ASPARTAME: METHANOL AND THE PUBLIC HEALTH

Woodrow C. Monte, Ph.D., R.D.
Director of the Food Science and Nutrition Laboratory
Arizona State University
Tempe, Arizona 85287

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ABSTRACT

Aspartame (L-asparty-L-phenylalanine methyl ester), a new sweetener marketed under the trade name NutraSweet*, releases into the human bloodstream one molecule of methanol for each molecule of aspartame consumed.

This new methanol source is being added to foods that have considerably reduce caloric content and, thus, may be consumed in large amounts. Generally, none of these foods could be considered dietary methanol sources prior to addition of aspartame. When diet sodas and soft drinks, sweetened with aspartame, are used to replace fluid loss during exercise and physical exertion in hot climates, the intake of methanol can exceed 250 mg/day or 32 times the Environmental Protection Agency's recommended limit of consumption for this cumulative toxin[8].

There is extreme variation in the human response to acute methanol poisoning, the lowest recorded *lethal* oral dose being 100 mg/kg with one individual surviving a dose over ninety times this level[55]. Humans, due perhaps to the loss of two enzymes during evolution, are more sensitive to methanol than any laboratory animal; even the monkey is not generally accepted as a suitable animal model[42]. There are *no* human or mammalian studies to evaluate the possible mutagenic, teratogenic, or carcinogenic effects of chronic administration of methyl alcohol[55].

The average intake of methanol from natural sources varies but limited data suggests an average intake of considerably less than 10 mg/day[8]. Alcoholics may average much more, with a potential range of between 0 and 600 mg/day, depending on the source and in some cases the quality of their beverages[15].

Ethanol, the classic antidote for methanol toxicity, is found in natural food sources of methanol at concentrations 5 to 500,000 times that of the toxin (Table 1). Ethanol inhibits metabolism of methanol and allows the body time for clearance of the toxin through the lungs and kidneys[40, 46].

The question asked whether uncontrolled consumption of this new sweetener might increase the methanol intake of certain individuals to a point beyond which our limited knowledge of acute and chronic human methanol toxicity can be extrapolated to predict safety.

*NutraSweet is a trademark of G.D. Searl & Co.

Director of the Food Science and Nutrition Laboratory
Arizona State University
Tempe, Arizona 85287

ASPARTAME

Aspartame (L-aspartyl-L-phenylalanine methyl ester) has recently been approved as a sweetener for liquid carbonated beverages. It has had wide acceptance as an additive in many dry food applications after Food and Drug Administration approval on July 24, 1981[48].

The Food and Drug Administration, Dr. Richard Wurtman and myself have received well over a thousand written complaints relative to aspartame consumption. By far, the most numerous of these include dizziness, visual impairment, disorientation, ear buzzing, high SGOT, tunnel vision, loss of equilibrium, severe muscle aches, numbing of extremities, pancreatitis, episodes of high blood pressure, retinal hemorrhaging, menstrual flow changes, and depression. The validity of these complaints has yet to be scientifically evaluated. However, a thorough knowledge of just what makes this new sweetener stand apart from other nutritional substances might aid physicians in making dietary recommendations for their patients.

Aspartame (NutraSweet)* is a small molecule made up of three components: Phenylalanine, aspartic acid, and methanol (wood alcohol)[47]. When digested, these components are released into the bloodstream[48]. Phenylalanine and aspartic acid are both amino acids which are found in natural proteins[14], and under normal circumstances are beneficial, if not essential, for health. Proteins are complex molecules which contain many chemically bonded amino acids. It takes several enzymes to break these bonds and liberate the amino acids. This is as slow process and the amino acids are released gradually into the blood stream[40]. The quaternary structure of protein also slows the digestion of these amino acids; the amino acids in the center of the protein molecule aren't released until the outer layers of amino acids on the surface have been swept away. This natural time release process saves the body from large numbers of any one of these 21 amino acids being released into the bloodstream at any one time.

Aspartame requires the breaking of only two bonds for absorption[47]. This happens very quickly with the potential to raise component blood levels rapidly[52]. The methyl ester bond of phenyalanine is the first to cleave due to its susceptibility to pancreatic enzymes[40]. This is highly unusual; the methyl esters associated with pectin for instance are completely impervious to all human digestive enzymes[6].

