Université de Montréal

The Relationship Between Fructose Consumption and Risk of Obesity in Two Aboriginal Populations

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"The Relationship Between Fructose Consumption and Risk of Obesity in Two Aboriginal Populations"

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A été évalué par un jury compose des personnes suivantes:

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Résumé

La prédominance de l'obésité qui touche les enfants et les adultes a augmenté dans le monde entier ces dernières décennies. Les différentes études épidémiologiques ont prouvé que l'obésité est devenue une préoccupation profonde de santé aux États-Unis et au Canada. Il a été montré que l'obésité a beaucoup d'effets sur la santé ainsi il serait important de trouver différentes causes pour le gain de poids. Il est clair que l'obésité soit la condition de multiples facteurs et implique des éléments génétiques et environnementaux. Nous nous concentrons sur les facteurs diététiques et particulièrement le fructose où sa consommation a parallèlement augmenté avec l'augmentation du taux d'obésité. La forme principale du fructose est le sirop de maïs à haute teneur en fructose (HFCS) qui est employé en tant qu'édulcorant primordial dans la plupart des boissons et nourritures en Amérique du Nord. Il a été suggéré que la prise du fructose serait probablement un facteur qui contribue à l'augmentation de la prédominance de l'obésité. L'objectif de cette étude était d'évaluer s'il y a un rapport entre la consommation du fructose et le risque d'obésité. Nous avons travaillé sur deux bases de données des nations Cree et Inuit. Nous avons eu un groupe de 522 adultes Cree, (263 femmes et 259 hommes) dans deux groupes d'âge : les personnes entre 20 et 40 ans, et les personnes de 40 à 60 ans. Nous les avons classés par catégorie en quatre groupes d'indice de masse corporelle (IMC). L'outil de collecte de données était un rappel de 24 heures. En revanche, pour la base de données d'Inuit nous avons eu 550 adultes (301 femmes et 249 hommes) dans deux groupes d'âge semblables à ceux du Cree et avec 3 catégories d'indice de masse corporelle. Les données dans la base d'Inuit ont été recueillies au moyen de deux rappels de 24 heures. Nous avons extrait la quantité de fructose par 100 grammes de nourriture

consommés par ces deux populations et nous avons créé des données de composition en nourriture pour les deux. Nous avons pu également déterminer les sources principales du fructose pour ces populations. Aucun rapport entre la consommation du fructose et l'augmentation de l'indice de masse corporelle parmi les adultes de Cree et d'Inuit n'a été détecté. Nous avons considéré l'apport énergétique comme facteur confondant potentiel et après ajustement, nous avons constaté que l'indice de masse corporelle a été associé à l'apport énergétique total et non pas à la consommation du fructose. Puisque dans les études qui ont trouvé une association entre la consommation de fructose et l'obésité, le niveau de la consommation de fructose était supérieure à 50 grammes par jour et comme dans cette étude ce niveau était inférieur à cette limite (entre 20.6 et 45.4 g/jour), nous proposons que des effets negatifs du fructose sur la masse corporelle pourraient être testés dans des populations à plus haute consommation. Les essais cliniques randomisés et éventuelles études cohortes avec différents niveaux de consommation de fructose suivis à long terme pourraient aussi être utiles.

Mots clés : fructose, sirop de maïs à haute teneur en fructose (HFCS), obésité et poids excessif

Summary

The prevalence of obesity has increased worldwide in recent decades in both children and adults. Different epidemiologic studies have shown that obesity has become a serious health concern in United States and Canada. It has been proved that obesity has many adverse health outcomes so it is important to identify the different causes of weight gain. It is clear that obesity is a multifactor condition and involves both genetic and environmental elements. In this study, we focus on dietary factors, specifically the consumption of fructose that has increased in parallel to the increase in the obesity rate. The main form of fructose in the diet is high fructose corn syrup (HFCS) that is used principally as a sweetener in most beverages and foods in North America. It has been suggested that the intake of fructose may possibly be a contributing factor to the increased incidence of obesity. The objective of this study was to assess if there is a relationship between consumption of fructose and risk of obesity. We worked on two databases. The first database contained 24-hour recall data collected from a sample of 522 Cree adults (263 women and 259 men), divided into two age groups: people between 20 and 40 years old, and people from 40 to 60 years old. We categorized them into four body mass index (BMI) groups. The second database contained data from two 24-hour recalls administered to 550 Inuit adults (301 women and 249 men). These adults were divided into two age groups similar to Cree and with three BMI categories. The amount of fructose per 100 grams of food consumed by these two samples was calculated and we created food composition data for both. We also determined the main sources of fructose in these populations that was sugar sweetened beverages. Based on our results, we could not detect any relationship between consumption of fructose and an increase in BMI among Cree and Inuit adults. We considered energy intake as a potential cofounding factor and, after adjustment, we found

that BMI was associated with total energy intake and not with the consumption of fructose. Since in studies that have found this association the level of fructose consumption was more than 50 grams per day but in this study, this level was lower than this limit (from 20.6 to 45.4 g / day) , we suggest that negative effects of fructose on body weight may appear only at higher dose. Randomized clinical trials and prospective cohort studies using different levels of consumption with long term follow up could be useful.

Key words: Fructose, High Fructose Corn Syrup (HFCS), Obesity, and Overweight

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APM: Aspartame
BMI: Body mass index
CANDI: Canadian Dietary Information System
CI: Confidence interval
CNF: Canadian Nutrient File
CNS: Central nervous system
Cu: Cupper
D: Dextrose
D: Day
F: Fructose
FAFH: Food away from home
FFQ: Food frequency questionnaire
FS: Fructose-starch
G: Gram
GABA: γ-aminobutyric acid
GAD65: Glutamic acid decarboxylase enzyme
GLUC: Glucose
HFCS: High fructose corn syrup
24HR: 24-h dietary recall
HFFQ: Harvard Service Food Frequency Questionnaire
HFr: Fructose-sweetened beverages
HGI: Glucose-sweetened beverages
KCAL: Kilo calorie
KG: Kilogram
KJ: Kilo joule
L: liter
M: Meter
Max: Maximum
MC4R: Melanocortin-4 receptor gene
MIN: Minimum
NPY: Neuropeptide Y
RCSD: Regular carbonated soft drink
S: Corn starch
SAS: Statistical Analysis System
SE: Standard deviation
SSBs: Sugar-sweetened beverages
SUC: Sucrose
TG: Triglycerides
U.S: United States
VMH: Ventromedial hypothalamic
YFFQ: Youth food-frequency questionnaire
YRS: Years

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I. INTRODUCTION

I. Introduction

The prevalence of obesity has increased worldwide (Elliott et al, 2002). According to Statistics Canada, the age-adjusted obesity rate was 13.8% in 1978/79 compared to 23.1% in 2004 (Tjepkema, 2004). A separate study shows that the Aboriginal Canadians have the highest frequency of obesity (Tremblay et al, 2005). This increase in the prevalence of Aboriginal obesity is consistent with other studies (Waldram et al, 2006).

Different genetic and environmental factors contribute to excess weight and obesity, such as race/ethnicity, age, physical activity, sedentary behaviors, food consumption patterns, smoking, technological advancements, and psychological factors (CDC, 2004; Rashad and Grossman, 2004 ; Forshee et al, 2007). Different groups in society, including researchers, government, and other organizations, are concerned with and working towards reducing the alarming rates of overweight and obesity (Forshee et al, 2007). This is necessary as obesity is associated with diseases like Type 2 diabetes, coronary heart disease and cerebrovascular disease (Webber, 2001). Obesity also increases the risk of obstructive sleep apnea, osteoarthritis of weight-bearing joints and some types of cancer (Webber, 2001).

On the other hand, the consumption of added sugars, notably fructose, has also increased recently (Elliott et al, 2002). Fructose can be found in great abundance because it is highly soluble in water, more so than glucose. It helps everything to be sweeter, makes bread crusts browner and cookies softer. Fructose is sweeter than sucrose, and so high-fructose corn syrup has become a prevalent sweetener used in the industry in the past thirty years.High fructose corn syrup (HFCS) was less than 1% of caloric sweeteners in 1970 but

in the year 2000 it had become 42% of caloric sweeteners used in the United States (Bray et al, 2004). There are important similarities between the trend in HFCS availability and the trends in the prevalence of obesity in the United States (Bray et al, 2004). However, evidence for a causal relationship between fructose consumption and risk of obesity is still lacking (Forshee et al, 2007).

This work will investigate whether there is a relationship between fructose consumption and risk of obesity in two Aboriginal populations in Canada, adult Cree and Inuit.

II. Litterature review

2.1 - Causes of obesity

Obesity is a condition of excess body fat. Although the measurement of body fat is difficult, the use of the body mass index (BMI) is a standard method of defining obesity and overweight status (Shils, 2005). BMI is defined as an individual's weight in kilograms divided by their height in meters squared (CDC, 2004).

According to the CDC (2004) categories, a BMI equal to or less than 18.5 is classified as underweight, a BMI between 18.5 and 24.9 as healthy weight, a BMI between 25 and 29.9 as overweight and a BMI equal to or greater than 30 as obese. The exact etiology of obesity is still unclear but it appears to be the result of a combination of different factors, including genetic, metabolic and environmental.

2.1.1 Genes and heredity

The fact that obesity is seen more in families suggests that there are genetic factors in its etiology, but one should also consider that a family's eating habits are generally similar (CDC, 2004). The idea is that obesity is a condition caused by an interaction between genes and environmental factors (e.g., nutrient intake and physical activity) (Shils, 2005).

There are studies that have shown some single genes cause obesity in rodents. In humans, one of the genes that researchers think is contributing to obesity is the melanocortin-4 receptor gene (MC4R) (Shils, 2005). There is evidence that strengthens the hypothesis of a susceptibility gene for obesity in the Chromosome 10p11–12 locus. Marker D10S197 is located in intron 7 of the GAD2 gene encoding the glutamic acid decarboxylase enzyme (GAD65). GAD65 catalyzes the formation of γ-aminobutyric acid (GABA) from L-

glutamic acid and is expressed in both pancreatic islets and the brain. GABA is colocalized in neuropeptide Y (NPY) neurons and is implicated in the leptin pathway through the arcuate nucleus in the hypothalamus. GABA interacts with NPY in the paraventricular nucleus to stimulate food intake (Boutin et al, 2003). It is suggested that several regions of the human genome might be involved in the susceptibility to obesity. The most important human chromosomal regions exhibiting linkage seem to be on 1p, 3p, 6p, 7q and 11q (Bouchard, 1997). The latest obesity gene map indicates that there are more than 100 genes or markers which have the potential to influence obesity (Pérusse and Bouchard, 2000).

2.1.2 Environmental causes of obesity

Environmental causes of obesity fall into two groups, non dietary and dietary causes, as explained in more detail below. Psychological factors have an effect on people's weight gain and loss (CDC, 2004). Some psychological conditions that affect weight gain are depression and stress (CDC, 2004) and some examples of eating disorders are Night Eating Syndrome, Binge Eating Disorder, and Progressive Hyperphagic Obesity (CDC, 2004).

Some disorders can affect body weight, including Cushing Syndrome, hypothyroidism, Down Syndrome, Cohen Syndrome, hypothalamic disorders, Polycystic Ovary Syndrome, and growth hormone deficiency (Shils, 2005).

A number of medications can be a cause of obesity, e.g. steroid medications, some migraine medications and some antidepressants (CDC, 2004).

Smoking cessation may be related to a small weight gain in spite of its health benefits (Shils, 2005).

2.1.2.1 Non dietary causes

Physical activity and physical fitness have a large role in controlling body weight (Shils, 2005). It is commonly thought that the current increased prevalence of obesity is mainly affected by lack of physical activity (Hill, 1998). Researchers have found that the risk of being obese is negatively associated with physical activity and positively related with time spent in sedentary behaviors (Dunton et al, 2009).

