation until the concentration is XX% to XX%.
- n. The concentrated liquid is spray-dried to a moisture content of XX% to XX%. The powdering procedure is conducted under clean air.
- o. The resulting IMD powder is then packed in 10-kg or 20-kg units in 3-ply Kraft bags, a lot number is printed on the bag and the sealed bags are screened using a metal detector.

The schematic diagram below shows the production steps in the IMD manufacturing process (Figure III-2).

Figure III-2 IMD Production Flow

3. IMD Producing Enzymes and Their Activity

The scientists at Hayashibara screened thousands of soil bacteria, and ultimately were able to identify a non-pathogenic, non-toxicogenic, non-genetically modified soil bacterial strain belonging to the genus *Paenibacillus*.¹ Based on the morphological, cultural, and physiological characteristics of the strain it was classified into the species *Paenibacillus alginolyticus*, according to *Bergey's Manual of Systematic Bacteriology*.⁴¹ The *Paenibacillus alginolyticus*, Nakamura strain, is deposited at ATCC and is categorized as biosafety level 1.²⁸ It is also categorized as risk level 1 in the German "Classification of Prokaryotes (Bacteria and Archaea) into Risk Groups".²⁹ The strain produces 2 enzymes, α -glucosyltransferase (EC 2.4.1.24) and α -amylase (EC 3.2.1.1), which are able to produce from hydrolyzed starch a novel highly water-soluble resistant dextrin, that can also be classified as a dietary fiber.¹ Analyses of the major substance from this production process have identified this novel water-soluble resistant dextrin (dietary fiber) as an IMD.

The production process of IMD involves 3 enzymatic steps. The first step involves liquefaction of starch with a thermostable α -amylase (EC 3.2.1.1) derived from *Bacillus licheniformis*. This step is common to the production of essentially all starch-based syrups that are produced. After the liquefaction, the mixture is heated to inactivate the thermostable α -amylase. For the second step of the production, the mixture is cooled and the pH adjusted.

The second enzymatic step uses the two enzymes, α -glucosyltransferase (EC 2.4.1.24) and α -amylase (EC 3.2.1.1), derived from *Paenibacillus alginolyticus*, which is non-genetically modified. This step involves 2 sequential enzymatic reactions.²¹ First, α -glucosyltransferase catalyzes the transfer reaction of a glucosyl residue from the non-reducing end of a glucan chain from the hydrolyzed starch to another non-reducing end of a glucan chain. This results in mainly α -1,6 glucosidic linkages (Step 1 in Figure III-3). Second, α -amylase acts on the α -1,4 glucosidic linkage in a glucan chain of the starch hydrosylate, and catalyzes transfer reactions to

C3- or C4-hydroxyl groups in α -1,6 linked glucosyl residues in the reaction product of the α -glucosyltransferase reactions. α -Amylase gradually increases α -1,3 or α -1,4 glucosidic linkages in the α -1,6 linked glucosyl residue in the middle, or in the non-reducing end of glucan chains (Step 2 in Figure III-3). Furthermore, α -glucosyltransferase catalyzes the transfer of glucosyl residues mainly in the form of α -1,6 glucosidic linkages to non-reducing ends in the residual product of the α -amylase reactions. These two enzymes repeat these reactions until the glucosidic linkages with which each enzyme can react disappears, and the IMD molecule is produced. After the reaction, the mixture is heated to inactivate both α -glucosyltransferase and α -amylase.

The final enzymatic step involves hydrolysis of unreacted starch with α -amylase (EC 3.2.1.1) derived from *Bacillus amyloliquefaciens*. This α -amylase treatment was incorporated to the IMD-production process after 2012 to improve the filtering efficiency of the process and does not affect the product in anyway. Commercial resistant dextrin, and it is believed commercial resistant maltodextrin, also incorporate a final α -amylase hydrolysis step, which allows for better filtration.^{5,7}

Hayashibara tested for differences in the sugar composition of IMD using samples from the lots produced with or without the final α -amylase treatment. Examination of HPLC profiles (not shown) demonstrated no differences between the preparation methods (Table III-8). In addition, no differences were observed in the specifications. Based on this data, Hayashibara concluded that the IMD product manufactured using an α -amylase at the end of the production process is essentially identical to that which is produced without the enzymatic treatment.

After the third enzymatic reaction, the pH of the mixture is lowered to inactivate the α -amylase. For purification the mixture is cooled and the reaction mixture containing IMD is subsequently decolorized by the addition of activated carbon and purified by filtration through diatomaceous earth and ion-exchange resins. To make a powdered product, the purified

solution is spray-dried. All these manufacturing steps and materials are consistent with the internationally recognized production methods and standards.

Figure III-3 Reaction of α -Glucosyltransferase and α -Amylase

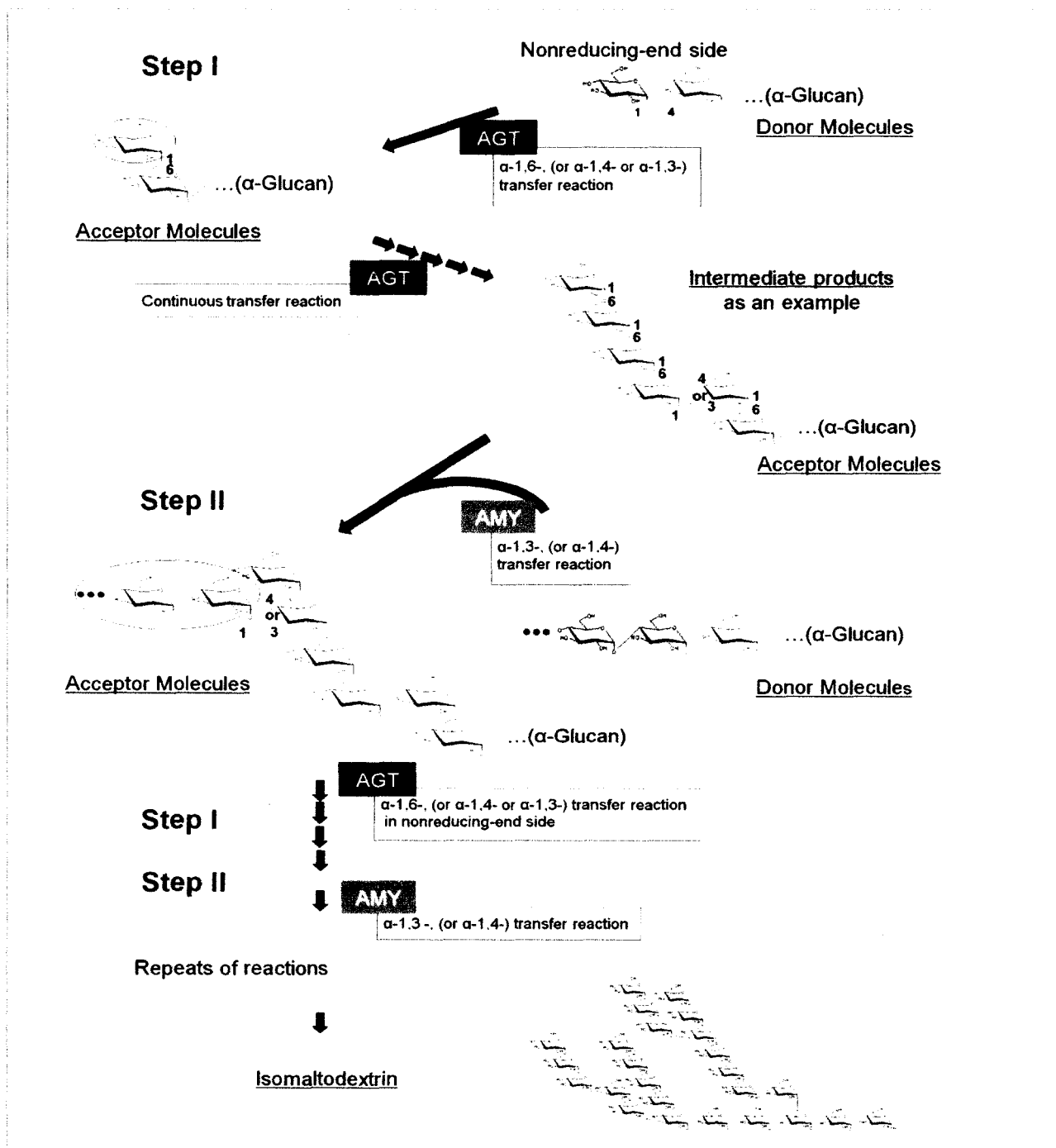


Table III-7 Sugar composition of IMD before and after the final α -amylase treatment

Process change	Lot No.	Sugar composition (%)									
		$\geq$ DP9	DP8	DP7	DP6	DP5	DP4	DP3	DP2	Glc	Fru
Before	070801	89.9	1.8	1.6	1.3	1.2	1.2	1.0	0.9	0.8	0.3
	070802	89.6	1.9	1.6	1.4	1.2	1.2	1.1	1.0	0.8	0.2
	070803	89.6	1.8	1.6	1.4	1.2	1.3	1.1	1.0	0.8	0.2
After	121220C1	90.2	1.8	1.6	1.2	1.1	1.2	1.0	1.0	0.8	0.1
	130130C1	90.0	1.7	1.7	1.3	1.2	1.2	1.1	1.0	0.8	0.0
	130720C1	89.6	1.8	1.5	1.3	1.2	1.1	1.2	1.1	1.0	0.2

As reported above in Section H.5., the IMD-producing enzyme containing α -glucosyltransferase (EC 2.4.1.24) and α -amylase (EC 3.2.1.1), were tested for the presence of both antibiotics and aflatoxins. It was shown that the three lots were negative for all antibiotics and aflatoxins.

4. Quality Control

Hayashibara maintains strict quality control by monitoring specified critical control points during the IMD manufacturing process. The individual processing steps are listed with the accompanying production steps (Table III-9).

Table III-8 Processing Steps, Monitoring variables, and Process Control Points*

Processing Steps	Process Control Variables
Slurry preparation	<i>Specific gravity, pH</i>
Liquefaction	<i>pH, Rate of Hydrolysis, Enzyme volume</i>
Saccharification	<i>pH, Enzyme volume, Dietary fiber content</i>
Heating	<i>pH, Temperature, Time of enzyme inactivation</i>
First decolorization	Color
First filtration	Color, Turbidity, <i>Foreign matter, pH, Iodine reaction</i>
Evaporation	Concentration
Second decolorization	Color
Second filtration	Color, Turbidity, <i>Foreign matter, pH</i>
Deionization	<i>Color, Turbidity, Foreign matter, pH, Relative conductivity</i>
Final filtration	Color, Turbidity, <i>Foreign matter, pH, Relative conductivity</i>
Evaporation	<i>Concentration</i>
Spray drying	<i>Loss on drying, Magnetic metal removal</i>
Weighing/ Filling / Packaging	Printing of lot number, <i>Heat seal quality</i> , Heat seal temperature, <i>Magnetic metal removal</i>

*All the items in bold italics are critical control points in the manufacturing process.
All other items are tested and recorded in the batch record.

5. Tracking Program

The manufacturing process of IMD at Hayashibara is organized into units consisting of a series of steps during the liquefaction and saccharification processes. One unit of liquefaction and saccharification is completed

within 1 week. The production date for the finished products produced within that week are assigned a lot number. The reference numbers and quantities of all materials and processing aids used in each unit of liquefaction and saccharification are recorded for each lot number and stored in company production records. Thus, it is possible for Hayashibara to track not only the finished product but also each raw material component that was used in the processing of that finished product. All raw materials and finished products can be traced to a particular week of the production. Therefore in the unlikely even of a product recall, the location of the lot can be quickly identified.

6. Substantial Equivalence – Manufacturing Process

As noted above (F.1.), there are various process for manufacturing the products discussed in this document. Dextrin, as defined in 21CFR184.1277, is primarily manufactured by the use of acidified starch and dry heat.⁸ The dextrin produced has some non-digestible bonds. Resistant starch is produced in the same manner; however, with modifications in various parameters, higher concentrations of non-digestible bonds can be formed.⁵ The purpose of this is to produce a product with a greater concentration of dietary fiber.⁵ One type of commercial resistant dextrin has also incorporated an α -amylase step, like IMD, to help in the filtration steps after the resistant dextrin is produced.⁵ In 21CFR184.1444 it states that maltodextrin is produced by partial hydrolysis of [starch] with safe and suitable acids and enzymes.⁹ Maltodextrin is normally considered completely digestible. While not published, it is thought that commercial resistant maltodextrin is produced essentially by an acid-dry heat process, like resistant dextrin, with at least one enzyme being used. This results in a branched polyglucose preparation with bonds that are resistant to digestion. This substance has a DE of 11, which can classify it as a maltodextrin (DE >10 and < 20). Polydextrose is produced by a condensation of a melt consisting of usually 89% D-glucose, 10% sorbitol, and 1% citric acid.¹⁰ This method results in a highly branched, digestion resistant, polyglucose molecule with a DE of 7 (dextrin), with glycosidic bonds similar to resistant dextrin and resistant

maltodextrin (Tables III-1 & 2). Pullulan is produced by fermentation of starch syrup with purification and concentration in a manner essentially the same as the other substances.¹¹ It is Hayashibara's conclusion that differences in production methods have little to do with the safety of the resultant products, all of which have been determined to be GRAS.^{5,8-10,11}

J. Stability of Isomaltodextrin

1. Summary

To test the stability of IMD, samples were taken from 3 different pilot lots of the product. Each sample was packed in the same heat-sealed polyethylene bag that is used as the inner layer of the 3-ply Kraft bag in which the final product is packaged. The pilot scale samples were and are being kept at controlled temperature and humidity ($25 \pm 2^{\circ}\text{C}$: RH $60 \pm 5\%$) in a storage room for a total of 42 months. The 24-month storage test was completed (Table III-9). The commercial scale samples are being kept at the same controlled temperature and humidity, and have been stored for 19 months to date. Currently the 18-month storage test was completed and the data provided in Table III-10. For the standard long-term storage conditions, the analytical results are reported every 3 months for the first 12 months, and then every 6 months for the final 42 months. An accelerated stability test was also conducted as reference data. Testing for samples under accelerated conditions was done at 1, 3 and 6 months of storage. The pilot scale samples were stored at controlled temperature and humidity ($40 \pm 2^{\circ}\text{C}$: RH $75 \pm 5\%$) in a thermo-hygrostat chamber (Table III-11). The following items were assayed at appropriate sampling times: Appearance, Purity, Loss on drying, Residue on Ignition, pH, Dietary fiber content, Lead, Arsenic, Viable count, Coliform organisms, Yeast and Mold. The stability study showed that the product remained within the prescribed specifications throughout the test period for both the standard long-term and the accelerated tests. It should be noted that loss on drying increased and pH decreased during the storage period; however, the values were still within specifications. These results confirm that IMD is stable, and the product quality will be maintained during a lengthy storage period.

2. Results

Table III-9 Pilot Scale IMD Stability Study (Long-term Stability)

Variable	Spec.	Lot No.	Storage period (months)						
			0	3	6	9	12	18	24
Appearance	White powder	070801	White powder	White powder	White powder	White powder	White powder	White powder	White powder
		070802	White powder	White powder	White powder	White powder	White powder	White powder	White powder
		070803	White powder	White powder	White powder	White powder	White powder	White powder	White powder
Purity	≥ 95%	070801	98.0	98.0	98.0	98.0	98.0	98.0	97.9
		070802	98.0	97.9	97.9	97.9	97.8	97.9	97.9
		070803	98.0	97.9	97.9	97.9	97.9	97.9	97.8
Loss on drying	≤ 8.0%	070801	4.3	4.7	4.9	5.0	5.2	5.8	6.5
		070802	4.2	4.6	4.8	4.9	5.3	5.9	6.5
		070803	4.0	4.4	4.6	4.7	5.0	5.7	6.3
Residue on ignition	≤ 0.1%	070801	0.01						0.02
		070802	0.01						0.01
		070803	0.01						0.01
pH (10% solution)	4.0-6.5	070801	5.8	5.3	4.9	4.8	4.6	4.5	4.5
		070802	5.7	5.2	4.6	4.6	4.3	4.3	4.3
		070803	5.7	5.6	5.3	5.2	4.9	4.8	4.8
Dietary fiber content (dry weight basis)	> 80%	070801	84.2	83.4	82.2	83.5	85.9	85.1	83.0
		070802	84.8	83.9	81.3	84.2	87.3	85.3	84.0
		070803	84.2	85.1	82.1	84.1	86.3	85.9	83.6
Lead	≤ 0.1 ppm	070801	0						0.01
		070802	0.01						0.01
		070803	0.01						0.01
Arsenic (as As ₂ O ₃)	≤ 2 ppm	070801	≤ 1						≤ 1
		070802	≤ 1						≤ 1
		070803	≤ 1						≤ 1
Viable count	≤ 300 CFU/g	070801	0	0	0	0	0	0	0
		070802	0	0	0	0	0	0	0
		070803	0	2	0	0	0	0	0
Coliform organisms	Negative	070801	Negative	Negative	Negative	Negative	Negative	Negative	Negative
		070802	Negative	Negative	Negative	Negative	Negative	Negative	Negative
		070803	Negative	Negative	Negative	Negative	Negative	Negative	Negative
Yeast and mold	≤ 100 CFU/g	070801	0	0	0	0	0	0	0
		070802	0	0	0	0	0	0	0
		070803	0	0	0	0	0	0	0

Table III-10 Commercial Scale IMD Stability Study (Long-term Stability)

Variable	Spec.	Lot No.	Storage period (months)					
			0	3	6	9	12	18
Appearance	White powder	130720C1	White powder	White powder	White powder	White powder	White powder	White powder
Purity	≥ 95%	130720C1	97.7				97.7	
Loss on drying	≤ 8.0%	130720C1	4.0	4.4	4.6	4.4	5.0	5.8
Residue on ignition	≤ 0.1%	130720C1	0.00				0.00	
pH (10% solution)	4.0-6.5	130720C1	4.9	4.7	4.6	4.6	4.7	4.5
Dietary fiber content (dry weight basis)	> 80%	130720C1	86.7	86.4	86.4	86.5	86.3	87.0
Lead	≤ 0.1 ppm	130720C1	0				0	
Arsenic (as As ₂ O ₃)	≤ 2 ppm	130720C1	≤ 1				≤ 1	
Viable count	≤ 300 CFU/g	130720C1	0				0	
Coliform organisms	Negative	130720C1	Negative				Negative	
Yeast and mold	≤ 100 CFU/g	130720C1	0				0	

Table III-11 Pilot Scale IMD Stability Study (Accelerated Stability)

Variable	Spec.	Lot No.	Storage period (months)			
			0	1	3	6
Appearance	White powder	070801	White powder	White powder	White powder	White powder
		070802	White powder	White powder	White powder	White powder
		070803	White powder	White powder	White powder	White powder
Purity	≥ 95%	070801	98.0	98.0	97.9	97.9
		070802	98.0	97.9	97.9	97.9
		070803	98.0	97.9	97.8	97.9
Loss on drying	≤ 8.0%	070801	4.3			6.3
		070802	4.2			6.5
		070803	4.0			6.5
Residue on ignition	≤ 0.1%	070801	0.01			0.01
		070802	0.01			0.01
		070803	0.01			0.01
pH (10% solution)	4.0-6.5	070801	5.8	5.1	4.9	4.7
		070802	5.7	4.9	4.6	4.4
		070803	5.7	5.4	5.3	5.0
Dietary fiber content (dry weight basis)	> 80%	070801	84.2			82.6
		070802	84.8			82.9
		070803	84.2			82.7
Lead	≤ 0.1 ppm	070801	0			0.01
		070802	0.01			0.01
		070803	0.01			0.01
Arsenic (as As ₂ O ₃)	≤ 2 ppm	070801	≤ 1			≤ 1
		070802	≤ 1			≤ 1
		070803	≤ 1			≤ 1
Viable count	≤ 300 CFU/g	070801	0			0
		070802	0			0
		070803	0			0
Coliform organisms	Negative	070801	Negative			Negative
		070802	Negative			Negative
		070803	Negative			Negative
Yeast and mold	≤ 100 CFU/g	070801	0			0

		070802	0			0
		070803	0			0

K. Physicochemical Properties of Isomaltodextrin

The following sections include summary information obtain from various analytical assays, which have been performed by Hayashibara to further characterize IMD.

1. Melting Point

The melting point/melting range and boiling point/boiling range of IMD were measured (25 to 350°C at 5 K/min). Based on the results, it was concluded that IMD did not melt or boil within the experimental temperature range, but rather decomposed under the test conditions.

2. Absorption Spectra

Using a standard and an infrared spectrophotometer, the absorption spectra for IMD was measured. No specific absorption spectra were observed in the UV and visible ranges, while spectra in the infrared range yielded strong peaks at between 900 and 1,100 nm and between 3,000 and 3,900 nm.

3. Hygroscopicity

The hygroscopicity of IMD was measured over time. Samples held at the various relative humidities (RH) approached a high value of water content at Day 1 and remained constant up to Day 7. The water content of samples were proportional to the RH. Caking was not observed at RH of 33.0, 52.8% and 60.0% up to Day 7. The sample stored at 75% RH gained about 18% moisture on Day 7, while the sample stored at RH 90.1% started to deliquesce on Day 1. It appeared that by Day 7 the samples held at the 3 lower RH had come to equilibrium by Day 3. The samples at 75.2% RH seemed to be approaching equilibrium at Day 7; however, the RH 90.1% sample was still collecting moisture. Because of the hygroscopicity data it is suggested that IMD be stored at the lowest RH possible. If there is any question that the IMD has been exposed to

elevated humidity it should be checked for high water content before use.

4. Viscosity

The viscosity of a 30% (w/w) IMD solution was measured at various temperatures. The viscosities at 10, 20, 30, 40, 50 and 60°C were 19.5, 13.2, 9.3, 6.7, 5.0 and 4.2 mPa·s, respectively. From these results, IMD has low viscosity that allows for its use without changing the texture of the finished products. Additionally, temperature adjustments can be made if there are issues when formulating with IMD.

Section IV. Intended Use
Section V. Analytical

Section VI. Safety

Section IV: Intended Use and Exposure Estimates of Isomaltodextrin in Food

Hayashibara intends to use IMD as a general food ingredient and as a dietary fiber in the following food categories: Milk and milk products; meat, poultry, fish and mixtures; legumes and meat substitutes, mainly legume protein; baked products; crackers and salty snacks from grain products; Pancakes, waffles, French toast, other grain products; pastas, cooked cereals, rice; cereals; grain mixtures, frozen plate meals, soups; meat substitutes, mainly cereal protein; fruits and fruit products; vegetable products; salad dressings; sugars, sweets, and beverages, selected water; formulated nutrition beverages, energy drinks, sports drinks, functional beverages. The use levels of IMD are in the range of 3.2-6.3 g per serving (Table IV-1).

Table IV-1 Intended use levels of IMD in selected foods

Food codes	Description	Serving size, g	g IMD/ serving
1	Milk and milk products		
11	Milks and milk drinks	5.2-250	3.2
12	Creams and cream substitutes	15-30	3.2
13	Milk desserts, sauces, gravies	56-165	3.2
14	Cheeses	30-130	3.2
2	Meat, poultry, fish and mixtures		
27	Meat, poultry, fish with nonmeat items	125-252	3.2
28	Frozen and shelf-stable plate meals, soups, and gravies with meat, poultry, fish base; gelatin and gelatin-based drinks	56.8-192	3.2
4	Dry Beans, Peas, Other Legumes, Nuts, and Seeds		
41	Legumes and meat substitutes, mainly legume protein	7-254	3.2
5	Grain products		
51	Yeast breads, rolls	15-55	3.2
52	Quick breads	55	3.2

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53	Cakes, cookies, pies, pastries	30-125	3.2
53	Breakfast bars and cereal bars	40-55	6.3
54	Crackers and salty snacks from grain products	30	3.2
55	Pancakes, waffles	85-110	3.2
56	Pastas, cooked cereals, rice	140-256	6.3
57	Cereals, not cooked or NS as to cooked	15-55	6.3
58	Grain mixtures, frozen plate meals, soups	119-255	3.2
59	Meat substitutes, mainly cereal protein	146	3.2
6	Fruits and fruit products		
62	Dried fruits	40	3.2
63	Other fruits	34-140	3.2
64	Fruit juices and nectars excluding citrus	240	3.2
7	Vegetable products		
74	Tomatoes and tomato mixtures	15-240	3.2
75	Other vegetables	30-240	3.2
8	Fats, Oils, and Salad Dressings		
83	Salad dressings	15-30	3.2
9	Sugars, Sweets, and Beverages		
91	Sugar substitutes, syrups, jams, jelly, and sweets	0.4-120	3.2
92	Nonalcoholic beverages	1.5-240	3.2
93	Alcoholic beverages-lite beer	240	3.2
94	Water, noncarbonated	240	3.2
95	Formulated nutrition beverages, energy drinks, sports drinks, functional beverages	240	6.3

Based on food consumption data reported in the most recent National Health and Nutrition Examination Survey (NHANES, 2009-2010; compiled by the U.S. Department of Health and Human Services, National Center for Health Statistics and the Nutrition Coordinating Center) estimates of 2-day average intakes of IMD were calculated from the food code list and the survey database of diet recalls. The 2009-2010 NHANES provides the most current food

consumption data available for non-institutionalized individuals in the U.S.

Table IV-2 shows Estimated Daily Intakes (EDIs) under the intended use. As shown in Table IV-2, the mean intakes of IMD under the intended uses were estimated to be 15.1 g/person/day (246 mg/kg body weight (BW)/day) for all the population and 16.3 g/person/day (265 mg/kg BW/day) or for all-users, while the 90th percentile intakes were determined as 31.9 g/person/day (533 mg/kg BW/day) and 32.7 g/person/day (552 mg/kg BW/day), respectively. Nearly all people in the total U.S. population and each of the selected subpopulations reported eating at least one food proposed for IMD (users are 92% of the population). The highest use level was found in males aged 20-99 years with the 90th percentile intake being 38.8 g/person/day (or 465 mg/kg BW/day).

Table IV-2 Estimated Daily Intakes (EDIs) of IMD

Age, years	Gender	N	g IMD/day		mg IMD/kg BW/day	
			Mean	90 th Percentile	Mean	90 th Percentile
Users of one or more foods containing IMD						
2-99	All	7,287	16.3±0.43	32.7±1.04	265.2±8.3	551.9±25.0
	Males	3,657	18.1±0.61	36.6±1.07	278.4±9.9	597.6±23.7
	Females	3,630	14.5±0.32	27.4±0.61	252.2±7.9	524.5±26.0
2-13	All	2,016	12.6±0.38	23.4±0.64	498.4±17.3	977.1±31.5
	Males	1,026	13.1±0.37	24.8±0.92	516.5±25.6	996.3±44.7
	Females	990	12.2±0.78	21.1±0.80	478.7±25.4	912.0±55.2
13-19	All	903	15.4±0.46	31.2±1.60	240.5±11.1	479.6±20.0
	Males	472	18.5±0.90	35.2±1.36	271.1±15.5	506.9±40.0
	Females	431	12.0±0.43	22.8±0.96	206.8±12.4	434.5±41.9
20-99	All	4,368	17.1±0.52	35.2±1.40	219.6±7.7	444.8±19.3
	Males	2,159	19.2±0.73	38.8±2.05	226.0±9.8	464.9±27.8
	Females	2,209	15.2±0.39	28.7±0.87	213.5±7.2	417.1±15.1
All population						
2-99	All	7,932	15.1±0.39	31.9±1.07	245.8±7.2	533.3±24.2
	Males	3,979	16.8±0.59	35.3±1.18	257.9±8.7	568.9±25.3
	Females	3,953	13.4±0.31	26.7±0.60	233.9±7.6	499.2±23.0

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2-13	All	2,123	12.0±0.42	23.0±0.67	472.9±17.7	967.1±38.4
	Males	1,072	12.6±0.32	24.6±0.83	496.7±21.0	985.1±45.4
	Females	1,051	11.4±0.88	20.9±0.86	447.8±30.1	888.4±56.9
13-19	All	1,009	14.0±0.47	29.7±1.57	218.4±11.1	458.1±18.5
	Males	514	17.1±0.90	34.7±2.02	250.3±15.1	501.3±25.2
	Females	495	10.7±0.53	21.9±1.26	184.5±13.2	434.4±44.2
20-99	All	4,800	15.9±0.45	33.9±1.15	203.0±6.6	429.0±16.2
	Males	2,393	17.6±0.70	37.9±1.86	207.7±9.0	451.4±26.5
	Females	2,407	14.2±0.33	28.0±0.69	198.6±6.3	411.4±16.5

The contribution of each food category to total EDI is shown in Table IV-3. Grain products and sugars, sweets, and beverages were the greatest contributors to the overall intake of IMD. These 2 food categories accounts for 78% of the exposure of users of one or more foods under the intended use.