AMINO ACID COMPONENTS

Phenylalanine

Phenylalanine is an essential amino acid, the daily consumption of which is required to maintain life. However, Dr. Richard J. Wurtman, Professor of Neuroendocrine Regulation at the Massachusetts Institute of Technology, presented data to the FDA demonstrating that in humans the feeding of a carbohydrate with aspartame significantly enhances aspartame's positive effect on plasma and brain phenylalanine and tyrosine levels (48 Federal Register at 31379). There are sound scientific reasons to believe that increasing the brain levels of these large neutral amino acids could affect the synthesis of neurotransmitters and in turn affect bodily functions controlled by the autonomic nervous system[61] (e.g., blood pressure). The proven ability of aspartame to inhibit the glucose-induced release of serotonin within the brain may also affect behaviors, such as satiety and sleep[61].

Aspartic Acid

Aspartic acid, is not an essential amino acid but is normally easily utilized for human metabolism. However, under conditions of excess absorption it has caused endocrine disorders in mammals with markedly elevated plasma levels of luteinizing hormone and testosterone in the rat[52] and release of pituitary gonadotropins and prolactin in the rhesus monkey[58]. The amount of luteinizing hormone in the blood is a major determinant of menstrual cycling in the human female[39].

METHANOL

Methanol (methyl alcohol, wood alcohol), a poisonous substance[60], is added as a component during the manufacture of aspartame[47]. The methanol is subsequently released within hours of consumption[51] after hydrolysis of the methyl group of the dipeptide by chymotrypsin in the small intestine[40]. Absorption in primates is hastened considerably if the methanol is ingested as free methanol[40] as it occurs in soft drinks after decomposition of aspartame during storage or in other foods after being heated[48]. Regardless of whether the aspartame-derived methanol exists in food in its free form or still esterified to phenylalanine, 10% of the weight of aspartame intake of an individual will be absorbed by the blood stream as methanol within hours after consumption[51].

Methanol has no therapeutic properties and is considered only as a toxicant[20]. The ingestion of two teaspoons is considered lethal in humans[19].

Methyl alcohol produces the *Methyl alcohol syndrome*, consistently , only in humans and *no other test animal*, including monkeys[42, 54]. There is a clear difference between "toxicity", which can be produced in every living thing, and the "toxic syndrome"[54].

The greater toxicity of methanol to man is deeply rooted in the limited biochemical pathways available to humans for detoxification. The loss of uricase (EC 1.7.3.3.), formyl-tetrahydrofolate synthetase (EC 6.3.4.3.)[42] and other enzymes[18] during evolution sets man apart from all laboratory animals including the monkey[42]. There is no generally accepted animal model for methanol toxicity[42, 59]. Humans suffer "toxic syndrome"[54] at a minimum lethal dose of < 1gm/kg, much less than that of monkeys, 3-6 g/kg[42, 59]. The minimum lethal dose of methanol in the rat, rabbit, and dog is 9, 5, 7, and 8 g/kg, respectively[43]; ethyl alcohol is more toxic than methanol to these test animals[43]. No human or experimental mammalian studies have been found to evaluate the possible mutagenic, teratogenic or carcinogenic effects of methyl alcohol[55], through a 3.5% chromosomal aberration rate in testicular tissues of grasshoppers was induced by an injection of methanol[51].

The United States Environmental Protection Agency in their Multimedia Environmental Goals for Environmental Assessment recommends a minimum acute toxicity concentration of methanol in drinking water at 3.9 parts per million, with a recommended limit of consumption below 7.8 mg/day[8]. This report clearly indicates that methanol:

> "is considered a cumulative poison due to the low rate of excretion once it is absorbed. In the body, methanol is oxidized to formaldehyde and formic acid; both of these metabolites are toxic."[8]

Role of Formaldehyde

Recently the toxic role of formaldehyde (in methanol toxicity) has been questioned[34]. No skeptic can overlook the fact that, metabolically, formaldehyde must be formed as an intermediate to formic acid production[54]. Formaldehyde has a high reactivity which may be why it has not been found in humans or other primates during methanol poisioning[59]. The *localized retinal* production of formaldehyde from methanol is still thought to be principally responsible for the optic papillitis and retinal edema always associated with the toxic syndrome in humans[20]. This is an intriguing issue since formaldehyde poisoning alone does not produce retinal damage[20].