2.1.2.2 Dietary causes

Dietary factors that have an effect on weight gain are not only diet composition but also energy excess, high energy density, portion size and diet qualities (Shils, 2005). Diets high in fat have been shown to be associated with increased risk of obesity (Moussavi et al, 2008).The studies in both animals and humans support the effects of dietary fat in development of overweight conditions and obesity (Shils, 2005). The suggested mechanism by which fat can contribute to weight gain is that fat is an energy dense macronutrient and is less satiating than carbohydrates and proteins, so it could lead to over consumption (Moussavi et al, 2008). It has been suggested that dietary fat composition also may have an effect on obesity (Moussavi et al, 2008).

Different studies show a positive relationship between fruit and vegetable consumption with being physically active, not smoking and not being overweight (Shils, 2005).

Dietary carbohydrates and sugars have been shown in different studies to increase the risk of weight gain (Shils, 2005). Here, we focus on dietary carbohydrates.

After World War II, the worldwide diet changed significantly. For example, in the United States the consumption of caloric sweetener increased (Popkin and Nielsen, 2003). It is said that the favorite taste for human beings is sweet and it is an inborn preference (Sigman-Grant and Jaime, 2003). The amniotic fluid is sweet; breast milk and commercial formula are also sweet. The principal sweetener in the world is sugar (Sigman-Grant and Jaime, 2003). Sugar adds other characteristics to foods than just sweetness; this includes texture, appearance, viscosity, capability to retain water, osmotic pressure, and consistency (Sigman-Grant and Jaime, 2003). Sugar alcohols, like sorbitol, mannitol, xylitol, maltitol, erythritol, and lactitol, also add qualities to foods, like texture to gums and candies, water retention and cooling sensations (Sigman-Grant and Jaime, 2003). Prior to recent centuries, sweets were used merely in ceremonies or other special occasions, but nowadays there are many snacks, desserts and candies in our daily diet (Shils, 2005).

2.2 Types of sugar

Definitions

From the chemical view, sugar is a substance that consists of carbon, hydrogen and oxygen atoms. Sugar is categorized as monosaccharides, disaccharides and oligosaccharides (Sigman-Grant and Jaime, 2003).

Monosaccharides have 3-7 carbon atoms per monomer. Absorbable types of monosaccharide are sugars. This group contains the glucose, fructose and galactose that exist in the human diet as well as mannose (Sigman-Grant and Jaime, 2003).

Disaccharides consist of two coupled monosaccharides (2 monomers). Sucrose, lactose, trehalose and maltose are disaccharides in the human diet (Sigman-Grant and Jaime, 2003).

Oligosaccharides have 3-9 monomers (Sigman-Grant and Jaime, 2003).

2.3 History of sugar

The entrance of sugar into the world diet was not so long ago. Before the usage of sugar, honey was the principal sweetener, but its use was limited to the higher social classes and after considered a medicine (Johnson et al, 2007). New Guinea and the Indian subcontinent were the first developers of sugar from sugar cane. In the middle Ages, sugar was introduced to Europe as it passed through Venice (Italy) and other trading ports. At that time it was used just by very wealthy people. In the 1400s, Spain and Portugal started to produce sugar cane (Johnson et al, 2007). Christopher Columbus then brought sugar cane in his voyages to Haiti, the Dominican Republic, the Caribbean islands, Guyana coasts, Brazil and the southern United States (Johnson et al, 2007). The increase in sugar production led to its increased accessibility to the public. In the 1800s, Germany, France and Austria produced sugar from beets. This production, in addition to production of sugar from cane, caused a vast sugar production increase in the world, thereby increasing its consumption (Johnson et al, 2007). By 1970, another sweetener started to be commonly used in the United States: high-fructose corn syrup (HFCS). HFCS is used to sweeten soft drinks, fruit drinks, pastries and processed foods. All in all, there has been a 30% increase in sweetener intake in the past forty years (Johnson et al, 2007).

2.4 Fructose

For thousands of years there was a small amount of fructose in humans' diets, mostly from fruits (Basciano et al, 2005). In 1976, fructose was introduced as a substitute for sugar because of some advantages over glucose; it has a smaller effect on serum insulin concentrations and no influence on plasma glucose levels. Therefore, fructose was named a positive alternative for controlling diabetes (Basciano et al, 2005). Ten years later, high fructose corn syrup was suggested as a substitute for fructose because it was cheaper. After some time, researchers noticed some negative effects of this fructose in weight gain, obesity and insulin resistance (Basciano et al, 2005). One study showed the unfavorable effect of replacing fructose in diabetic patients (Basciano et al, 2005). The metabolism of fructose is done by the liver. If a large amount of fructose enters into the liver, the result will be rapid stimulation of lipogenesis and an increase of triglycerides (TG), causing a reduction in insulin sensitivity (Basciano et al, 2005).

In the United States, HFCS is a substitute for sucrose as a sweetener in most beverages and foods, but in other countries sucrose is still the first choice (Forchee et al, 2007). The food and beverage industry were interested in using HFCS because of its taste and its capacity to mix together with other ingredients (Schoeller et al, 1997; Forchee et al, 2007). There are a number of HFCS: HFCS-42, HFCS-55 and HFCS-90 (Forchee et al, 2007). HFCS-42 contains 42% fructose, 53% glucose and 5% polysaccharides. HFCS-55 contains 55% fructose, 42% glucose and 3% polysaccharides. HFCS-90 consists of 90% fructose, 9%

glucose and 1% polysaccharides (Forchee et al, 2007). At first, HFCS-42 was used most often, but in the 1980s the use of HFCS-55 increased (Forchee et al, 2007).

2.4.1 Sources of fructose

Fructose can be found naturally in fruit, some vegetables, honey and some plants (Basciano et al, 2005). About two-thirds of HFCS used in the United States is found in beverages. Many processed foods have HFCS as well (Bray et al, 2004). It has been said that almost all food and beverages that have a caloric sweetener contain HFCS in the United States. These include soft drinks, fruit drinks, dairy desserts, flavored yogurts, cereals, candies, ice cream, pastries and jellies (Bray et al, 2004). About 60% of the calories in apple juice, a base for some fruit drinks, are from HFCS (Bray et al, 2004). The utilization of HFCS-42 and HFCS-55 is different. HFCS-42 is used in baked goods, canned fruits and condiments, while HFCS-55 is mostly used in soft drinks, sweetened beverages, ice cream and frozen desserts (Forshee et al, 2007).

2.4.2 Level of fructose consumption

Since ancient times, the consumption level of fructose in a daily diet was 16-20 grams, principally from fruits. Mean consumption of fructose among all Americans was 37 g per day (8% of total intake) in 1977-1978 (Vos et al, 2008). Another study shows 29-54 g per day consumption of fructose in 1993 in American adolescents and adults (Elliott et al, 2002). Yet another study based on food disappearance data shows an increase in per capita use of HFCS from 0.23 kg in 1970 to 28.4 kg in 1997 in United States (Putnam and Allshouse, 1999).

The consumption of fruit and vegetables has also increased by 19% from 1982 to 1997, so investigators proposed that of the 97 g per day of fructose consumed in 1997; about 15-16

g came from fresh fruits and vegetables (Elliott et al, 2002). The consumption of two soft drinks per day (355 ml) could add about 50 g of fructose (Elliott et al, 2002). After the great change in diet from adding sweeteners more recently, the consumption level of fructose is often 85-100 g per day (Basciano et al, 2005).

2.4.3 Fructose metabolism

The metabolism of fructose is done in the liver. The portal vein delivers absorbed fructose to the liver and then fructose is phosphorylated there by adenosine triphosphate to make fructose-1-phosphate. The enzyme, fructokinase, catalyzes this reaction. Then aldolase B splits fructose-1-phosphate into glyceraldehyde and dihydroxyacetone phosphate, and these two molecules can transform to glyceraldehyde-3-phosphate (Elliott et al, 2002). So fructose bypasses the control point that is the inhibitory signals from citrate and ATP to inhibit phosphofructokinase production (Elliott et al, 2002) (Figure 1). The result of this different metabolism is that fructose is a source of glycerol-3-phosphate and acetyl-CoA for lipogenesis in the liver (Elliott et al, 2002). Fructose consumption also leads to increased amounts of circulatory lactate compared to glucose (Elliott et al, 2002).

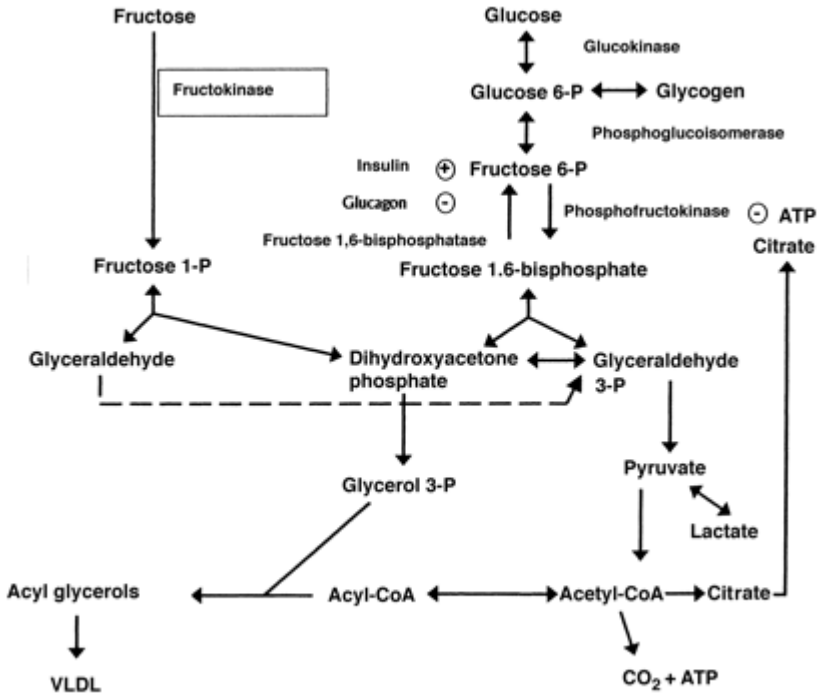

Figure 1: Metabolic pathways for fructose; Adapted from Elliott et al (2002).

Further fructose does not stimulate pancreatic ß cells to release insulin but glucose does (Elliott et al, 2002). This could be because the fructose transporter GLUT5 is found in low concentration in these cells (Elliott et al, 2002). Insulin receptors in the central nervous system control food intake, body adiposity and energy homeostasis (Elliott et al, 2002). Subsequently, the reduction in the delivery of insulin into the CNS could affect weight gain (Elliott et al, 2002). Insulin stimulates leptin secretion and has a regulatory role for its production and secretion (Havel, 2002). Some studies have shown that leptin decreases food intake and activates the sympathetic nervous system in some animals (Elliott et al, 2002). Other studies have found that humans with impairments in producing leptin have resulting hyperphagia and obesity (Elliott et al, 2002). Researchers have found that a

reduction in circulatory leptin levels is associated with an increase in a sense of hunger and that leptin administration reduces appetite (Elliott et al, 2002).

The other point of difference between fructose and glucose metabolism is that the ghrelin level was less suppressed after the ingestion of a fructose-sweetened beverage compared with a glucose-sweetened beverage (Elliott et al, 2002).Ghrelin also has been proposed to be a key regulator of energy balance in the CNS, similar to insulin and leptin (Elliott et al, 2002). Ghrelin is the only known circulating orexigenic hormone. It is a stomach-derived peptide. Ghrelin is acylated with a medium-chain fatty acid by the enzyme ghrelin *O*-acetyltransferase (GOAT) and has a wide range activities including central control of food intake (Kirchner, 2010).Therefore, a decline in insulin and leptin levels and an increase in ghrelin could result in a larger energy intake and possibly an overweight condition and obesity (Elliott et al, 2002). There is also other research that found that the satiety level after fructose and glucose consumption differs, possibly because fructose was unable to stimulate enough insulin and leptin and inhibit ghrelin (Teff et al, 2004). Another theory is that calories ingested in liquid form do not give the sensation of satiety and the body does not compensate for calories in liquid form (Bray et al, 2004).