The full report of the details of NHANES food codes included in intended use of IMD and use levels in select foods can be found in Appendix C.

It is believed that the estimated daily intake is conservatively high because these EDIs are based on the assumption that 100% of the products in the identified categories are used at the maximum intended use levels. Other factors for daily intake amounts being less than the EDI include the fact that the amount of a food ingredient used is limited by the level that can be added without adversely affecting the quality of the food, and the highly cost sensitive nature of the food industry. Additionally there are a number of ingredients on the market that, while not identical, are used for similar applications.

Table IV-3. NHANES food code groups included in intended use of IMD in select foods and contribution of each food category to total EDI

Food codes	Description	% of EDI
1	Milk and milk products	7.78
11	Milks and milk drinks	4.07
12	Creams and cream substitutes	0.55
13	Milk desserts, sauces, gravies	1.09
14	Cheeses	2.06
2	Meat, poultry, fish and mixtures	1.00
27	Meat, poultry, fish with nonmeat items	0.89
28	Frozen and shelf-stable plate meals, soups, and gravies with meat, poultry, fish base; gelatin and gelatin-based drinks	0.11
4	Dry Beans, Peas, Other Legumes, Nuts, and Seeds	1.37
41	Legumes and meat substitutes, mainly legume protein	1.37
5	Grain products	40.93
51	Yeast breads, rolls	10.52
52	Quick breads	1.00
53	Cakes, cookies, pies, pastries	3.34
54	Crackers and salty snacks from grain products	3.03
55	Pancakes, waffles, french toast, other grain products	0.11
56	Pastas, cooked cereals, rice	2.66
57	Cereals, not cooked or NS as to cooked	15.12
58	Grain mixtures, frozen plate meals, soups	5.15
59	Meat substitutes, mainly cereal protein	0.01
6	Fruits and fruit products	3.39
62	Dried fruits	0.67
63	Other fruits	1.58
64	Fruit juices and nectars excluding citrus	1.13
7	Vegetable products	7.39
74	Tomatoes and tomato mixtures	7.26

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75	Other vegetables	0.13
8	Fats, Oils, and Salad Dressings	0.73
83	Salad dressings	0.73
9	Sugars, Sweets, and Beverages	37.41
91	Sugar substitutes, syrups, jams, jelly, and sweets	9.33
92	Nonalcoholic beverages	16.77
93	Alcoholic beverages-lite beer	5.41
94	Water, noncarbonated	0.76
95	Formulated nutrition beverages, energy drinks, sports drinks, functional beverages	5.14

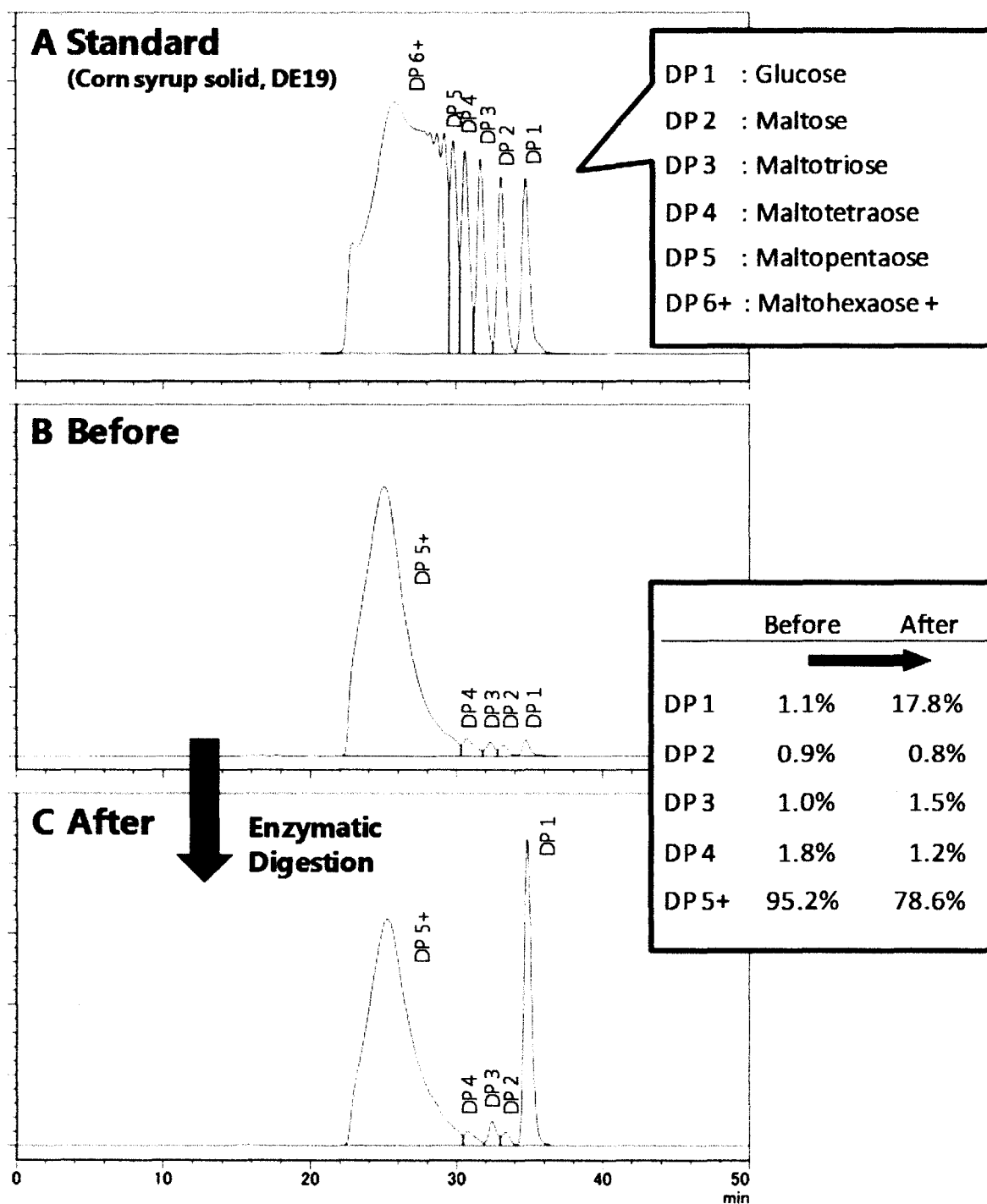
These food categories and subcategories are essentially the same as those into which resistant dextrin are intended to be used.⁵ Further the mean intake and 90th percentile values are similar.^{5,42} Hayashibara believes that the types of food categories and intakes of IMD are substantially equivalent to publically available information on resistant dextrin.⁵ The use amounts and categories are similar to but not identical for dextrin, maltodextrin, polydextrose and pullulan.^{8-10,11} Dextrin can be used with no limitation other than cGMP as a direct human food ingredient as a formulation aid, processing aid, a stabilizer, thickener, and surface-finishing agent.⁸ Maltodextrin has no limitation other than cGMP, while polydextrose is listed as a bulking agent, formulation aid, humectant and texturizer.^{9,10} Pullulan was GRASed using a general use in food at a mean of 9.4 g/person/day, and 90th percentile of 18.8 g/person/day.^{11,43}

Section V: Analytical Method of Isomaltodextrin in Foods

Hayashibara uses the analytical method AOAC 2001.03 for assaying the quantity of IMD as total dietary fiber in foods.²² This method determines the total dietary fiber (TDF) value of processed foods. Use of AOAC 2001.03 includes not only insoluble dietary fiber (IDF) and high molecular weight soluble dietary fiber (HMWSDF), which are precipitated in ethanol, but also low molecular weight IMD (LMWIMD) which is soluble in ethanol. This method defines dietary fiber as non-digestible carbohydrates with a degree of polymerization (DP) not less than 3 after an enzymatic hydrolysis step.

All the starches contained in food are converted to glucose after this enzymatic hydrolysis. This method to determine TDF content in processed foods containing IMD is a combination of AOAC 985.29 for dietary fiber (DF) and a Liquid Chromatographic (LC) method for LMWIMD.²² The total quantity of IDF and HMWSDF precipitated by the ethanol procedure is first determined in the food sample, using AOAC 985.29.⁴⁴ The supernatant from the ethanol precipitation step is desalted and analyzed by LC. This provides the quantity of LMWIMD. These 2 values [(IDF + HMWSDF) + LMWIMD] are summed to obtain the TDF value in the food. Figure V-1 shows the changes before and after IMD is treated with the hydrolytic enzymes.

Figure V-1 LC chromatogram of DE-19 corn syrup (A), IMD before treatment with hydrolytic enzymes (B) and, IMD after treatment with hydrolytic enzymes (C)



Section VI: Safety**A. Introduction**

IMD is produced by enzymatic starch hydrolysis and transglycosylation at manufacturing facilities of Hayashibara. Hayashibara was established in 1883 as a manufacturer of malt syrup, and in 1931 Hayashibara developed a two-step method to produce a more consistent malt syrup product. In 1959, Hayashibara was the first company in the world to commercialize the production of glucose, exclusively using enzymes. Hayashibara has an excellent safety record of enzymatically producing a variety of starch-based products.

IMD is a multi-branched polysaccharide composed of only D-glucose units. These glucose molecules are bound together by α linkages, which are found in all dextrin/maltodextrin and resistant dextrin/maltodextrin products as well as polydextrose and pullulan. IMD contains these approximate percentages of glucose molecules that are bound with glucosidic linkages: 49% α -1,6; 19% α -1,4; 3% α -1,3; 7% α -1,3,6; and 5% α -1,4,6. The remaining 17% glucose units are α -1 glucosidic linkages (non-reducing end group).¹ Assay of IMD using the official AOAC method 2001.03 results in a dietary fiber content of approximately 80%.²² The molecular formula of IMD is $(C_6H_{10}O_5)_n$. As mentioned in Section II and III of this document the physical components and structure of IMD classifies it as a dextrin, resistant dextrin, α -glucan, and a soluble dietary fiber.

To support the conclusion that IMD is safe for consumption by humans for the intended uses, Hayashibara offers the following information and data. This section provides safety information from other starch-based substances that Hayashibara claims are "substantially equivalent" to IMD. Although Hayashibara has determined that IMD is GRAS because of substantial equivalence to other GRAS products, as part of the companies stewardship program, Hayashibara has undertaken a number of safety-based studies, which demonstrate the specific safety and tolerance of IMD, and its equivalence to the other previously identified commercial products. The data from the IMD studies include the intrinsic safety of IMD, the safety of the production process, and the

results of *in vitro* and *in vivo* studies (animal and human).

B. Safety and Regulatory Status of other Commercial Starch or Glucose-based Products

Hayashibara claims that a number of commercial products are chemically similar or equivalent to IMD, as described in Sections II and III, and therefore the reported safety data of these substances is directly relevant to the determination that IMD is safe for its intended use. The substances are dextrin, resistant dextrin, resistant maltodextrin, polydextrose and pullulan.

Dextrin is one commercial group of substances that are derived from unmodified starch and products that are made from hydrolysis of this starch. They include starch, dextrin, maltodextrin, starch syrups, and glucose.²⁻⁴ These are classified by their molecular weights. However, as explained earlier, the classification is fairly ambiguous and not consistent throughout the world. Each of these products contains a heterogeneous mixture of molecules (molecular weight and structures) that include molecules of high molecular weights down to individual glucose molecules. Most production processes attempt to remove the smaller molecules to increase the amount of larger branched chains. What is important is that each of these starch-derived substances has been GRASed by the FDA in 21 CFR §184.1277, 21 CFR §184.1444, 21 CFR §184.1865, and 21 CFR §184.1857, respectively.^{8-10,45,46} Further, two other polyglucose substances whose safety is applicable to the safety of IMD have the similar glycosidic bonding and structure as these products, but are manufactured from glucose and starch syrup, polydextrose (21 CFR §172.841) and pullulan, respectively, are also GRAS.^{10,11}

1. Safety of Dextrin

Common commercial dextrin is derived from food grade starch that is dry roasted with the addition of acid.^{8,23} The FDA requested that the Select Committee on GRAS Substances (SCOGS) review the published safety data on dextrin as a food ingredient. It should be noted that the dextrin used came from various sources and using different, but similar production methods. Their report was issued in 1975. The report gives an estimated

daily per capita consumption rate of 180 mg in 1972.

- a. In three summaries of "short-term studies" there were different end points being tested. In the first study, groups of 10 male Wistar rats were fed starches, modified starches, disaccharides, or monosaccharides up to 75 g carbohydrates/kg bw/day. After 28 days "protein efficiency and weight gain per gram of dry food were significantly lower for corn dextrin than for cornstarch but were greater or equal to values for dextrose." The corn dextrin resulted in slight diarrhea and also enlarged ceca as compared to rats that consumed unmodified cornstarch. No untoward effects were noted on liver weight or liver fat content.²³
- b. The second study was to investigate protein utilization and liver fat. Sprague-Dawley rats were fed for 2 to 12 weeks with one of a number of carbohydrates, including two dextrin preparations. Both dextrin products resulted in rates of weight gain at 4 weeks of about 15% less than autoclaved cornstarch; however, the rate of the autoclaved cornstarch was about 2 times that of glucose or sucrose. Deposition of liver fat was less for one of the dextrin products, than for sucrose, but the results for the other dextrin was not reported.²³
- c. In the third study starch, dextrin or glucose were fed to Sprague-Dawley and Osbourne-Mendel weanling rats at about 80 g/kg bw/day, with or without niacin. With niacin supplementation four-week weight gains were equal for all groups. In the groups where niacin was not given growth rates were 40% less for starch and dextrin, whereas it was 60% less for the glucose fed group.²³
- d. An 18-month feeding study was performed using 2-month old Sprague-Dawley rats that received either a basal diet, or a diet supplemented with 20% (w/w) of their diet from dextrin, sucrose or dextrose (10 g/bw). After treatment the weight gain of the dextrin group was 5% less than the sucrose and dextrose groups, but 5% more than the basal diet group (no statistical significance was reported). The liver/body weight ratios were the same. The testicle/body weight ratio

was greater for rats consuming the dextrin. "The toxicological significance was not apparent."²³ The conclusion of SCOGS was:

"Animal feeding studies have shown dextrans to be digested and metabolized to a limited degree without toxic effects when fed at levels many times greater than those present from use of these products as a direct food additive, or at levels that are orders of magnitude greater than might occur by migration from food packaging materials containing dextrans. There is no evidence in the available information on dextrin and corn dextrin that demonstrates or suggests reasonable grounds to suspect, a hazard to the public when they are used at levels that are now current or that might be reasonably expected in the future."²³

2. Safety of Resistant Dextrin

Resistant dextrin is made from starch in similar manner as dextrin, except that the method is designed to produce a high percentage of glycosidic bonds and subsequent polyglucose structures with an increased resistance to enzymatic digestion in the small intestine.⁵ In addition the resistant starch is modified using an enzymatic treatment, the purpose of which is as an aid in post production filtration. There are two grades that were considered in the GRAS report; however, it was felt that the grade with the higher content of the "non-digestible" α - and β -linkages was the best one to use for the safety studies.⁵

Resistant dextrin was GRAS notified in mid-2012, and received a "FDA has no questions" letter early in 2013. A number of studies have been published in the scientific literature to support the conclusion that resistant dextrin is GRAS.⁴⁷ IMD is enzymatically formed by hydrolysis and transglycosylation from starch while resistant dextrin is a hydrolysis product of starch treated with heat and acid.

- a. Mutagenicity studies -- Resistant dextrin, was tested in two separate assays of a standard Ames test (OECD 471) using 5 strains of *Salmonella typhimurium*, with and without S9-activation at a concentration of 5000 μ g/plate. A second study used an L5178y mouse

lymphoma mutation assay testing at the TK locus (OECD 476). The cells were tested at 5000 µg/ml with and without S9-activation. Resistant dextrin did not result in any mutagenic activity in either model assay system.⁴⁷

- b. Acute oral study – An acute oral toxicity study was performed using the fixed dose procedure (OECD 420). Five fasted female Sprague-Dawley rats were given a dose of 2,000 mg/kg in water (10 mL/kg) by gavage. No negative response was observed in mortality or morbidity over the 14-day observation period. One animal had a slight reduction in weight during the second week, but the other rats did not. No abnormalities were observed at necropsy. It was concluded the LD₅₀ was greater than 2000 mg/kg.⁴⁷
- c. 90-day feeding study – Resistant dextrin was administered in the feed to 4 groups of 40 OFA-Sprague-Dawley rats (20 female, 20 male) at concentrations of 0, 1.25, 2.5, or 5% according to OECD Guideline 408.⁴⁷ The animals were fed the powdered diet *ad libitum* for a minimum of 90 days. Standard macro-examinations were performed 5 days per week, and a more cursory examination was done on weekends, except if there was an indication of an abnormality.

No deaths, behavior changes of significance or related to treatment, loose stools or ophthalmologic abnormalities were noted in any animals during the study. Body weight gains were essentially identical for either sex at all doses. Absolute and relative organ weights of either sex showed no effect at any dose, except an approximately 15% increase in the absolute empty cecum weight of both sexes fed the 5% resistant dextrin ration. The relative weight of the cecum was greater in females, and there was no significant effect on the weight of the full cecum.⁴⁷ This increase in cecal weight is a known physiological response to high concentrations of indigestible carbohydrates.⁴⁷

Histological findings (control vs high dose) in female rats were minimal in the control and high dose animals, and no significant differences ($p < 0.05$) were reported. In male rats, lesions were noted in the liver and

thymus, which were graded as minimal. Both types of lesions were observed in the male control group, and the effect was judged as not treatment related. Neither type of lesion was noted in females.⁴⁷

While there were a few significant differences in blood chemistry in female rats at the 4-week sampling, no treatment dose-related differences were noted between the control group and any treatment groups at 13 weeks. The significant differences ($p < 0.05$) at 4 weeks were either not dose-related, within normal range and/or not associated with any related abnormality. Further no differences in these were observed at the 13-week reading. No significant changes in blood variables evaluated were noted in male rats at either the 4- or 13-week sampling. The only exception was a slight decrease in blood glucose at the high dose. The decrease was not considered significant.⁴⁷

No significant dose-related changes in hematologic and coagulation variable were found in female animals after 13 weeks of consumption of resistant dextrin. A significant increase ($p < 0.05$) in platelets and prothrombin time were reported in the mid-dose and high-dose groups, respectively. As with other noted significant changes the values were not dose-dependent and within the normal range, and was a "slight" increase, within the normal range with no other related changes, respectively, the changes were not considered to be toxicologically significant.⁴⁷

The conclusion of the journal article was that there were no treatment-related adverse effects at a consumption rate of 5% of the diet for 13 weeks. The no observable adverse effect level (NOAEL) for female rats was 6.5 g/kg bw/day and 4.4 g/kg bw/day in males. The authors concluded that this amount was consistent with other dextrans and polydextrose.⁴⁷

3. Safety of Resistant Maltodextrin

A commercial resistant maltodextrin is sold in the US under 21 CFR §184.1444.^{7,9} The production process uses similar methods to resistant

dextrin (enzyme modified) and produces a product with a branched structure and similar bonds that make it relatively resistant to digestion. The difference is that the production process of resistant maltodextrin results in a mean molecular size with a slightly higher dextrose equivalence (DE) of approximately 11, as compared to resistant dextrin of approximately 6. This product with a DE of 11 is classified as a maltodextrin by the manufactures.

Safety studies have been summarized in English.⁷ An acute toxicity study demonstrated that this resistant maltodextrin has an LD₅₀ of > 20 g/kg bw in rats. Mutagenic tests did not show any negative effects. In a "long-term" feeding study in rats, there was only a slight effect in growth rates, weight of internal organs and any blood biochemical variables.⁷

4. Safety of Polydextrose

Polydextrose is a food additive with a branching structure and a bonding structure that is resistant to enzymatic digestion in the small intestine. As noted previously it is produced by the condensation of a melt which consists either of approximately 89 percent D-glucose, 10 percent sorbitol, and 1 percent citric acid or of approximately 90 percent D-glucose, 10 percent sorbitol, and 0.1 percent phosphoric acid, on a weight basis.¹⁰ It has been GRASed and may be used in accordance with "current good manufacturing practices as a bulking agent, formulation aid, humectant, and texturizer in all foods, except meat and poultry, baby food, and infant formula."¹⁰ IMD is formed by enzymatic hydrolysis and transglycosylation of starch, whereas polydextrose is polymerized from glucose.

Burdock and Flamm published a review article in 1999 that provided information about the safety of polydextrose used in food.⁴⁸ The review included data from two forms of polydextrose, which included a powder (acidic), and as a 70% solution (neutral pH). Results from a number of studies using various species were reported. This section will attempt to summary as completely as possible the available data; however, several of these studies were complex. The overall conclusion of the review of all

these studies was that “.... omnivores such as rats, mice and monkeys are relatively refractory to the effects of polydextrose with a no-effect level for systemic toxicity at 2,500 to 10,000 mg/kg body weight/day.”

a. Acute Studies in Mice, Rats and Dogs

Single doses of polydextrose (PD) were administered and the animals were examined for mortality or morbidity for 7 days, and the rodents were necropsied for possible macro-pathology. The LD₅₀ for the two mice studies in which the substances were administered by gavage were > 30.5 g/kg and > 47.3 g/kg. Rats gavaged with each PD had LD₅₀s of > 18.8 and > 18.9 g/kg. Dogs were given PD via gavage, capsules and intravenous injection. The LD₅₀ for these were > 20 g/kg, > 20 g/kg and > 2 g/kg, respectively. No acute toxicity was reported in any of the studies. All animals demonstrated soft stools “soon” after administration, which cleared by 24 hours.

b. 3-Month Gavage Study in Monkeys

Sixteen (16) rhesus monkeys (8 female, 8 males) were divided into 4 equal groups and given 0, 1, 2 or 10 g/kg of the liquid solution of PD by gavage daily for 91 days. All animals in the 10 g/kg group had loose stools (“diarrhea”) during the entire study. This occurred only sporadically in the other groups. All treated animals gained weight during the study. One of 4 animals at day 57 and 3 or 4 animals at day 85 in the high dose group had decreased serum calcium, respectively. One monkey in the high dose group showed hematuria and slight proteinuria on days 29 and 85. Ophthalmoscopic, physical and electrocardiographic finding were negative. Histology showed that all high-dose animals had moderate dilatation of the colon with focal areas of macrophages with hemosiderin in the mucosa. It was concluded that the hemosiderin was the result of the chronic loose stools (osmotic diarrhea). No other treatment-related observations were noted.

c. 3-Month Feeding Study in Dogs

Ten (10) male beagle dogs were assigned to a group of either 6 treated or 4 control animals. The treated animals received a ration of canned and dry food, plus 50% by dry weight of PD. The amount of feed was modified once during the study to account for growth of the dogs. Animals were fed for a total of 97 days. All animals survived and all PD-treated dogs lost weight (0.6 – 2.2 kg), while 3 of the 4 control dogs also lost weight (0.5 – 1.8 kg). All the treated dogs had loose, partially formed and sometimes watery stools during the entire study. The animals drank 2 to 2.5 times the amount of water of the control dogs. All PD-treated animals appeared to be normal. While mean calcium concentrations were increased in the PD-treated dogs no samples were above the normal range. PD-treated dogs also had increased excreted urinary calcium. No hematologic values for any animals were outside of normal limits. Further, histopathologic findings and organ weights (absolute or relative) were not different between treated and control animals.

d. 6-Month Feeding Study in Dogs

Eight (8) male beagle dogs received either a control or the powdered PD at 50% of the entire ration (≈ 12.5 g/kg bw/day) for 135 days. The diet was changed to include the liquid preparation of PD at days 136-195. Food was offered for 1 hour per day and the amount was increased as the animals grew, while water was *ad libitum*. All 4-control dogs and 1 treated dog lost weight (0.5 - 1.9 kg), while the 3 remaining treated dogs gained from 0.2 - 1.0 kg. All 4 treated dogs had watery stools 2 - 3 hours after consumption during the first half of the study, which changed to thicker, but still loose stools when the PD type was changed to the liquid. The stools became normal by early the next day. After 9 days water consumption of the treated animals was 2 - 3 times greater than controls, and when checked on days 174 - 177, consumption of water was about 2.3 - 3 times greater. No hematologic variables were significantly different between the controls and treated animal groups. There were rhythmic fluctuations noted in serum calcium, and all treated dogs had an increase in calcium during

the study. There were differences in various parameters between treatment and control animals, and between treatments with the two different PD preparations. While some mean sodium values were significantly higher than control values, the values were within normal limits. There was one type of treatment-related lesion in two treated dogs, which was typical of calcium nephropathology. Focal areas of mineralization appeared to obstruct tubules.

e. 13-Month Feeding Study of Beagle Dogs

Fifteen (15) beagle dogs of each sex were fed diets of 0, 16.7%, and 33% containing powdered PD ($\approx$ 4 and 8 g/kg bw/day, respectively). The animals had a 1-hour feeding time each day. Water consumption was measured at several times during the treatment period, but it was not stated if it was given *ad libitum*. No deaths occurred and 3 of 10 control dogs lost weight during the study, while 1 of the low-dose lost weight, one was weight neutral, and the high-dose dogs had one that lost a small amount of weight, one was weight neutral, and the remainder gained from 0.1 to 4.5 kg over the treatment period. Control dogs had only occasional soft stools; whereas the animals that consumed the 33% PD usually had soft stools within 3 hours of feeding and then watery stools by 6 hours. Occasionally the loose stools were debilitating and the animals were taken off the high content diet for a number of days until the stools had normal consistency. The dogs were returned to the 33% PD diet. The lower dose group had intermediate stool consistency. Animals in the high-dose group drank about 1.5 more water than control animals. The low dose group did not drink more water than control.

f. 24-Month Toxicity Study in Beagle Dogs

Four (4) groups consisting of 6 dogs per sex per group were fed a diet of 10 or 20% PD, 10% sucrose, or the standard diet. Dogs were given the diet for 24 months, except for 2 dogs per sex per group that were sacrificed at 12 months. The PD and sucrose was calculated on a dry weight basis of the total daily diet. The animals first received 100 g of canned meat with one of the three treatments. After consumption they

were then given 175 g of a dry chow (200 g of food on a dry weight basis). Water was given *ad libitum*.

There was no significant difference in mean body weight between PD-treated dogs and controls. Whereas the body weight of male dogs given sucrose was significantly greater than control (at least $p < 0.05$) at 1 year through the study, the females were only significantly heavier at 1 year. The animals usually consumed their diet with the PD; however, some dogs didn't finish the dry food. This was especially noticeable in females given the sucrose from 9 months throughout the study. Females in the 10% sucrose group had typical body fat deposition, while it was not as noticeable in males. There was not an observable effect reported on animal behavior.

Both groups of PD dogs had diarrhea throughout the study, but the higher dose group had diarrhea only marginally more severe than the 10% group. Additionally severe diarrhea was primarily observed during the first two weeks of consumption. Some fresh blood was seen in stools, likely due to bleeding because of irritation of the lower bowel aggravated by the diarrhea. Occasional vomiting occurred in all groups, but was not considered significant.

No gross physical, ECG, or ophthalmic changes were ascribed to PD or sucrose treatment. The hemoglobin, RBC and hematocrit decreased in 3 of 4 male and 1 of 4 female dogs in the 20% PD group, resulting in anemia by the end of the study. Other blood-related variables were generally within normal limits. Blood chemistries demonstrated that the PD-treated animals had elevated calcium ($p < 0.05$) during and/or by the end of the study. Urea was elevated at 24 months in the 20% PD group. At 24 months urine osmolality was decreased in the 20% PD males and both female PD groups. There were no differences in organ weights of PD animals. Pulmonary and renal lesions at 2 years were observed in the PD and sucrose groups and were considered significant. The only treatment-related histological lesions were in the kidneys of PD animals

after 2 years of consumption.

g. 24-Month Toxicity Study in Beagle Dogs

Six (6) dogs per sex were treated with a diet supplemented with either 50% PD or sucrose, with a third group being untreated. The animals were fed the PD and sucrose mixed into 100 g of canned meat, followed by 225 g of a dry chow. Each dog being given 250 g of food per day on a dry weight basis for 18 months, after which all animals received the standard ration for 6 additional months. Water was given *ad libitum*.

One of the PD-dosed dogs could not tolerate the diet and at month 5 was moved to the control group. A replacement dog was added to the group and sampled 5 months behind the others for 12 months. This animal's data was not used for the group mean values. A sucrose-treated animal died at day 349, and had severe acute bronchopneumonia. One control animal was "ill" during the study but recovered.