If formaldehyde is produced from methanol and does have a reasonable half life within certain cells in the poisoned organism the chronic toxicological ramifications could be grave. Formaldehyde is a know carcinogen[57] producing squamous-cell carcinomas by inhalation exposure in experimental animals[22]. The available epidemiological studies do not provide adequate data for assessing the carcinogenicity of formaldehyde in man[22, 24, 57]. However, reaction of formaldehyde with deoxyribonucleic acid (DNA) has resulted in irreversible denaturation that could interfere with DNA replication and result in mutation[37]. Glycerol formal, a condensation product of glycerol and formaldehyde (which may be formed in vivo), is a potent teratogen causing an extremely high incidence of birth defects in laboratory animals[52]. Even the staunchest critic of formaldehyde involvement in methanol toxicity admits:

"It is not possible to completely eliminate formaldehyde as a toxic intermediate because formaldehyde could be formed slowly within cells and interfere with normal cellular function without ever obtaining levels that are detectable in body fluids or tissues."[34]

Acute Toxicity in Man "Toxic Syndrome"

A striking feature of methyl alcohol syndrome is the asymptomatic interval (latent period) which usually lasts 12 to 18 hours after consumption. This is followed by a rapid and severe acidosis caused partially by the production of formic acid[19]. Insufficient formic acid is generated to account for the severity of metabolic acidosis produced and, therefore, other organic acids may also be involved[32].

Patients may complain of lethargy, confusion, and impairment of articulation, all frequently encountered signs in moderate central nervous system (CNS) intoxication's resulting from other toxic compounds[20].

Patients may also suffer leg cramps, back pain, severe headache, abdominal pain, labored breathing, vertigo and visual loss, the latter being a very important clue to making a diagnosis of methanol poisoning[20]. Other striking clinical features associated only with the oral administration of methanol are elevated serum amylase and the finding of pancreatitis or pancreatic necrosis on autopsy[20, 55].

In fatal cases liver, kidneys and heart may show parenchymatous degeneration. The lungs show desquamation of epithelium, emphysema, edema, congestion and bronchial pneumonia[12].

Chronic Human Exposure

This is the most important aspect of methanol toxicity to those who are interested in observing the effect of increased methanol consumption on a population.

The data presented here were compiled by the Public Health Service. The individuals studied were working in methanol contaminated environments. It is interesting to note that the visual signs always associated with acute toxicity often do not surface under chronic conditions[20].

Many of the signs and symptoms of intoxication due to methanol ingestion are not specific to methyl alcohol. For example, headaches, ear buzzing, dizziness, nausea and unsteady gait (inebriation), gastrointestinal disturbances, weakness, vertigo, chills, memory lapses, numbness and shooting pains in the lower extremities hands and forearms, behavioral disturbances, and neuritis[55]. The most characteristic signs and symptoms of methyl alcohol poisoning in humans are the various visual disturbances which can occur without acidosis[55] although they unfortunately do not always appear[20]. Some of these symptoms are the following: misty vision, progressive contraction of visual fields (vision tunneling), mist before eyes, blurring of vision, and obscuration of vision[20, 55].

ALCOHOLICS: CHRONIC METHANOL CONSUMPTION

Alcoholics in general, but particularly those who consume large quantities of wine or fruit liqueur, would seem, from the available evidence, to be the only population thus far exposed to consistently high levels of methanol ingestion (Table 1). The high ethanol/methanol ration of alcoholic beverages must have a very significant protective effect, though enzyme kinetics mandate some constant but low level of methanol metabolism. One could speculate that the delicate balance which maintains this defense might be jeopardized by the general nutrition neglect and specifically the folic acid deficiency[21] associated with the meager food intake of some alcoholics. Alcoholics have a much higher incidence of cancer and other degenerative diseases, non of which can be attributed to ethanol alone[56]. The fascinating similarities linking unusual clinical features of methanol toxicity and alcoholism are worth noting.

Neuritis:

Chronic occupational exposure to methanol often produces human complaints of neuritis with paresthesia, numbing, pricking and shooting pains in the extremities[4, 55].

Alcoholic polyneuropathy[36] or multiple peripheral neuritis[21] differs symptomatically from the methanol induced syndrome only in its first and often exclusive affinity for legs. The unpleasant sensations of intolerable pain associated with slight tactile stimulation[36] is not an uncommon anecdotal consumer complaint following long term consumption of aspartame. In one such case reported to me, my interpretation of an electromyogram indicated the signs of denervation indicative of alcoholic polyneuropathy[36]. The individual's ischemic lactate pyruvate curve, before and after fasting, was flat. Less than six weeks after aspartame consumption ceased the major symptoms subsided and repetition of these tests produced normal responses, although the individual still experienced intermittent pain.