Some researchers have also proposed that fructose may slow the basal metabolic rate (Johnson et al, 2007).

2.4.4 Relationship between fructose and body weight

Studies suggest that there is an estimated parallel increase in the trends of HFCS' availability and the prevalence of obesity in the United States (Bray et al, 2004) (Fig.2). The graph adapted from the study of Bray et al. (2004) shows these trends. They used the

data on HFCS availability and age-standardized nationally representative measure of obesity between 1960 and 1999.

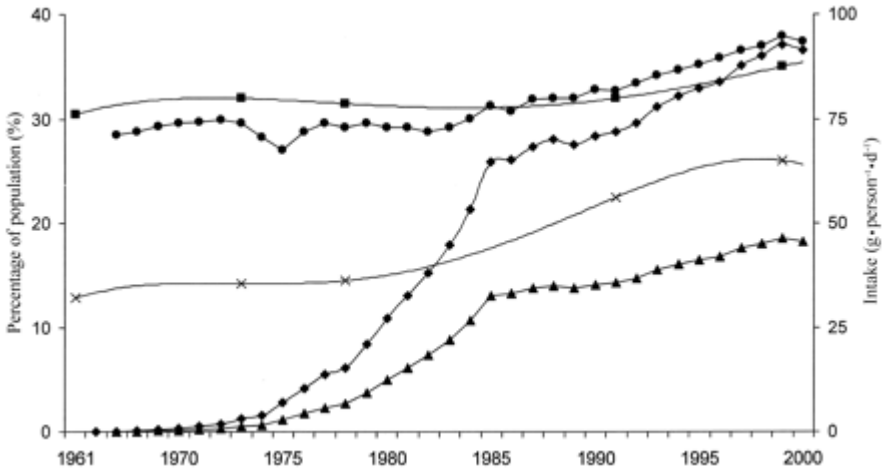

Figure 2: Estimated intakes of total fructose (•), free fructose (▲), and high-fructose corn syrup (HFCS, ♦) in relation to trends in the prevalence of overweight (■) and obesity (x) in the United States; Adapted from Bray, 2004.

Another ecological study showed that trends in the prevalence of obesity and diabetes were consistent with an increase in consumption of refined carbohydrates in the United States (Gross et al, 2004). Other findings show that there is a similarity between an increase in sugar consumption and obesity; obesity was originally observed in rich people with access to sugar and the countries that have the first documentation of obesity, high blood pressure and diabetes, England, France and Germany, are where the use of sugar first became common. Additionally, in the United States and United Kingdom there has been a corresponding increase in sugar intake and weight gain. The increase in obesity in developing countries is lagging in comparison to developed countries and the entry of sugar to these countries also follows this trend (Johnson et al, 2007).

2.5 Role of fructose as a potential risk factor of obesity

There are some studies about the relationship between fructose consumption and the risk of obesity, but they are limited due to the newness of the subject. More time is needed in order to evaluate this relationship fully. Here we describe studies that generally have focused on proxies for fructose consumption. We searched Medline and Pubmed to find these studies using the key words fructose, high fructose corn syrup, obesity and overweight. We also found some studies by reviewing references of retrieved articles. The studies are presented in reverse chronological order, starting with animal studies and then human studies.

2.5.1 Evidence from animal studies

Shapiro et al. (2008) assessed if chronic fructose consumption causes leptin resistance, which consequently could promote obesity in response to a high-fat diet. They used 23 male Sprague Dawley rats that were divided into two groups: 12 rats on a 60% fructose diet and 11 rats were fed a fructose-free control diet for 6 months. After six months half of the rats in each group were then switched to a high-fat diet for 14 days, whereas the other rats continued on their particular diets. Rats in both groups gradually gained weight over the six months. In general there were no differences in food intake or body weight gain between control and high-fructose-fed rats. No differences were evident in serum cholesterol, uric acid, fasting glucose levels, blood urea nitrogen, or serum creatinine between the two groups. Serum leptin levels were also similar between groups and increased in both groups in parallel with the rise in adiposity. Intraperitoneal leptin injections however reduced 24-h food intake in the fructose-free group but had no effect in fructose-fed rats. All groups increased food intake and body weight when they were switched to the high-fat diet, but rats that had formerly been fed fructose then showed

significantly higher energy intake, weight gain and adiposity. The authors explained that a strong point in this study is that it showed that a silent leptin resistance occurred without any obvious differences detected between the fructose and control-fed rats. So the detrimental effects of chronic fructose consumption may build up long before there is any evidence of elevated leptin or detectable obesity.

Nakagawa et al. (2006) hypothesized that fructose-induced hyperuricemia may have a pathogenic role in metabolic syndrome. They performed four sets of experiments on male rats (n=24). The first experiment was treatment of fructose-induced hyperuricemia with allopurinol. The second experiment was prevention of fructose-induced hyperuricemia with allopurinol. A third experiment looked at the effect of lowering uric acid by either allopurinol or benzbromarone on body weight and food consumption. The fourth experiment was a comparison between 60% dextrose and 60% fructose in the development of metabolic syndrome and the effect of lowering uric acid with benzbromarone.

Serum uric acid levels, systolic blood pressure, and fasting insulin levels were elevated in fructose-fed rats compared with rats fed a control diet. The body weight of fructose-fed rats tended to increase compared with rats fed a normal diet. In rats receiving a high-fructose diet, the lowering of uric acid improved features of metabolic syndrome. The administration of allopurinol prophylactically prevented fructose-induced hyperinsulinemia, systolic hypertension, hypertriglyceridemia and weight gain. As compared with the effects of the 60% dextrose and 60% fructose diets on the development of metabolic syndrome, only the fructose-fed rats developed hyperuricemia, hypertriglyceridemia, and hyperinsulinemia, and these symptoms were significantly improved by lowering uric acid levels with benzbromarone, the uricosuric agent. The

authors concluded that fructose caused metabolic syndrome. Allopurinol that lowers serum uric acid was able to prevent and reverse features of metabolic syndrome in fructose-fed rats. They suggest that uric acid may also have a contributory role in the development of metabolic syndrome induced by fructose.

Jürgens et al. (2005) assessed if and how fructose may promote obesity in an animal model. Studies were performed in three month-old male adult mice. Mice were assigned to four groups (n = 8 to 9), with similar mean body weight among the groups. Water, fructose dissolved in water, a sucrose-sweetened soft drink, or a non-caloric "diet" soft drink was given for 73 days. They chose the concentration of fructose dissolved in water as 15% to be similar to the highest amount of fructose in U.S. brands of fructose-sweetened soft drinks, which are higher than the European soft drinks because of the use of HFCS instead of sucrose. A standard diet was accessible ad libitum. All four groups of mice significantly gained body fat and weight during the study period but the fructose group gained more compared to the other groups. Body weight in the soft drink group and the diet soft drink group did not change significantly compared with the water control group.

Davail et al. (2005) assessed the effect of partial replacement of dietary glucose provided by corn starch with fructose on body weight and fatty liver production in three groups of 30 Mule ducks. From hatching day to six weeks of age, they were fed on a diet providing 200 g protein and 12,200 kj/kg ad libitum. From six to twelve weeks of age, birds were given a restricted diet providing 182 g protein and 11,500 kj /kg to avoid excess fatness. The following eight days corresponded to the period before the overfeeding period, during

which the amount of food was progressively increased up to 380 g a day. Ducks were then overfed twice a day for two weeks with a mixture of grain, corn mash and water, supplemented with 9,800 kj in the form of glucose (control animals), sucrose or high fructose corn syrup (HFCS) solutions. The two-week overfeeding with these three substances (glucose, HFCS or sucrose) led to a significant body weight gain (41.7%, 45.7% and 44.7%, respectively). At the end of overfeeding, body weights in the three groups were similar, but liver weight was significantly higher in ducks overfed with food supplemented with HFCS or sucrose than in the glucose group. Postprandial plasma insulin concentrations were similar in all of the three groups. The authors concluded that the dietary fructose, by increasing hepatic lipogenesis, leads to liver steatosis and also that this effect of fructose on liver steatosis is not mediated by insulin.

Suga et al. (2000) examined the influence of dietary fructose and glucose on circulating leptin levels in sham-operated lean and ventromedial hypothalamic (VMH)-lesioned obese rats. They used female rats (n=92) that were divided into three groups, the Standard diet group, Fructose diet group and Glucose diet group, and given free access to food and water for a two week period of time. The food intake of rats with VMH lesions fed normal rations was increased twofold compared with that of sham-operated rats. Fructose or glucose feeding slightly increased the amount of food intake in sham-operated rats but not in VMH-lesioned rats. The VMH-lesioned rats gained body weight at rates fourfold higher and had two times the increased parametrial fat-pad weight compared with sham-operated rats. Fructose or glucose feeding tended to suppress body weight gain in sham-operated rats, yet it did not reach statistical significance. In VMH-lesioned rats, neither fructose nor glucose feeding affected body weight gain or fat-pad weight. Plasma leptin concentrations were increased six times in VMH-lesioned rats fed normal food compared with lean rats.

Fructose feeding did not affect leptin levels in either of the two groups. Glucose feeding increased plasma leptin levels 2.4 fold in lean rats but not in VMH-lesioned rats. The authors concluded that hyperleptinemia in VMH-lesioned rats is related with increased adiposity and hyperinsulinemia but not with insulin resistance .Dietary fructose did not change leptin levels, suggesting that hyperinsulinemia compensated for insulin resistance does not stimulate leptin production.

Kasim-Karakas et al. (1996) evaluated the effects of diets containing 60% fructose or sucrose on glucose and lipid metabolism in hamsters. The authors used the male golden Syrian hamsters. They were separated into three groups (n=6-8): control group, fructose group and sucrose group. The hamsters received these diets for two weeks. Control and sucrose-fed animals had similar daily food intakes, whereas fructose-fed hamsters ate significantly more. The body weight of the fructose-fed animals was higher than that in controls and sucrose-fed animals. Both fructose and sucrose feedings increased the relative adiposity in the hamster but did not alter the fasting plasma glucose level. Fasting insulin was higher in the fructose group than in the sucrose group and control group. Glucose levels during the glucose tolerance test were higher in fructose-fed animals than in both other groups. Fructose-fed hamsters had higher plasma insulin levels than sucrose-fed hamsters and control hamsters, and also had higher non-esterified fatty acid and fasting plasma triglyceride levels than other groups. In all, fructose-fed animals consumed larger amounts of food and gained more weight than animals in the other groups. The authors concluded that fructose induces obesity, hyperinsulinemia and hypertiglyceridemia in hamsters.

Rawana et al. (1993) examined whether drinking fructose or glucose water with a balanced diet affects pregnant and lactating rats and their litters. The 60 female rats were divided into three groups with 20 rats per group. All groups consumed the same food but different water (tap water, 100 g/L glucose water or 100 g/L fructose water). Throughout pregnancy, body weights were similar in all groups. During lactation, the fructose-fed group gained significantly more weight than other groups. During gestation, the control group had significantly greater food intake, lower water intake and higher energy intake from others. The respective groups consumed a significantly greater amount of glucose water than fructose water, and the energy intake from water was significantly higher for the glucose water group than for the fructose-fed group. During lactation, food intake was significantly lower in the glucose water group, but its water intake was significantly greater than intakes of the other two groups. The dams ingesting glucose water consumed more energy from their water than dams that drank fructose water. Dams in the fructose-fed and glucose-fed groups consumed significantly less energy from food than the control group. On day 19 of pregnancy, plasma glucose concentration was significantly greater in the group consuming fructose water than in the group consuming tap water. After weaning, the fructose-fed and glucose-fed groups had significantly higher plasma glucose concentrations than did the group consuming tap water. The fructose-fed group had the highest plasma triglyceride concentration on day 19 of pregnancy. After weaning, the fructose- and tap water-fed groups had significantly higher plasma triglyceride concentrations than the glucose-fed group. The authors suggest that these observations could be the result of insulin resistance and the type of carbohydrate ingested may be responsible for this insulin resistance.