During the 18 months of treatment the PD-group gained no weight, while the control gained and weighed 3-4 kg more at week 50 through 82. After PD was removed from the dog's diet they gained weight, but did not recover all the weight by study termination. Sucrose treated dogs gained more weight than controls for about the first 40 weeks, and were 2.5 kg heavier. The sucrose group lost mean body weight at about 12 months because 1 male and 2 females had severe weight loss. Once sucrose was removed from their diet at 18 months the males ended the study with weight equal to controls, while the female dogs were still heavier. Except for the smallest female all control animals ate all the food offered. Animals of both the sucrose and PD groups had anorexia, which was alleviated once the PD or sucrose was withdrawn at 18 months. Diarrhea occurred daily in the PD group, which stopped 3 days after treatment. Vomiting was rare, and neither PD nor sucrose resulted in changes in the estrus cycle. PD-treated males had abnormal ECG recordings thought related to hypercalcemia. No ophthalmic lesions were treatment related. Few treatment-related

chemistries were affected. Plasma calcium were increased in 9 of 12 of PD-treated dogs throughout the treatment phase, but normalized after PD was removed from their diet. Concentration of urea was increased in some PD dogs, and in males did not completely normalize during the 6-month follow-up. There were changes in dogs treated with PD that included kidney pathology (primarily calcification), and increased plasma calcium and blood urea. Similar histopathology was observed in the previous 24-month study.

h. 18-Month Carcinogenicity in Mice

Fifty (50) mice per sex were given 5 or 10% of the powdered PD from weaning for 18 months. Appropriate positive (10% sucrose) and negative groups were used. No clinical symptoms were related to treatment. The survival was higher in the PD groups, but not significantly better than controls. Weight gains were equal, except for the female sucrose group gain was significantly greater ($p > 0.05$) than all other groups. Relative food intakes were essentially the same. Any changes in ophthalmological variables were attributed to traumatic, post-embryologic or senile factors. No changes were observed in terminal body weights, and the only organ weight was a decrease of liver weight in the 5% PD group. No gross findings were associated with treatment. There were no reported differences in incidence of total malignant tumors, total benign tumors, or latency. The PD mice had WBC counts that were consistent with values for historical controls. At 18 months no significant differences were observed in any treatment groups.

i. 3-Month Dietary Study in Rats

Eighty (80) rats were divided into a control and three treatment groups receiving powdered PD for 3 months (10/sex/treatment; 0, 1, 2 or 10 g/kg bw/day). No dose-dependent relationship was noted in body weight, and no other remarkable effects in physical, clinical pathological, ophthalmological, or histopathological were noted in any groups.

j. 24-Month Carcinogenicity Study in Rats

In this study 70 female and 70 male CD-COBS^R SD rats were used, with 20 per sex being sacrificed at day-40. The animals were administered 0, 5, or 10% of the powdered PD preparation, and a positive control group receiving 10% sucrose in the diet. The animals were given the ration from birth for 775 days. No differences in general health were noted, but animals consuming the both PD and sucrose had soft and dark stools for a few days after the start of the study. There were a number of conditions that are common to this type of study, but these were not treatment-related. A few days before the final sampling all animals presented with symptoms of sialodacryoadenitis. No mortality was related to treatment and deaths were judged as caused by common causes in aging rats.

Animals were bred during the experiment and there were changes in consumption and body weights that were incidental to mating and lactation. Ophthalmic examination showed no lesions that were attributed to either the PD or sucrose. No statistically significant values in the clinical chemistry were noted in relation to treatment, including sucrose. At weaning there was a statistically significant ($p < 0.05$) increase in hemoglobin and RBC in females and male in the 10% PD group, and of WBC in females. These resolved over the treatment period. There were various values that were abnormal in a few animals, but were found in all groups. The presumed infection with sialodacryoadenitis is believed to have resulted in neutrophilia in all groups at the end of the study. Necropsy did not find any noticeable aberrations. Differences in organ weights were not observed, and no increases in the total, type, or timing of tumors was seen, as compared to the control group. Histopathology showed no treatment-related problems.

k. 3 Reproductive Studies

Three studies were performed related to reproductive function using Sprague-Dawley CD COB^R rats. The first examined fertility and general

reproductive performance (FGRP), the second pregnancy and fetal development (PFD), and the third on the perinatal and postnatal development (PNPND). In the FGRP study 30 female and 15 male rats were divided into five groups that received 0, 1, 2, or 4 g PD/day. The control group received 4 g sucrose/day. These represent about 5, 10 and 20% of the daily food consumption. The treatments were dissolved in distilled water and administered by gavage. The males were treated for 79 days before mating, and the females were treated from 14 days before mating to 13 days after or through gestation. The PFD study included 20 females per group receiving the same doses by gavage as the FGRP, except from day 6 to 15. On day-20 after mating the animals were examined for a number of variables related to fertility and fetal development. The PNPND study was to examine the effects, if any, on the last third of pregnancy, lactation, birth variables, and viability and development of newborn pups. One hundred (100) female rats were mated and were considered to be pregnant by vaginal examination, which was considered to be at day 0 of the study. These animals were given the same doses as the other groups starting 15 days after being impregnated up to weaning.

A brief summary of the results of the three studies follows.

FGRP – As noted in other studies the animals in the PD 4 g/day groups had loose stools throughout the study. The pregnancy rate for all groups was greater than historical controls, similar for all groups, and no differences were reported in the mean growth rates. No statistical differences were seen in number of *corpora lutea*, implant efficiency, number of implants, *in utero* mortality, or number of viable fetuses. All variables related to live births were similar, and no treatment-related malformations were observed.

PFD – No abnormal symptoms or behavior were reported. Growth rates were equal, except for the sucrose group, but it was not significant. The sucrose group also had a low fertility rate, but this was judged as non-treatment related. No differences were noted in maternal mortality,

corpora lutea, implantation, or embryomortality variables, fetal weights and sex ratios. The sucrose group had the highest percentage of total external abnormalities, while the PD groups were below control numbers. All treatment groups, except the 1 g/day PD group had higher percentages of internal abnormalities, whereas the 2 g/day PD group had the highest. The 4 g/day PD showed a percentage slightly less than the sucrose group. The 2 g/day PD animals had an incidence higher than the historical controls. It was determined that these effects were not the result of PD treatment.

PNPND – No substance-related adverse symptoms or abnormal behavior was reported. Weight gain during pregnancy was equal, and two deaths were the result of gavage failures. There were implant failures, but these occurred before treatment was started. The length of pregnancy was slightly shorter than controls for both PD groups and sucrose. Variations in maternal variables and postnatal development of pups were not treatment-related. No lactation problems were seen; however, the pups from the PD groups had lower growth rates than the control or sucrose groups. Gross and histologic lesions were not considered treatment-related.

I. 3-Generation Study in Rats

A standard 3-generation study in rats was performed mixing powdered PD into the chow at 5 and 10% of the diet. A diet with 10% sucrose and a control diet were also given to groups. Treatment for F₀ was from age 23 days to sacrifice, while F₁, F₂ and F₃ until death or termination. When mated the animals were treated for 60 (F₁) or 70 days (F₂ and F₃). Because of the complex nature of the results only a general conclusion will be given. Soft and dark stools were noted in both the PD and sucrose groups, but not frank diarrhea. There were no significant toxicological effects reported for PD treatment alone. Even at 10% of the diet no treatment-related maternal fertility or gestational variables were seen. Further the pups did not experience treatment-related issues. The rats from the F₁ generation were used in the 24-month

carcinogenic study, therefore having *in utero* exposure had no untoward effect during the carcinogenic study.

m. Pregnancy and Fetal Development in Rabbits

Fifteen (15) New Zealand white rabbits were assigned to each group receiving 0, 3, 6, or 12 g/day PD or 12 g/day sucrose via gavage from day 7 to 18. Animals were euthanized on day 28 after insemination. Of the surviving rabbits, diarrhea was observed in one animal in the control and high-dose group and two in the sucrose and mid-dose groups, but was not treatment-related. While deaths occurred they appeared to be from a latent infection aggravated by stress. There were no differences in growth of pregnant rabbits, but there was high variability. Embryo mortality was low and was not significant. Sucrose appeared to have an effect to delay fetal and annexial development, which has been reported in the literature. Hematocetes were reported in the sucrose, 6 g and 12 g/day groups, but there was no dose-dependent response. The 6 g/day group had a number of external and internal abnormalities, but these were judged not treatment-related.

n. Genotoxicity Studies

There were a number of genotoxicity studies performed with PD using both powder and syrup. These included, i) Spot test with *Salmonella typhimurium*, ii) Quantitative plate assay with *S. typhimurium*, iii) Host-mediated assay with mice injected with *S. typhimurium*, iv) In vivo and In vitro mouse bone marrow, and human lymphocyte assay, respectively, and v) Dominant lethal assay in mice. All assays of each substance, at all doses showed that PD had no genotoxic or mutagenic effect.

5. Safety of Pullulan

Pullulan is a polyglucose molecule in which 3 glucose molecules are bonded by α -1,4 linkages, which are subsequently bond by α -1,6 linkages.¹¹ This forms stair-step molecules of heterogeneous molecular weights. The heterogeneous molecular weight occurs for all other dextrin-like substances.

The average molecular weight of the commercially available product is approximately 200,000 daltons.¹¹ Evaluation of pullulan using standard methods of the AOAC have shown that pullulan is approximately 70% non-digestible, classifying it as a resistant dextrin. Unlike IMD, dextrin and maltodextrin and polydextrose, pullulan is produced by a controlled fermentation process.¹¹ An FDA GRAS Notice was submitted to the Agency March 2002, and the Agency provided a "no questions" letter dated August 2002 (GRN 0099).^{11,43} The following section reviews the relevant safety studies performed with pullulan. The 13-week sub-chronic feeding study reported below was not available when the GRAS Notice was reviewed by the FDA, but was used in subsequent submissions to the EU (July 2006) as a food additive petition and for JECFA (June 2005).

a. Acute Study

A study in mice was performed at the School of Medicine of Juntendo University in Japan. The study examined the acute response of male dd strain mice to consumption of a commercial sample of pullulan. No deaths were observed and the LD₅₀ was > 14.28 g/kg bw. The scientists concluded that this was likely the maximum dose that could be administered because of the viscosity of the pullulan solution.¹¹

b. 62-Week Study

Pullulan was administered to 120 Spargue-Dawley rats (15 females and males/group) divided into 4 equal groups at 0, 1, 5 and 10% in a standard laboratory diet for 62 weeks.⁴⁹ The study was designed to last 24 months, but a pneumonia outbreak caused the study to be terminated early. Pullulan did not effect food consumption, efficiency or body weights as compared to the control group. At termination of the study, hematology and clinical chemistry values of treated animals were comparable to control values. Examination of selected organs revealed no indication of pullulan-related toxicity in the organs and macroscopic and microscopic examinations revealed no toxic lesions due to treatment, except in females fed 10% pullulan where cecal enlargement was seen. According to the authors, cecal enlargement is

a generic response to poorly absorbed sugars and carbohydrates and is considered an adaptive rather than a pathologic change.^{11,24} This was observed in other dextrin-related products reported in this document. The actual organ weights varied in comparison to those of the controls; however, the variation was not considered treatment related. Statistical analysis showed that there were no significant differences when organ weight to body weight was calculated. Bronchitis was observed in all animal groups. Male rats had principally pneumonia and pulmonary abscesses and while females had fewer pneumonic lesions, they had lesions in other organs. These findings were judged as not related to treatment. On the basis of the study results, it was concluded that pullulan lacked toxicological activity. The no-observed-adverse-effect level determined was the highest concentration tested, which was equal to or greater than 4,450 mg/kg body weight/day in males and 5,080 mg/kg body weight/day in females.⁴⁹

c. High Dose Rat Study

A study in male Wister rats tested the effects of pullulan and cellulose on the gastrointestinal tract of rats. Pullulan was administered to 10 rats at 20 and 40%. Treated rats gained less weight on diets containing pullulan than did controls (n=5). Additionally dose related hypertrophy of the large intestine and cecum were noted after 4 and 9 weeks of feeding at both 20 and 40% of pullulan in the diet. As noted above, this effect was considered to be physiological and not indicative of a toxic response.⁵⁰

d. 13-Week Subchronic Feeding Study

In a 13-week toxicity study, groups of 10 Wistar rats of each sex were fed diets containing Pullulan PI-20 at concentrations of 0, 2.5, 5 and 10% for 13 weeks.⁵¹ No treatment-related clinical signs were reported during the study and there were no mortalities. The body weights and food intakes did not differ between treated groups and controls. The hematological and clinical chemical parameters revealed no changes

that could be attributed to the treatment. Urine volumes were significantly increased in females in the mid- and high-dose group but this difference was interpreted as artifact rather than a treatment-related effect. Except for the cecum, organ weights were not affected by the treatment. The weight of the empty cecum was significantly increased in males and females of the high-dose group and in males of the mid-dose group. The weight of the full cecum was increased in males of the mid-dose group. Except for cecal enlargement, there were no macroscopic observations at necropsy that could be attributed to the treatment. The histopathological examination of the liver, kidneys and gross lesions did not reveal treatment-related changes.

The only effect in rats receiving 5 and 10% pullulan in the diet was cecal enlargement. This effect is a common consequence of the ingestion of high doses of not absorbed, fermentable carbohydrates. As reported and mentioned above, cecal enlargement is generally recognized to be an adaptive phenomenon, which lacks toxicological relevance. Accordingly, the NOAEL for Pullulan PI-20 as 10% in the diet is equivalent to doses of 7.9 and 9.7 g/kg bw/d for male and female rats, respectively.⁵¹

e. Genotoxicity Studies

The mutagenicity (Ames test) of pullulan was assessed with and without metabolic activation in standard strains of *Salmonella typhimurium*. Pullulan did not increase the number of revertants per plate, including 10,000 µg/plate with or without activation.¹¹

6. Conclusion

Review of literally dozens of safety studies performed on appropriate samples of dextrin and dextrin-type substances (resistant dextrin/maltodextrin, polydextrin, and pullulan) have consistently demonstrated that these substances are safe for their intended uses under the conditions of current Good Manufacturing Practice.

C. Safety of Isomaltodextrin

Hayashibara has determined that IMD is GRAS and therefore safe for consumption by humans based on its substantial equivalence to dextrin and dextrin-like commercial products. These other substances have previously been determined to be GRAS by the FDA.^{5,8-11} In support of this GRAS determination by Hayashibara, IMD has also been evaluated by an independent panel of experts qualified by scientific training and national and international experience to evaluate the safety of food and food ingredients, specifically IMD, under the conditions of its intended use in food (Appendix A). As part of Hayashibara's stewardship and in further support of the GRAS determination Hayashibara has performed and is providing further safety-related information and data about IMD. Since these studies have not been reviewed before by the FDA, they are reported in more detail than the studies of dextrin, and dextrin-like substances.

1. Safety of the Raw Materials

All raw materials, processing aids and equipment are food grade (see Section III), and are used by Hayashibara in the production of tens of thousands of tons of similar products that use these same materials, aids and equipment. Further, the same type of raw materials, processing aids, and equipment are used by many other companies to produce millions of tons of similar products each year. The only exception to the preceding statement are the two IMD producing enzymes used in the manufacturing process, that are naturally produced by a unique non-pathogenic organism (see below).

2. Innate Safety of IMD

The 2010 USDA Dietary Guidelines for Americans states that 45-65% of diets of all age groups should consist of carbohydrates.⁵² The average amount of digestible carbohydrates in the US diet consists of about: a) 60% starch, which is essentially all D-glucose; b) 30% sucrose, which is 50% glucose, c) 5% lactose, which is 50% glucose, and d) 5% glucose and other monosaccharides.³ This makes D-glucose the most common nutrient in the human diet. IMD is composed of only D-glucose, and the portion that is

digestible provides only D-glucose to the body.

As noted above the chemical structure of IMD classifies it a dextrin, maltodextrin, resistant dextrin, and resistant maltodextrin. In the Introduction it was explained that the differences between dextrin and maltodextrin are not universally formalized.^{2,4} Dextrin is a larger hydrolytic product of starch and is mostly digestible, while maltodextrin is smaller in average molecular weight and completely digestible.³ The exception is when the preparation method is such that the usual α -1,4 and α -1,6 linkages are modified. The new linkages resist digestion by the enzymes located in the small intestine, and so are called resistant dextrin or resistant maltodextrin.

Both dextrin, including resistant dextrin, and maltodextrin, including resistant maltodextrin, are listed as GRAS in 21CFR §184.1277 and 21CFR §184.1444, respectively.^{5,8,9} The GRAS listing of dextrin mentions it is produced by dry heating various starches with or without bases, acids or pH control agents. These factors are responsible, to various extents for the development of the resistant portion of the dextrin produced.^{3,4} According to 21CFR §184.1444 maltodextrin can be produced from a variety of food grade starches with "safe and suitable acids and enzymes".⁹ A resistant dextrin was GRAS Notified recently, and the FDA had no objection to its GRAS status.^{5,42} The substance was referred as an "enzyme modified dextrin" or a "resistant dextrin".⁵ It is produced by the dry roasting with acid, which makes it a classical dextrin; however, the manufacturer added an α -amylase treatment step, which like IMD, is used to increase filtration efficiency.⁵ Polydextrose, a branched polyglucose similar to resistant starch, with a similar average molecular weight distribution, and with similar glucosyl linkage is listed as GRAS in 21CFR §172.841.¹⁰ The difference is in how it is produced. Polydextrose is polymerized from glucose instead of being hydrolyzed from starch.¹⁰ Another example of a resistant dextrin and a polyglucose branched molecule that has been accepted as GRAS by the Agency is pullulan.⁴³ Pullulan is a fermentation product of a mold. IMD is produced by direct enzymatic action, and is chemically and structurally another example of a resistant dextrin.

The rationale that is being presented here is that there are a number of substances that fit the chemical definition, if not the production method, as specified in 21 CFR, of a dextrin. The definition of a maltodextrin includes the use of enzymes in the production process. These have been reviewed and either approved or been allowed GRAS Notice status, and are considered safe at use amounts consistent with cGMP.^{5,8-10,42,43}

3. Safety of the Manufacturing Process of IMD

a. Production

Hayashibara developed IMD in 2007, and has established an industrial manufacturing process that is based on principles of safe production that have been developed over decades. As noted in Section III, and in subsection C.1. (above) of this Notification, all raw materials are food grade and have been used in the production of tens of thousands of metric tons of starch-based saccharides each year at Hayashibara and at many other companies around the world. They are considered safe for use for production of these types of products.

Briefly, starch is hydrolyzed by α -amylase (EC 3.2.1.1) derived from *Bacillus licheniformis* to liquefy the starch. The enzyme is deactivated by an increase in temperature. The hydrolyzed starch is then simultaneously treated with α -glucosyltransferase (EC 2.4.1.24) and α -amylase (EC 3.2.1.1), which are the IMD producing enzymes. Both are derived from non-recombinant *Paenibacillus alginolyticus*, to produce branched and low molecular weight polysaccharides. α -Glucosyltransferase catalyzes the cleavage of α -1,4 glucosidic linkage at the non-reducing end of the starch chain and simultaneously transfers the glucosyl residue to the hydroxyl group at the 6-position of the non-reducing end of another chain. This reaction occurs continuously and leads to the formation of repeated α -1,6 glucosidic linkages at the non-reducing end of the hydrolyzed starch. At this stage, α -amylase catalyzes the cleavage of α -1,4 glucosidic linkage of hydrolyzed starch and simultaneously transfers the glucan to the

hydroxyl group at the 3-position of repeating α -1,6 glucosidic linkage residues. These reactions with α -glucosyltransferase and α -amylase occur continuously. The very small amount of unreacted starch is hydrolyzed by the action of α -amylase (EC 3.2.1.1) derived from *Bacillus amyloliquefaciens*. The final IMD product is prepared by spray-drying purified IMD solution after processing, using heat to deactivate enzymes, purification steps and concentration that are standards of the industry. There are a number of critical control steps to assure that the safety and quality of the product meet the specified standards (see Section III).

b. Bacteria and Enzymes

To produce IMD, Hayashibara uses two common enzymes, which are produced by a unique bacterial source.¹ The enzymes are, first α -glucosyltransferase (EC 2.4.1.24), which transfers an α -D-glucosyl residue in a (1 $\rightarrow$ 4)- α -D-glucan to the primary hydroxyl group of glucose, free or combined in a (1 $\rightarrow$ 4)- α -D-glucan. The second enzyme, α -amylase (EC 3.2.1.1), which acts on the α -1,4 glucosidic linkage in a (1 $\rightarrow$ 4)- α -D-glucan, and catalyzes transfer reactions to C3- or C4-hydroxyl groups in α -1,6 linked glucosyl residues in the reaction product of the α -glucosyltransferase reactions. α -Amylase gradually increases α -1,3 or α -1,4 glucosidic linkages in the α -1,6 linked glucosyl residue in the middle, or in the non-reducing end of glucan chains.³ In addition to these enzymes, the process uses two other α -amylases. One is a thermostable α -amylase (EC 3.2.1.1), which is used to initially liquefy the starch and make it soluble (This enzyme might be the most common enzyme used for the production of starch syrups), and a second α -amylase (EC 3.2.1.1) that is used to treat unreacted starch. This helps in the subsequent filtration process.

The organism that was identified as producing the two enzymes is a species of the genus *Paenibacillus*.^{1,21} This genus consists of organisms that are straight or curved rod about 0.5-1.0 x 2-6 μ m. They have a cell wall that is Gram-positive, but stains have been found

to be variable or negative.⁴¹ Some members are facultative anaerobes or strict aerobes. Optimum growth occurs at about 28 - 40°C and at a pH of around 7.0; however, some strains can grow in alkaline conditions. They are spore-formers. The global habitat of this genus is essentially soils that are generally high in humus and plant material, with some species being isolated in specific areas or ecosystems of the world. They are considered saprophytic in nature.⁴¹

Scientists at Hayashibara examine the morphological, cultural, and physiological characteristics of the strain and it was classified as *Paenibacillus alginolyticus*, according to Bergey's Manual of Systematic Bacteriology (Bergey's).⁴¹ The isolate was cultured from soil.¹ The strain has been deposited at ATCC.

Bergey's states that members of the genus *Paenibacillus* are not associated with human or mammalian pathogenicity. Some isolates have been shown to cause disease in insects, usually the larval stage.⁴¹ The ATCC classifies *Paenibacillus alginolyticus* as biosafety risk group 1, as well as the German Committee on Biologic Agents.^{28,29} It is not listed in the FDA Bad Bugs Book.³⁰ Examination of the literature has revealed no reports of *Paenibacillus alginolyticus* causing or being present in any human infections, even though it is found in the soil. Review of the literature has shown that members of the *Paenibacillus* genus have been isolated from human infections. Some of these infections were thought to be simple contaminants, others occurred in immunocompromised individuals, and/or puncture wounds. Their participation in the infection is not known, but thought to be incidental.⁵³

Hayashibara has concluded that there is no basis to consider that *Paenibacillus alginolyticus* should be considered a safety risk, in the production of two of the enzymes used in the production of IMD. Further, the enzyme preparation obtained from *Paenibacillus alginolyticus* is ultrafiltered to remove organisms. The subsequent production processes include heating to 50°C, and analysis of the final product for contamination by *Paenibacillus alginolyticus*.

In addition, one of the members of the Expert Panel is an internationally renowned expert on the safety of organisms used in food, and the enzymes these organisms produce. He has determined that, in his expert opinion, there is no reason to believe that this organism or subsequent enzymes (paragraph below) are a safety risk (Appendix B).

The two enzymes produced by *Paenibacillus alginolyticus*, α -glucosyltransferase (EC 2.4.1.24) and α -amylase (EC 3.2.1.1) are prepared by standard methods. The enzyme preparation is ultrafiltered, assayed for enzymatic activity, and then used in the production of IMD as explained in Section III. To examine the possibility of any of the enzymes remaining in the final product, a standard Bradford protein assay was run. The detection limit of the protein assay is 2.0 $\mu\text{g/mL}$. Hayashibara wanted a more sensitive assay to demonstrate that essentially no protein from the enzymes remained. Three separate ELISA assays were developed to detect the thermostable α -amylase, the IMD producing enzymes, and the final α -amylase used to increase the efficiency of filtration. The results (Table VI-1), are provided in the following table. The three ELISA assays provide a detection sensitivity of 0.5, 2.0 and 0.5 ng/mL , respectively. All values for 6 lots were below the limits of detection. This suggests that essentially no protein is present, and that none of the enzymes remain in the final IMD product.

Table VI-1 Results of a protein assay and three ELISA assay

	Protein assay ($\mu\text{g/mL}$)	ELISA assay (ng/mL)		
		Thermostable α -Amylase	IMD producing enzymes	α -Amylase
Lower detection limit	< 2.0	< 0.5	< 2.0	< 0.5
121220C1	< 2.0	< 0.5	< 2.0	< 0.5

130130C1	< 2.0	< 0.5	< 2.0	< 0.5
130720C1	< 2.0	< 0.5	< 2.0	< 0.5
130208T1	< 2.0	< 0.5	< 2.0	< 0.5
130208T2	< 2.0	< 0.5	< 2.0	< 0.5
130208T3	< 2.0	< 0.5	< 2.0	< 0.5

*IMD concentration of all samples is 5% (w/v).

4. Safety Studies

a. Acute Toxicity Study

IMD (Lot No. 130130C1) was assessed for acute oral toxicity in a study performed according to OECD Guidelines for the Testing of Chemicals 420 (17th December, 2001).⁵⁴ In this study, a single dose of 2,000 mg/kg of IMD as a solution of 200 mg/mL was administered to 5 female Crl:CD(SD) strain rats by gavage following an overnight fast. The dose volume was 1.0 mL per 100 g-body weight (BW). The animals were fasted for a further 3 hours after dosing. The general condition of the animals were observed once within 30 minutes and once at 1, 2, 3, and 4 hours after dosing (Day 0). For 14 days from the 1st day after dosing (from Day 1 to Day 14), the general condition of the test animals was observed once daily. The viability, as well as signs of toxicity, were assessed, and any observed effects were recorded. Body weights were recorded on Days 0 (before dosing), 7 and 14. All animals were sacrificed on Day 14 of the observation period and the organs/tissues were examined.⁵⁴

All 5 animals survived and no animals showed abnormal clinical signs during the observation period. The rats showed normal body weight gains during the observation period and showed no abnormal gross findings in the examined organs and tissues.⁵⁴

Based on the above findings, it was concluded that the acute oral 50%

lethal dose (LD₅₀) of IMD is greater than 2,000 mg/kg in female rats under the conditions of this study.

b. Repeated Dose 90-Day Study

IMD (Lot No. 130130C1) was assessed for repeat dose oral toxicity in a study performed according to OECD Guideline for the Testing of Chemicals 408 (21st September, 1998).⁵⁵ IMD (dose levels: 0, 100, 300 or 1,000 mg/kg/day) was administered daily by gavage to Crl:CD(SD) rats (10 males and 10 females for each dose) for 13 weeks. Ten (10), 30 and 100 mg/mL solutions were prepared for the 100, 300 and 1,000 mg/kg dosing groups, respectively. The dose volume was 1.0 mL per 100 g-BW. The general condition of the animals was observed twice a day (before and after dosing) during the administration period, and the body weight and food consumption were determined at Days 1 (before grouping), 8, 15, 22, 29, 36, 43, 50, 57, 64, 71, 78, 85, and 90. The animals to be necropsied were weighed before necropsy (Day 91 or 92). A standard safety pharmacology test, Functional Observational Battery (FOB), was conducted once a week to examine responses on removal from cage (ease/difficulty of removal, vocalization), conditions when hand-held (muscle tone, subnormal temperature, piloerection, soiled fur, unkempt fur, skin color, lacrimation, exophthalmos, pupillary size, salivation), behavior in an arena (air-righting reflex, posture, motor activity, respiration, eyelids, gait, tremor, twitch, tonic convulsion, clonic convulsion, stereotypic behavior, abnormal behavior), sensorimotor reactivity test (approaching contact, tactile response, auditory response, pain response, pupillary reflex), grip strength test (forelimb, hindlimb), locomotor activity test [amount of movement in a 10 minute interval, total amount of movement (1-hour activity)]. Urinalysis at the 13th week of administration, ophthalmological examinations during the quarantine period (Day -2, -1), and administration period (Day 83) were conducted. For the urinalysis, fresh urine (within 3 hours of urination) and pooled urine (24 hours) were collected. After the completion of the administration period, clinical examinations (examinations of hematology, blood coagulation,

blood chemistry and serum protein electrophoresis) and pathological examinations (organ weight measurement, macroscopic and histopathological examinations) were conducted. Blood samples were collected from the abdominal aorta under isoflurane anesthesia after overnight fasting. For pathological examination, all animals were necropsied after blood sampling and euthanasia by exsanguination under isoflurane anesthesia.