Methanol and the Heart:

A 21-year-old non-drinking male who had been exposed daily to the fine dust of aspartame at the packaging plant he had worked for over a year, was complaining of blurred vision, headaches, dizziness, and severe depression before his sudden death. An autopsy revealed (aside from the organ involvement one might expect from methanol toxicity) myocardial hypertrophy and dilatation with the myocardiopathy and left ventricle involvement reminiscent of alcoholic cardiomyopathy. Alcoholic cardiomyopathy, however, typically occurs in 30-55 year old men who have a history of alcohol intake in quantities comprising 30-50 percent of their daily caloric requirement over a 10 to 15 year period[56].

It has been suggested that alcohol is the etiologic factor in at least 50 percent of the cases of congestive cardiomyopathy[56]. The significantly lower hospitalization incidence for coronary disease among moderate drinkers than among nondrinkers and the protection to coronary risk afforded the moderate drinker (less than two drinks a day) over the nondrinker[56] seems contradictory. However, if we implicate methanol as the etiologic factor, then clearly the nondrinker is at a disadvantage with a much lower ethanol to methanol ratio (Table 1) when consuming naturally occurring methanol in a diet otherwise equivalent to the drinkers. The chronic alcoholic for reasons already proposed might sacrifice this protection.

As mentioned below, high temperature canning as developed late in the 19th century should increase significantly the methanol content of fruits and vegetables. The increased availability and consumption of these food products in various countries over the years may parallel better than most other dietary factors the increase in incidence of coronary disease in their populations. Cigarette smoke, a known coronary risk factor, contains four times as much methanol as formaldehyde and only traces of ethanol.

ETHANOL AND FOLIC ACID

The importance of ethanol as an antidote to methanol toxicity in humans is very well established in the literature[46, 55]. The timely administration of ethanol is still considered a vital part of methanol poisoning management[11, 12, 19, 20, 50]. Ethanol slows the rate of methanol's conversion to formaldehyde and formate, allowing the body time to excrete methanol in the breath and urine. Inhibition is seen in vitro even when the concentration of ethyl alcohol was only 1/16th that of methanol[62]. The inhibitory effect is a linear function of the log of the ethyl alcohol concentration, with a 72% inhibition rate at only a 0.01 molar concentration of ethanol[2, 46].

Oxidation of methanol, like that of ethanol, proceeds independently of the blood concentration, but at a rate only one seventh[20] to one fifth[12] that of ethanol.

Folacin may play an important role in the metabolism of methanol by catalyzing the elimination of formic acid[41]. If this process proves to be as protective for humans as has been shown in other organisms[50, 38] it may account, in part, for the tremendous variability of human responses to acute methanol toxicity. Folacin is a nutrient often found lacking in the normal human diet, particularly during pregnancy and lactation[14].

METHANOL CONTENT OF ASPARTAME SWEETENED BEVERAGES

An average aspartame-sweetened beverage would have a conservative aspartame content of about 555 mg/liter[48, 51] and therefore, a methanol equivalent of 56 mg/liter (56 ppm). For example, if a 25 kg child consumed on a warm day, after exercising, two-thirds of a two-liter bottle of soft drink sweetened with aspartame, that child would be consuming over 732 mg of aspartame (29 mg/kg). This alone exceeds what the Food and Drug Administration considers the 99 + percentile daily consumption level of aspartame[48]. The child would also absorb over 70 mg of methanol from that soft drink. This is almost ten times the Environmental Protection Agency's recommended daily limit of consumption for methanol.

To look at the issue from another perspective, the literature reveals death from consumption of the equivalent of 6 gm of methanol[55, 59]. It would take 200 12 oz. cans of soda to yield the lethal equivalent of 6 gm of methanol. According to FDA regulations, compounds added to foods that are found to cause some adverse health effect at a particular usage level are actually permitted in foods only at much lower levels. The FDA has established these requirements so that an adequate margin of safety exists to protect particularly sensitive people and heavy consumers of the chemical. Section 170.22 of Title 21 of the Code of Federal Regulations mandates that this margin of safety by 100-fold below the "highest no-effect" level. If death has been caused by the methanol equivalent of 200 12 oz. cans of aspartame sweetened soda, one hundredth of that level would be two cans of soda. The relationship of the lethal dose to the "highest no effect" level has tragically not been determined for methanol[9, 11] but assuming very conservatively that the level is one tenth of the lethal dose, the FDA regulations should have limited consumption to approximately 2.4 ounces of aspartame sweetened soft drink per day.