Rizkalla et al. (1992) evaluated the long-term effects of fructose feeding with normal or high amounts of Cu on body weight. Forty male rats aged 21 days were used. The rats were randomized into five groups, each consisting of eight rats. The rats in four groups were fed a powder diet containing 570 g carbohydrate/kg supplied either as corn starch **(S)**, dextrose (D), fructose (F), or fructose-starch (FS) and an adequate amount of copper. The fifth group was fed a 570 g fructose/kg diet supplemented with twice the amount of Cu (FCu).

The rats fed on diets D and FS almost always gained more weight than those fed on diets **S,** F and F/Cu. These differences were significant until Week 6**,** after which this significance started to decline. The total food intake was significantly higher in the rats fed on diet D than in those fed on diets S, F, FS and FCu. At the end of Week 10, neither body weights nor weight gain were different, whereas epididymal fat pads increased in weight in groups F and FCu compared with groups S and FS. When the results were expressed as relative weight, groups F and FCu remained higher than groups S and FS. Fat deposition in the groups fed on fructose-rich diets was related to an increase in the number of adipocytes. The kidneys increased in weight in all of the fructose-fed groups compared with group S, but only in the high fructose groups (F and FCu) compared with group D. The authors concluded that a high fructose diet in rats over 10 weeks resulted in harmful effects on adipose tissue, insulin binding to adipocyte and plasma insulin. However, moderate fructose intakes are unlikely to have adverse effects.

Kanarek et al. (1982) examined if the type of carbohydrate could affect weight gain in rats. Thirty-five male rats were divided in five groups: glucose group, fructose group, sucrose group, granulated sucrose group and standard diet group. The rats were given the diets for

fifty days. Rats given the sucrose solution had the highest daily caloric intake followed by animals given the fructose solution and then those given the glucose solution. Animals provided with access to the sucrose solution consumed more sugar than animals in the other groups. The glucose group rats consumed more sugar than animals given either the fructose solution or granulated sucrose. Rats given the fructose solution consumed more stock diet than animals in the other three groups. Differences in weight gain were not significant but animals in the fructose and sucrose groups gained the most weight. After calculating daily weight gain as a function of caloric intake, it was concluded that rats given granulated sucrose gained the most weight, followed by animals in the fructose group, sucrose group, glucose group and animals given only the standard diet. The fructose group had higher serum triglyceride levels than others. Rats given one of the three sugar solutions consumed approximately 15% more calories per day than animals given the standard diet. The authors concluded that animals given fructose chose a smaller amount of their calories as sugar than did animals given either sucrose or glucose and also these rats had higher triglyceride levels than others.

Zavaroni et al. (1980) evaluated the effect of fructose on insulin secretion and insulin resistances in rats. Eighty-three Sprague-Dawley male rats weighing between 160-180 g were divided into two groups: animals (n=44) with a diet consisting of 66% fructose, 22% casein and 12% fat, and animals (n=39) with standard rat chow, consisting of 60% vegetable starch, 29% animal protein and 11% fat. These two diets were given for seven days. During the first three days, the weight gain was slower in the fructose group than in the control group (3.15 ± 0.3 g/d and 7.47 ± 0.21 g/d, respectively). On the contrary, during the next four days, the weight gain was similar for the two groups (7.36 ± 0.17 g/d and

7.22 ± 0.24 g/d, respectively). The authors concluded that fructose feeding for seven days resulted in an increase in the insulin response and a loss of normal insulin sensitivity.

Table 1: Summary of animal studies

Authors **(year)**	**Description**	**Principal result**
Shapiro et al. (2008)	23 male rats in 2 groups:12 rats on a 60% fructose diet and 11 rats on a fructose-free control diet for 6 mo, then half of the rats in each group were given a high-fat diet for 2 weeks while the other rats continued on their former diets	No differences in food intake or weight gain between groups after 6 mos. After 2 weeks of high-fat diet, rats that had been fed fructose showed a significantly higher energy intake, weight gain and higher adiposity
Nakagawa et al. (2006)	4 sets of experiments on male rats (n=24): treatment of fructose-induced hyperuricemia with allopurinol, prevention of fructose-induced hyperuricemia with allopurinol, effect of lowering of uric acid by either allopurinol or benzbromarone on body weight, comparison between 60% dextrose and 60% fructose in development of metabolic syndrome and effect of lowering uric acid with benzbromarone.	Greater weight gain in fructose-fed rats compared with rats fed normal diet
Jügens et al. (2005)	3-month old male adult mice, (n=32-36), 4 groups (control, fructose-rich soft drink, sucrose-rich soft drink, diet soft drink) for 73 days	Exposure to fructose significantly increased body weight & adiposity greater than other groups.
Davail et al. (2005)	Mule ducks (n=90) in 3 groups. From hatching day to 6 weeks, a diet providing 200 g protein and 12,200 kj/kg ad libitum. From 6-12 weeks, a restricted diet with 182 g protein and 11,500 kj /kg. Overfeeding for 2 weeks in three groups, glucose (control animals), sucrose or high fructose corn syrup (HFCS)	Body weight gain during overfeeding. At the end of overfeeding, body weights in the 3 groups were similar. Significant increased liver weight in Sucrose and HFCS groups
Suga et al. (2000)	Sham-operated lean and ventromedial hypothalamic (VMH)-lesioned obese female rats (n=92), 2 groups fed by 3 ways: standard diet, fructose diet, glucose diet, for 2 weeks.	Plasma leptin concentrations ↑ 6-fold in VMH-lesioned rats fed normal food. Fructose feeding did not affect leptin levels in any of 2 groups. Glucose feeding ↑ plasma leptin levels 2.4-fold in lean rats. No effect on weight gain.
Kasim-Karakas et al. (1996)	Male golden Syrian hamsters(n=18-24), in 3 groups : control, fructose and sucrose, diets containing 60% fructose or sucrose, two weeks	Body weight of the fructose-fed animals was higher than those of controls and sucrose-fed animals
Rawana et al. (1993)	Female rats (n=60), 3 groups: tap water, 100 g/L glucose water or 100 g/L fructose water.	More weight gain in fructose-fed group during lactation.
Rizkalla et al. (1992)	Male rats (n=40), 5 groups. The rats in 4 groups were fed on a powder diet containing 570 g carbohydrate/kg supplied either as corn starch **(S**), dextrose (D),	Rats fed on diets D and FS gained more weight than those fed on diets **S,** F and F/Cu. After 6 weeks, the significance

	fructose (F), or fructose-starch (FS) and an adequate amount of copper. The 5th group was fed on 570g fructose/kg diet supplemented with twice the amount of Cu (FCu).	started to decline.
Kanarek et al. (1982)	Male rats (n=35), 5 groups. Glucose, fructose, sucrose, granulated sucrose and standard diet group, 50 days.	Differences in weight gain were not significant but rats in the fructose and sucrose groups gained the most weight
Zavaroni et al. (1980)	Male rats (n=83), 2 groups. Diet consisting of 66% fructose, 22% casein and 12% fat and animals with standard rat chow consisting of 60% vegetable starch, 29% animal protein and 11% fat for 7 days.	In the first 3 days the weight gain was slower in fructose group. In the following days, the weight gain was similar for the 2 groups.

In summary (Table 1), some of studies found the association between fructose and weight gain. Shapiro et al. (2008) showed that chronic fructose feeding induces leptin resistance, which in turn could predispose rats to increased weight gain in response to a high-fat diet. Nakagawa et al. (2006) showed a weight gain in fructose-fed rats compared with rats fed a normal diet. In the study of Jügens et al. (2005), providing mice with fructose-sweetened beverages resulted in an increase in body weight. Kasim-Karakas et al. (1996) found that body weights of the fructose-fed hamsters were higher than those of controls and sucrose-fed animals. Rawana et al. (1993) showed that an intake of fructose during gestation can cause, at weaning, greater weight gain in dams.

Other studies did not find this association including Suga et al. (2000) that didn't find an effect of fructose on weight gain in rats. Rizkalla et al. (1992) didn't find a significant effect of fructose on body weight in rats. Kanarek et al. (1982) didn't find significant weight gain in rats fed fructose compared to other groups (i.e. glucose, sucrose, granulated sucrose and standard diet group), but rats in the fructose and sucrose groups gained the most weight. Zavaroni et al. (1980) didn't find any effect of fructose on weight gain in rats.

Animal studies seem therefore quite consistent in demonstrating a potential effect of fructose in promoting weight gain and metabolically related parameters in various experimental conditions.

2.5.2 Evidence from human studies

The studies are presented by reverse chronological order in each of three categories: clinical studies, cohort studies and cross-sectional studies.

2.5.2.1 Clinical studies

Ebbeling et al. (2006) in a randomized, controlled trial evaluated the effect of diminishing sugar-sweetened beverages (SSBs) consumption on body weight. The subjects were 103 adolescents (47 males and 56 females), aged 13 to 18 years who reported the consumption of at least 1 serving (360 ml or 12 fl oz) of SSBs daily. Subjects were divided into intervention and control groups. During 25 weeks, the intervention group had home deliveries of non-caloric beverages. They received 4 servings per day each week. Subjects in the control group continued their usual beverage consumption habits during the 25-week intervention period. Consumption of SSBs decreased by 82% in the intervention group and did not change in the control group. The change in BMI was 0.07 ± 0.14 kg/m^2 (mean ± SE) for the intervention group and 0.21 ± 0.15 kg/m^2 for the control group. The net difference, adjusted for gender and age, was –0.14 ± 0.21 kg/m^2, and not significant overall. However, baseline BMI was a significant effect modifier. Among the subjects in the upper baseline-BMI tertile, BMI change differed significantly between the intervention

and control groups. The authors found that the interaction between weight change and baseline BMI was not attributable to baseline consumption of SSBs. They suggested that decreasing sugar sweetened beverages consumption had a valuable effect on body weight for individuals with higher baseline BMI.

James et al. (2004) examined the effect of an educational program with the aim of reducing intake of carbonated drinks on preventing excessive weight gain in children. The subjects were 644 children aged 7-11 years in six primary schools in southwest England. Their intervention plan was a focused on nutrition over one school year with the objective to discourage the consumption of "fizzy" drinks (sweetened and unsweetened) with positive affirmation of a balanced healthy diet. Anthropometric measurements were taken at intervals of six months. They obtained diaries at baseline and at the end of the trial on drinks consumed over three days. Records were made over two weekdays and one weekend day. They found that the intake of carbonated drinks over three days decreased by 0.6 glasses (average glass size 250 ml) in the intervention group but increased by 0.2 glasses in the control group (mean difference 0.7, 95% confidence interval 0.1 to 1.3). The percentage of overweight and obese children increased in the control group by 7.5% in comparison to a decrease in the intervention group of 0.2% (mean difference 7.7%, 95% CI 2.2% to 13.1%) at the end of one year. The authors concluded that their school based educational program with the purpose of reducing consumption of carbonated drinks to prevent excessive weight gain in children aged 7 to 11 years old was effective.