Observation of the animals showed no deaths in either the males or females in any group throughout the administration period. There were no adverse effects due to test substance administration on clinical signs, body weight, body weight gain, food consumption, blood coagulation, blood chemistry, ophthalmology, organ weight, and upon histopathological examinations.

Review of the hematologic data showed that the hemoglobin concentration in the 1,000 mg/kg/day administered male group was significantly lower ($p < 0.05$) than that in the male control group. However, this change was judged not to be toxicologically significant because its degree was very slight and not outside normal values recorded for these animals. Additionally there were no changes in other parameters related to erythrocytes (hematocrit, mean corpuscular volume, etc.). The ratio of monocytes in the 300 mg/kg/day administered female group was significantly less ($p < 0.05$) than that in the female control group. This finding was also judged by the laboratory performing this study not to be a test substance related effect because there was no dose dependent relationship, and the values were not outside the established normal range.

The concentration of α -2 globulin in the 1,000 mg/kg/day male group was significantly higher ($p < 0.05$) than that in the male control group. However, because the ratio of globulin and total protein were not changed at all this difference was judged not to be toxicologically significant. The values of the α -2 globulin in the 1,000 mg/kg/day male

group were not above the normal range.

Evaluation of the urinalysis values showed that the total sodium, potassium and chloride excretion in the 1,000 mg/kg/day female group and the total sodium excretion in the 300 mg/kg/day female group were significantly lower ($p < 0.05$) than those in the female control group. However, there were no changes in the serum ion concentrations (sodium, potassium and chloride) of the blood chemistry. The significant lower values were not outside the normal range for these animals. This indicates that physiological homeostasis of the animals was maintained. Histopathological examination of the kidneys and pituitary glands, which regulate renal function, did not reveal any abnormalities. Thus, the changes in the urinary ion concentrations were judged not to be adverse effects.

Based on the above findings, the No Observed Adverse Effect Level (NOAEL) of IMD was specified as 1,000 mg/kg/day for both male and female rats under the conditions of this study, which was the highest dose tested.⁵⁵

c. Mutagenicity and Genotoxicity Studies of IMD

i. Bacterial Reverse Mutation Test

The Bacterial Reverse Mutation Test of IMD (Lot No. 130130C1) was performed according to OECD Guideline for the Testing of Chemicals 471 (21st July 1997).⁵⁶ The assay was conducted using *Salmonella typhimurium* strains (TA98, TA100, TA1535 and TA1537), as well as *Escherichia coli* strain [WP2uvrA(pKM101)]. All experiments were performed in the presence and absence of the S9 mix. A preliminary Dose Range Finding study to test for cytotoxicity and solubility was conducted to determine the highest dose possible for the main study. The highest dose of the test substance was 5,000 µg/plate, which is required by the test guidelines. The highest dose was sequentially diluted by a geometric ratio of 4 to produce 5 lower dose levels (1,250, 313, 78.1,

19.5, and 4.88 µg/plate). In addition, the positive and negative control groups were tested concurrently. This preliminary study was conducted using the same method as that of the main study. Results of the preliminary study demonstrated no growth inhibition by IMD or a solubility problem at any dose in any of the strains in the absence and presence of S9 mix. Therefore, 5,000 µg/plate in all strains was chosen as the highest dose level in the main study in the absence and presence of S9 mix.

The main study involved the pre-incubation method. All treatments were divided into two groups, and each group was examined in the absence and presence of S9 mix. The main study was performed twice. The bacterial strains were treated with IMD at concentrations of 313, 625, 1,250, 2,500, and 5,000 µg/plate. Also, positive and negative control substances were tested concurrently. Water vehicle served as a negative control for all strains. The following compounds were employed as positive controls: sodium azide, 2-nitrofluorene, 2-aminoanthracene, 9-aminoacridine, 2-(2-furyl)-3-(5-nitro-2-furyl) acrylamide. Base on the results of 1st and 2nd main studies, the mean number of revertant colonies in all strains was less than twice the negative control values at all dose levels of IMD regardless of the absence and presence of S9 mix, without dose dependency. In the positive control group the number of revertant colonies in all strains was markedly increased when compared to that of the negative control group. Growth inhibition by IMD and solubility issues were not observed at any dose, or with any bacterial strain in both the absence and presence of S9 mix.

It was concluded that IMD did not exhibit any indications of mutagenic potential under the conditions of this study.⁵⁶

ii. Mammalian Chromosome Aberration Test

An *in vitro* Mammalian Chromosome Aberration Test of IMD (Lot No. 130130C1) was conducted using a Chinese hamster lung

fibroblast cell line (CHL/IU) to evaluate the potential of IMD to induce chromosomal aberrations. The study was in compliance with OECD Guideline for the Testing of Chemicals 473 (21st July 1997).⁵⁷ In the cell growth inhibition test (preliminary test), the maximum concentration was 5,000 µg/mL, as prescribed in the test guidelines, and dilution concentrations of 2,500, 1,250, 625, 313, 156, 78.1 and 39.1 µg/mL were used. Results of the preliminary test indicated no cytotoxicity in the -S9, +S9 or 24-hour assays. Therefore, the maximum concentration was set at 5,000 µg/mL as prescribed in the test guideline, and concentrations of 2,500, 1,250 and 625 µg/mL were also used for the chromosome aberration test (main test).

The CHL/IU cells were treated with IMD or control substances under the following conditions: 1) short-term treatment (6 hours) in the absence of S9 mix followed by an 18-hour recovery period (-S9 assay); 2) short-term treatment (6 hours) in the presence of S9 mix followed by an 18-hour recovery period (+S9 assay); and 3) continuous treatment for 24 hours in the absence of S9 mix (24-hour assay). As a negative control, water for injection, which is the solvent used to prepare the test substance solutions, was used. Mitomycin C (MMC) was used at concentrations of 0.1 and 0.05 µg/mL as a positive control for the -S9 and 24-hour assays, respectively. Cyclophosphamide (CP) was used as a positive control at the concentration of 12.5 µg/mL for the +S9 assay. Microscopic examinations were conducted at concentrations of 1,250, 2,500 and 5,000 µg/mL for the -S9, +S9 and 24-hour assays.

The results are as follows;

In the -S9 assay, the incidences of cells with structural chromosome aberrations in the groups treated with IMD at 1,250, 2,500 and 5,000 µg/mL were 2.5, 0.5 and 1.0%, respectively. These values were not statistically significantly different in comparison with the incidence in the negative control group (0.5%).

The incidences of polyploid cells in the groups treated with IMD at 1,250, 2,500 and 5,000 µg/mL were 0.0, 0.0 and 1.0%, respectively, which were not statistically significantly different from the negative control group (0.5%). Cell growth inhibition was not observed at any concentration. At the start and end of the treatments, precipitation was not observed at any concentration. Conversely, there was a high incidence of cells with structural chromosomal aberrations (63.0%) in the positive control group, which was statistically significantly higher than the negative control group (0.5%).

In the +S9 assay group, the incidences of cells with structural chromosome aberrations treated with IMD at 1,250, 2,500 and 5,000 µg/mL were 0.0, 1.0 and 1.5%, respectively. These percentages were not statistically different from the negative control group (0.5%). There were no polyploid cells in the groups treated with IMD at 1,250, 2,500 and 5,000 µg/mL, which was the same as the negative control group (0.0%). Cell growth inhibition was not observed at any concentration, and no precipitation was observed at any concentration at either the start or end of the study period. As expected there was a high incidence of cells with structural chromosomal aberrations (65.0%) in the positive control group, which was statistically greater than that in the negative control group (0.5%).

In the 24-hour assay, the incidences of cells with structural chromosome aberrations or polyploid cells in the groups treated with IMD at 1,250, 2,500 and 5,000 µg/mL were 0.5, 1.0 and 0.5%, and 0.0, 0.0 and 0.0%, respectively. None of the comparisons to the incidences in the negative control group (0.0%) were significantly different. Cell growth inhibition was not observed at any concentration, and no precipitation was observed at any time or concentration. The positive control group had a significantly higher percentage of structural chromosomal aberrations (49.0%)

than the negative control group (0.0%).

The results of this study revealed no significant increase in the incidence of cells with structural chromosomal aberrations or polyploid cells when treated with IMD in any of the assays conditions. Both MMC and CP, as the positive controls for the -S9 and 24-hour assays and the +S9 assay, respectively, significantly induced structural chromosomal aberrations.

It was concluded that IMD did not induce chromosomal aberrations in cultured mammalian cells under the conditions of this study.⁵⁷

iii. Mammalian Erythrocyte Micronucleus Test

A Mammalian Erythrocyte Micronucleus Test using IMD (Lot No. 130130C1) was conducted with Crl:CD (SD) male rats. The study methods complied with OECD Guideline for the Testing of Chemicals 474 (21st July, 1997).⁵⁸ Three dose levels, including the highest dose of 2,000 mg/kg specified in the guideline and lower doses of 1,000 and 500 mg/kg, were used for the micronucleus test. Water and mitomycin C (MMC) at the concentration of 2 mg/kg were used as negative and positive controls, respectively. The dosing volume was 1 mL per 100 g-BW. IMD and the negative control were orally administered to 6 male rats per dose group once a day for 2 consecutive days. The positive control was injected once via the tail vein using a disposable syringe with a 25-gauge needle on the day before preparation of bone marrow samples. At 24 hours after the final administration, the bone marrow was sampled. The frequency of micronucleated immature erythrocytes (MNIE) and the ratio of immature erythrocytes (IE) to the total number of analyzed erythrocytes were calculated for each group. Body weights of the animals were measured before preparation of bone marrow samples. In the IMD-treated groups and negative control group, clinical signs of the animals were observed at 1, 24 and 25 hours

after the first dosing, and just before preparation of bone marrow samples (48 hours after the first dosing). In the positive control group, clinical signs were observed at 1 hour after dosing and just before preparation of bone marrow samples (24 hours after dosing).

No difference in body weight gain, or abnormal clinical signs were observed in any of the groups treated with IMD. In the groups treated with 500, 1,000 and 2,000 mg/kg of IMD, the frequencies of MNIE were 0.20%, 0.07% and 0.12%, respectively. All of these were within the acceptable ranges (mean $\pm$ 3S.D.) calculated from the historical data in the test laboratory. The ratios of IE to the total number of analyzed erythrocytes, which are indexes of the influence of the test substance on the bone marrow cells, were 57.0, 59.3 and 60.7% in the 500, 1,000 and 2,000 mg/kg groups, respectively. In the negative control group, 0 to 4 MNIE in 2,000 IE per animal were observed and a group mean frequency was 0.11% (0 - 0.2%). The ratio of IE to the total number of analyzed erythrocytes was 57.0% in the negative control group. No statistically significant decreases in the ratio of IE were observed in any of the IMD-treated groups as compared with that in the negative control group. In the positive control group treated intravenously with MMC at a dose of 2 mg/kg, the frequency of MNIE (3.03%) was significantly increased ($p \leq 0.025$) as compared with that in the negative control group, and the ratio of IE was 44.0%.

It was concluded that IMD did not induce micronucleated erythrocytes in rat bone marrow cells under the conditions of this study.⁵⁸

D. Tolerance Studies in Humans

It is well documented that certain foods and food ingredients, that are not completely digested, and pass into the large intestine can result in

gastrointestinal effects.^{59,60} Two of the best-known classes of ingredients that cause such activity are oligosaccharide and dietary fiber, including resistant dextrin/maltodextrin. The symptoms are influenced by various factors such as dose, the structure and molecular weight of the substance, and the fermentability by the microorganisms residing in the large intestine. This section provides summary information on the tolerance of resistant dextrin, resistant maltodextrin, polydextrose, and pullulan, and studies in which the tolerance of IMD was studied.

1. Tolerance of Resistant Dextrin

a. Short-term Digestive Tolerance

Twenty (20) healthy males (age 31.7 ± 9.1 yr; BMI 24.5 ± 2.9 kg/m²) were divided into two equal groups and administered various doses of resistant dextrin in addition to their normal diet.⁶⁰ The subjects were requested not to consume various foods that could prejudice the results. The study was a randomized, placebo-controlled, double-blind crossover study. One half of the first group (n=5) was given 10, 30, and 60 g/day for 7 days at each dose, while the other half consumed a placebo of maltodextrin. The second group followed the same pattern except they received 15, 45 and 80 g/day for 7 days at each dose, and the other half the control. The daily doses were divided into 4 individual doses during the day, which were given mixed in juice or yogurt. After 21 days of the increasing doses, there was a 7-day washout and then each group crossed-over from the placebo group to the treatment, and visa versa. The subjects were questioned on the first and seventh day of each week about their gastrointestinal condition. Other factors were studied that are not directly related to tolerance. The data showed that a split daily dose of 45 g/day was well tolerated. During the last 6 days the 30, 60 or 80 g/day treatment groups had significantly more flatulence ($p < 0.05$), which increased during the last 24 hours in the 60 or 80 g/day treatment groups. In the final 24 hours, the 80 g/day group had significantly greater bloating ($p > 0.05$). Diarrhea was not observed at any dose and it was well tolerated up to a dose of 45 g per day.⁶⁰

b. Long-term GI Tolerance

A randomized, placebo-controlled, double-blind parallel study was performed in which 48 male subjects (age: 34.7 ± 8.2 years; BMI 24.9 ± 3.3 kg/m²) were divided into 3 groups of 16.⁵⁹ These groups consumed either a placebo (maltodextrin), or 30 or 45 g/day of resistant dextrin for 4 to 5 weeks. Five of the subjects did not complete the study (3 control, 2 30 g/day). The subjects were given the daily dose as four sub-doses during the day. In the first week a ½ dose of each substance was given to allow the subjects to acclimate to the increase in the high resistant dextrin diet. The treatments were mixed into various drinks or yogurt. A questionnaire was used to assess the occurrence and severity of GI complaints. Both doses were well tolerated with a tendency for increased flatulence; however this was not significant when compared to control during the final 6 days of the study (13 control, 14 30 g/day, 17 45 g/day). No diarrhea was reported and long-term consumption of 30 or 45 g of resistant dextrin was well tolerated.⁵⁹

c. Energy Value of Resistant Dextrin

A study was performed with the specific purpose of evaluating the energy value of resistant dextrin; however, as part of the study, information was generated about the tolerance of the substance.⁶¹ The study consisted of two parts, with the first preliminary study looking at the tolerability of the resistant dextrin. Ten (10) healthy males were given increasing doses of resistant dextrin from 20 to 100 g/day over a 20-day period. Each dose was given in water and divided up into 6 equal doses throughout the day. Set balanced diets were given during specific times of the experiments. The subjects continued on the 100 g/day for 5 days, and were asked to report on various GI symptoms. In the second cross-over study, the same 10 subjects were given increasing doses (20 g/day to 100 g/day) of resistant dextrin or dextrose over 18 days. This acclimation period was followed by 13 days of consumption, and then 11 days with a standard meal. The

substance was divided into 6 doses per day. After the first cycle, there was a wash-out period of 4 weeks and the subjects were given the other substance. GI tolerance data from combining the results of the two experiments (preliminary and main) are presented below.

Gas emission:	low 9/20; medium 2/20; intense 4/20
Borborygmus:	low 2/20
Flatulence:	low 4/20
Abdominal pain:	low 3/20 (pain continued in one subject after end of study)
Diarrhea:	low 2/20 (once)

From this data it was concluded that intakes under 50 g/day would likely not produce GI distress (note that the resistant dextrin was given in 6 daily sub-doses, which would equal 8.33 g per dose).⁶¹

2. Tolerance of Resistant Maltodextrin

Five (5) female and 5 male Japanese subjects were recruited for a single dose escalation tolerance study.⁶² The subjects were administered single doses of 0.7, 0.8, 0.9, 1.0 and 1.1 g/kg bw dissolved in water to a volume of approximately 200 mL. All subjects were started on the lowest dose, with a 1-week washout period before the next dose. The principal end point was to determine the dose at which no diarrhea ('muddy or watery stools') was observed. In addition, the occurrence of GI symptoms common to the consumption of high amounts of non-digestible carbohydrates was also reported. The maximum amount of resistant maltodextrin that was consumed in a single dose, which did not result in diarrhea was 1.0 g/kg bw. At the 1.1 g/kg bw treatment only one male subject reported "muddy" stools 2 hours after consumption of the resistant maltodextrin. Regarding the other GI symptoms, various numbers of subjects had various symptoms. In a dose ascending order the number of subjects out of 10 having GI symptoms and the number of symptoms the subjects reported (eg. 3/5, meaning 3 subjects reported 5 symptoms) were; 2/3, 4/4, 2/2, 1/1, and 4/6, respectively. Of 16 total GI symptoms reported borborygmus (gurgling) and

flatus accounted for 7 and 9, respectively. Except for the slight increase in symptoms at the highest dose there did not appear to be a dose-related effect. No subjects reported stomachache, tenesmus, bloating, or vomiting/nausea. Therefore 1.0 g/kg bw is considered the no effect dose.⁶²

3. Tolerance of Polydextrose

There are 9 reported studies including 448 subjects, including adult females, males, and children and adolescents, where polydextrose was administered in various forms.²⁴ These have been reviewed and published in an article in 2004. Because of the differences in each study they will not be reported individually. The studies were reviewed individually in the review so it is not necessary to do so here. These studies were reviewed by JECFA and the European Scientific Committee for Food and it was concluded that "polydextrose has a mean laxative threshold of ≈ 90 g/d (1.3 g/kg bw) or 50 g as a single dose."²⁴

4. Tolerance of Pullulan

Fifteen (15) subjects (7 female, 8 male; aged 26.7 ± 5.6 yr; BMI of 23.0 ± 3.2 kg/m²) were randomly assigned to a treatment group in a single-blind cross-over protocol: however, because of the differences in viscosity and taste of the two substances a true blind was not possible. Additionally, the viscosity of pullulan only allowed for a maximum dose of 25 g. The subjects were administered a single dose of 25 g pullulan or 25 g glucose, which served as the control.⁶³ Subjects ate similar meals the night before the study and fasted overnight before consuming the samples the next morning. The samples were given in 350 mL of water and consumed over a maximum of 5 minutes. After a washout period of at least 1 day the subjects were given the other substance. Subjects were asked to report GI symptoms in the 2-hour and 24-hour period following consumption. One hundred (100) mm visual analog scales were used to determine if the test substances produced gastrointestinal symptoms. Specifically, subjects were questioned about nausea, abdominal cramping, abdominal distention, and flatulence. No statistically significant differences in either the 2-hour or

24-hour gastrointestinal symptoms were detected between the groups. No score for pullulan greater than 52 mm was reported for any symptom on either the 2-hour or 24-hour gastrointestinal questionnaires. This suggests that no major gastrointestinal symptoms were elicited by ingestion of 25 grams of pullulan. One subject reported dizziness immediately following the glucose trial.⁶³

5. Tolerance of IMD

Hayashibara conducted a number of studies that provided data on the tolerability of IMD in human subjects. The following paragraphs provide details of both acute and chronic ingestion of IMD.

a. Single Dose Escalation Study

40 healthy subjects (age, 39.3 ± 6.9 years of age; female/15, male/25; body height, 166.1 ± 9.0 cm; BW, 58.1 ± 9.7 kg) were enrolled in a dose escalation study.⁶⁴ The first dose was administered as a single-blind cross-over study in which 30 g of either IMD or maltodextrin (MD; control) was administered in 200 mL water. The carbohydrates were given 2 hours after eating a normal meal. Additional treatments were ingested in a similar manner with solutions containing IMD at 30, 40, 50, 60, and 70 g, in 200 mL water. There was at least a 3-day rest between treatments. No additional MD was consumed. The gastrointestinal reaction of the subjects to the ingestion of the various doses of IMD, and MD, were recorded by the test subjects. The tolerance-related items included: the time from consumption till the first bowel movement, shape/consistency of feces during the first 24 hours after consumption, change in the smell of feces, abdominal symptoms (upper abdominal pain, lower abdominal pain, tenesmus, borborygmus, abdominal bloating, flatulence, weakness of low back, vomiting, discomfort, nausea, others), and fever. The subjects were asked to provide any other specific comments, if they desired. The status of feces was graded as: "very hard," "banana-shaped," "soft," "muddy," and "watery." Loose stools were defined as the condition when the feces were reported to be "muddy" or "watery."

None of the subjects consuming the MD, reported loose stools. Thirty five (35) of the 40 subjects that ingested the MD did not report any abdominal symptoms. The remaining 5 subjects reported a total of 4 different symptoms (Table VI-2). None of the subjects in any treatment reported fever.

The occurrence of loose stools was not observed with IMD treatment except in one subject administered the 60-g dose, and in a second subject who ingested the 70-g dose. Upon interviewing the subject who reacted to the 60-g dose, it was found that around the time of ingestion of the IMD the subject developed symptoms and signs of a common cold. The subject experienced loose stools following IMD consumption. It was thought likely that the illness might have been the cause of the loose stools. The subject stated that he wanted to proceed with the next higher dose of IMD. The subject consumed the 70-g dose and reported no loose stools in the following 24 hours. It was concluded by the study staff that the loose stools, following ingestion of the 60-g dose, were not the result of the IMD, but rather more likely a result of the illness experienced coincident to the IMD treatment. The report of the loose stools after consuming the 60 g of IMD was not recorded as an adverse event.

The subject who reported loose stools after ingesting 70 g of IMD reported the feces as "muddy." 5 subjects reported "soft" feces after taking the 30-g dose, 4 at the 40-g dose, and 9 at ≥ 50 -g doses, suggesting a tendency of soft stools at higher doses. There was no difference in the timing of the first bowel movement among the doses, so IMD did not appear to have an effect on bowel emptying. The number of subjects not reporting any abdominal effects in the 30, 40, 50, 60 or 70 g treatment groups were, 35, 34, 27, 26, and 27, respectively. Further, the number of subjects reporting abdominal symptoms, and the total number of symptoms reported at each dose were, 5/5, 6/6, 13/19, 14/21, and 13/19, respectively (Table VI-2).

These data suggest a dose effect increase starting at a 50-g dose, which appears to be almost unchanged at doses higher than 50 g. Of the total 70 abdominal complaints, the majority (52; 74%) were reported as borborygmus, abdominal bloating and flatus. Two symptoms reported in the MD control group were similar to the number reported at all doses of the IMD group, namely tenemus, and "discomfort".

**Table VI-2 Occurrence of abdominal symptoms and fever
(multiple answers allowed)**

		MD	IMD				
		30g	30g	40g	50g	60g	70g
Abdominal symptoms	Without symptoms	35	35	34	27	26	27
	Upper abdominal pain	0	0	1	1	1	1
	Lower abdominal pain	1	0	0	0	0	0
	Tenesmus	1	1	1	1	1	2
	Borborygmus	0	1	0	6	4	5
	Abdominal bloating	0	1	4	4	7	6
	Flatus	1	0	0	5	5	4
	Weakness in low back	0	0	0	0	0	0
	Vomiting	0	0	0	0	0	0
	Discomfort	2	2	0	2	2	1
	Nausea	0	0	0	0	0	0
	Others	0	0	0	0	1*	0
Fever		0	0	0	0	0	0

*a feeling of IMD lying heavy on the stomach

The No-observed-effect level (NOEL) of IMD for loose stools — A

simple linear regression analysis between IMD ingestion per kilogram body weight and the cumulative incidence of loose stools was to be performed, and the NOEL for loose stools was to be calculated according to the method of Oku et al.⁶⁵ However, as only one subject was considered to have loose stools as a result of consumption of IMD, the NOEL for loose stools could not be calculated by this method.

The data suggests that gastrointestinal issues would be uncommon, at a single dose of less than 50 g of IMD. Higher doses do not seem to increase the number of, or the nature of the complaints. Only one subject developed loose stools, and this was when a single dose of 70 g was consumed.⁶⁴

b. Single Dose Ingestion Study

A study was conducted to examine the effects of IMD intake on the blood glucose and serum insulin concentrations, but only items related to GI tolerance will be discussed.⁶⁴ Twelve (12) healthy male subjects (age, 41 ± 7 years; height, 172 ± 7 cm; weight, 66 ± 8 kg) finished the evening meals by 9:00 pm on the day prior to the examination. After an overnight fast, 50 g of IMD or maltodextrin (MD; control) in about 200 mL water was orally administered to the subjects. Blood was collected immediately before ingestion and at 15, 30, 45, 60, 90, and 120 min after ingestion. The washout period between the two carbohydrates was ≥ 1 week. Subjects were interviewed about any problems with abdominal symptoms related to IMD or MD.

There were no reports of any abdominal symptoms after ingestion of IMD or MD. No subjects reported any problems that might be associated with blood collection.⁶⁴

c. Single Dose Ingestion Study

A single dose ingestion study was conducted to determine the glycemic index of IMD, but only items related to GI tolerance will be discussed.⁶⁴ Eleven (11) healthy adult subjects consisting of 7 female and 4 male

subjects (age, 40.8 ± 4.8 years; height, 162.7 ± 6.0 cm; weight, 58.5 ± 9.7 kg), with a body mass index (BMI) of ≤ 30 and no glucose intolerance, were asked to fast for ≥ 5 h, and then ingest a 50-g dose of IMD dissolved in 150 mL of water. The subjects then underwent a washout period of at least 1 week. After the washout, and a fast of at least 5 hours, subjects consumed 66.7 g of partially hydrolyzed starch (Trelan-G.50; equivalent to ingestion of 50 g of glucose), dissolved in 150 mL of water. Blood was collected before, and at 15, 30, 45, 60, 90, and 120 min after ingestion. The collected blood was analyzed for glucose and insulin concentrations. Subjects were interviewed two hours after ingestion of both substances. No subjects reported any gastrointestinal complaints.⁶⁴

d. 4-week, Multiple Daily Dose Ingestion Study

A 4-week multiple daily dose ingestion study was conducted using 29 adult women with a bowel movement frequency of 2-4 per week.⁶⁴ The subjects were divided into three treatment groups, of which two were given IMD, and the third ingested maltodextrin (MD; control). The first group of 10 subjects (IMD30g group; age, 45.5 ± 8.1 years; height, 159.1 ± 4.4 cm; weight, 58.0 ± 5.7 kg) was provided three 10 g doses of IMD in 100 mL of water, daily with meals for 4 weeks. The second group consisted of 9 subjects (IMD60g group; age, 45.2 ± 9.8 years; height, 156.6 ± 4.8 cm; weight, 49.5 ± 9.4 kg) that consumed 20 g of IMD in 100 mL water, three times per day with meals. The final group of 10 subjects consisted of a control group in which 10 subjects (MD60g group; age, 44.8 ± 8.2 years; height, 156.4 ± 5.9 cm; weight, 49.8 ± 6.4 kg) consumed 20 g of MD in 100 mL water, three times per day for the 4-week period. The variables that were recorded during the study related to tolerance were: fecal shape/consistency, and symptoms including vomiting, tenesmus, abdominal bloating, abdominal pain or discomfort, and flatus. The subjects examined their bowel movements and reported the condition during a subsequent interview. A bowel frequency of 2-4 per week is considered abnormal to low normal, respectively. Consumption of 10 g of IMD three times

per day (IMD30g group) for 4 weeks provided a significant ($p < 0.05$) improvement in bowel movement signs and symptoms of increased fecal volume, the days of defecation per week, and a feeling of complete evacuation. This group also experienced a significant increase in the frequency of flatus at 2 weeks that continued till the end of the study. Interestingly, the IMD60g group did not demonstrate any significant changes. The MD60g group had a significant increase in the number of defecations per week, but not in the number of days per week after 4 weeks of consumption. Loose stools were not noted in either treatment group. No significant changes in any other symptoms were observed at any dose or treatment, and no adverse events were reported during the course of the study.⁶⁴

6. Summary

The results of human tolerance studies with IMD (3 single-ingestion studies and 1 long-term ingestion study) did not show significant gastrointestinal problems related to IMD ingestion. In a single-ingestion dose elevation study of IMD in humans, only one of the 40 subjects developed loose stools within 24 hours after oral administration of 70 g of IMD (0.88 g/kg bw). The NOEL for loose stools could not be calculated because of the single occurrence. However, It has been documented that the intake of large amounts of partially digestible saccharide can result in loose stools and/or abdominal symptoms.²⁴ Examples include a reported NOEL of fructo-oligosaccharide at 0.34 g/kg bw in women.⁶⁶ The NOEL of polydextrose is 1.3 g/kg bw in adults in divided doses (0.7 g/kg bw single dose), and in the resistant dextrin (enzyme modified) and resistant maltodextrin mentioned previously was reported to cause abdominal symptoms if the doses exceed 45 g/person/day (divided dose) and 1.0 g/kg bw, respectively.^{24,59,62}

Thus, IMD can be considered to have the same propensity to cause GI symptoms as other resistant dextrin products or resistant dextrin-like products. As with resistant dextrin, resistant maltodextrin, polydextrose and pullulan, the dose necessary is relatively high, and well below the estimated daily consumption.