The FDA allows a lower safety margin only when "evidence is submitted which justifies use of a different safety factor." (21.C.F.R.170.22) No such evidence has been submitted to the FDA for methanol. Thus, not only have the FDA's requirements for acute toxicity not been met, but also, no demonstration of chronic safety has been made. The fact that methyl alcohol appears in other natural food products increases greatly the danger of chronic toxicity developing by adding another unnatural source of this dangerous cumulative toxin to the food system.

NATURAL SOURCES OF METHANOL

Methanol does appear in nature.

To determine what impact the addition of a toxin will have on an environment it is very helpful to accurately determine the background levels of consumption.

Fruit and vegetables contain pectin with variable methyl ester content. However, the human has no digestive enzymes for pectin[6, 25] particularly the pectin esterase required for its hydrolysis to methanol[26]. Fermentation in the gut may cause disappearance of pectin[6] but the production of free methanol is not guaranteed by fermentation[3]. In fact, bacteria in the colon probably reduce methanol directly to formic acid or carbon dioxide[6] (aspartame is completely absorbed before reaching the

colon). Heating of pectins has been shown to cause virtually no demethoxylation; even temperatures of 120°C produced only traces of methanol[3]. Methanol evolved during cooking of high pectin foods[7] has been accounted for in the volatile fraction during boiling and is quickly lost to the atmosphere[49]. Entrapment of these volatiles probably accounts for the elevation in methanol levels of certain fruit and vegetable products during canning[31, 33].

In the recent denial by the Food and Drug Administration of my request for a public hearing on this issue[13], the claim is made by them that methanol occurs in fruit juices at an average of 140 parts per million (a range of between 15-640 parts per million). This often used average originates from an informative table in a conference paper presented by Francot and Geoffroy[15]. The authors explain that the data presented in the table "may not" represent their work but "other authors"[15]. There is no methodology given nor is the original source cited and only the identity of the lowest methanol source, grape juice (12 ppm), and the highest, black currant (680 ppm), are revealed. The other 22 samples used to generate this disarmingly high average are left completely to the imagination. The authors conclude their paper by insisting that "the content of methanol in fermented or non-fermented beverages should not be of concern to the fields of human physiology and public health." They imply that wines "do not present any toxicity" due to the presence of certain natural protective substances[15]. When they present their original data relating to the methanol content of French wines (range 14-265 ppm) or when the methanol content of any alcoholic beverage is given, the ration of methanol to ethanol is also presented. Of the wines they tested, the ratio associated with the highest methanol content (265 ppm) indicates over 262 times as much ethanol present as methanol. The scientific literature indicates that a fair estimate of methanol content of commonly consumed fruit juices is on the order of 40 parts per million (Table 1). Stegink, et al. Points out that some neutral spirits contain as much as 1.5 grams/liter of methanol[51]; what is not mentioned is the fact that if these spirits are at least 60 proof (30% ethanol) this still represents the presence of over 200 molecules of ethanol for every molecule of methanol that is digested. An exhaustive search of the present literature indicates that no testing of natural substances has ever shown methanol appearing alone; in every case ethanol is also present, usually, in much higher concentrations[15, 27, 28, 30, 31, 35, 44, 45]. Fresh orange juices can have very little methanol (0.8 mg/liter), and have a concomitant ethyl alcohol content of 380 mg/liter [28]. Long term storage in cans has a tendency to cause an increase in these levels, but even after three years of storage, testing has revealed only 62 mg/liter of methanol, with an ethanol content of 484 mg/liter. This is a ratio of almost eight times ethanol/methanol[28]. Testing done recently in Spain showed orange juice with 33 mg/liter methanol and 651 mg/liter ethanol (20/1 ratio)[45]. The range for grapefruit juices are similar, ranging from 0.2 mg methanol/liter[27] to 43 mg methanol/liter[27]. The lowest ratio of any food item was found in canned grapefruit sections with 50-70 mg/liter methanol and 200-400 mg/liter ethanol[27], thus averaging six molecules ethanol for every molecule of methanol.