Tordoff et al. (1990) studied if artificial sweeteners have an effect in the control of long-term food intake and body weight. The subjects were 30 normal weight persons (9 females and 21 males). Each subject maintained a dietary record for nine weeks. During this period

they received, for 3 weeks each, four bottles (1135 g) of soda sweetened with aspartame (APM), four bottles (1135 g) of soda sweetened with high-fructose corn syrup (HFCS), or no experimental drinks. Subjects gained significantly more weight after three weeks of drinking HFCS-sweetened soda than after the same period drinking APM-sweetened soda or no experimental soda. To compare with when no soda was given, drinking APM-sweetened soda for three weeks significantly reduced calorie intake of both sexes and decreased the body weight of males but not of females. Drinking HFCS-sweetened soda for three weeks significantly increased the calorie intake of both sexe. The authors concluded that consumption of HFCS-sweetened soda increased both calorie intake and body weight in normal weight subjects.

2.5.2.2 Cohort studies

Bes-Rastrollo et al. (2006) assessed whether the consumption of sweetened drinks and other food items increased the risk of weight gain in a Mediterranean population. This was a prospective cohort analysis of 7,194 men and women with a mean age of 41 years who were followed-up for a median of 28.5 months with mailed questionnaires. Dietary exposure was assessed with a semi-quantitative food-frequency questionnaire for the sugar-sweetened soft drinks, diet soda, and milk. During the follow-up they observed that 49.5% of the participants increased their weight. In the participants who had gained ≥3 kg in the five years before the baseline, the adjusted odds ratio of subsequent weight gain for the fifth quintile compared with the first quintile of sugar-sweetened soft drink consumption was 1.6 (95% CI: 1.2, 2.1). They did not find this relationship in the participants who had not gained weight in the five year period before baseline. The consumption of hamburgers, pizza, and sausages (as a proxy for fast-food consumption) was also independently

associated with weight. The authors also found a significant, but weaker, association between weight gain and both red meat and sweetened fruit juice consumption. The authors observed that the association that they found was only evident in the subjects who reported a prior weight gain.

Welsh et al. (2005) examined the association between sweet drink consumption and overweight conditions among preschool children in a retrospective cohort study with 10,904 children who were aged two and three years. The data of these children was collected between January 1999 and December 2001 with the Harvard Service Food Frequency Questionnaire. Height and weight data was collected one year later. They evaluated sweet drinks as all sugar-sweetened and naturally sweet drinks listed on the HFFQ: "vitamin C juice," "other juices," "fruit drinks" and "soda." They adjusted for age, gender, race/ethnicity, birth weight, and the intake of high-fat foods, sweet foods, and total calories. For children who were normal or underweight at baseline, the relationship between sweet drink consumption and weight gain was positive but not significant. Children who were at risk for developing an overweight condition at baseline and who consumed 1 to <2 drinks/day, 2 to <3 drinks/day, and ≥3 drinks/day were, respectively, 2.0 (95% CI: 1.3–3.2), 2.0 (95% CI: 1.2–3.2), and 1.8 (95% CI: 1.1–2.8) times at risk to become overweight as the referent (<1 drink/day). Relative risk for children who were overweight at baseline and consumed 1 to <2 drinks/day, 2 to <3 drinks/day, and ≥3 drinks/day were, respectively, 2.1, 2.2, and 1.8 times as likely to remain overweight as the referent. The authors suggested that one approach to manage and control the weight of preschool children could be to reduce sweet drink consumption.

Blum et al. (2005) evaluated changes in beverage consumption and relations between beverages consumed and BMI Z-score in children in grades 3 through 6 (n = 164) across two years. The sample consisted of 92 girls and 74 boys. They obtained data on beverage consumption (milk, 100% juice, diet soda or sugar sweetened) using a 24-hour diet recall. Subjects were categorized as normal weight, overweight, gained weight and lost weight. They found significant decreases in milk and increases in diet soda over two years in all subjects. Change in milk consumption was inversely correlated with sugar-sweetened beverage consumption. Increases in diet soda consumption were significantly larger for overweight and subjects who gained weight in comparison to normal weight subjects. The authors concluded that changes in beverage consumption were found in this study during two years. Only diet soda consumption was associated with year 2 BMI Z-score, and consumption was greater in overweight subjects and subjects who gained weight as compared to normal weight subjects at two years. No association was found with sugar sweetened beverages .

Berkey et al. (2004) evaluated the relationship between intakes of sugar-added beverages, milk, fruit juices, and diet soda and changes in body mass index. This prospective cohort study included 16,771 boys and girls. The participants were 9 to 14 years old in 1996. They completed questionnaires in 1996, 1997 and 1998. The data was gathered using a self-administered semi-quantitative food frequency questionnaire for youth. The beverages they studied were sugar-added beverages, fruit juices, diet soda, and milk. They asked about physical activity, race/ethnicity, tanner stage and menarche. In cross-sectional results, older children drank less milk but more orange juice, soda, iced tea, and punch than younger children. Boys reported higher energy intakes and drank more milk, punch, orange juice, and soda than same-age girls. At baseline, children who drank more milk and less diet soda

were leaner, whereas girls who drank more sugar-added beverages were heavier. Diet soda intakes were not associated with higher total energy intakes. Per serving effects for sugar-added beverages and fruit juice intakes were larger than their own energy contents. In longitudinal results, consumption of sugar-added beverages was associated with small BMI gains during the corresponding year. Girls who drank one serving per day of sugar-added beverages gained significantly more weight than girls drinking none, as did girls drinking two servings per day or over three servings per day. Boys who increased consumption of sugar-added beverages from the prior year had weight gain. Children who increased intakes by two or more servings per day from the prior year gained weight. After adjusting for total energy intake, the estimated effects were reduced and were no longer significant. The authors concluded that the consumption of sugar added beverages could have a role in weight gain among adolescents probably by virtue of their contribution to total energy intake, seeing that adjustment for calories greatly weakened the estimated associations.

Schulze et al. (2004) examined the association between consumption of sugar-sweetened beverages, weight change and risk of Type 2 diabetes. This study was a prospective cohort analyses conducted from 1991 to 1999. They had 116,671 female U.S. nurses aged 24 to 44 years at study initiation in 1989. The diabetes analysis included 91,249 women free of diabetes and other major chronic diseases at baseline in 1991. The weight change analysis consisted of 51,603 women for whom there were records of complete dietary information and body weight in 1991, 1995, and 1999. The data was collected with a 133-item semi-quantitative food frequency questionnaire. They evaluated sugar-sweetened soft drinks, fruit juice, fruit punch, and diet soft drinks. The persons with steady eating patterns had no difference in weight gain. Weight gain was highest among women who increased their sugar-sweetened soft drink consumption from one or fewer drinks per week to one or more

drinks per day for both periods, 1991 to 1995 and 1995 to 1999, and was smallest among women who decreased their intake after adjustment for confounders. Increased drinking of fruit punch and fruit juice was also associated with larger weight gain compared with decreased consumption. The authors commented that there is a positive relationship between sugar-sweetened beverages consumption and the risk of obesity and type 2 diabetes, and that effect may be due to the low satiety of liquids.

Ludwig et al. (2001) examined the relationship between the consumption of sugar-sweetened drinks and obesity in children. They obtained the data from the Planet Health intervention and project evaluation that was done in schools in four communities in the U.S. They enrolled children from five randomly assigned control schools that were not in the intervention program. A total of 780 children completed the baseline evaluation in October, 1995. Follow-up data was obtained in May, 1997, for 84% (654) of the baseline sample. After exclusion of children with implausible daily energy intakes, a cohort of 548 individuals with a mean age 7 to 11 years was remaining. The primary hypotheses were that the baseline and changes in consumption of sugar-sweetened drinks could predict a rise or fall in BMI over two academic years. The youth food-frequency questionnaire (YFFQ) was used to assess the average intake of drinks, percentage energy intake from dietary fat, and total energy intake. Sugar-sweetened drink consumption was calculated from responses to the YFFQ. Intake of sugar-sweetened drinks increased from baseline to follow-up: only 38 (7%) children showed no change in sugar-sweetened drink intake while 57% (312) showed increased intake, with a quarter drinking more than one extra serving daily. BMI for each serving per day and additional serving increased in the baseline. In the fully adjusted model, the odds of becoming obese increased 1.6 times (95% CI, 1.14-2.24) for each additional daily serving of sugar-sweetened drink. The authors concluded that the

consumption of sugar-sweetened soft drinks is related with weight gain in children probably for the reason of inadequate compensation for energy consumed in liquid form.

2.5.2.3 Cross-sectional studies

Ariza, et al. (2004) evaluated the prevalence of and possible risk factors for overweight in a sample of 250 (123 girls, 127 boys), 5- to 6-year-old Hispanic children in Chicago, Illinois. Data were collected at school during September–November 1996. They obtained data about demography, acculturation, infant and toddler feeding practices, current eating patterns and food preparation habits, physical activity, and psychosocial family characteristics. They asked about current eating and food preparation habits with 12 questions on food purchases, food preparation styles, and frequency of consumption of commonly used foods and beverages. They found that overweight children made up 23% of the sample and these children were significantly more likely than non-overweight children to watch television for more than 3 hours during weekend days and to consume sweetened beverages (powdered drinks, soda pop, atole) daily. Children with daily consumption of sweetened beverages were more likely to be overweight than those with less-than-daily consumption of sweetened beverages (adjusted odds ratio 3.7, 95% CI 1.2–11.0).

Forshee et al. (2004) studied the relative importance of demographics, beverage consumption, physical activity, and sedentary behaviour for maintaining a healthy body weight. They used data from the third National Health and Nutrition Examination Survey 1988- 1994 on 2,216 adolescent males and females aged 12- 16 years. Dietary data were collected using both a food frequency questionnaire (FFQ) and a one-day 24-h dietary

recall (24HR). Using the 24HR, males 12-16 years old consumed a mean of 524.4 g/day of regular carbonated soft drink (RCSD) while females 12-16 years old consumed a mean of 346.8 g/day of RCSD. The results from the FFQ were slightly lower. They found a positive non significant association between soda consumption and body mass index and an inverse non significant relationship between fruit drinks consumption and body mass index. RCSD consumption was not statistically significant in any of the models. They suggested that changes in RCSD consumption produce only small changes in predicted BMI.

Gillis et al. (2003) studied if particular foods may be associated with obesity in children and adolescents and attempted to determine the effect of consuming food away from home (FAFH) on the nutritional quality of their diets. Subjects were 181 children and adolescents 4-16 years old and were observed over the year 2001. They were divided into two groups, one defined as obese (n=91) and the other as non-obese (n=90). The data regarding dietary history included a 24-hour recall and a modified food frequency questionnaire (FFQ). The obese group consumed significantly more servings of meat and alternatives, grain products, FAFH, sugar-sweetened drinks and potato chips compared to the non-obese group. Consumption of sugar-sweetened drinks was only significantly greater in boys. There were significant positive correlations between percent body fat with consumption of meat and alternatives, sugar sweetened drinks and FAFH and significant negative correlations between percent body fat and consumption of cheese and fruit including fruit juice. The authors concluded that obese children and adolescents consume more FAFH and sugar-sweetened beverages than non-obese ones which correlates positively with body fatness.

Giammattei et al. (2003) determined the prevalence of obesity among students and studied lifestyle parameters related to obesity. The subjects were 385 sixth and seventh grade

students (186 boys and 199 girls) from three schools. Their ages were from 11 to just under 14 years. They obtained data about health behaviors and the number of regular and diet soft drinks being consumed by the subjects each day. 17.9% of subjects had a BMI between the 85th and 95th percentiles, and 17.4% had a BMI above the 95th percentile. These rates were higher among Latino students and lower among Asian students, as compared with non-Hispanic white students. They found significant associations between BMI and hours of television watched per day and daily soft drink consumption. The students who drank three or more soft drinks per day had a BMI *z* score that was 0.51 higher (95% CI, 0.17 to 0.85) and also had 4.4% more body fat. These students were more likely to have a BMI at or above the 85th percentile than those who consumed fewer than three soft drinks per day. The authors also observed a significant relationship between television watching and soft drink consumption with weight gain. They suggest that it is not the calories in the drinks that are responsible for this association because diet soft drinks also had this association with obesity.