E. Overall Conclusion

Based on the data presented in this and other sections of this GRAS Notification, Hayashibara has concluded that the intended uses as a general ingredient and a dietary fiber in foods of IMD are GRAS based on scientific procedures including substantial equivalence to other glucose-based, and starch derived commercial products that are currently GRAS substances.

Section VII. References
Appendices A-C

Section VII: References

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November 10, 2015

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Appendix A

Expert Panel Opinion Report

000114

Expert Panel Opinion on the Generally Recognized as Safe (GRAS) Status of Hayashibara Co., Ltd. Isomaltodextrin (Resistant Dextrin) for Use in Food as a General Ingredient in Food and as a Dietary Fiber

30 May 2015

An independent panel of experts, qualified by their scientific training and national and international experience to evaluate the safety of food and food ingredients (the "Expert Panel"), was specially convened by Hayashibara Co., Ltd. of Okayama, Japan, to evaluate the safety and "Generally Recognized As Safe" ("GRAS") status of the proposed uses in multiple food applications of Isomaltodextrin (IMD), a resistant dextrin, derived from corn or other plant starches. Isomaltodextrin is a common name for a resistant dextrin product produced by Hayashibara Co., Ltd.

Resistant dextrins are intended for use in food as general food ingredients and as dietary fiber in multiple food categories at approximately three to seven grams per serving, including the general categories of: i) milk and milk products, ii) meats, poultry and fish mixtures, iii) dry beans, peas, legumes, nuts and seeds, iv) grain products, v) fruits and fruit products, vi) vegetable products vii) fats, oils and salad dressings, and viii) sugars, sweets and beverages.

The Expert Panel reviewed a dossier, "Isomaltodextrin (IMD) GRAS Report" (March 30, 2015), prepared by Hayashibara Co., Ltd., that summarized the results of a literature search on the safety of resistant dextrins and maltodextrins, and included details of the manufacturing processes for IMD (resistant dextrin) including: i) the safety of the substances used in manufacturing, ii) specifications, iii) stability, iv) the results of analyses of the finished products for toxigenic substances and microbial pathogens of potential concern, and v) safety information for IMD and other resistant dextrin and resistant maltodextrin products. The Expert Panel also reviewed other materials deemed appropriate.

Hayashibara's Isomaltodextrin (resistant dextrin) is manufactured using processes consistent with the Japanese Food Sanitation Act. IMD is produced from food grade starch. This same starch is the basis for many GRASed products, such as polydextrose, and other commercial non-resistant and resistant dextrin/maltodextrin. IMD, resistant dextrins and polydextrose all have a percentage of atypical bonds compared to standard dextrin and maltodextrin. IMD and non-resistant dextrin/maltodextrin are composed entirely of glucose, whereas resistant dextrin/maltodextrin may have a percentage of levoglucosan molecules at the reducing end. Polydextrose typically has one sorbitol molecule at the reducing end; however, in a small proportion of the molecules the sorbitol may be replaced by levoglucosan. The glucose units in standard dextrin/maltodextrin are bound by α -1,4 or α -1,6 glycosidic linkages. These substances are, usually completely broken down to glucose by the hydrolytic enzymes in the small intestine. The glucose, is absorbed through the wall of the small intestine into the circulatory system. Resistant dextrin/maltodextrin including IMD have a proportion of atypical glycosidic bonds which are resistant to enzymatic digestion in the small intestine. Any portion of these carbohydrate molecules that are not digested pass to the large intestine where bacteria may partially or completely ferment the resistant dextrin/maltodextrin.

Any resistant dextrin/maltodextrin that is not digested or fermented is excreted in the feces.

A critical review of information provided by Hayashibara Co., Ltd. demonstrates that IMD and the various commercial resistant dextrin/maltodextrin products are substantially chemically, functionally and toxicologically equivalent. Therefore, it is appropriate to consider the extensive published safety data on dextrin, maltodextrin, resistant dextrin/maltodextrin and polydextrose to be directly relevant to the safety of IMD produced by Hayashibara Co., Ltd.

As part of its product stewardship policy, and to corroborate the publicly available safety data noted above, Hayashibara Co., Ltd. conducted genotoxicity, acute toxicity and 90-day subchronic oral toxicity studies at independent laboratories. These studies were GLP-complaint and consistent with OECD guidelines. IMD is of very low acute oral toxicity; it is not mutagenic and not clastogenic; and the NOAEL in the subchronic study was 1,000 mg IMD/kg bw/day, the highest dose tested (the other doses were 100 and 300 mg/kg bw/day). There were no consistent, compound-related, dose-dependent significant adverse effects reported.

Four (4) human tolerance studies were performed in which gastrointestinal symptoms (GI) were reported. Two (2) were single dose studies, a dose escalation study, and a 4-week split dose study. In the two single dose studies, a total of 7 female and 19 male healthy subjects were administered a 50 gram dose of IMD after fasting for a minimum of 5 hours to overnight. A maltodextrin control was used for both studies. No subjects reported any gastrointestinal symptoms two hours after consumption. In the dose escalation study, only one of the 40 subjects developed loose stools related to IMD within 24 hours after oral administration of 70 g of IMD (0.88 g/kg-BW). Other common symptoms were reported at lower doses, but these were not severe. At the 70 g-dose 13 of 40 healthy subjects reported various symptoms. The 4-week study consisted of three groups of 10, 9 and 10 healthy subjects, which consumed 10 g IMD, 20 g IMD, or 20 g maltodextrin at each meal for a total daily intake of 30, 60 and 60 g, respectively. Signs and symptoms of GI and other health-related variables were recorded at weeks 0, 2 and 4. None of the groups reported loose stools, and only the 30 g IMD group had a significant increase in flatus. These studies demonstrated that the consumption of relatively high doses of IMD resulted in GI symptoms, substantially equivalent to reports of other resistant dextrin/maltodextrin products and polydextrose.

Conclusion

Following its independent and critical evaluation of the material presented in the dossier, "Isomaltodextrin (IMD) GRAS Report," and other materials deemed appropriate, the Expert Panel convened by telephone with scientists from Hayashibara Co., Ltd. and then independently and collectively unanimously concluded that the intended uses of Hayashibara's Isomaltodextrin (resistant dextrin), as a general food ingredient and dietary fiber in multiple food applications including: i) milk and milk products, ii) meats, poultry and fish mixtures, iii) dry beans, peas, legumes, nuts and seeds, iv) grain products, v) fruits and fruit products, vi) vegetable products vii) fats, oils and salad dressings, and viii) sugars, sweets and beverages, manufactured consistent with cGMP and meeting the food specifications presented in the dossier, are safe and suitable and GRAS based on scientific procedures (substantial equivalence to resistant and non-resistant dextrin, maltodextrin and polydextrose), and corroborated by a long history of safe use of these starch-based ingredients.

It is the opinion of this Expert Panel that other qualified experts would concur with these conclusions.

(b) (6)

20 June 2015

Joseph F. Borzelleca, Ph.D.
Emeritus Professor, Pharmacology & Toxicology
School of Medicine
Virginia Commonwealth University

(b) (6)

2 June 2015

Michael W. Pariza, Ph.D.
Professor Emeritus, Food Science
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Madison, WI

(b) (6)

3 June 2015

Robert J. Nicolosi, Ph.D.
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University of Massachusetts-Lowell
Lowell, MA

Appendix B

Expert Statement on Bacteria and Enzymes

Michael W. Pariza Consulting LLC
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Michael W. Pariza, Member

June 4, 2015

Alan B. Richards, PhD
Vanguard Regulatory Services, Inc.
1311 Iris Circle
Broomfield, CO 80020

Dear Dr. Richards,

I have reviewed the information that you provided on Hayashibara's *Paenibacillus alginolyticus* production strain, which is used to manufacture two enzymes, α -glucosyltransferase and α -amylase. These enzymes are in turn used to manufacture isomaltodextrin (IMD), which is the subject of this GRAS Notification document.

In evaluating Hayashibara's *P. alginolyticus* production strain I considered the biology of the genus (*Paenibacillus*) and species (*P. alginolyticus*), relevant information available in the peer-reviewed scientific literature, and information that you provided on the organism, its enzyme products (α -glucosyltransferase and α -amylase), and the final manufactured product, IMD.

The genus *Paenibacillus* was formerly classified within the *Bacillus* genus. It is now recognized as a distinct genus comprised of saprophytic soil species, some of which express enzymes that have unique commercial applications. Some species of *Paenibacillus* are associated with toxin production, for example *Paenibacillus larvae* which is toxigenic for honey bees (D Krska et al., J. Biol. Chem. 290(3)1639-1653, 2014), but there is no indication in the peer-reviewed scientific literature that any strain of *P. alginolyticus* produces such toxins.

The two enzymes produced by Hayashibara's *P. alginolyticus* production strain, α -amylase and α -glucosyltransferase, are permitted for use as starch processing aids under the current Japanese Food Sanitation Act. The final manufactured product, IMD, has been evaluated for safety as documented elsewhere in this GRAS Notice document.

The safety of Hayashibara's *P. alginolyticus* production strain for its intended use was formally

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evaluated using the Pariza-Johnson decision tree. The conclusion of this analysis was that Hayashibara's *P. alginolyticus* production strain is acceptable for the manufacture of enzymes to be used in food grade IMD manufacture, under the described manufacturing process.

Based on the foregoing, I concur with the evaluation made by Hayashibara that it's *Paenibacillus alginolyticus* production strain is safe to use for the manufacture of food grade α -amylase and α -glucosyltransferase. I further conclude that the α -glucosyltransferase and α -amylase enzyme preparations manufactured using this production strain by the process you described is GRAS (Generally Recognized As Safe) for use in the manufacture of food grade IMD.

It is my professional opinion that other qualified experts would also concur in this conclusion.

Sincerely,

(b) (6)



Michael W. Pariza, Ph.D.
Professor Emeritus, Department of Food Science
Director Emeritus, Food Research Institute
University of Wisconsin-Madison

Food Enzyme Safety Decision Tree, from MW Pariza and EA Johnson (2001): *Evaluating the Safety of Microbial Enzyme Preparations Used in Food Processing: Update for a New Century*, Regulatory Toxicology and Pharmacology, 33:173-186 (for ease of viewing, steps that do not pertain have been deleted).

1. Is the production strain genetically modified? **NO**

~~If yes, go to 2.~~ If no, go to 6.

6. Is the production strain derived from a safe lineage, as previously demonstrated by repeated assessment via this evaluation procedure?

~~If yes, the test article is ACCEPTED.~~ If no, go to 7. **NO**

7. Is the organism nonpathogenic? **YES**

If yes, go to 8. ~~If no, go to 12.~~

8. Is the test article free of antibiotics? **YES**

If yes, go to 9. ~~If no, go to 12.~~

9. Is the test article free of oral toxins known to be produced by other members of the same species?

If yes, go to 11. ~~If no, go to 10.~~ **YES-- (Note: There are no known toxins that act via the oral route associated with this species)**

11. Is the NOAEL for the test article in appropriate oral studies sufficiently high to ensure safety? **YES**

If yes, the test article is **ACCEPTED.**

Appendix C

Estimated Daily Intake

February 8, 2015

To: Hayashibara Co., Ltd., Osayama 702-8006, Japan

From:

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Susan Cho, Ph.D.

NutraSource, Inc., Clarksville, Maryland 21029, USA

Susanscho1@yaoo.com; +1-301-875-6454

Subject: Exposure Estimates for Isomaltodextrin (IMD)

Hayashibara intends to use IMD as a food ingredient in the following food categories: Milk and milk products; meat, poultry, fish and mixtures; legumes and meat substitutes, mainly legume protein; baked products; crackers and salty snacks from grain products; Pancakes, waffles, French toast, other grain products; pastas, cooked cereals, rice; cereals; grain mixtures, frozen plate meals, soups; meat substitutes, mainly cereal protein; fruits and fruit products; vegetable products; salad dressings; sugars, sweets, and beverages, selected water; formulated nutrition beverages, energy drinks, sports drinks, functional beverages (Table 1). The use levels of IMD are in the range of 3.2-6.3 g per serving.

Based on food consumption data reported in the most recent National Health and Nutrition Examination Survey (NHANES, 2009-2010; compiled by the U.S. Department of Health and Human Services, National Center for Health Statistics and the Nutrition Coordinating Center) estimates of 2-day average intakes of IMD were calculated from the food code list and the survey database of diet recalls. The 2009-2010 NHANES provides the most current food consumption data available for the non-institutionalized individuals in the U.S.

Table 2 shows Estimated Daily Intakes (EDIs) under the intended use. As shown in Table 2, the mean intakes of IMD under the intended uses were estimated to be 15.1 g/person/day (246 mg/kg BW/day) for all population and 16.3 g/person/day (265 mg/kg BW/day) or for all-users, while the 90th percentile intakes were determined as 31.9 g/person/day (533 mg/kg BW/day) or and 32.7 g/person/day (552 mg/kg BW/day), respectively. Nearly all people in the total U.S. population and each of the selected subpopulations reported eating at least one food proposed for IMD (users are 92% of the population). The highest use level was found in males aged 20-99 years with the 90th percentile intake of 38.8 g/person/day (or 465 mg/kg BW/day). These EDIs are based on the assumption that 100% of the products are used at the maximum intended use levels. However, these estimates are highly optimistic since all foods under the intended uses will not be used at the maximum levels.

The contribution of each food category to total EDI is shown in Table 3. Grain products and sugars, sweets, and beverages were the greatest contributors to the overall intake of IMD.

These 2 food categories accounts for 78% of the exposure of users of one or more foods under the intended use.

Table 4 presents details of NHANES food codes included in proposed use of IMD and use levels in select foods.

Table 1. Intended use levels of IMD in selected foods

Food codes	Description	Serving size, g	g IMD/serving
1	Milk and milk products		
11	Milks and milk drinks	5.2-250	3.2
12	Creams and cream substitutes	15-30	3.2
13	Milk desserts, sauces, gravies	56-165	3.2
14	Cheeses	30-130	3.2
2	Meat, poultry, fish and mixtures		
27	Meat, poultry, fish with nonmeat items	125-252	3.2
28	Frozen and shelf-stable plate meals, soups, and gravies with meat, poultry, fish base; gelatin and gelatin-based drinks	56.8-192	3.2
4	Dry Beans, Peas, Other Legumes, Nuts, and Seeds		
41	Legumes and meat substitutes, mainly legume protein	7-254	3.2
5	Grain products		
51	Yeast breads, rolls	15-55	3.2
52	Quick breads	55	3.2
53	Cakes, cookies, pies, pastries	30-125	3.2
53	Breakfast bars and cereal bars	40-55	6.3
54	Crackers and salty snacks from grain products	30	3.2
55	Pancakes, waffles	85-110	3.2
56	Pastas, cooked cereals, rice	140-256	6.3
57	Cereals, not cooked or NS as to cooked	15-55	6.3
58	Grain mixtures, frozen plate meals, soups	119-255	3.2
59	Meat substitutes, mainly cereal protein	146	3.2
6	Fruits and fruit products		
62	Dried fruits	40	3.2
63	Other fruits	34-140	3.2
64	Fruit juices and nectars excluding citrus	240	3.2
7	Vegetable products		
74	Tomatoes and tomato mixtures	15-240	3.2
75	Other vegetables	30-240	3.2
8	Fats, Oils, and Salad Dressings		
83	Salad dressings	15-30	3.2
9	Sugars, Sweets, and Beverages		
91	Sugar substitutes, syrups, jams, jelly, and sweets	0.4-120	3.2
92	Nonalcoholic beverages	1.5-240	3.2
93	Alcoholic beverages-lite beer	240	3.2
94	Water, noncarbonated	240	3.2
95	Formulated nutrition beverages, energy drinks, sports drinks, functional beverages	240	6.3

Table 2. Estimated Daily Intakes (EDI) of isomaltodextrin (IMD)

Age, years	Gender	N	g IMD/day		mg IMD/kg BW/day	
			Mean	90 th Percentile	Mean	90 th Percentile
Users of one or more foods containing IMD						
2-99	All	7,287	16.3±0.43	32.7±1.04	265.2±8.3	551.9±25.0
	Males	3,657	18.1±0.61	36.6±1.07	278.4±9.9	597.6±23.7
	Females	3,630	14.5±0.32	27.4±0.61	252.2±7.9	524.5±26.0
2-13	All	2,016	12.6±0.38	23.4±0.64	498.4±17.3	977.1±31.5
	Males	1,026	13.1±0.37	24.8±0.92	516.5±25.6	996.3±44.7
	Females	990	12.2±0.78	21.1±0.80	478.7±25.4	912.0±55.2
13-19	All	903	15.4±0.46	31.2±1.60	240.5±11.1	479.6±20.0
	Males	472	18.5±0.90	35.2±1.36	271.1±15.5	506.9±40.0
	Females	431	12.0±0.43	22.8±0.96	206.8±12.4	434.5±41.9
20-99	All	4,368	17.1±0.52	35.2±1.40	219.6±7.7	444.8±19.3
	Males	2,159	19.2±0.73	38.8±2.05	226.0±9.8	464.9±27.8
	Females	2,209	15.2±0.39	28.7±0.87	213.5±7.2	417.1±15.1
All population						
2-99	All	7,932	15.1±0.39	31.9±1.07	245.8±7.2	533.3±24.2
	Males	3,979	16.8±0.59	35.3±1.18	257.9±8.7	568.9±25.3
	Females	3,953	13.4±0.31	26.7±0.60	233.9±7.6	499.2±23.0
2-13	All	2,123	12.0±0.42	23.0±0.67	472.9±17.7	967.1±38.4
	Males	1,072	12.6±0.32	24.6±0.83	496.7±21.0	985.1±45.4
	Females	1,051	11.4±0.88	20.9±0.86	447.8±30.1	888.4±56.9
13-19	All	1,009	14.0±0.47	29.7±1.57	218.4±11.1	458.1±18.5
	Males	514	17.1±0.90	34.7±2.02	250.3±15.1	501.3±25.2
	Females	495	10.7±0.53	21.9±1.26	184.5±13.2	434.4±44.2
20-99	All	4,800	15.9±0.45	33.9±1.15	203.0±6.6	429.0±16.2
	Males	2,393	17.6±0.70	37.9±1.86	207.7±9.0	451.4±26.5
	Females	2,407	14.2±0.33	28.0±0.69	198.6±6.3	411.4±16.5

Table 3. NHANES food code groups included in proposed use of IMD in select foods and contribution of each food category to total EDI

Food codes	Description	% of EDI
1	Milk and milk products	7.78
11	Milks and milk drinks	4.07
12	Creams and cream substitutes	0.55
13	Milk desserts, sauces, gravies	1.09
14	Cheeses	2.06
2	Meat, poultry, fish and mixtures	1.00
27	Meat, poultry, fish with nonmeat items	0.89
28	Frozen and shelf-stable plate meals, soups, and gravies with meat, poultry, fish base; gelatin and gelatin-based drinks	0.11
4	Dry Beans, Peas, Other Legumes, Nuts, and Seeds	1.37
41	Legumes and meat substitutes, mainly legume protein	1.37
5	Grain products	40.93
51	Yeast breads, rolls	10.52
52	Quick breads	1.00
53	Cakes, cookies, pies, pastries	3.34
54	Crackers and salty snacks from grain products	3.03
55	Pancakes, waffles	0.11
56	Pastas, cooked cereals, rice	2.66
57	Cereals, not cooked or NS as to cooked	15.12
58	Grain mixtures, frozen plate meals, soups	5.15
59	Meat substitutes, mainly cereal protein	0.01
6	Fruits and fruit products	3.39
62	Dried fruits	0.67
63	Other fruits	1.58
64	Fruit juices and nectars excluding citrus	1.13
7	Vegetable products	7.39
74	Tomatoes and tomato mixtures	7.26
75	Other vegetables	0.13
8	Fats, Oils, and Salad Dressings	0.73
83	Salad dressings	0.73
9	Sugars, Sweets, and Beverages	37.41
91	Sugar substitutes, syrups, jams, jelly, and sweets	9.33
92	Nonalcoholic beverages	16.77
93	Alcoholic beverages -lite beer	5.41
94	Water, noncarbonated	0.76
95	Formulated nutrition beverages, energy drinks, sports drinks, functional beverages	5.14

Table 4. Details of NHANES Food Codes Included in Proposed Use of IMD in Select Foods**1. Milk and milk products**

Food codes	Description	Serving size, g	g IMD/serving
11111170	Milk, calcium fortified, cow's, fluid, skim or nonfat	247	3.2
11112000	Milk, cow's, fluid, other than whole, NS as to 2%, 1%, or skim (formerly milk, cow's, fluid, "lowfat", NS as to percent fat)	244	3.2
11113000	Milk, cow's, fluid, skim or nonfat, 0.5% or less butterfat	245	3.2
11114320	Milk, cow's, fluid, lactose reduced, nonfat	245	3.2
11422000	Yogurt, vanilla, lemon, maple, or coffee flavor, lowfat milk	225	3.2
11423000	Yogurt, vanilla, lemon, maple, or coffee flavor, nonfat milk	225	3.2
11424000	Yogurt, vanilla, lemon, maple, or coffee flavor, nonfat milk, sweetened with low calorie sweetener	225	3.2
11427000	Yogurt, chocolate, nonfat milk	225	3.2
11430000	Yogurt, fruit variety, NS as to type of milk	225	3.2
11432000	Yogurt, fruit variety, lowfat milk	225	3.2
11432500	Yogurt, fruit variety, lowfat milk, sweetened with low-calorie sweetener	225	3.2
11433000	Yogurt, fruit variety, nonfat milk	225	3.2
11433500	Yogurt, fruit variety, nonfat milk, sweetened with low-calorie sweetener	225	3.2
11445000	Yogurt, fruit and nuts, lowfat milk	225	3.2
11459990	Yogurt, frozen, NS as to flavor, NS as to type of milk	100	3.2
11460000	Yogurt, frozen, flavors other than chocolate, NS as to type of milk	100	3.2
11460150	Yogurt, frozen, NS as to flavor, lowfat milk	100	3.2
11460170	Yogurt, frozen, flavors other than chocolate, lowfat milk	100	3.2
11460250	Yogurt, frozen, flavors other than chocolate, with sorbet or sorbet-coated	75	3.2
11460300	Yogurt, frozen, flavors other than chocolate, nonfat milk	79.5	3.2
11460410	Yogurt, frozen, flavors other than chocolate, nonfat milk, with low-calorie sweetener	93	3.2
11461270	Yogurt, frozen, cone, flavors other than chocolate, lowfat milk	118	3.2
11511300	Milk, chocolate, skim milk-based	250	3.2
11511400	Milk, chocolate, lowfat milk-based	250	3.2
11513200	Cocoa and sugar mixture, lowfat milk added	250	3.2
11513300	Cocoa and sugar mixture, skim milk added	250	3.2
11513400	Chocolate syrup, milk added, NS as to type of milk	250	3.2
11513600	Chocolate syrup, lowfat milk added	250	3.2

11513700	Chocolate syrup, skim milk added	250	3.2
11514300	Cocoa with nonfat dry milk and low calorie sweetener, mixture, water added	250	3.2
11514500	Cocoa, whey, and low calorie sweetener, mixture, fortified, water added	249	3.2
11516000	Cocoa, whey, and low-calorie sweetener mixture, lowfat milk added	250	3.2
11541000	Milk shake, NS as to flavor or type	226.4	3.2
11541500	Milk shake, made with skim milk, chocolate	127	3.2
11541510	Milk shake, made with skim milk, flavors other than chocolate	127	3.2
11553100	Fruit smoothie drink, NFS	202	3.2
11613000	Instant breakfast, powder, sweetened with low calorie sweetener, milk added	247	3.2
11623000	Meal supplement or replacement, commercially prepared, ready-to-drink	248	3.2
11830110	Cocoa powder with nonfat dry milk and low calorie sweetener, dry mix, not reconstituted	19	6.3
11830120	Cocoa, whey, and low calorie sweetener, fortified, dry mix, not reconstituted	11.6	6.3
11830150	Cocoa powder, not reconstituted (no dry milk)	5.4	6.3
11830170	Cocoa (or chocolate) flavored beverage powder with low-calorie sweetener, dry mix, not reconstituted	5.2	6.3
11830550	Milk beverage, powder, with nonfat dry milk and low calorie sweetener, dry mix, not reconstituted, flavors other than chocolate	21	3.2
11830810	Instant breakfast, powder, sweetened with low calorie sweetener, not reconstituted	20	3.2
11830900	Protein supplement, milk-based, powdered, not reconstituted	33	3.2
11830940	Meal replacement, high protein, milk based, fruit juice mixable formula, powdered, not reconstituted	31	3.2
11830970	Meal replacement, protein type, milk-based, powdered, not reconstituted	33	3.2
11830990	Nutrient supplement, milk-based, powdered, not reconstituted	31	3.2
12100100	Cream, NS as to light, heavy, or half and half	15	3.2
12110100	Cream, light, fluid	15	3.2
12110300	Cream, light, whipped, unsweetened	15	3.2
12120110	Cream, half and half, fat free	30	3.2
12310300	Sour cream, reduced fat	30	3.2
12310350	Sour cream, light	30	3.2
12310370	Sour cream, fat free	30	3.2
12350020	Dip, sour cream base, reduced calorie	30	3.2
13130100	Light ice cream, NS as to flavor (formerly ice milk)	65.5	3.2
13130300	Light ice cream, flavors other than chocolate (formerly ice	65.5	3.2

	milk)		
13130320	Light ice cream, no sugar added, NS as to flavor	68.5	3.2
13130330	Light ice cream, no sugar added, flavors other than chocolate	68.5	3.2
13130590	Light ice cream, soft serve, NS as to flavor (formerly ice milk)	87.5	3.2
13130600	Light ice cream, soft serve, flavors other than chocolate (formerly ice milk)	87.5	3.2
13130620	Light ice cream, soft serve cone, flavors other than chocolate (formerly ice milk)	142	3.2
13130700	Light ice cream, soft serve, blended with candy or cookies	114	3.2
13135000	Ice cream sandwich, made with light ice cream, flavors other than chocolate	68	3.2
13140100	Light ice cream, bar or stick, chocolate-coated (formerly ice milk)	56	3.2
13140110	Light ice cream, bar or stick, chocolate covered, with nuts (formerly ice milk)	149	3.2
13140500	Light ice cream, cone, flavors other than chocolate (formerly ice milk)	78	3.2
13140650	Light ice cream, sundae, soft serve, not fruit or chocolate topping, with whipped cream (formerly ice milk)	165	3.2
13140660	Light ice cream, sundae, soft serve, chocolate or fudge topping (without whipped cream) (formerly ice milk)	165	3.2
13140670	Light ice cream, sundae, soft serve, fruit topping (without whipped cream) (formerly ice milk)	165	3.2
13140680	Light ice cream, sundae, soft serve, not fruit or chocolate topping (without whipped cream) (formerly ice milk)	165	3.2
13140700	Light ice cream, creamsicle or dreamsicle (formerly ice milk)	66	3.2
13150000	Sherbet, all flavors	96.5	3.2
13160160	Fat free ice cream, no sugar added, flavors other than chocolate	72	3.2
13160400	Fat free ice cream, flavors other than chocolate	68.5	3.2
13161000	Milk dessert bar, frozen, made from lowfat milk	81	3.2
13161500	Milk dessert sandwich bar, frozen, made from lowfat milk	64	3.2
13161520	Milk dessert sandwich bar, frozen, with low-calorie sweetener, made from lowfat milk	59	3.2
13161600	Milk dessert bar, frozen, made from lowfat milk and low calorie sweetener	41	3.2
13161630	Light ice cream, bar or stick, with low-calorie sweetener, chocolate-coated (formerly ice milk)	53	3.2
13200110	Pudding, NFS	132	3.2
13210220	Pudding, chocolate, NS as to from dry mix or ready-to-eat	130.5	3.2
13210250	Pudding, chocolate, low calorie, containing artificial sweetener, NS as to from dry mix or ready-to-eat	130	3.2
13210290	Pudding, flavors other than chocolate, low calorie,	130	3.2

	containing artificial sweetener, NS as to from dry mix or ready-to-eat		
13220210	Pudding, flavors other than chocolate, prepared from dry mix, low calorie, containing artificial sweetener, milk added	125	3.2
13220220	Pudding, chocolate, prepared from dry mix, low calorie, containing artificial sweetener, milk added	125	3.2
13220230	Pudding, ready-to-eat, chocolate, reduced fat	133.5	3.2
13220235	Pudding, ready-to-eat, chocolate, fat free	130.5	3.2
13220240	Pudding, ready-to-eat, flavors other than chocolate, reduced fat	133.5	3.2
13220245	Pudding, ready-to-eat, flavors other than chocolate, fat free	130.5	3.2
13230120	Pudding, ready-to-eat, low calorie, containing artificial sweetener, flavors other than chocolate	125	3.2
13230140	Pudding, ready-to-eat, low calorie, containing artificial sweetener, chocolate	125	3.2
13230510	Pudding, ready-to-eat, tapioca, fat free	127.5	3.2
14010000	Cheese, NFS	30	3.2
14104015	Cheese, natural, Cheddar or American type, reduced fat	30	3.2
14106500	Cheese, Monterey, reduced fat	30	3.2
14107010	Cheese, Mozzarella, NFS	30	3.2
14107030	Cheese, Mozzarella, part skim	30	3.2
14107060	Cheese, Mozzarella, nonfat or fat free	30	3.2
14107250	Cheese, Muenster, reduced fat	30	3.2
14108015	Cheese, Parmesan, dry grated, reduced fat	5	3.2
14108060	Cheese, Parmesan, dry grated, fat free	5	3.2
14109030	Cheese, Swiss, reduced fat	30	3.2
14110030	Cheese, Cheddar or Colby, lowfat	30	3.2
14120020	Cheese, Mexican blend, reduced fat	30	3.2
14204010	Cheese, cottage, lowfat (1-2% fat)	110	3.2
14204020	Cheese, cottage, lowfat, with fruit	110	3.2
14303010	Cheese, cream, light or lite (formerly called Cream Cheese Lowfat)	30	3.2
14410300	Cheese, processed, American or Cheddar type, lowfat	30	3.2
14410330	Cheese spread, American or Cheddar cheese base, reduced fat	30	3.2
14410350	Cheese, processed, American or Cheddar type, nonfat or fat free	30	3.2
14410380	Cheese, processed cream cheese product, nonfat or fat free	30	3.2
14410420	Cheese, processed, Swiss, lowfat	30	3.2
14420210	Cheese spread, cream cheese, light or lite	30	3.2