This high ethanol to methanol ratio, even at these low ethanol concentrations, may have some protective effect. As stated previously, ethanol slows the rate of methanol's conversion to formaldehyde and formate allowing the body time to excrete methanol in the breath and urine. Inhibition is seen in vitro even when the concentration of ethyl alcohol was only 1/16th that of methanol[62]. The inhibitory effect is a linear function of the log of the ethyl alcohol concentration, with a 72% inhibition rate at only a 0.01 molar concentration of ethanol[2]. Therefore if a liter of a high methanol content orange juice is consumed, with 33 mg/liter of methanol and a 20/1 ration of ethanol/methanol, only one molecule of methanol in 180 will be metabolized into dangerous metabolites until the majority of the ethanol has been cleared from the bloodstream. If a similar amount of methanol equivalent from aspartame were consumed, there would be no competition[46].

Another factor reducing the potential danger associated with methanol from natural juices is that they have an average caloric density of 500 Kcal/liter and high Osmolality which places very definite limits to their consumption level and rate.

Data obtained in a Department of Agriculture survey of the food intake of a statistically sampled group of over 17,000 consumers nationwide[1], indicate that the 17.6% of the population that consume orange juice daily take in an average of 185.5 gm of that juice. These statistics indicate that 1.1% of the population consume an average of 173.9 gm of grapefruit juice while only 1.8% drink approximately 201 gm of tomato juice daily. Table 1 shows that under normal conditions these individuals would only be expected to consume between 1 and 7 mg of methanol a day from these sources. Even if an individual consumed two juices in the same day or a more exotic juice such as black currant, there would still be some protection afforded by the ethanol present in these natural juices. Consumption of aspartame sweetened drinks at levels commonly used to replace lost fluid during exercise yields methanol intake between 15 and 100 times these normal intakes (Table 1). This is comparable to that of "winos" but without the metabolic reprieve afforded by ethanol. An alcoholic consuming 1500 calories a day from alcoholic sources alone may consume between 0 and 600 mg of methanol each day depending on his choice of beverages (Table 1).

The consumption of aspartame sweetened soft drinks or other beverages in not limited by either calories or Osmolality, and can equal the daily water loss of an individual (which for active people in a state like Arizona can exceed 5 liters). The resultant daily methanol intake might then rise to unprecedented levels. Methanol is a cumulative toxin[8] and for some clinical manifestations it may be a human-specific toxin.

CONCLUSION

Simply because methanol is found "naturally" in foods, we can not dismiss the need for carefully documented safety testing in appropriate animal models before allowing a dramatic increase in its consumption.

We know nothing of the mutagenic, teratogenic or carcinogenic effect of methyl alcohol on man or mammal[55, 59]. Yet, if predictions are correct[5] it won't be long before an additional 2,000,000 pound of it will be added to the food supply yearly[53].

Must this, then, constitute our test of its safety?

TABLE 1
AVAILABLE METHANOL IN VARIOUS BEVERAGES

	METHANOL Mg/liter	CALORIC DENSITY Calories/Liter	METHANOL (mg.) Consumed per 1,000 Calories	RATIO Ethanol (wt.) Methanol (wt.)	*Methanol (mg.) Consumption per day
Juices					
*Orange, fresh[28]	1	470	2	475	1
*Orange, fresh[45]	33	470	70	20	6 mg
*Orange, fresh[31]	34	470	72	16	6 mg
*Orange, canned[28]	31	470	66	15	6 mg
*Grapefruit, fresh[27]	1	400	1	2000	1 mg
*Grapefruit[31]	43	400	108	5	7 mg
*Grapefruit, canned[31]	27	400	68	9	5 mg
Grape[15]	12	660	18	-	-
Alcoholic Beverages					
Beer (4.5%)	0	400	-	-	
Grain Alcohol[55]	1	2950	1	500000	-
Bourbon, 100 proof[55]	55	2950	19	9090	-
Rum, 80 proof[15]	73	2300	32	5000	-
Wines (French)[15]					-
White	32	800	44	2500	-
Rose	78	800	98	1000	-
Red	128	800	160	667	-
Pear	188	1370	137	250	-
Cherry	276	1370	201	294	-
Wines, (American)[30]					-
Low	50	800	62	2500	-
High	325	800	406	385	
Aspartame Sweetened[48] Beverages				2 liters	5 liters
Uncarbonated Drinks[48]	55	8	6875	0	110 mg 275 mg
Cola (Carbonated)[48]	56	8	7000	0	112 mg 280 mg
Orange (Carbonated)[48]	91	8	11375	0	182 mg 455 mg
Aspartame, pure			25000		

*17.6% of U.S. Population consume an average of 185.5 gm. of Orange Juice a day[1]
*1.1% of the U.S. Population consume an average of 173.9 gm. of Grapefruit Juice a day[1]

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