Nicklas et al. (2003) examined the relationship between eating patterns and overweight conditions in children who participated in the Bogalusa Heart Study. The data was collected with a single 24-hour dietary recall in a sample of 1,562 ten-year-old children over was a 21 year period. They considered having a body mass index greater than the 85th percentile using Centers for Disease Control and Prevention reference standards as overweight. They adjusted for energy, age, study year, ethnicity, and sex. The authors found that the consumption of sweetened beverages (58% soft drinks, 20% fruit flavored drinks, 19% tea, and 3% coffee), sweets, and meats was positively associated with weight gain. They concluded that numerous eating patterns were associated with an overweight condition.

Liebman et al. (2003) assessed the relationship between different lifestyle variables and body mass index (BMI). They used baseline cross-sectional data from the "Wellness IN the Rockies" project. The subjects consisted of 928 males and 889 females, aged from 18 to 99 years from six rural communities in Wyoming, Montana, and Idaho (USA). The data was gathered with a questionnaire that consisted of sociodemographic information, self-reported height and weight, and data related to specific dietary intakes, like the individual's frequency of consumption of sweetened beverages, fruits and vegetables, milk, and whole grains, eating-related behaviors, and physical activity. They adjusted for confounding variables such as age, gender, race, and level of education. Prevalence of overweight conditions was 70% in men and 59% in women. The authors found that an increased probability of being overweight or obese was associated with greater frequency of drinking sweetened beverages such as soft drinks/soda pop, ordering supersized portions, eating while doing other activities, and watching television.

These studies are summarized in Table 2.

Table 2: Summary of human studies

Description		Principal Result
A. Clinical studies		
Ebbeling et al. (2006)	randomized, controlled trial,103 adolescents (47 males and 56 females), aged 13 to 18 years, weekly home delivery of noncaloric beverages for 25 weeks (4 servings/day for subjects)	Decreasing sugar-sweetened beverage consumption significantly reduced body weight in people with baseline BMI>30
James et al. (2004)	644 children aged 7-11 years, Focused educational programme to discourage the consumption of "fizzy" drinks (sweetened and unsweetened) over one school year, measurement of drink consumption and number of overweight and obese children	Decreasing consumption of carbonated drinks in the intervention group but increased in the control, increasing the percentage of overweight and obese children in the control group and decrease in the intervention group
Tordoff et al. (1990)	30 normal weight (9 F and 21 M), for 3 wks each, 4 bottles (1135 g) soda sweetened with APM, 4 bottles (1135 g) soda with HFCS, effect of artificial sweeteners on body weight	Drinking HFCS-sweetened soda for 3 wk significantly ↑ body weight of both sexes
B. Cohort studies		
Bes-Rastrollo et al. (2006)	Prospective cohort, 7,194 men and women, mean age of 41 yrs, 28.5 month follow-up, consumption of sweetened drinks and other food items and weight gain, food-frequency questionnaire, sugar-sweetened soft drinks, diet soda, and milk.	↑ body weight in 49.5% of participants
Welsh et al. (2005)	retrospective cohort, 10,904 children 2 and 3 yrs, Harvard FFQ, association between sugar sweetened drink consumption and overweight,1 yr follow-up	consumption of sweet drinks 1 to 2 /day ↑ the odds of becoming overweight among those who are at risk for overweight at baseline and of remaining overweight among those who are already overweight by 60% or more
Blum et al. (2005)	Cohort, 164 children, grade 3 to 6, 92 girls and 74 boys, a 24-hour recall, milk, 100% juice, diet soda or sugar sweetened	No significant association between sugar-sweetened beverages consumption and year 2 BMI z score
Berkey et	prospective cohort, 16,771 boys and girls,	↑ BMI, after adjusting for

al. (2004)	aged 9-14 yrs, 2 yr follow-up, relationship between intakes of sugar-added beverages, milk, fruit juices, and diet soda and BMI, youth food-frequency questionnaire	total energy intake, the estimated effects were no longer significant
Schulze et al. (2004)	prospective cohort, 51,603 women, 8 yr follow-up, consumption of sugar-sweetened beverages and weight change and risk of Type 2 diabetes	↑ body weight and ↑ risk of Type 2 diabetes
Ludwig et al. (2001)	prospective cohort, 548 children, mean age of 11.7 yrs, 19 months, consumption of sugar-sweetened drinks and obesity, youth food-frequency questionnaire	↑ BMI
C. Cross-sectional studies		
Ariza, et al (2004)	Cross-sectional study, 250 children (123 girls, 127 boys), 5- to 6-year-old, Hispanic American, 23% of children were overweight	Over weight children had significantly more consumption of sweetened beverages. Daily consumption was associated with overweight compared with less than daily consumption
Forshee et al. (2004)	Cross-sectional, 2,216 adolescents 12-16 years, FFQ and one 24-hour recall	Consumption of regular carbonated soft drinks and fruit drinks were not statistically associated with BMI in any of the models
Gillis et al. (2003)	One-year cross-sectional study, 181 children and adolescents, 4-16 yrs, 91 obese and 90 non-obese children, one 24-hour recall and a modified FFQ,	The obese group consumed significantly more servings of sugar-sweetened drinks compared to non-obese group
Giammattei et al. (2003)	385 children aged 11 to just younger than 14 years (186 boys and 199 girls), the number of regular and diet soft drinks per day by subjects, one year cross-sectional	Significant associations between BMI and 3 or more daily soft drink consumptions
Nicklas et al. (2003)	relationship between eating patterns and overweight conditions, a single 24-hour dietary recall, 1,562 children aged 10 yrs, 21-year cross-sectional study	The consumption of sweetened beverages; sweets; meats were positively associated with significant weight gain
Liebman et al. (2003)	relationship between different lifestyle variables and BMI, cross-sectional, 928 males and 889 females, aged 18-99 yrs, questionnaires	Increased probability of being overweight or obese was associated with greater frequency of drinking sweetened beverages such as soft drinks/soda pop

We can compare the findings of human studies that were done in adults with those that were done in children and adolescents. In adult studies, all used proxies for fructose consumption. Tordoff et al. (1990) showed that drinking HFCS-sweetened soda for three weeks significantly increased body weight. Bes-Rastrollo et al. (2006) found an association only in subjects who gained 3 to 5 kg in the five years before the study and not in those whose weight was stable during this period. In this study the weight gain was self-reported. Schulze et al. (2004) found the association between consumption of sugar-sweetened beverages and an increase in body weight. They found this association also for fruit juice. Liebman et al. (2003) showed that an increased likelihood of being overweight or obese was associated with greater frequency of drinking sweetened beverages such as soft drinks/soda pop. It was also associated with ordering supersized portions, eating while doing other activities, and watching television.

In children and adolescents' studies proxies for fructose intake were also generally used. Ebbeling et al. (2006) found that decreasing sugar-sweetened beverages intake had a beneficial effect on body weight that was associated with baseline BMI .James et al. (2004) showed that the school based educational program with the purpose of reducing consumption of carbonated drinks to prevent excessive weight gain in children aged 7 to 11 years old was effective.. Welsh et al. (2005) found the association only in overweight or obese children. They could not find the association in normal weight children. Blum et al. (2005) did not find a significant relationship between the assessed changes in the consumption of sugar-sweetened beverages and BMI z scores. Berkey et al. (2004) showed the association but it was not significant after adjustment for energy intake. They

calculated BMI values from self-reported heights and weights. Ludwig et al. (2001) also confirmed this association in children 11 to 12 years old. Ariza et al. (2004) found that daily consumption of sweetened beverages was associated with overweight compared with less than daily consumption. Forshee et al. (2004) found the association was not significant. Gillis et al. (2003) found that the obese group consumed significantly more servings of sugar-sweetened drinks compared to the non-obese group. They found this association for other foods also, e.g. meat and alternatives, grain products, FAFH and potato chips, compared to the non-obese group. Giammattei et al. (2003) found the association only for more than three servings per day of soft drinks. This study was limited to sixth and seventh grade students from three schools. Nicklas et al. (2003) showed that the consumption of sweetened beverages, sweets, and meats were positively associated with significant weight gain; however, they did not control for physical activity.

Overall, the majority of the metabolic studies in animals were consistent with the idea of a relationship between fructose consumption and obesity. Human studies, however, are less consistent and more were based on estimated fructose intake. Instead, proxies were used. It seems that there is a trend toward a positive association in children but there is less evidence in adults.

III. Rationale

III. Rationale

Over the past thirty years, the prevalence of obesity has risen in both developed and developing countries. Fructose consumption has also significantly increased during the past few decades. As we noted, obesity has different causes; among them, dietary causes are important for nutrition researchers. It is difficult to refer to just one unique food as a cause of obesity but some foods seem likely to be more directly related to the risk of obesity.

Some researchers have shown that the increase in obesity in recent years is paralleled with the introduction of corn sweeteners into the U.S. food supply and the increase in fructose consumption in diverse forms such as soft drinks, baked goods, condiments, prepared desserts, and other processed foods.

Because this is a young hypothesis, the number of studies is limited; however we found sufficient documents to discuss the matter. Different studies have been done in human and animal models. Some observational studies are indeed consistent with the possibility that increased fructose consumption is one of the causal factors in the current obesity epidemic especially for children. Some studies did not find, however, any association. All used proxies of fructose consumption rather than calculated fructose intake.

We therefore aimed at assessing whether there is evidence of a relationship between fructose consumption and risk of obesity among adults from aboriginal communities with a high prevalence of obesity.

In this study we selected two Canadian aboriginal populations, the Cree and the Inuit. The Cree are the largest group of First Nations in Canada, with over 200,000 members and 135 registered bands. The Inuit are a people indigenous to the Arctic region whose homeland stretches from the easternmost tip of Russia, across Alaska and Canada, to Greenland. As we noted before, there has been an increase in the prevalence of obesity in recent decades in these two communities and there has also been a transition in their food from traditional foods to commercial foods; a transition associated with high sugar intake (Kuhnlein et al, 2000)

Research question:

Is there a relationship between fructose consumption and obesity in adults from two aboriginal populations in Canada: the Cree and the Inuit?

IV. Methodology

IV. Methodology

We utilized two publicly available databases in this study. Here are the descriptions of each database, including target population, sampling and data collection method, followed by the principal variables and our analysis.

4.1 The Cree Database

This database was extracted from the 1991 Santé Québec survey of the Cree population living in the James Bay. The aim of this survey was to have a description of the health conditions of the James Bay Cree by the description of their food intake and the nutritional values of the foods consumed. The target population was the Cree adults aged between 18 and 74 years old in nine communities (Santé Québec, 1991). There were 1,716 private households in these nine communities at the time of the survey (Santé Québec, 1991).

The population of James Bay Cree lives in a territory of northern Quebec between the 49th and 55th parallels, covering 300,000 square kilometers of boreal forest (Robinson et al, 1995). Their traditional diet consisted of animals and plants (Robinson et al, 1995).

The sampling was done on 400 Cree households inside nine communities selected by the Quebec statistics office. Among the 400 households that were first selected, 354 consented to reply to the household questionnaire included in the general health survey (88.5%). Among the respondents, 1,115 individuals, aged from 15 to 74 years old, gave permission for the clinical visit and the nutritional interview. Among them, 943 participated in biological measurements (74.9%) and 855 responded to the dietary recall (67.9%) (Annex

1). Finally, our database consisted of 835 people 18-74 y that had data on both the 24-hour recall and BMI measurement. The 24-hour (24hr) dietary recall was used with the aim of gathering more precise and complete information on the food consumed by the respondents. Data collection was in the summer season (24 June to 16 August, 1991). Summer was chosen because it is the season when the maximum numbers of people are present in the community; the Cree often leave to do different activities like hunting and fishing from September to May. A pilot survey was done before the survey in order to verify the methods. Height and weight were measured.