2. Meat, poultry, meat and mixtures

Food codes	Description	Serving size, g	g IMD/ serving
27111000	Beef with tomato-based sauce (mixture)	140	3.2
27111050	Spaghetti sauce with beef or meat other than lamb or mutton, homemade-style	125	3.2
27111300	Mexican style beef stew, no potatoes, tomato-based sauce (mixture) (Carne guisada sin papas)	244	3.2
27111310	Mexican style beef stew, no potatoes, with chili peppers, tomato-based sauce (mixture) (Carne guisada con chile)	244	3.2
27120100	Ham or pork with tomato-based sauce (mixture)	140	3.2
27120110	Sausage with tomato-based sauce (mixture)	140	3.2
27120130	Mexican style pork stew, no potatoes, tomato-based sauce (mixture) (cerdo guisado sin papas)	244	3.2
27120250	Frankfurters or hot dogs with tomato-based sauce (mixture)	140	3.2
27135110	Veal parmigiana	140	3.2
27136050	Venison/deer with tomato-based sauce (mixture)	140	3.2
27141000	Chicken or turkey cacciatore	244	3.2
27141030	Spaghetti sauce with poultry, home-made style	125	3.2
27141050	Stewed chicken with tomato-based sauce, Mexican style (mixture) (Pollo guisado con tomate)	140	3.2
27146300	Chicken or turkey parmigiana	140	3.2
27150110	Shrimp cocktail (shrimp with cocktail sauce)	140	3.2
27150310	Fish with tomato-based sauce (mixture)	140	3.2
27150330	Mussels with tomato-based sauce (mixture)	140	3.2
27150350	Sardines with tomato-based sauce (mixture)	140	3.2
27151040	Crabs in tomato-based sauce, Puerto Rican style (mixture) (Salmorejo de jueyes)	140	3.2
27162010	Meat with tomato-based sauce (mixture)	125	3.2
27162050	Spaghetti sauce with combination of meats, homemade-style	125	3.2
27162060	Spaghetti sauce with meat and vegetables, homemade-style	125	3.2
27211100	Beef stew with potatoes, tomato-based sauce (mixture)	252	3.2
27211110	Mexican style beef stew with potatoes, tomato-based sauce (mixture) (Carne guisada con papas)	244	3.2
27212100	Beef and noodles with tomato-based sauce (mixture)	249	3.2
27213100	Beef and rice with tomato-based sauce (mixture)	244	3.2
27213120	Porcupine balls with tomato-based sauce (mixture)	176	3.2
27214110	Meat loaf made with beef, with tomato-based sauce	178	3.2
27220120	Sausage and rice with tomato-based sauce (mixture)	244	3.2
27220150	Sausage and rice with (mushroom) soup (mixture)	244	3.2
27242400	Chicken or turkey and noodles, tomato-based sauce (mixture)	224	3.2

27243500	Chicken or turkey and rice with tomato-based sauce (mixture)	244	3.2
27250810	Fish and rice with tomato-based sauce	248	3.2
27250950	Shellfish mixture and noodles, tomato-based sauce (mixture)	224	3.2
27260100	Meat loaf made with beef and pork, with tomato-based sauce	178	3.2
27311310	Beef stew with potatoes and vegetables (including carrots, broccoli, and/or dark-green leafy), tomato-based sauce	252	3.2
27311320	Beef stew with potatoes and vegetables (excluding carrots, broccoli, and dark-green leafy), tomato-based sauce	252	3.2
27313210	Beef, noodles, and vegetables (including carrots, broccoli, and/or dark-green leafy), tomato-based sauce (mixture)	249	3.2
27313220	Beef, noodles, and vegetables (excluding carrots, broccoli, and dark-green leafy), tomato-based sauce (mixture)	249	3.2
27315210	Beef, rice, and vegetables (including carrots, broccoli, and/or dark-green leafy), tomato-based sauce (mixture)	249	3.2
27315220	Beef, rice, and vegetables (excluding carrots, broccoli, and/or dark-green leafy), tomato-based sauce (mixture)	249	3.2
27320080	Sausage, noodles, and vegetables (excluding carrots, broccoli, and dark-green leafy), tomato-based sauce	249	3.2
27320100	Pork, potatoes, and vegetables (including carrots, broccoli, and/or dark-green leafy), tomato-based sauce (mixture)	252	3.2
27320110	Pork, potatoes, and vegetables (excluding carrots, broccoli, and dark-green leafy), tomato-based sauce (mixture)	252	3.2
27320340	Pork, rice, and vegetables (including carrots, broccoli, and/or dark-green leafy), tomato-based sauce (mixture)	249	3.2
27320350	Pork, rice, and vegetables (excluding carrots, broccoli, and dark-green leafy), tomato-based sauce (mixture)	249	3.2
27330060	Lamb or mutton, rice, and vegetables (including carrots, broccoli, and/or dark-green leafy), tomato-based sauce (mixture)	252	3.2
27330210	Lamb or mutton stew with potatoes and vegetables (including carrots, broccoli, and/or dark-green leafy), tomato-based sauce	252	3.2
27330220	Lamb or mutton stew with potatoes and vegetables (excluding carrots, broccoli, and dark-green leafy), tomato-based sauce	252	3.2
27336100	Venison/deer stew with potatoes and vegetables (including carrots, broccoli, and/or dark-green leafy), tomato-based sauce	252	3.2
27341510	Chicken or turkey stew with potatoes and vegetables (including carrots, broccoli, and/or dark-green leafy), tomato-based sauce	247	3.2
27341520	Chicken or turkey stew with potatoes and vegetables	247	3.2

	(excluding carrots, broccoli, and dark-green leafy), tomato- based sauce		
27343510	Chicken or turkey, noodles, and vegetables (including carrots, broccoli, and/or dark-green leafy), tomato-based sauce (mixture)	224	3.2
27343520	Chicken or turkey, noodles, and vegetables (excluding carrots, broccoli, and dark-green leafy), tomato-based sauce (mixture)	224	3.2
27345510	Chicken or turkey, rice, and vegetables (including carrots, broccoli, and/or dark-green leafy), tomato-based sauce (mixture)	249	3.2
27345520	Chicken or turkey, rice, and vegetables (excluding carrots, broccoli, and dark-green leafy), tomato-based sauce (mixture)	249	3.2
27350310	Seafood stew with potatoes and vegetables (including carrots, broccoli, and/or dark-green leafy), tomato-base sauce	252	3.2
27411100	Beef with vegetables (including carrots, broccoli, and/or dark-green leafy (no potatoes)), tomato-based sauce (mixture)	249	3.2
27411150	Beef rolls, stuffed with vegetables or meat mixture, tomato-based sauce	195	3.2
27411200	Beef with vegetables (excluding carrots, broccoli, and dark-green leafy (no potatoes)), tomato-based sauce (mixture)	249	3.2
27418310	Corned beef with tomato sauce and onion, Puerto Rican style (mixture)	235	3.2
27420410	Pork and vegetables (excluding carrots, broccoli, and dark- green leafy (no potatoes)), tomato-based sauce (mixture)	249	3.2
27420450	Sausage and vegetables (including carrots, broccoli, and/or dark-green leafy (no potatoes)), tomato-based sauce (mixture)	249	3.2
27420460	Sausage and vegetables (excluding carrots, broccoli, and dark-green leafy (no potatoes)), tomato-based sauce (mixture)	249	3.2
27450700	Fish and vegetables (including carrots, broccoli, and/or dark-green leafy (no potatoes)), tomato-based sauce (mixture)	224	3.2
27450710	Fish and vegetables (excluding carrots, broccoli, and dark- green leafy (no potatoes)), tomato-based sauce (mixture)	224	3.2
27510700	Meatball and spaghetti sauce submarine sandwich	195	3.2
27540230	Chicken patty sandwich with cheese, on wheat bun, with lettuce, tomato and spread	140	3.2
27540240	Chicken fillet, (broiled), sandwich, on whole wheat roll, with lettuce, tomato and spread	140	3.2

27540250	Chicken fillet, broiled, sandwich with cheese, on whole wheat roll, with lettuce, tomato and non-mayonnaise type spread	140	3.2
28110150	Beef with vegetable (diet frozen meal)	195	3.2
28110390	Salisbury steak, potatoes, vegetable, dessert (diet frozen meal)	195	3.2
28110660	Meatballs, Swedish, in gravy, with noodles (diet frozen meal)	195	3.2
28113110	Salisbury steak, baked, with tomato sauce, vegetable (diet frozen meal)	195	3.2
28120310	Pork with rice, vegetable, in soy-based sauce (diet frozen meal)	195	3.2
28141201	Teriyaki chicken with rice and vegetable (diet frozen meal)	195	3.2
28141250	Chicken with rice-vegetable mixture (diet frozen meal)	195	3.2
28141300	Chicken with rice and vegetable, reduced fat and sodium (diet frozen meal)	195	3.2
28141610	Chicken and vegetables in cream or white sauce (diet frozen meal)	195	3.2
28141650	Chicken and vegetables au gratin with rice-vegetable mixture (diet frozen entree)	195	3.2
28143020	Chicken and vegetable entree with rice, Asian (diet frozen meal)	195	3.2
28143030	Chicken and vegetable entree, oriental (diet frozen meal)	195	3.2
28143040	Chicken chow mein with rice (diet frozen meal)	195	3.2
28143080	Chicken with noodles and cheese sauce (diet frozen meal)	195	3.2
28143110	Chicken cacciatore with noodles (diet frozen meal)	195	3.2
28143150	Chicken and vegetable entree with noodles (diet frozen meal)	195	3.2
28143180	Chicken in butter sauce with potatoes and vegetable (diet frozen meal)	195	3.2
28143210	Chicken in orange sauce with almond rice (diet frozen meal)	195	3.2
28143220	Chicken in barbecue sauce, with rice, vegetable and dessert, reduced fat and sodium (diet frozen meal)	195	3.2
28145100	Turkey with dressing, gravy, vegetable and fruit (diet frozen meal)	195	3.2
28145110	Turkey with vegetable, stuffing (diet frozen meal)	195	3.2
28150210	Haddock with chopped spinach (diet frozen meal)	195	3.2
28154010	Shrimp and vegetables in sauce with noodles (diet frozen meal)	195	3.2
28160710	Stuffed cabbage, with meat and tomato sauce (diet frozen meal)	195	3.2
28340170	Chicken broth, canned, low sodium	245	3.2
28345040	Chicken or turkey soup, cream of, canned, reduced sodium, undiluted	122.5	3.2

28345140	Chicken or turkey soup, cream of, canned, undiluted	122.5	3.2
28501010	Gravy, beef or meat, fat free	56.75	3.2
28501110	Gravy, poultry, fat free	56.75	3.2

4. Beans, peas, other legumes, nuts and seeds

Food codes	Description	Serving size, g	g IMD/ serving
41205050	Bean dip, made with refried beans	30	3.2
41205070	Hummus	30	3.2
41420350	Soy sauce, reduced sodium	16	3.2
41420410	Teriyaki sauce, reduced sodium	5	3.2
41440000	Textured vegetable protein, dry	17	3.2
41602070	Split pea soup, canned, reduced sodium, prepared with water or ready-to-serve	245	3.2
41602090	Split pea and ham soup, canned, reduced sodium, prepared with water or ready-to-serve	245	3.2
41810200	Bacon strip, meatless	15	3.2
41810250	Bacon bits, meatless	7	3.2
41810400	Breakfast link, patty, or slice, meatless	38	3.2
41810610	Chicken, meatless, breaded, fried	130	3.2
41811400	Frankfurter or hot dog, meatless	140	3.2
41811600	Luncheon slice, meatless-beef, chicken, salami or turkey	140	3.2
41811800	Meatball, meatless	144	3.2
41811890	Vegetarian burger or patty, meatless, no bun	85	3.2
41811900	Soyburger, meatless, no bun	85	3.2
41811910	Vegetable burger or patty, meatless, no bun	85	3.2
41812000	Sandwich spread, meat substitute type	55	3.2
41812450	Vegetarian chili (made with meat substitute)	254	3.2
41812600	Vegetarian, fillet	140	3.2
41812850	Vegetarian stroganoff (made with meat substitute)	125	3.2
41812900	Vegetarian meat loaf or patties (meat loaf made with meat substitute)	140	3.2

5. Grain products - Baked products

Food codes	Description	Serving size, g	g IMD/ serving
51000100	Bread, NS as to major flour	50	3.2
51000110	Bread, NS as to major flour, toasted	50	3.2
51000180	Bread, made from home recipe or purchased at a bakery, NS as to major flour	50	3.2
51000200	Roll, NS as to major flour	50	3.2
51000300	Roll, hard, NS as to major flour	50	3.2

51101000	Bread, white	50	3.2
51101010	Bread, white, toasted	50	3.2
51122000	Bread, reduced calorie and/or high fiber, white or NFS	50	3.2
51122010	Bread, reduced calorie and/or high fiber, white or NFS, toasted	50	3.2
51122050	Bread, reduced calorie and/or high fiber, Italian	50	3.2
51122100	Bread, reduced calorie and/or high fiber, white or NFS, with fruit and/or nuts	50	3.2
51122300	Bread, white, special formula, added fiber	50	3.2
51123010	Bread, high protein	50	3.2
51152000	Roll, white, soft, reduced calorie and/or high fiber	50	3.2
51161030	Roll, sweet, with fruit, frosted, diet	55	3.2
51161070	Roll, sweet, with fruit, frosted, fat free	55	3.2
51165100	Coffee cake, yeast type, fat free, cholesterol free, with fruit	55	3.2
51180010	Bagel	55	3.2
51180020	Bagel, toasted	55	3.2
51180030	Bagel, with raisins	55	3.2
51180080	Bagel, with fruit other than raisins	55	3.2
51184100	Bread stick, hard, low sodium	15	3.2
51201010	Bread, whole wheat, 100%	50	3.2
51201020	Bread, whole wheat, 100%, toasted	50	3.2
51201060	Bread, whole wheat, 100%, made from home recipe or purchased at bakery	50	3.2
51201070	Bread, whole wheat, 100%, made from home recipe or purchased at bakery, toasted	50	3.2
51201120	Bread, whole wheat, 100%, with raisins, toasted	50	3.2
51201150	Bread, pita, whole wheat, 100%	50	3.2
51207010	Bread, sprouted wheat	50	3.2
51207020	Bread, sprouted wheat, toasted	50	3.2
51208100	Bagel, whole wheat, 100%, with raisins	55	3.2
51220000	Roll, whole wheat, 100%	50	3.2
51300050	Bread, whole grain white	50	3.2
51300110	Bread, whole wheat, NS as to 100%	50	3.2
51300120	Bread, whole wheat, NS as to 100%, toasted	50	3.2
51300180	Bread, puri or poori (Indian puffed bread), wheat	50	3.2
51300210	Bread, whole wheat, with raisins	50	3.2
51300220	Bread, whole wheat, with raisins, toasted	50	3.2
51301010	Bread, wheat or cracked wheat	50	3.2
51301020	Bread, wheat or cracked wheat, toasted	50	3.2
51301120	Bread, wheat or cracked wheat, with raisins	50	3.2
51301510	Bread, wheat or cracked wheat, reduced calorie and/or high fiber	50	3.2
51301520	Bread, wheat or cracked wheat, reduced calorie and/or high fiber, toasted	50	3.2

51301540	Bread, French or Vienna, whole wheat, NS as to 100%	50	3.2
51301600	Bread, pita, whole wheat, NS as to 100%	50	3.2
51301620	Bread, pita, wheat or cracked wheat	50	3.2
51301700	Bagel, wheat	55	3.2
51301750	Bagel, whole wheat, NS as to 100%	55	3.2
51301800	Bagel, wheat, with raisins	55	3.2
51301820	Bagel, wheat, with fruit and nuts	55	3.2
51301900	Bagel, wheat bran	55	3.2
51302020	Bread, wheat bran, toasted	50	3.2
51302050	Bread, wheat bran, with raisins	50	3.2
51302060	Bread, wheat bran, with raisins, toasted	50	3.2
51302500	Muffin, English, wheat bran	55	3.2
51302520	Muffin, English, wheat bran, with raisins	55	3.2
51303010	Muffin, English, wheat or cracked wheat	55	3.2
51303030	Muffin, English, whole wheat, NS as to 100%	55	3.2
51303050	Muffin, English, wheat or cracked wheat, with raisins	55	3.2
51303070	Muffin, English, whole wheat, NS as to 100%, with raisins	55	3.2
51320010	Roll, wheat or cracked wheat	50	3.2
51320020	Roll, wheat or cracked wheat, toasted	50	3.2
51320500	Roll, whole wheat, NS as to 100%	50	3.2
51320530	Roll, whole wheat, NS as to 100%, made from home recipe or purchased at bakery	50	3.2
51601010	Bread, multigrain, toasted	50	3.2
51601020	Bread, multigrain	50	3.2
51601210	Bread, multigrain, with raisins	50	3.2
51601220	Bread, multigrain, with raisins, toasted	50	3.2
51602010	Bread, multigrain, reduced calorie and/or high fiber	50	3.2
51620000	Roll, multigrain	50	3.2
51630000	Bagel, multigrain	55	3.2
51630100	Bagel, multigrain, with raisins	55	3.2
51630200	Muffin, English, multigrain	55	3.2
51804020	Bread, soy, toasted	50	3.2
52104040	Biscuit, whole wheat	55	3.2
52215200	Tortilla, flour (wheat)	55	3.2
52215260	Tortilla, whole wheat	55	3.2
52301000	Muffin, NFS	55	3.2
52302020	Muffin, fruit, low fat	55	3.2
52302100	Muffin, fruit, fat free, cholesterol free	55	3.2
52303010	Muffin, whole wheat	55	3.2
52303500	Muffin, wheat	55	3.2
52304010	Muffin, wheat bran	55	3.2
52304040	Muffin, bran with fruit, lowfat	55	3.2
52304060	Muffin, bran with fruit, no fat, no cholesterol	55	3.2
52304150	Muffin, oat bran	55	3.2

52304200	Muffin, oat bran with fruit and/or nuts	55	3.2
53102300	Cake, applesauce, diet, without icing	80	3.2
53104300	Cake, carrot, diet	80	3.2
53104520	Cheesecake, diet	80	3.2
53104570	Cheesecake, diet, with fruit	80	3.2
53105500	Cake, chocolate, with icing, diet	80	3.2
53105750	Cake, chocolate, devil's food, or fudge, pudding type mix, made by "cholesterol free" recipe (water, oil and egg whites added to dry mix), with "light" icing, coating or filling	80	3.2
53109210	Cake, cupcake, not chocolate, with icing or filling, lowfat, cholesterol free	80	3.2
53109270	Cake, cupcake, chocolate, with or without icing, fruit filling or cream filling, lowfat, cholesterol free	80	3.2
53114200	Cake, lemon, lowfat, without icing	80	3.2
53114250	Cake, lemon, lowfat, with icing	80	3.2
53116390	Cake, pound, reduced fat, cholesterol free	80	3.2
53120500	Cake, whole wheat, with fruit and nuts, without icing	80	3.2
53123500	Cake, shortcake, with whipped topping and fruit, diet	125	3.2
53204830	Cookie, brownie, lowfat, with icing	40	3.2
53204840	Cookie, brownie, reduced fat, NS as to icing	40	3.2
53204850	Cookie, brownie, fat free, cholesterol free, with icing	40	3.2
53204860	Cookie, brownie, fat free, NS as to icing	40	3.2
53206030	Cookie, chocolate chip, reduced fat	30	3.2
53207050	Cookie, chocolate, with chocolate filling or coating, fat free	30	3.2
53209020	Cookie, chocolate sandwich, reduced fat	30	3.2
53220010	Cookie, fruit-filled bar, fat free	30	3.2
53220040	Cookie, fig bar, fat free	30	3.2
53231400	Cookie, multigrain, high fiber	30	3.2
53233030	Cookie, oatmeal, fat free, with raisins	30	3.2
53233040	Cookie, oatmeal, reduced fat, NS as to raisins	30	3.2
53239010	Cookie, shortbread, reduced fat	30	3.2
53243050	Cookie, vanilla sandwich, reduced fat	30	3.2
53260030	Cookie, chocolate chip, sugar free	30	3.2
53260150	Cookie, lemon wafer, lowfat	30	3.2
53260200	Cookie, oatmeal, sugar free	30	3.2
53260300	Cookie, sandwich, sugar free	30	3.2
53260400	Cookie, sugar or plain, sugar free	30	3.2
53300100	Pie, NFS	125	3.2
53300170	Pie, individual size or tart, NFS	125	3.2
53301750	Pie, apple, diet	125	3.2
53366000	Pie, yogurt, frozen	125	3.2
53420210	Cream puff, eclair, custard or cream filled, iced, reduced fat	125	3.2

5. Grain products - Breakfast bars and cereal bars

Food codes	Description	Serving size, g	g IMD/serving
53530010	Breakfast tart, lowfat	55	6.3
53540000	Breakfast bar, NFS	40	6.3
53540200	Breakfast bar, cereal crust with fruit filling, lowfat	40	6.3
53540250	Breakfast bar, cereal crust with fruit filling, fat free	40	6.3
53540300	Fiber One Chewy Bar	40	6.3
53540400	Kellogg's Nutri-Grain Cereal Bar	40	6.3
53540402	Kellogg's Nutri-Grain Yogurt Bar	40	6.3
53540404	Kellogg's Nutri-Grain Fruit and Nut Bar	40	6.3
53540500	Breakfast bar, date, with yogurt coating	40	6.3
53540600	Milk 'n Cereal bar	40	6.3
53540700	Kellogg's Special K bar	40	6.3
53540800	Kashi GOLEAN Chewy Bars	40	6.3
53540802	Kashi TLC Chewy Granola Bar	40	6.3
53540804	Kashi GOLEAN Crunchy Bars	40	6.3
53540806	Kashi TLC Crunchy Granola Bar	40	6.3
53540900	Nature Valley Chewy Trail Mix Granola Bar	40	6.3
53540902	Nature Valley Chewy Granola Bar with Yogurt Coating	40	6.3
53540904	Nature Valley Sweet and Salty Nut Granola Bar	40	6.3
53540906	Nature Valley Crunchy Granola Bar	40	6.3
53541000	Quaker Chewy Granola Bar	40	6.3
53541002	Quaker Chewy 90 Calorie Granola Bar	40	6.3
53541004	Quaker Chewy 25% Less Sugar Granola Bar	40	6.3
53541006	Quaker Chewy Dipp's Granola Bar	40	6.3
53541200	Meal replacement bar	40	6.3
53541300	Slim Fast Original Meal Bar	40	6.3
53542000	Snack bar, oatmeal	40	6.3
53542100	Granola bar, NFS	40	6.3
53542200	Granola bar, lowfat, NFS	40	6.3
53542210	Granola bar, nonfat	40	6.3
53543000	Granola bar, reduced sugar, NFS	40	6.3
53543100	Granola bar, peanuts, oats, sugar, wheat germ	40	6.3
53544200	Granola bar, chocolate-coated, NFS	40	6.3
53544210	Granola bar, with coconut, chocolate-coated	40	6.3
53544220	Granola bar with nuts, chocolate-coated	40	6.3
53544230	Granola bar, oats, nuts, coated with non-chocolate coating	40	6.3
53544250	Granola bar, coated with non-chocolate coating	40	6.3
53544300	Granola bar, high fiber, coated with non-chocolate yogurt coating	40	6.3
53544400	Granola bar, with rice cereal	40	6.3

53544410	Quaker Granola Bites	40	6.3
53544450	PowerBar (fortified high energy bar)	40	6.3
53710400	Fiber One Chewy Bar	40	6.3
53710500	Kellogg's Nutri-Grain Cereal Bar	40	6.3
53710502	Kellogg's Nutri-Grain Yogurt Bar	40	6.3
53710504	Kellogg's Nutri-Grain Fruit and Nut Bar	40	6.3
53710600	Milk 'n Cereal bar	40	6.3
53710700	Kellogg's Special K bar	40	6.3
53710800	Kashi GOLEAN Chewy Bars	40	6.3
53710802	Kashi TLC Chewy Granola Bar	40	6.3
53710804	Kashi GOLEAN Crunchy Bars	40	6.3
53710806	Kashi TLC Crunchy Granola Bar	40	6.3
53710900	Nature Valley Chewy Trail Mix Granola Bar	40	6.3
53710902	Nature Valley Chewy Granola Bar with Yogurt Coating	40	6.3
53710904	Nature Valley Sweet and Salty Granola Bar	40	6.3
53710906	Nature Valley Crunchy Granola Bar	40	6.3
53711000	Quaker Chewy Granola Bar	40	6.3
53711002	Quaker Chewy 90 Calorie Granola Bar	40	6.3
53711004	Quaker Chewy 25% Less Sugar Granola Bar	40	6.3
53711006	Quaker Chewy Dipp's Granola Bar	40	6.3
53711100	Quaker Granola Bites	40	6.3
53712000	Snack bar, oatmeal	40	6.3
53712100	Granola bar, NFS	40	6.3
53712200	Granola bar, lowfat, NFS	40	6.3
53712210	Granola bar, nonfat	40	6.3
53713000	Granola bar, reduced sugar, NFS	40	6.3
53713100	Granola bar, peanuts , oats, sugar, wheat germ	40	6.3
53714200	Granola bar, chocolate-coated, NFS	40	6.3
53714210	Granola bar, with coconut, chocolate-coated	40	6.3
53714220	Granola bar with nuts, chocolate-coated	40	6.3
53714230	Granola bar, oats, nuts, coated with non-chocolate coating	40	6.3
53714250	Granola bar, coated with non-chocolate coating	40	6.3
53714300	Granola bar, high fiber, coated with non-chocolate yogurt coating	40	6.3
53714400	Granola bar, with rice cereal	40	6.3
53714500	Breakfast bar, NFS	40	6.3
53714510	Breakfast bar, date, with yogurt coating	40	6.3
53714520	Breakfast bar, cereal crust with fruit filling, lowfat	40	6.3
53720100	Balance Original Bar	40	6.3
53720200	Clif Bar	40	6.3
53720300	PowerBar	40	6.3
53720400	Slim Fast Original Meal Bar	40	6.3
53720500	Snickers Marathon Protein bar	40	6.3
53720510	Snickers Marathon Energy bar	40	6.3
53720600	South Beach Living Meal Bar	40	6.3

53720610	South Beach Living High Protein Bar	40	6.3
53720700	Tiger's Milk bar	40	6.3
53720800	Zone Perfect Classic Crunch nutrition bar	40	6.3
53729000	Nutrition bar or meal replacement bar, NFS	40	6.3