The recalls were conducted by a trained nurse at the participant's home with a Cree interpreter if necessary. The food models consisted of 54 food items. The collected data was analyzed with the CANDI software (Canadian Dietary Information System) (Thompson, 1990).

These individuals had consumed 755 food items. Considering that there may be an interaction between age and the fructose-obesity relationship, we categorized them into two age groups: Age Group 1 included people between 20 and 40 years old and Age Group 2 included people from 40 to 60 years old. We did not include people less than 20 years old or more than 60 years old in the analysis in order to have a more homogenous sample and also because of their small number. After applying the Goldberg limits, we had a final sample of 522 Cree adults for analysis: 263 women and 259 men. We considered the four BMI groups as Group 1 (BMI between 18.5-25), Group 2 (BMI between 25-30), Group 3 (BMI between 30-35) and Group 4 (BMI more than 35).

We noted the name of the consumed food, the given codes of 1991, and the corresponding codes of 1997. We then extracted the amount of fructose per 100 g of food from the

Canadian Nutrient File (CNF) 1997. For the amounts missing in CNF 1997, we used CNF 2007, and for the amounts that were still missing we imputed the appropriate amount based on the amount found in similar foods.

The final food composition database we created is included in the Annex 2. The fructose content for 115 food items was available from CNF 1997. For other food items, the fructose content was taken from CNF 2007**.** For the rest food items, we imputed the value based on existing amounts. 'Zero' was noted for other remaining missing data.

4.2 The Inuit Database

This database was extracted from a study of Inuit communities in five regions: Inuvialuit, Kitimeot, Kivalliq, Qikiqtaaluk (Baffin) and Labrador (Kuhnlein et al, 2000). Eighteen participating communities were selected to represent approximately 50 Inuit communities in these regions.

The data collection was done in fall (September-November, 1998) and winter (February-April, 1999), both for the same 18 communities to avoid underestimation of traditional food intake when a large number of high consumers of traditional food were out on the land. The interviews were carried out in English or Inuktitut (Kuhnlein et al, 2000).

Self –reported height and weight were collected, with optional body weight and height measurements. A total of 1,929 interviews were completed, 929 in fall and 1001 in winter. There were four age groups: 15-19, 20-40, 41-60 and the group of people more than 60

years old. The results of self-reported height and weight and measured height and weight were in good agreement for all age and gender categories (Kuhnlein et al, 2000).

For the analysis we excluded two groups, the 15-19 year olds and the over 60s, because the sample size was too small in both groups. We also excluded the persons that didn't have the weight or height measurements and the persons that were interviewed both in fall and winter. We analyzed two age groups: Group 1 (the people between 20 and 40 years old) and Group 2 (the people from 40 to 60 years old). We had a total of 550 Inuit adults for analysis (301 women and 249 men). We divided them into three BMI groups: Group 1 (BMI between 18.5-25), Group 2 (BMI between 25-30) and Group 3 (BMI more than 30), because there were not enough individuals to make up a forth BMI group. The same goldberg factors as for the Cree were used.

We had a list of 244 foods consumed by Inuit in the form of g/person/day and we extracted the amount of fructose in each food item according to Canadian Nutrient File (CNF) 2007. For the food items without an amount in CNF 2007, we replaced the value from CNF 1997. For the rest, we imputed the values from the existing amounts (Annex 3).

4.3 Statistical Analysis

In each of these two databases a descriptive analysis was performed to characterize the target population of the study. The chi-square test was done to compare the proportion of participants in each BMI category.

For evaluating the risk of underestimation of consumption in different BMI groups, we used Goldberg factor limits, 0.87 to 2.75, as a threshold for the activity factor, which shows the minimal level of sedentary activity in healthy individuals. We selected this limit because it was reasonable for one 24hr recall (Black, 2000).

For the analysis, we used a Univariate (ANOVA) model to evaluate differences in fructose consumption by BMI categories then adjusted for energy intake. We considered energy intake and age as confounding factors because they may independently affect both BMI and fructose consumption. We further posited that interaction by age may occur, based on Kuhnlein et al. (2000), and therefore, for the energy adjusted analyses, we stratified by age. The non-parametrical analysis (GLM with Rank Procedure) was selected due to the small number of observations in BMI categories. Separate Kruskal-Wallis tests were done for total fructose, fructose coming from foods, and fructose coming from beverages according to BMI categories, adjusted for total energy intake; when p was <0.05, multiple comparisons were made using the Bonferroni correction. Data was analyzed using the Statistical Analysis System (SAS 9.1.3, Package 4).

V. Results

V. Results

5.1 Cree Database

Table 3 shows a description of the Cree database that includes mean, standard deviation, and minimum and maximum of characteristic variables (age, body mass index, weight, height, fructose from foods, fructose from beverages, fructose total from foods and beverages, energy and Goldberg factor). There are four groups in this table: A. women 20-40 years of age, B. women 40-60 years of age, C. men 20-40 years of age, and D. men 40-60 years of age. The number of young men and women is nearly similar and the number of old men and women is also the same. In both women and men there are more young people than old. The amount of total consumed fructose in younger people is greater than older ones and this amount is less in women than men. The Table shows that the minimum and maximum total fructose intake is similar in men and women.

Table 4 shows the distribution of studied variables presented in Table 1 by body mass index categories. It is obvious that there are a small number of older women and men in the normal weight category.

Table 5 includes principal sources of fructose in the Cree database in each of the four groups described in Table 1. These are the sources accounting for at least 90% of fructose intake in this study's groups. As this Table shows, the main sources of consumed fructose in this population are the beverages. These sources are similar between different sex and age groups. The principal sources are fruit punch and orange flavored drinks, cola soft drinks, and lemon and lime soft drinks.

Table 6 shows the result of the GLM procedure with Rank in evaluating the association between BMI categories and fructose intake by sex and age groups in the Cree database. Separate Kruskal-Wallis tests were done for total fructose, fructose coming from foods, and fructose coming from beverages according to BMI categories; when p was <0.05, adjustment for multiple comparisons was made using Bonferroni (means not sharing the same superscript were statistically significant, $p<0.05$). Although total fructose intake and fructose from beverages appeared to differ across BMI categories for younger and older women respectively, adjustment for multiple comparisons showed no statistically significant difference.

Curiously, younger overweight women had a greater total fructose intake than obese women. Among older women, fructose intake from beverages appeared to increase with BMI but with a statistically significant difference between overweight and morbidly obese women. No differences in fructose intake were detected among men.

Table 7 shows the association between BMI categories and fructose intake by sex and age groups in the Cree database, adjusted for energy intake. After adjustment for energy intake, the difference among women disappeared.

Table 3: Description of Cree database (mean, standard deviation, minimum and maximum of characteristic variables)

A. Women , 20 -40 yrs of age					
Variable	N	Mean	Std Dev	Min	Max
Age (yrs)	187	28.0	5.3	20.0	39.0
BMI (kg/m2)	187	30.8	6.1	18.7	50.7
Weight (kg)	187	80.5	16.7	44.0	136.0
Height(m)	187	1.61	0.05	1.43	1.75
Fructose(g) foods(g) beverages(g)	187	29.8 7.9 21.9	27.5 17.8 22.3	0.2 0.1 0	243.8 235.6 152.9
Energy (Kcal)	187	2110	588	1045	5201
Goldberg factor *	187	1.33	0.33	0.88	2.39
B. Women , 40-60 yrs of age					
Age(yrs)	76	48.2	5.7	40.0	59.0
BMI (kg/m2)	76	33.1	5.6	21.9	46.5
Weight (kg)	76	84.5	16.0	45.0	122.0
Height(m)	76	1.59	0.06	1.43	1.75
Fructose(g) foods(g) beverages(g)	76	20.6 7.0 13.6	22.5 6.8 21.5	0.3 0.3 0	100.8 30.8 95.0
Energy (Kcal)	76	2196	655	1204	4522
Goldberg factor *	76	1.40	0.38	0.87	2.73

* For evaluation the risk of underestimation of consumption in different BMI groups, Goldberg factor limits 0.87 to 2.75 was selected as threshold for activity factor.

Table 3 (suite)

C. Men , 20 -40 yrs f age					
Variable	N	Mean	Std Dev	Min	Max
Age(yrs)	195	28.4	5.3	20.0	39.0
BMI (kg/m2)	195	27.7	4.4	19.5	43.3
Weight (kg)	195	83.7	14.6	54.0	135.0
Height(m)	195	1.73	0.05	1.43	1.87
Fructose(g) foods(g) beverages(g)	195	39.3 6.9 32.4	36.5 5.6 36.0	1.3 0.5 0	225.4 40.1 212.0
Energy (Kcal)	195	2784	803	1502	5685
Goldberg factor *	195	1.46	0.43	0.87	2.72
D. Men , 40-60 yrs of age					
Age(yrs)	64	48.0	5.9	40.0	59.0
BMI (kg/m2)	64	31.9	5.8	22.5	55.7
Weight (kg)	64	95.3	16.5	60.0	136.0
Height(m)	64	1.73	0.06	1.58	1.87
Fructose(g) foods(g) beverages(g)	64	24.9 6.6 18.3	24.8 6.1 24.5	0.5 0.5 0	100.5 33.2 96.5
Energy (Kcal)	64	2822	866	1528	5111
Goldberg factor *	64	1.41	0.44	0.87	2.72

* For evaluation the risk of underestimation of consumption in different BMI groups, Goldberg factor limits 0.87 to 2.75 was selected as threshold for activity factor.

Table 4: Studied variables by BMI categories

BMI= 18.5-25 ,Women, 20 -40 yrs of age					
Variable	N	Mean	Std Dev	Min	Max
Energy(Kcal)	34	1961	580	1045	3453
Fructose(g) foods(g) beverages(g)	34	26.1 4.5 21.5	19.8 3. 1 19.9	0.8 0. 8 0	73.6 12.7 72.6
Goldberg factor *	34	1.44	0.40	0.90	2.33
BMI= 18.5-25 , Women , 40-60 yrs of age					
Variable	N	Mean	Std Dev	Min	Max
Energy(Kcal)	6	1815	643	1376	2989
Fructose(g) foods(g) beverages(g)	6	14.0 6.6 7.4	6.8 6.6 6.3	2.1 2.1 0	19.7 19.5 14.9
Goldberg factor *	6	1.37	0.45	1.01	2.20
BMI= 18.5-25 , Men , 20 -40 yrs f age					
Variable	N	Mean	Std Dev	Min	Max
Energy(Kcal)	56	2802	816	1502	4798
Fructose(g) foods(g) beverages(g)	56	39.8 5.8 34.1	37.1 3.2 37.7	2.1 0.8 0	198.7 14.0 195.8
Goldberg factor *	56	1.62	0.46	0.88	2.62
BMI= 18.5-25 , Men , 40-60 yrs of age					
Variable	N	Mean	Std Dev	Min	Max
Energy(Kcal)	4	3216	1282	1753	4841
Fructose(g) foods(g) beverages(g)	4	9.0 5.0 4.1	7.2 3.0 8.1	2.1 2.1 0	19.1 8.2 16.3
Goldberg factor *	4	1.84	0.70	1.03	2.72

Table 4 (suite)