5. Grain products – Crackers, salty snacks, pancakes, and waffles

Food codes	Description	Serving size, g	g IMD/ serving
54001000	Crackers, NS as to sweet or nonsweet	30	3.2
54101010	Cracker, animal	30	3.2
54102100	Crackers, graham, lowfat	30	3.2
54102110	Crackers, graham, fat free	30	3.2
54201010	Crackers, matzo, low sodium	30	3.2
54202010	Crackers, saltine, low sodium	30	3.2
54202050	Crackers, saltine, fat free, low sodium	30	3.2
54203010	Crackers, toast thins (rye, wheat, white flour), low sodium	30	3.2
54204010	Cracker, 100% whole wheat, low sodium	30	3.2
54205010	Cracker, snack, low sodium	30	3.2
54205030	Cracker, cheese, low sodium	30	3.2
54205100	Cracker, snack, lowfat, low sodium	30	3.2
54210010	Cracker, multigrain, low sodium	30	3.2
54301100	Cracker, snack, reduced fat	30	3.2
54301200	Cracker, snack, fat free	30	3.2
54304100	Cracker, cheese, reduced fat	30	3.2
54304500	Cracker, high fiber, no added fat	30	3.2
54318500	Rice cake, cracker-type	30	3.2
54319000	Crackers, rice	30	3.2
54319010	Puffed rice cake	30	3.2
54319020	Popcorn cake	30	3.2
54322000	Crispbread, rye, no added fat	30	3.2
54325000	Crackers, saltine	30	3.2
54325050	Crackers, saltine, whole wheat	30	3.2
54328110	Cracker, sandwich-type, peanut butter filled, reduced fat	30	3.2
54336000	Crackers, water biscuits	30	3.2
54337000	Cracker, 100% whole wheat	30	3.2
54337050	Cracker, 100% whole wheat, reduced fat	30	3.2
54338000	Crackers, wheat	30	3.2
54338100	Crackers, wheat, reduced fat	30	3.2
54401090	Salty snacks, corn or cornmeal base, corn chips, corn-cheese chips, unsalted	30	3.2
54401100	Salty snacks, corn or cornmeal base, tortilla chips, light (baked with less oil)	30	3.2
54401120	Salty snacks, corn or cornmeal base, tortilla chips, fat free, made with Olean	30	3.2

54401150	Salty snacks, corn or cornmeal base, tortilla chips, lowfat, baked without fat	30	3.2
54401170	Salty snacks, corn or cornmeal base, tortilla chips, lowfat, baked without fat, unsalted	30	3.2
54401210	Salty snacks, corn based puffs and twists, cheese puffs and twists, lowfat	30	3.2
54402080	Salty snacks, corn or cornmeal base, tortilla chips, unsalted	30	3.2
54402600	Salty snacks, multigrain, whole grain, chips (made with whole corn, whole wheat, rice flour, and whole oat flour)	30	3.2
54408000	Pretzels, NFS	30	3.2
54408010	Pretzels, hard	30	3.2
54408030	Pretzel, hard, unsalted	30	3.2
54408200	Pretzel, hard, chocolate-coated	30	3.2
54408250	Pretzel, yogurt-covered	30	3.2
54408300	Pretzels, cheese-filled	30	3.2
54420010	Multigrain mixture, pretzels, cereal and/or crackers, nuts	30	3.2
54420100	Oriental party mix, with peanuts, sesame sticks, chili rice crackers and fried green peas	30	3.2
54420200	Multigrain mixture, bread sticks, sesame nuggets, pretzels, rye chips	30	3.2
55101010	Pancakes, reduced calorie, high fiber	110	3.2
55105000	Pancakes, buckwheat	110	3.2
55105200	Pancakes, whole wheat	110	3.2
55202000	Waffle, wheat, bran, or multigrain	85	3.2
55205000	Waffle, 100% whole wheat or 100% whole grain	85	3.2
55206000	Waffle, oat bran	85	3.2
55211000	Waffle, plain, fat free	85	3.2
55211050	Waffle, plain, lowfat	85	3.2

5. Grain products - Pastas, cooked cereals, rice

Food codes	Description	Serving size, g	g IMD/ serving
56200300	Cereal, cooked, NFS	240	6.3
56200350	Cereal, cooked, instant, NS as to grain	234	6.3
56200990	Grits, cooked, corn or hominy, NS as to regular, quick, or instant, NS as to fat added in cooking	242	6.3
56201000	Grits, cooked, corn or hominy, NS as to regular, quick, or instant, fat not added in cooking	242	6.3
56201010	Grits, cooked, corn or hominy, regular, fat not added in cooking	242	6.3
56201020	Grits, cooked, corn or hominy, regular, fat added in cooking	247	6.3
56201030	Grits, cooked, corn or hominy, regular, NS as to fat added	242	6.3

	in cooking		
56201040	Grits, cooked, corn or hominy, NS as to regular, quick, or instant, fat added in cooking	247	6.3
56201060	Grits, cooked, corn or hominy, with cheese, NS as to regular, quick, or instant, NS as to fat added in cooking	247	6.3
56201062	Grits, cooked, corn or hominy, with cheese, NS as to regular, quick, or instant, fat added in cooking	240	6.3
56201070	Grits, cooked, corn or hominy, with cheese, regular, NS as to fat added in cooking	235	6.3
56201071	Grits, cooked, corn or hominy, with cheese, regular, fat not added in cooking	235	6.3
56201072	Grits, cooked, corn or hominy, with cheese, regular, fat added in cooking	240	6.3
56201082	Grits, cooked, corn or hominy, with cheese, quick, fat added in cooking	240	6.3
56201091	Grits, cooked, corn or hominy, with cheese, instant, fat not added in cooking	235	6.3
56201092	Grits, cooked, corn or hominy, with cheese, instant, fat added in cooking	240	6.3
56201110	Grits, cooked, corn or hominy, quick, fat not added in cooking	242	6.3
56201120	Grits, cooked, corn or hominy, quick, fat added in cooking	247	6.3
56201130	Grits, cooked, corn or hominy, quick, NS as to fat added in cooking	242	6.3
56201210	Grits, cooked, corn or hominy, instant, fat not added in cooking	242	6.3
56201220	Grits, cooked, corn or hominy, instant, fat added in cooking	247	6.3
56201230	Grits, cooked, corn or hominy, instant, NS as to fat added in cooking	247	6.3
56201240	Grits, cooked, flavored, corn or hominy, instant, fat not added in cooking	242	6.3
56202960	Oatmeal, cooked, NS as to regular, quick or instant; NS as to fat added in cooking	234	6.3
56202970	Oatmeal, cooked, quick (1 or 3 minutes), NS as to fat added in cooking	234	6.3
56202980	Oatmeal, cooked, regular, NS as to fat added in cooking	234	6.3
56203000	Oatmeal, cooked, NS as to regular, quick or instant, fat not added in cooking	234	6.3
56203010	Oatmeal, cooked, regular, fat not added in cooking	234	6.3
56203020	Oatmeal, cooked, quick (1 or 3 minutes), fat not added in cooking	234	6.3
56203030	Oatmeal, cooked, instant, fat not added in cooking	234	6.3
56203050	Oatmeal, cooked, regular, fat added in cooking	239	6.3
56203060	Oatmeal, cooked, quick (1 or 3 minutes), fat added in cooking	239	6.3

56203070	Oatmeal, cooked, instant, fat added in cooking	239	6.3
56203080	Oatmeal, cooked, instant, NS as to fat added in cooking	234	6.3
56203210	Oatmeal, NS as to regular, quick, or instant, made with milk, fat not added in cooking	234	6.3
56203220	Oatmeal, NS as to regular, quick, or instant, made with milk, fat added in cooking	239	6.3
56203230	Oatmeal, NS as to regular, quick, or instant, made with milk, NS as to fat added in cooking	234	6.3
56203610	Oatmeal, multigrain, cooked, fat not added in cooking	234	6.3
56205510	Rice, brown, cooked, regular, fat added in cooking	140	3.2
56205540	Rice, brown, cooked, instant, fat not added in cooking	140	3.2
56205550	Rice, brown, cooked, instant, fat added in cooking	140	3.2
56206990	Wheat, cream of, cooked, NS as to regular, quick, or instant, NS as to fat added in cooking	251	6.3
56207000	Wheat, cream of, cooked, NS as to regular, quick, or instant, fat not added in cooking	251	6.3
56207010	Wheat, cream of, cooked, regular, fat not added in cooking	251	6.3
56207020	Wheat, cream of, cooked, quick, fat not added in cooking	239	6.3
56207030	Wheat, cream of, cooked, instant, fat not added in cooking	241	6.3
56207040	Wheat, cream of, cooked, made with milk	243	6.3
56207060	Wheat, cream of, cooked, instant, fat added in cooking	246	6.3
56207080	Wheat, cream of, cooked, NS as to regular, quick, or instant, fat added in cooking	256	6.3
56207200	Whole wheat cereal, cooked, fat not added in cooking	246	6.3
56207220	Wheat, cream of, cooked, regular, fat added in cooking	251	6.3
56207230	Wheat, cream of, cooked, quick, fat added in cooking	244	6.3
56207300	Whole wheat cereal, wheat and barley, cooked, fat not added in cooking	249	6.3
56207330	Whole wheat cereal, wheat and barley, cooked, fat added in cooking	254	6.3
56207360	Wheat cereal, chocolate flavored, cooked, fat not added in cooking	246	6.3
56207370	Wheat cereal, chocolate flavored, cooked, NS as to fat added in cooking	246	6.3
56208500	Oat bran cereal, cooked, fat not added in cooking	242	6.3
56208510	Oat bran cereal, cooked, fat added in cooking	247	6.3
56210000	Nestum cereal	245	6.3
56102000	Macaroni, whole wheat, cooked, NS as to fat added in cooking	140	3.2
56102010	Macaroni, whole wheat, cooked, fat not added in cooking	140	3.2
56102020	Macaroni, whole wheat, cooked, fat added in cooking	140	3.2
56104010	Macaroni, cooked, vegetable, fat not added in cooking	91	3.2
56104020	Macaroni, cooked, vegetable, fat added in cooking	96	3.2
56113010	Noodles, cooked, whole wheat, fat not added in cooking	140	3.2

56114000	Noodles, cooked, spinach, fat not added in cooking	160	3.2
56114020	Noodles, cooked, spinach, fat added in cooking	165	3.2
56132990	Spaghetti, cooked, whole wheat, NS as to fat added in cooking	140	3.2
56133000	Spaghetti, cooked, whole wheat, fat not added in cooking	140	3.2
56133010	Spaghetti, cooked, whole wheat, fat added in cooking	140	3.2

5. Grain products- Cereals

57000000	Cereal, NFS	30	6.3
57000050	Kashi cereal, NS as to ready to eat or cooked	30	6.3
57000100	Oat cereal, NFS	30	6.3
57100100	Cereal, ready-to-eat, NFS	30	6.3
57100400	Character cereals, TV or movie, General Mills	30	6.3
57100500	Character cereals, TV or movie, Kellogg's	30	6.3
57101000	All-Bran	30	6.3
57101020	All-Bran with Extra Fiber	30	6.3
57102000	Alpen	55	6.3
57103000	Alpha-Bits	30	6.3
57103050	Amaranth Flakes	30	6.3
57103100	Apple Cinnamon Cheerios	30	6.3
57103500	Apple Cinnamon Squares Mini-Wheats, Kellogg's (formerly Apple Cinnamon Squares)	55	6.3
57104000	Apple Jacks	30	6.3
57106050	Banana Nut Crunch Cereal (Post)	55	6.3
57106100	Basic 4	55	6.3
57106250	Berry Berry Kix	30	6.3
57106260	Berry Burst Cheerios	30	6.3
57106530	Blueberry Morning, Post	55	6.3
57107000	Booberry	30	6.3
57110000	All-Bran Bran Buds, Kellogg's (formerly Bran Buds)	30	6.3
57111000	Bran Chex	55	6.3
57117000	Cap'n Crunch	30	6.3
57117500	Cap'n Crunch's Christmas Crunch	30	6.3
57119000	Cap'n Crunch's Crunch Berries	30	6.3
57120000	Cap'n Crunch's Peanut Butter Crunch	30	6.3
57123000	Cheerios	30	6.3
57124000	Chex cereal, NFS	30	6.3
57124200	Chocolate flavored frosted puffed corn cereal	30	6.3
57124500	Cinnamon Grahams, General Mills	30	6.3
57125000	Cinnamon Toast Crunch	30	6.3
57125900	Honey Nut Clusters (formerly called Clusters)	55	6.3
57126000	Cocoa Krispies	30	6.3
57127000	Cocoa Pebbles	30	6.3

57128000	Cocoa Puffs	30	6.3
57128880	Complete Oat Bran Flakes, Kellogg's (formerly Common Sense Oat Bran, plain)	30	6.3
57130000	Cookie-Crisp	30	6.3
57131000	Crunchy Corn Bran, Quaker	30	6.3
57132000	Corn Chex	30	6.3
57134000	Corn flakes, NFS	30	6.3
57135000	Corn flakes, Kellogg's	30	6.3
57137000	Corn Puffs	15	6.3
57138000	Total Corn Flakes	30	6.3
57139000	Count Chocula	30	6.3
57143000	Cracklin' Oat Bran	55	6.3
57143500	Cranberry Almond Crunch, Post	55	6.3
57144000	Crisp Crunch	30	6.3
57148000	Crispix	30	6.3
57148500	Crispy Brown Rice Cereal	30	6.3
57151000	Crispy Rice	30	6.3
57152000	Crispy Wheats'n Raisins	55	6.3
57201800	Disney cereals, Kellogg's	30	6.3
57206000	Familia	55	6.3
57206700	Fiber One	30	6.3
57206800	Fiber 7 Flakes, Health Valley	30	6.3
57207000	Bran Flakes, NFS (formerly 40% Bran Flakes, NFS)	55	6.3
57208000	All-Bran Complete Wheat Flakes, Kellogg's	30	6.3
57209000	Natural Bran Flakes, Post (formerly called 40% Bran Flakes, Post)	30	6.3
57211000	Frankenberry	30	6.3
57212100	French Toast Crunch, General Mills	30	6.3
57213000	Froot Loops	30	6.3
57213850	Frosted Cheerios	30	6.3
57214000	Frosted Mini-Wheats	55	6.3
57214100	Frosted Wheat Bites	55	6.3
57215000	Frosty O's	30	6.3
57218000	Frosted Rice Krispies, Kellogg's	30	6.3
57219000	Fruit & Fibre (fiber), NFS	55	6.3
57221000	Fruit & Fibre (fiber) with dates, raisins, and walnuts	55	6.3
57221650	Fruit Harvest cereal, Kellogg's	30	6.3
57221700	Fruit Rings, NFS	30	6.3
57223000	Fruity Pebbles	30	6.3
57224000	Golden Grahams	30	6.3
57227000	Granola, NFS	55	6.3
57228000	Granola, homemade	55	6.3
57229000	Granola, lowfat, Kellogg's	55	6.3
57229500	Granola with Raisins, lowfat, Kellogg's	55	6.3
57230000	Grape-Nuts	55	6.3

57231000	Grape-Nuts Flakes	30	6.3
57231200	Great Grains, Raisin, Date, and Pecan Whole Grain Cereal, Post	55	6.3
57231250	Great Grains Double Pecan Whole Grain Cereal, Post	55	6.3
57232100	Healthy Choice Almond Crunch with raisins, Kellogg's	55	6.3
57237100	Honey Bunches of Oats Honey Roasted Cereal	30	6.3
57237300	Honey Bunches of Oats with Almonds, Post	30	6.3
57238000	Honeycomb, plain	30	6.3
57239000	Honeycomb, strawberry	30	6.3
57239100	Honey Crunch Corn Flakes, Kellogg's	30	6.3
57240100	Honey Nut Chex	30	6.3
57241000	Honey Nut Cheerios	30	6.3
57241200	Honey Nut Shredded Wheat, Post	55	6.3
57243000	Honey Smacks, Kellogg's (formerly Smacks; Honey Smacks)	30	6.3
57245000	Just Right Fruit and Nut (formerly Just Right with raisins, dates, and nuts)	55	6.3
57301100	Kaboom	30	6.3
57301500	Kashi, Puffed	15	6.3
57301510	Kashi GOLEAN	55	6.3
57301511	Kashi GOLEAN Crunch	55	6.3
57301520	Kashi Good Friends	55	6.3
57301530	Kashi Heart to Heart Honey Toasted Oat	55	6.3
57302100	King Vitaman	30	6.3
57303100	Kix	30	6.3
57304100	Life (plain and cinnamon)	55	6.3
57305100	Lucky Charms	30	6.3
57305150	Frosted oat cereal with marshmallows	30	6.3
57305170	Malt-O-Meal Coco-Roos	30	6.3
57305180	Malt-O-Meal Corn Bursts	30	6.3
57305210	Malt-O-Meal Frosted Flakes	30	6.3
57305500	Malt-O-Meal Honey and Nut Toasty O's	30	6.3
57305600	Malt-O-Meal Marshmallow Mateys	30	6.3
57306100	Malt-O-Meal Puffed Rice	15	6.3
57306120	Malt-O-Meal Puffed Wheat	15	6.3
57306500	Malt-O-Meal Golden Puffs (formerly Sugar Puffs)	30	6.3
57306700	Malt-O-Meal Toasted Oat Cereal	30	6.3
57306800	Malt-O-meal Tootie Fruities	30	6.3
57307150	Marshmallow Safari, Quaker	30	6.3
57307500	Millet, puffed	30	6.3
57308150	Mueslix cereal, NFS	55	6.3
57308190	Muesli, dried fruit and nuts (formerly Muesli with raisins, dates, and almonds)	55	6.3
57308300	Multi Bran Chex	55	6.3
57308400	MultiGrain Cheerios	30	6.3

NutraSource, Inc.

57309100	Nature Valley Granola, with fruit and nuts	55	6.3
57316200	Nutty Nuggets, Ralston Purina	55	6.3
57316300	Oat Bran Flakes, Health Valley	55	6.3
57316410	Oatmeal Crisp, Apple Cinnamon (formerly Oatmeal Crisp with Apples)	55	6.3
57316450	Oatmeal Crisp with Almonds	55	6.3
57316500	Oatmeal Crisp, Raisin (formerly Oatmeal Raisin Crisp)	55	6.3
57316710	Oh's, Honey Graham	30	6.3
57316750	Oh's, Fruitangy, Quaker	30	6.3
57318000	100% Bran	30	6.3
57319000	100% Natural Cereal, plain, Quaker	55	6.3
57319500	Sun Country 100% Natural Granola, with Almonds	55	6.3
57320500	100 % Natural Cereal, with oats, honey and raisins, Quaker	55	6.3
57321500	100 % Natural Wholegrain Cereal with raisins, lowfat, Quaker	55	6.3
57321700	Optimum, Nature's Path	55	6.3
57321800	Optimum Slim, Nature's Path	55	6.3
57322500	Oreo O's cereal, Post	30	6.3
57323000	Sweet Crunch, Quaker (formerly called Popeye)	30	6.3
57323050	Sweet Puffs, Quaker	30	6.3
57325000	Product 19	30	6.3
57327450	Quaker Oat Bran Cereal	55	6.3
57327500	Quaker Oatmeal Squares (formerly Quaker Oat Squares)	55	6.3
57329000	Raisin bran, NFS	55	6.3
57330000	Raisin Bran, Kellogg's	55	6.3
57330010	Raisin Bran Crunch, Kellogg's	55	6.3
57331000	Raisin Bran, Post	55	6.3
57332050	Raisin Bran, Total	55	6.3
57332100	Raisin Nut Bran	55	6.3
57335550	Reese's Peanut Butter Puffs cereal	30	6.3
57336000	Rice Chex	30	6.3
57337000	Rice Flakes, NFS	30	6.3
57339000	Rice Krispies, Kellogg's	30	6.3
57339500	Rice Krispies Treats Cereal, Kellogg's	30	6.3
57340000	Rice, puffed	15	6.3
57340700	Scooby Doo cereal, Kellogg's	30	6.3
57341000	Shredded Wheat'N Bran	55	6.3
57341200	Smart Start Strong Heart Antioxidants Cereal, Kellogg's	55	6.3
57342010	Smorz, Kellogg's	30	6.3
57344000	Special K	30	6.3
57344010	Special K Red Berries	30	6.3
57344020	Special K Vanilla Almond	30	6.3
57346500	Oatmeal Honey Nut Heaven, Quaker (formerly Toasted Oatmeal, Honey Nut)	55	6.3

57347000	Corn Pops	30	6.3
57347500	Strawberry Squares Mini-Wheats, Kellogg's (formerly Strawberry Squares)	30	6.3
57348000	Frosted corn flakes, NFS	30	6.3
57349000	Frosted Flakes, Kellogg's	30	6.3
57355000	Golden Crisp (Formerly called Super Golden Crisp)	30	6.3
57401100	Toasted oat cereal	30	6.3
57403100	Toasties, Post	30	6.3
57404100	Malt-O-Meal Toasty O's	30	6.3
57404200	Malt-O-Meal Apple and Cinnamon Toasty O's	30	6.3
57406100	Total	30	6.3
57407100	Trix	30	6.3
57408100	Uncle Sam Cereal (formerly Uncle Sam's Hi Fiber Cereal)	55	6.3
57409100	Waffle Crisp, Post	30	6.3
57410000	Weetabix Whole Wheat Cereal	55	6.3
57411000	Wheat Chex	55	6.3
57412000	Wheat germ, plain	55	6.3
57416000	Wheat, puffed, plain	15	6.3
57416010	Wheat, puffed, presweetened with sugar	30	6.3
57417000	Shredded Wheat, 100%	55	6.3
57418000	Wheaties	30	6.3
57601100	Wheat bran, unprocessed	15	6.3
57602100	Oats, raw	45	6.3
57602500	Oat bran, uncooked	15	6.3

5. Grain products- Grain mixtures, frozen plate meals, soups

Food codes	Description	Serving size, g	g IMD/ serving
58100360	Chilaquiles, tortilla casserole with salsa, cheese, and egg	232	3.2
58100370	Chilaquiles, tortilla casserole with salsa and cheese, no egg	232	3.2
58100400	Enchilada with beef, no beans	140	3.2
58100520	Enchilada with meat and beans, red-chile or enchilada sauce	140	3.2
58100530	Enchilada with meat, red-chile or enchilada sauce	140	3.2
58100600	Enchilada with chicken, tomato-based sauce	195	3.2
58100610	Enchilada with chicken and beans, tomato-based sauce	195	3.2
58100620	Enchilada with chicken and beans, red-chile or enchilada sauce	195	3.2
58100630	Enchilada with chicken, red-chile or enchilada sauce	195	3.2
58100710	Enchilada with beans, meatless	140	3.2
58100720	Enchilada with beans, meatless, red-chile or enchilada sauce	140	3.2
58100800	Enchilada, just cheese, meatless, no beans, red-chile or	140	3.2

	enchilada sauce		
58101310	Taco or tostada with beef, lettuce, tomato and salsa	140	3.2
58101320	Taco or tostada with meat	140	3.2
58101510	Taco or tostada with chicken or turkey, lettuce, tomato and salsa	140	3.2
58101520	Taco or tostada with chicken	140	3.2
58101530	Soft taco with beef, cheese, lettuce, tomato and salsa	140	3.2
58101540	Taco or tostada with fish	140	3.2
58101710	Taco or tostada with beans, meatless, with lettuce, tomato and salsa	140	3.2
58101720	Taco or tostada with beans	140	3.2
58101730	Taco or tostada with meat and beans	140	3.2
58101800	Ground beef with tomato sauce and taco seasonings on a cornbread crust	179	3.2
58101820	Mexican casserole made with ground beef, beans, tomato sauce, cheese, taco seasonings, and corn chips	144	3.2
58101830	Mexican casserole made with ground beef, tomato sauce, cheese, taco seasonings, and corn chips	144	3.2
58104290	Gordita, sope, or chalupa with meat	140	3.2
58104340	Gordita, sope, or chalupa with chicken	140	3.2
58106210	Pizza, cheese, from restaurant or fast food, NS as to type of crust	140	3.2
58106220	Pizza, cheese, from restaurant or fast food, thin crust	140	3.2
58106230	Pizza, cheese, from restaurant or fast food, thick crust	140	3.2
58106310	Pizza, cheese, with vegetables, NS as to type of crust	140	3.2
58106320	Pizza, cheese, with vegetables, thin crust	140	3.2
58106330	Pizza, cheese, with vegetables, thick crust	140	3.2
58106360	Pizza, cheese, with fruit, thick crust	140	3.2
58106510	Pizza with meat, NS as to type of crust	140	3.2
58106520	Pizza with meat, thin crust	140	3.2
58106530	Pizza with meat, thick crust	140	3.2
58106710	Pizza with meat and vegetables, NS as to type of crust	140	3.2
58106720	Pizza with meat and vegetables, thin crust	140	3.2
58106730	Pizza with meat and vegetables, thick crust	140	3.2
58106740	Pizza with meat and fruit, NS as to type of crust	140	3.2
58106750	Pizza with meat and fruit, thin crust	140	3.2
58106760	Pizza with meat and fruit, thick crust	140	3.2
58106780	Pizza with meat and vegetables, prepared from frozen, lowfat, thin crust	140	3.2
58106820	Pizza with beans and vegetables, thin crust	140	3.2
58106830	Pizza with beans and vegetables, thick crust	140	3.2
58107030	Pizza, no cheese, NS as to type of crust	140	3.2
58107050	Pizza, no cheese, thin crust	140	3.2
58107100	Pizza, no cheese, thick crust	140	3.2
58108050	Pizza rolls	119	3.2

58116110	Meat turnover, Puerto Rican style (Pastelillo de carne; Empanadilla)	140	3.2
58126150	Turnover, meat- and cheese-filled, tomato-based sauce	195	3.2
58126300	Turnover, meat- and cheese-filled, tomato-based sauce, lower in fat	140	3.2
58130011	Lasagna with meat	140	3.2
58130013	Lasagna with meat, canned	140	3.2
58130020	Lasagna with meat and spinach	140	3.2
58130140	Lasagna with chicken or turkey	140	3.2
58130310	Lasagna, meatless	140	3.2
58130320	Lasagna, meatless, with vegetables	140	3.2
58131110	Ravioli, NS as to filling, with tomato sauce	195	3.2
58131320	Ravioli, meat-filled, with tomato sauce or meat sauce	195	3.2
58131323	Ravioli, meat-filled, with tomato sauce or meat sauce, canned	195	3.2
58131520	Ravioli, cheese-filled, with tomato sauce	195	3.2
58131523	Ravioli, cheese-filled, with tomato sauce, canned	195	3.2
58131530	Ravioli, cheese-filled, with meat sauce	195	3.2
58131610	Ravioli, cheese and spinach filled, with tomato sauce	195	3.2
58132110	Spaghetti with tomato sauce, meatless	248	3.2
58132113	Pasta with tomato sauce and cheese, canned	249	3.2
58132310	Spaghetti with tomato sauce and meatballs or spaghetti with meat sauce or spaghetti with meat sauce and meatballs	248	3.2
58132313	Pasta with tomato sauce and meat or meatballs, canned	249	3.2
58132340	Spaghetti with tomato sauce and vegetables	248	3.2
58132350	Spaghetti with tomato sauce, meatless, whole wheat noodles	248	3.2
58132360	Spaghetti with tomato sauce and meatballs, whole wheat noodles or spaghetti with meat sauce, whole wheat noodles or spaghetti with meat sauce and meatballs, whole wheat noodles	248	3.2
58132450	Spaghetti with tomato sauce, meatless, made with spinach noodles	248	3.2
58132460	Spaghetti with tomato sauce and meatballs made with spinach noodles, or spaghetti with meat sauce made with spinach noodles, or spaghetti with meat sauce and meatballs made with spinach noodles	248	3.2
58132710	Spaghetti with tomato sauce and frankfurters or hot dogs	248	3.2
58132713	Pasta with tomato sauce and frankfurters or hot dogs, canned	253	3.2
58132810	Spaghetti with red clam sauce	248	3.2
58132910	Spaghetti with tomato sauce and poultry	248	3.2
58133120	Manicotti, cheese-filled, with tomato sauce, meatless	195	3.2
58133130	Manicotti, cheese-filled, with meat sauce	195	3.2
58133140	Manicotti, vegetable- and cheese-filled, with tomato	195	3.2

	sauce, meatless		
58134120	Stuffed shells, cheese-filled, with tomato sauce, meatless	195	3.2
58134130	Stuffed shells, cheese-filled, with meat sauce	195	3.2
58134210	Stuffed shells, with chicken, with tomato sauce	195	3.2
58134610	Tortellini, meat-filled, with tomato sauce	210	3.2
58134620	Tortellini, cheese-filled, meatless, with tomato sauce	250	3.2
58134623	Tortellini, cheese-filled, meatless, with tomato sauce, canned	247	3.2
58134710	Tortellini, spinach-filled, with tomato sauce	200	3.2
58145140	Macaroni or noodles with cheese and tomato	243	3.2
58146100	Pasta with tomato sauce, meatless	248	3.2
58146110	Pasta with meat sauce	255	3.2
58146120	Pasta with cheese and meat sauce	242	3.2
58146150	Pasta with cheese and tomato sauce, meatless	242	3.2
58146310	Pasta, whole wheat, with tomato sauce, meatless	248	3.2
58160220	Rice with vegetables, tomato-based sauce (mixture)	254	3.2
58161300	White rice with tomato sauce	243	3.2
58161310	Rice, brown, with tomato sauce	243	3.2
58163310	Flavored rice mixture	218	3.2
58163330	Flavored rice mixture with cheese	230	3.2
58163360	Flavored rice, brown and wild	217	3.2
58163380	Flavored rice and pasta mixture	196	3.2
58163410	Spanish rice, fat added in cooking	243	3.2
58163510	Rice dressing	167	3.2
58163610	Rice-vegetable medley	206	3.2
58164110	Rice with raisins	185	3.2
58301020	Lasagna with cheese and sauce (diet frozen meal)	195	3.2
58301030	Veal lasagna (diet frozen meal)	195	3.2
58301050	Lasagna with cheese and meat sauce (diet frozen meal)	195	3.2
58301150	Zucchini lasagna (diet frozen meal)	195	3.2
58302000	Macaroni and cheese (diet frozen meal)	195	3.2
58302050	Beef and noodles with meat sauce and cheese (diet frozen meal)	195	3.2
58302080	Noodles with vegetables in tomato-based sauce (diet frozen meal)	195	3.2
58304050	Spaghetti with meat and mushroom sauce (diet frozen meal)	195	3.2
58304060	Spaghetti with meat sauce (diet frozen meal)	195	3.2
58304200	Ravioli, cheese-filled, with tomato sauce (diet frozen meal)	195	3.2
58304250	Manicotti, cheese-filled, with tomato sauce (diet frozen meal)	195	3.2
58304400	Linguini with vegetables and seafood in white wine sauce (diet frozen meal)	195	3.2
58305250	Pasta with vegetable and cheese sauce (diet frozen meal)	195	3.2

58306100	Chicken enchilada (diet frozen meal)	195	3.2
58400100	Noodle soup, NFS	245	3.2
58400200	Rice soup, NFS	245	3.2
58401010	Barley soup, home recipe, canned, or ready-to-serve	245	3.2
58403030	Chicken noodle soup, canned, low sodium, ready-to-serve	245	3.2
58403060	Chicken or turkey noodle soup, reduced sodium, canned or ready-to-serve	245	3.2
58404040	Chicken or turkey rice soup, reduced sodium, canned, prepared with water or ready-to-serve	245	3.2
58407010	Instant soup, noodle	245	3.2
58407030	Soup, mostly noodles	245	3.2
58407040	Instant soup, rice	245	3.2
58407050	Instant soup, noodle with egg, shrimp or chicken	245	3.2
59003000	Meat substitute, cereal- and vegetable protein-based, fried	146	3.2

6. Fruits and fruit products

Food codes	Description	Serving size, g	g IMD/ serving
62101000	Fruit, dried, NFS (assume uncooked)	40	3.2
62101050	Fruit mixture, dried (mixture includes three or more of the following: apples, apricots, dates, papaya, peaches, pears, pineapples, prunes, raisins)	40	3.2
62101100	Apple, dried, uncooked	40	3.2
62101200	Apple, dried, cooked, NS as to sweetened or unsweetened; sweetened, NS as to type of sweetener	40	3.2
62101300	Apple chips	40	3.2
62104100	Apricot, dried, uncooked	40	3.2
62104200	Apricot, dried, cooked, NS as to sweetened or unsweetened; sweetened, NS as to type of sweetener	40	3.2
62107200	Banana chips	40	3.2
62108100	Currants, dried	40	3.2
62109100	Cranberries, dried	40	3.2
62110100	Date	40	3.2
62113100	Fig, dried, uncooked	40	3.2
62114050	Mango, dried	40	3.2
62114110	Papaya, dried	40	3.2
62116100	Peach, dried, uncooked	40	3.2
62119100	Pear, dried, uncooked	40	3.2
62119230	Pear, dried, cooked, with sugar	40	3.2
62120100	Pineapple, dried	40	3.2
62122100	Prune, dried, uncooked	40	3.2
62122200	Prune, dried, cooked, NS as to sweetened or unsweetened; sweetened, NS as to type of sweetener	40	3.2
62125100	Raisins	40	3.2

62125110	Raisins, cooked	40	3.2
62126000	Tamarind pulp, dried, sweetened ("Pulpitas")	40	3.2
63101110	Applesauce, stewed apples, NS as to sweetened or unsweetened; sweetened, NS as to type of sweetener	140	3.2
63101120	Applesauce, stewed apples, unsweetened	140	3.2
63101130	Applesauce, stewed apples, with sugar	140	3.2
63101140	Applesauce, stewed apples, sweetened with low calorie sweetener	140	3.2
63101150	Applesauce with other fruits	140	3.2
63101320	Apple, baked, unsweetened	140	3.2
63135110	Peach, cooked or canned, NS as to sweetened or unsweetened; sweetened, NS as to type of sweetener	140	3.2
63135120	Peach, cooked or canned, unsweetened, water pack	140	3.2
63135130	Peach, cooked or canned, in heavy syrup	140	3.2
63135140	Peach, cooked or canned, in light or medium syrup	140	3.2
63135150	Peach, cooked or canned, drained solids	140	3.2
63135170	Peach, cooked or canned, juice pack	140	3.2
63137110	Pear, cooked or canned, NS as to sweetened or unsweetened; sweetened, NS as to type of sweetener	140	3.2
63137130	Pear, cooked or canned, in heavy syrup	140	3.2
63137140	Pear, cooked or canned, in light syrup	140	3.2
63137150	Pear, cooked or canned, drained solids	140	3.2
63137170	Pear, cooked or canned, juice pack	140	3.2
63141110	Pineapple, cooked or canned, NS as to sweetened or unsweetened; sweetened, NS as to type of sweetener	140	3.2
63141130	Pineapple, cooked or canned, in heavy syrup	140	3.2
63141140	Pineapple, cooked or canned, in light syrup	140	3.2
63141150	Pineapple, cooked or canned, drained solids	140	3.2
63141170	Pineapple, cooked or canned, juice pack	140	3.2
63207000	Cranberries, NS as to raw, cooked, or canned	55	3.2
63207110	Cranberries, cooked or canned	70	3.2
63408010	Guacamole with tomatoes	30	3.2
63408200	Guacamole with tomatoes and chili peppers	30	3.2
63409010	Guacamole	30	3.2
63409020	Chutney	34	3.2
63420100	Fruit juice bar, frozen, orange flavor	85	3.2
63420110	Fruit juice bar, frozen, flavor other than orange	85	3.2
63420200	Fruit juice bar, frozen, sweetened with low calorie sweetener, flavors other than orange	85	3.2
63430100	Sorbet, fruit, noncitrus flavor	85	3.2
63430110	Sorbet, fruit, citrus flavor	85	3.2
64100100	Fruit juice, NFS	240	3.2
64100110	Fruit juice blend, 100% juice	240	3.2
64100200	Fruit juice blend, with cranberry, 100% juice	240	3.2

7. Vegetable products

Food codes	Description	Serving size, g	g IMD/serving
74301100	Tomato juice	240	3.2
74301150	Tomato juice, low sodium	240	3.2
74302000	Tomato juice cocktail	240	3.2
74303000	Tomato and vegetable juice, mostly tomato	240	3.2
74304000	Tomato juice with clam or beef juice	240	3.2
74401010	Tomato catsup	15	3.2
74402100	Salsa, NFS	32	3.2
74402110	Salsa, pico de gallo	30	3.2
74402150	Salsa, red, commercially-prepared	32	3.2
74403010	Tomato sauce	60	3.2
74403110	Tomato paste	30	3.2
74404010	Spaghetti sauce, meatless	125	3.2
74404020	Spaghetti sauce with vegetables, homemade-style	125	3.2
74404030	Spaghetti sauce with meat, canned, no extra meat added	125	3.2
74404060	Spaghetti sauce, meatless, fat free	125	3.2
74406010	Barbecue sauce	30	3.2
74602100	Tomato soup, canned, low sodium, ready-to-serve	245	3.2
74602200	Tomato soup, canned, reduced sodium, prepared with water, or ready-to-serve	245	3.2
74602300	Tomato soup, canned, reduced sodium, prepared with milk	245	3.2
75306010	Eggplant in tomato sauce, cooked, fat not added in cooking	110	3.2
75316010	Zucchini with tomato sauce, cooked, fat not added in cooking	110	3.2
75412030	Eggplant dip	58.25	3.2
75412070	Eggplant with cheese and tomato sauce	110	3.2
75418030	Squash, summer, casserole, with rice and tomato sauce	233	3.2
75506100	Mustard sauce	30	3.2
75607050	Mushroom soup, cream of, low sodium, prepared with water	245	3.2
75607140	Mushroom soup, cream of, canned, reduced sodium, prepared with water	245	3.2
75609050	Pea soup, canned, low sodium, prepared with water	245	3.2
75649030	Vegetable soup, canned, low sodium, prepared with water or ready-to-serve	245	3.2
75649070	Vegetable soup, made from dry mix, low sodium	245	3.2
75650990	Minestrone soup, reduced sodium, canned or ready-to-serve	245	3.2
75651150	Vegetable noodle soup, reduced sodium, canned, prepared with water or ready-to-serve	245	3.2

83. Salad dressings

Food codes	Description	Serving size, g	g IMD/ serving
83110010	Mayonnaise-type salad dressing, cholesterol-free	15	3.2
83200100	Salad dressing, light, NFS	30	3.2
83201000	Blue or roquefort cheese dressing, light	30	3.2
83201050	Blue or roquefort cheese dressing, reduced calorie	30	3.2
83201200	Blue or roquefort cheese dressing, reduced calorie, fat-free, cholesterol-free	30	3.2
83202000	French dressing, low-calorie	30	3.2
83202010	French dressing, reduced calorie, fat-free, cholesterol-free	30	3.2
83202020	French or Catalina dressing, light	30	3.2
83203000	Caesar dressing, light	30	3.2
83203250	Mayonnaise-type salad dressing, fat-free	15	3.2
83204000	Mayonnaise, light	15	3.2
83204020	Mayonnaise, reduced calorie or diet, cholesterol-free	15	3.2
83204050	Mayonnaise-type salad dressing, light	15	3.2
83204060	Mayonnaise-type salad dressing, low-calorie or diet, cholesterol-free	15	3.2
83204500	Honey mustard dressing, light	30	3.2
83205000	Italian dressing, low calorie	30	3.2
83205450	Italian dressing, light	30	3.2
83205500	Italian dressing, reduced calorie, fat-free	30	3.2
83206000	Russian dressing, light	30	3.2
83207000	Thousand Island dressing, light	30	3.2
83207100	Thousand Island dressing, reduced calorie, fat-free, cholesterol-free	30	3.2
83208000	Vinegar, sugar, and water dressing	30	3.2
83210000	Creamy dressing, made with sour cream and/or buttermilk and oil, diet, NS as to low or reduced calorie	30	3.2
83210100	Creamy dressing, light	30	3.2
83210200	Creamy dressing, made with sour cream and/or buttermilk and oil, reduced calorie, fat-free, cholesterol-free	30	3.2
83210250	Creamy dressing, made with sour cream and/or buttermilk and oil, reduced calorie, cholesterol-free	30	3.2
83220000	Salad dressing, low calorie, oil free	30	3.2

9. Sugars, sweets, and beverages - Sugar substitutes

Food codes	Description	Serving size, g	g IMD/ serving
91106000	Sugar substitute, sugar-aspartame blend, dry powder	1	3.2
91107000	Sucralose-based sweetener, sugar substitute	1	3.2
91108000	Sugar substitute, herbal extract sweetener, powder	1	3.2

91108010	Sugar substitute, herbal extract sweetener, liquid	5	3.2
91109000	Blue Agave liquid sweetener, sugar substitute	0.8	3.2
91200000	Sugar substitute, low-calorie, powdered, NFS	0.8	3.2
91200020	Sugar substitute, saccharin-based, dry powder	0.8	3.2
91200030	Brown sugar substitute, saccharin-based, dry powder	0.4	3.2
91200040	Sugar substitute, saccharin-based, dry powder and tablets	1	3.2
91200110	Sugar substitute, saccharin-based, liquid	5	3.2
91201010	Sugar substitute, aspartame-based, dry powder	1	3.2

9. Sugars, sweets, and beverages – Syrups, jams, jelly, sweets, and beverages

Food codes	Description	Serving size, g	g IMD/ serving
91300010	Syrup, NFS	60	3.2
91300100	Pancake syrup, NFS	60	3.2
91301060	Maple syrup (100% maple)	60	3.2
91301080	Chocolate syrup, thin type	60	3.2
91301081	Chocolate syrup, thin type, light	60	3.2
91301250	Maple and corn and/or cane pancake syrup blends (formerly Corn and maple syrup (2% maple))	60	3.2
91301510	Syrup, pancake, reduced calorie	60	3.2
91304010	Topping, butterscotch or caramel	42.4	3.2
91304020	Topping, chocolate, thick, fudge type	42	3.2
91305010	Icing, chocolate	34.4	3.2
91305020	Icing, white	39.8	3.2
91351010	Syrup, dietetic	60	3.2
91351020	Topping, dietetic	28.4	3.2
91401000	Jelly, all flavors	19	3.2
91402000	Jam, preserves, all flavors	21	3.2
91403000	Fruit butter, all flavors	18	3.2
91404000	Marmalade, all flavors	20	3.2
91405000	Jelly, dietetic, all flavors, sweetened with artificial sweetener	18.8	3.2
91405500	Jelly, reduced sugar, all flavors	18.8	3.2
91406000	Jams, preserves, marmalades, dietetic, all flavors, sweetened with artificial sweetener	14	3.2
91406500	Jams, preserves, marmalades, sweetened with fruit juice concentrates, all flavors	20	3.2
91406600	Jams, preserves, marmalades, low sugar (all flavors)	18.1	3.2
91501010	Gelatin dessert	120	3.2
91501015	Gelatin snacks	115	3.2
91511010	Gelatin dessert, dietetic, sweetened with low calorie sweetener	120	3.2
91511020	Gelatin dessert, dietetic, with fruit, sweetened with	120	3.2

	low calorie sweetener		
91511030	Gelatin dessert, dietetic, with whipped topping, sweetened with low calorie sweetener	113.5	3.2
91511070	Gelatin dessert, dietetic, with fruit and sour cream, sweetened with low calorie sweetener	124.5	3.2
91511100	Gelatin salad, dietetic, with vegetables, sweetened with low calorie sweetener	121.5	3.2
91611100	Ice pop, sweetened with low calorie sweetener	85	3.2
91700010	Candy, NFS	40	3.2
91703080	Caramel, all flavors, sugar free	40	3.2
91708100	Fruit snacks candy, with high vitamin C	40	3.2
91770000	Dietetic or low calorie candy, NFS	40	3.2
91770010	Dietetic or low calorie gumdrops	40	3.2
91770020	Dietetic or low calorie hard candy	15	3.2
91770030	Dietetic or low calorie candy, chocolate covered	40	3.2
91770050	Dietetic or low calorie mints	2	3.2

9. Sugars, sweets, and beverages –Coffee, tea, and other beverages

Food codes	Description	Serving size, g	g IMD/ serving
92100000	Coffee, NS as to type	240	3.2
92100500	Coffee, regular, NS as to ground or instant	240	3.2
92101500	Coffee, made from ground, equal parts regular and decaffeinated	240	3.2
92101600	Coffee, Turkish	240	3.2
92101610	Coffee, espresso	240	3.2
92101630	Coffee, espresso, decaffeinated	240	3.2
92101700	Coffee, made from ground, regular, flavored	240	3.2
92101800	Coffee, Cuban	240	3.2
92101900	Coffee, Latte	240	3.2
92101910	Coffee, Latte, decaffeinated	240	3.2
92101920	Blended coffee beverage, made with regular coffee, milk, and ice, sweetened	240	3.2
92101930	Blended coffee beverage, made with decaffeinated coffee, milk, and ice, sweetened	240	3.2
92101950	Coffee, mocha	240	3.2
92103000	Coffee, made from powdered instant, regular	240	3.2
92104000	Coffee, made from powdered instant, 50% less caffeine	240	3.2
92106000	Coffee, acid neutralized, from powdered instant	240	3.2
92111000	Coffee, decaffeinated, NS as to ground or instant	240	3.2
92114000	Coffee, decaffeinated, made from powdered instant	240	3.2
92121000	Coffee, made from powdered instant mix, with	240	3.2

	whitener and sugar, instant		
92121010	Coffee, made from powdered instant mix, presweetened, no whitener	240	3.2
92121020	Coffee and cocoa (mocha), made from powdered instant mix, with whitener, presweetened	240	3.2
92121030	Coffee and cocoa (mocha), made from powdered instant mix, with whitener and low calorie sweetener	240	3.2
92121040	Coffee, made from powdered instant mix, with whitener and low calorie sweetener	240	3.2
92121050	Coffee and cocoa (mocha), made from powdered instant mix, with whitener and low calorie sweetener, decaffeinated	240	3.2
92152000	Coffee and chicory, made from ground	240	3.2
92161000	Cappuccino	240	3.2
92162000	Cappuccino, decaffeinated	240	3.2
92191000	Coffee, dry instant powder, NS as to regular or decaffeinated	1.5	3.2
92191100	Coffee, dry instant powder, regular	1.5	3.2
92191200	Coffee, dry instant powder, decaffeinated	1.5	3.2
92192000	Coffee and cocoa (mocha) mix, dry instant powder with whitener, presweetened	12.8	3.2
92193000	Coffee, dry instant powder, with whitener and sugar	12.8	3.2
92201010	Postum	240	3.2
92301000	Tea, NS as to type, unsweetened	240	3.2
92301080	Tea, NS as to type, presweetened with low calorie sweetener	240	3.2
92301100	Tea, NS as to type, decaffeinated, unsweetened	240	3.2
92301130	Tea, NS as to type, presweetened, NS as to sweetener	240	3.2
92301160	Tea, NS as to type, decaffeinated, presweetened with sugar	240	3.2
92301180	Tea, NS as to type, decaffeinated, presweetened with low calorie sweetener	240	3.2
92301190	Tea, NS as to type, decaffeinated, presweetened, NS as to sweetener	240	3.2
92304000	Tea, made from frozen concentrate, unsweetened	240	3.2
92304700	Tea, made from frozen concentrate, decaffeinated, presweetened with low calorie sweetener	240	3.2
92305000	Tea, made from powdered instant, presweetened, NS as to sweetener	240	3.2
92305010	Tea, made from powdered instant, unsweetened	240	3.2
92305040	Tea, made from powdered instant, presweetened with sugar	240	3.2
92305050	Tea, made from powdered instant, decaffeinated, presweetened with sugar	240	3.2
92305090	Tea, made from powdered instant, presweetened with low calorie sweetener	240	3.2

92305110	Tea, made from powdered instant, decaffeinated, presweetened with low calorie sweetener	240	3.2
92305180	Tea, made from powdered instant, decaffeinated, unsweetened	240	3.2
92305800	Tea, made from powdered instant, decaffeinated, presweetened, NS as to sweetener	240	3.2
92306000	Tea, herbal	240	3.2
92306020	Tea, herbal, presweetened with sugar	240	3.2
92306030	Tea, herbal, presweetened with low calorie sweetener	240	3.2
92306040	Tea, herbal, presweetened, NS as to sweetener	240	3.2
92307000	Tea, powdered instant, unsweetened, dry	1.4	3.2
92307400	Tea, powdered instant, sweetened, NS as to sweetener, dry	2	3.2
92410110	Carbonated water, sweetened	240	3.2
92410210	Carbonated water, unsweetened	240	3.2
92410250	Carbonated water, sweetened, with low-calorie or no-calorie sweetener	240	3.2
92431000	Carbonated juice drink, NS as to type of juice	240	3.2
92433000	Carbonated noncitrus juice drink	240	3.2
92512040	Frozen daiquiri mix, frozen concentrate, not reconstituted	36	3.2
92512050	Frozen daiquiri mix, from frozen concentrate, reconstituted	240	3.2
92520410	Fruit drink, low calorie	240	3.2
92520910	Lemonade, low calorie	240	3.2
92530310	Cherry drink with vitamin C added	240	3.2
92530410	Fruit flavored drink, with high vitamin C	240	3.2
92530510	Cranberry juice drink or cocktail, with high vitamin C	240	3.2
92530520	Cranberry-apple juice drink with vitamin C added	240	3.2
92530610	Fruit juice drink, with high vitamin C	240	3.2
92530810	Grapefruit juice drink with vitamin C added	240	3.2
92530840	Guava juice drink with vitamin C added	240	3.2
92530910	Lemonade with vitamin C added	240	3.2
92530950	Vegetable and fruit juice drink, with high vitamin C	240	3.2
92531010	Orange drink and orangeade with vitamin C added	240	3.2
92531030	Fruit juice drink, with thiamin (vitamin B1) and high vitamin C	240	3.2
92541010	Fruit flavored drink, made from powdered mix	240	3.2
92541100	Apple cider-flavored drink, made from powdered mix, with sugar and vitamin C added	240	3.2
92542000	Fruit flavored drink, made from powdered mix, with high vitamin C	240	3.2
92544000	Fruit-flavored drink, made from unsweetened powdered mix (fortified with vitamin C), with sugar added in preparation	240	3.2

92550030	Fruit juice drink, low calorie, with high vitamin C	240	3.2
92550050	Apple-white grape juice drink, low calorie, with vitamin C added	240	3.2
92550110	Cranberry juice drink or cocktail, low calorie, with high vitamin C	240	3.2
92550210	Cranberry-apple juice drink, low calorie, with vitamin C added	240	3.2
92550300	Grapefruit juice drink, low calorie, with vitamin C added	240	3.2
92550610	Fruit flavored drink, low calorie, with high vitamin C	240	3.2
92550620	Fruit flavored drink, low calorie	240	3.2
92551700	Juice drink, low calorie	240	3.2
92552000	Fruit flavored drink, made from powdered mix, low calorie, with high vitamin C	240	3.2
92552010	Fruit flavored drink, made from powdered mix, low calorie	240	3.2
92552020	Fruit juice drink, reduced sugar, with thiamin (vitamin B1) and high vitamin C	240	3.2
92552100	Orange-cranberry juice drink, low calorie, with vitamin C added	240	3.2
92553000	Fruit-flavored thirst quencher beverage, low calorie	240	3.2
92560000	Fruit-flavored thirst quencher beverage	240	3.2
92560100	Gatorade Thirst Quencher sports drink	240	3.2
92560200	Powerade sports drink	240	3.2
92565000	Fruit-flavored sports drink or thirst quencher beverage, low calorie	240	3.2
92565100	Gatorade G2 thirst quencher sports drink, low calorie	240	3.2
92565200	Powerade Zero sports drink, low calorie	240	3.2
92570100	Fluid replacement, electrolyte solution	240	3.2
92570500	Fluid replacement, 5% glucose in water	240	3.2
92582100	Fruit juice drink, with high vitamin C, plus added calcium	240	3.2
92582110	Fruit juice drink, with thiamin (vitamin B1) and high vitamin C plus calcium	240	3.2
92650000	Red Bull Energy Drink	240	3.2
92650005	Red Bull Energy Drink, sugar-free	240	3.2
92650100	Full Throttle Energy Drink	240	3.2
92650200	Monster Energy Drink	240	3.2
92650205	Mountain Dew AMP Energy Drink	240	3.2
92650210	Mountain Dew AMP Energy Drink, sugar-free	240	3.2
92650700	Rockstar Energy Drink	240	3.2
92650705	Rockstar Energy Drink, sugar-free	240	3.2
92650800	Vault Energy Drink	240	3.2
92650805	Vault Zero Energy drink	240	3.2
92651000	Energy drink	240	3.2

92900110	Fruit-flavored beverage, dry concentrate, with sugar, not reconstituted	25	6.3
92900200	Fruit-flavored beverage, dry concentrate, low calorie, not reconstituted	16	6.3
93102000	Beer, lite	240	3.2
94100200	Water, bottled, sweetened, with low or no calorie sweetener	240	3.2
94210100	Propel Water	240	3.2
94210200	Glaceau Water	240	3.2

9. Sugars, sweets, and beverages –Formulated nutrition beverages, energy drinks, sports drinks, functional beverages

Food codes	Description	Serving size, g	g IMD/ serving
95101000	Boost, nutritional drink, ready-to-drink	240	6.3
95101010	Boost Plus, nutritional drink, ready-to-drink	240	6.3
95102000	Carnation Instant Breakfast, nutritional drink, regular, ready-to-drink	240	6.3
95102010	Carnation Instant Breakfast, nutritional drink, sugar free, ready-to-drink	240	6.3
95103000	Ensure, nutritional shake, ready-to-drink	240	6.3
95103010	Ensure Plus, nutritional shake, ready-to-drink	240	6.3
95104000	Glucerna, nutritional shake, ready-to-drink	240	6.3
95105000	Kellogg's Special K Protein Shake	240	6.3
95106000	Muscle Milk, ready-to-drink	240	6.3
95106010	Muscle Milk, light, ready-to-drink	240	6.3
95110000	Slim Fast Shake, meal replacement, regular, ready-to-drink	240	6.3
95110010	Slim Fast Shake, meal replacement, sugar free, ready-to-drink	240	6.3
95110020	Slim Fast Shake, meal replacement, high protein, ready-to-drink	240	6.3
95120000	Nutritional drink or meal replacement, ready-to-drink, NFS	240	6.3
95120010	Nutritional drink or meal replacement, high protein, ready-to-drink, NFS	240	6.3
95120020	Nutritional drink or meal replacement, high protein, light, ready-to-drink, NFS	240	6.3
95120050	Nutritional drink or meal replacement, liquid, soy-based	240	6.3
95201000	Carnation Instant Breakfast, nutritional drink mix, regular, powder	33	6.3
95201010	Carnation Instant Breakfast, nutritional drink mix, sugar free, powder	33	6.3
95201200	EAS Whey Protein Powder	33	6.3

95201300	EAS Soy Protein Powder	33	6.3
95201500	Herbalife, nutritional shake mix, high protein, powder	33	6.3
95201600	Isopure protein powder	33	6.3
95201700	Kellogg's Special K20 Protein Water Mix	33	6.3
95202000	Muscle Milk, regular, powder	33	6.3
95202010	Muscle Milk, light, powder	33	6.3
95210000	Slim Fast Shake Mix, powder	33	6.3
95210010	Slim Fast Shake Mix, sugar free, powder	33	6.3
95210020	Slim Fast Shake Mix, high protein, powder	33	6.3
95220000	Nutritional drink mix or meal replacement, powder, NFS	33	6.3
95220010	Nutritional drink mix or meal replacement, high protein, powder, NFS	33	6.3
95230000	Protein powder, whey based, NFS	33	6.3
95230010	Protein powder, soy based, NFS	33	6.3
95230020	Protein powder, light, NFS	33	6.3
95230030	Protein powder, NFS	33	6.3
95310200	Full Throttle Energy Drink	240	3.2
95310400	Monster Energy Drink	240	3.2
95310500	Mountain Dew AMP Energy Drink	240	3.2
95310550	No Fear Energy Drink	240	3.2
95310555	No Fear Motherload Energy Drink	240	3.2
95310560	NOS Energy Drink	240	3.2
95310600	Red Bull Energy Drink	240	3.2
95310700	Rockstar Energy Drink	240	3.2
95310750	SoBe Energize Energy Juice Drink	240	3.2
95310800	Vault Energy Drink	240	3.2
95311000	Energy Drink	240	3.2
95312400	Monster Energy Drink, Lo Carb	240	3.2
95312500	Mountain Dew AMP Energy Drink, sugar-free	240	3.2
95312550	No Fear Energy Drink, sugar-free	240	3.2
95312555	NOS Energy Drink, sugar-free	240	3.2
95312560	Ocean Spray Cran-Energy Cranberry Energy Juice Drink	240	3.2
95312600	Red Bull Energy Drink, sugar-free	240	3.2
95312700	Rockstar Energy Drink, sugar-free	240	3.2
95312800	Vault Zero Energy Drink	240	3.2
95312900	XS Energy Drink	240	3.2
95312905	XS Gold Plus Energy Drink	240	3.2
95320200	Gatorade Thirst Quencher sports drink	240	3.2
95320500	Powerade sports drink	240	3.2
95321000	Fruit-flavored thirst quencher beverage	240	3.2
95322200	Gatorade G2 Thirst Quencher sports drink, low calorie	240	3.2
95322500	Powerade Zero sports drink, low calorie	240	3.2
95323000	Fruit-flavored sports drink or thirst quencher beverage,	240	3.2

NutraSource, Inc.

	low calorie		
95330100	Fluid replacement, electrolyte solution	240	3.2
95330500	Fluid replacement, 5% glucose in water	240	3.2
95341000	FUZE Slenderize fortified low calorie fruit juice beverage	240	3.2
95342000	MonaVie acai blend beverage	240	3.2

SUBMISSION END

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