BMI=25-30, Women, 20 -40 yrs of age					
Variable	N	Mean	Std Dev	Min	Max
Energy(Kcal)	58	1938	450	1265	3112
Fructose(g) foods(g) beverages(g)	58	31.9 11.5 20.3	320.7 30.9 24.3	1.7 1.3 0	243.8 235.6 93.4
Goldberg factor *	58	1.28	0.29	0.89	2.10
BMI=25-30 , Women , 40-60 yrs of age					
Variable	N	Mean	Std Dev	Min	Max
Energy(Kcal)	20	2039	533	1204	3093
Fructose(g) foods(g) beverages(g)	20	12.9 8.9 4.0	14.5 9.3 8.0	0.3 0.3 0	57.1 30.8 26.3
Goldberg factor *	20	1.40	0.36	0.87	2.10
BMI=25-30 , Men , 20 -40 yrs f age					
Variable	N	Mean	Std Dev	Min	Max
Energy(Kcal)	85	2691	721	1602	4758
Fructose(g) foods(g) beverages(g)	85	36.2 7.4 28.9	28.8 7.0 28.0	1.3 0.5 0	137.7 40.1 134.4
Goldberg factor *	85	1.41	0.38	0.87	2.51
BMI=25-30 , Men , 40-60 yrs of age					
Variable	N	Mean	Std Dev	Min	Max
Energy(Kcal)	16	2485	644	1528	3529
Fructose(g) foods(g) beverages(g)	16	26.7 5.5 21.2	30.5 4.5 29.3	0.5 0.5 0	95.7 16.1 88.8
Goldberg factor *	16	1.34	0.35	0.88	1.94

Table 4 (suite)

BMI=30-35 , Women, 20-40 yrs of age					
Variable	N	Mean	Std Dev	Min	Max
Energy(Kcal)	51	2092	493	1408	3401
Fructose(g) foods(g) beverages(g)	51	27.0 6.3 27.0	21.4 4.7 21.1	1.5 0.1 0	107.3 25.1 101.9
Goldberg factor *	51	1.28	0.29	0.88	2.13
BMI=30-35 , Women , 40-60 yrs of age					
Variable	N	Mean	Std Dev	Min	Max
Energy(Kcal)	22	2135	464	1494	3277
Fructose(g) foods(g) beverages(g)	22	22.4 6.3 16.1	27.0 5.6 25.2	1.5 1.5 0	100.8 22.1 95.0
Goldberg factor *	22	1.36	0.31	0.93	2.16
BMI=30-35 , Men , 20 -40 yrs f age					
Variable	N	Mean	Std Dev	Min	Max
Energy(Kcal)	43	2943	908	1716	5685
Fructose(g) foods(g) beverages(g)	43	45.8 7.5 38.3	50.3 5.5 48.7	2.0 1.3 0	225.4 28.9 212.0
Goldberg factor *	43	1.41	0.42	0.87	2.72
BMI=30-35 , Men , 40-60 yrs of age					
Variable	N	Mean	Std Dev	Min	Max
Energy(Kcal)	33	2890	934	1659	5111
Fructose(g) foods(g) beverages(g)	33	25.5 6.5 19.1	24.6 6.2 24.5	1.0 0.7 0	100.5 33.2 96.5
Goldberg factor *	33	1.42	0.46	0.87	2.65

Table 4 (suite)

BMI > 35 , Women, 20 -40 yrs of age					
Variable	N	Mean	Std Dev	Min	Max
Energy(Kcal)	44	2474	701	1468	5201
Fructose(g) foods(g) beverages(g)	44	33.2 7.7 25.5	24.9 7.5 22.9	0.2 0.2 0	95.1 43.8 80.4
Goldberg factor *	44	1.35	0.34	0.91	2.39
BMI > 35 , Women , 40-60 yrs of age					
Variable	N	Mean	Std Dev	Min	Max
Energy(Kcal)	28	2438	796	1399	4522
Fructose(g) foods(g) beverages(g)	28	26.0 6.2 19.8	24.4 5.5 25.0	0.4 0.4 0	90.2 24.8 89.0
Goldberg factor *	28	1.44	0.45	0.87	2.73
BMI > 35 , Men , 20 -40 yrs f age					
Variable	N	Mean	Std Dev	Min	Max
Energy(Kcal)	11	2795	909	2114	4973
Fructose(g) foods(g) beverages(g)	11	34.7 6.0 28.8	21.3 2.7 21.4	7.3 1.2 0	72.4 10.6 64.8
Goldberg factor *	11	1.21	0.40	0.89	2.06
BMI > 35 , Men , 40-60 yrs of age					
Variable	N	Mean	Std Dev	Min	Max
Energy(Kcal)	11	2968	737	2070	3883
Fructose(g) foods(g) beverages(g)	11	25.8 8.9 17.0	20.6 8.4 21.0	2.5 2.5 0	61.3 29.9 56.3
Goldberg factor *	11	1.29	0.28	0.96	1.67

Table 5: Principal sources of fructose in Cree database (sources accounting for at least 90% of fructose intake)

Women , 20 -40 yrs of age , N=187		
Fructose(g)	Percent	Food item
4.8	16%	drinks flavored with fruit punch powder + water
4.4	15%	drink orange flavor, vitamin C + powder
3.6	12%	cola soft drinks
2.6	9%	soft drinks, soda, lemon and lime
2.1	7%	orange juice, canned
1.2	4%	cereal, cream of wheat 5 minutes, iron-fortified, cooked
1.2	4%	apple juice, canned / bottle, vitamin C added
1	3.5%	soft drinks, orange soda
0.8	3%	white bread, 1 to 2% milk powder, toasted
0.5	2%	apples, raw, with peel
0.4	1.5%	white bread (1 to 2% skimmed milk powder)
0.4	1.5%	apple juice, canned / bottle, saw no added C
0.4	1.5%	raisins, seedless (Sultana)
0.4	1.5%	orange juice, frozen concentrate, diluted
0.4	1.5%	drink, flavored lemonade, powdered
0.3	1%	pears, raw, with peel
0.3	1%	quencher (type Gatorade), bottled
0.3	1%	bananas, raw
0.3	1%	drink citrus juice, frozen concentrate + water
0.2	0.7%	bread, bread, commercial, nature, hot-dog/hamburger
0.2	0.7%	grapes, European type, adhering skin, raw
0.2	0.7%	tomato ketchup

0.2	0.7%	peaches, halves / sliced canned, light syrup ,solid+liquid
0.2	0.7%	cereal, oatmeal, régulier/rapide/1 minute, cooked
	9.5%	Others

Table 5 (suite)

Women , 40-60 yrs of age, N=76		
Fructose(g)	Percent	Food item
4	20%	drink orange flavor, vitamin C + powder
2.5	12%	drinks flavored with fruit punch powder + water
1.7	8.5%	soft drinks, soda lemon and lime
1.4	7%	soft drinks, orange soda
1.2	6%	orange juice, canned
1.2	6%	apple juice, canned / bottle, vitamin C added
1.0	5%	raisins, seedless (Sultana)
1.0	5%	cola soft drinks
1.0	5%	orange juice, frozen concentrate, diluted
0.6	3%	white bread, 1 to 2% milk powder, toasted
0.6	3%	grapes, European type, adhering skin, raw
0.5	2.5%	apples, raw, with peel
0.4	2%	apple juice, canned / bottle, saw no added C
0.4	2%	oranges, all commercial varieties, raw
0.3	1.5%	drink citrus juice, frozen concentrate + water
0.3	1.5%	jams and preserves
	10%	Others

Table 5 (suite)

Men , 20 -40 yrs of age, N=195		
Fructose(g)	Percent	Food item
9	23%	drink orange flavor, vitamin C + powder
8	20%	cola soft drinks
5	13%	drinks flavored with fruit punch powder + water
4	11%	soft drinks, soda, lemon and lime
2	6%	orange juice, canned
1.5	4%	orange juice, frozen concentrate, diluted
1.5	4%	drink flavored fruit punch, + vitamin C, powder + water
1.1	3%	soft drinks, orange soda
1.1	3%	white bread, 1 to 2% milk powder, toasted
1	2.5%	white bread (1 to 2% skimmed milk powder)
0.5	1.5%	apples, raw, with peel
	9%	Others

Table 5 (suite)

Men , 40-60 yrs of age, N=64		
Fructose(g)	Percent	Food item
5	20%	cola soft drinks
5	20%	soft drinks, soda, lemon and lime
3.5	14%	drinks flavored with fruit punch powder + water
2	8%	soft drinks, orange soda
2	8%	orange juice, canned
1	4%	white bread, 1 to 2% milk powder, toasted
1	4%	lemonade, white, frozen concentrate + water
0.6	2.5%	white bread (1 to 2% skimmed milk powder)
0.6	2.5%	raisins, seedless (Sultana)
0.5	2%	carbonated drinks, ginger ale
0.5	2%	orange flavored drink, vitamin C + powder
0.4	1.7%	blueberries, raw
0.4	1.7%	jams and preserves
	9.6%	Others

Table 6: Association between BMI categories and fructose intake by sex in Cree database*

Women , 20 -40 yrs of age (N=187)					
means (standard error)					
BMI categories	18.5-25 (n=34)	25-30 (n=58)	30-35 (n=51)	>35 (n=44)	P value *
Fructose (g) Foods	4.5(3.1)a	11.5(2.3)b	6.3(2.5)ab	7.7(2.7)ab	0.034
Fructose (g) beverages	21.5(3.9)	20.3(3.0)	20.8(3.1)	25.5(3.4)	0.527
Fructose(g)	26.1(4.8)	31.9(3.6)	27.0(3.9)	33.2(4.2)	0.609

Women , 40-60 yrs of age (N=76)					
means (standard error)					
BMI categories	18.5-25 (n=6)	25-30 (n=20)	30-35 (n=22)	>35 (n=28)	P value*
Fructose (g) Foods	6.6(2.8)	8.9(1.5)	6.4(1.4)	6.2(1.3)	0.983
Fructose (g) beverages	7.4(8.5)ab	4.0(4.7)a	16.1(4.5)ab	19.8(4.0)b	0.052
Fructose(g)	14.0(9.1)	13.0(5.0)	22.4(4.8)	26.0(4.2)	0.177

* Separate Kruskal-Wallis were done for total fructose, fructose coming from foods and fructose coming from beverages according to BMI categories; when p was <0.05, multiple comparison were done using Bonferroni (means not sharing the same superscript were statistically significant , $p<0.05$)

Table 6 (suite)

Men , 20 -40 yrs f age(N=195)					
means (standard error)					
BMI categories	18.5-25 (n=56)	25-30 (n=85)	30-35 (n=43)	>35 (n=11)	P value*
Fructose (g) Foods	5.8(0.8)	7.4(0.6)	7.5(0.9)	6.0(1.7)	0.665
Fructose (g) beverages	34.1(4.9)	28.9(4.0)	38.3(5.5)	29.8(10.9)	0.958
Fructose(g)	39.8(4.9)	36.2(4.0)	45.8(5.6)	34.7(11.0)	0.989

Men , 40-60 yrs of age (N=64)					
means (standard error)					
BMI categories	18.5-25 (n=4)	25-30 (n=16)	30-35 (n=33)	>35 (n=11)	P value*
Fructose (g) Foods	5.0(3.1)	5.5(1.5)	6.5(1.1)	8.9(1.9)	0.739
Fructose (g) beverages	4.1(12.4)	21.2(6.2)	19.1(4.3)	17.0(7.5)	0.517
Fructose(g)	9.0(12.5)	26.7(6.3)	25.5(4.7)	25.8(7.6)	0.543

* Separate Kruskal-Wallis were done for total fructose, fructose coming from foods and fructose coming from beverages according to BMI categories; when p was <0.05, multiple comparison were done using Bonferroni (means not sharing the same superscript were statistically significant, $p<0.05$)

Table 7: Association between BMI categories and fructose intake by sex in Cree database (adjusted for energy intake) *

Women , 20 -40 yrs of age (N=187)					
Least squares means (standard error)					
BMI categories	18.5-25 (n=34)	25-30 (n=58)	30-35 (n=51)	>35 (n=44)	P value *
Fructose (g) Foods	5.0(3.1)	12.0(2.4)	6.3(2.5)	6.7(2.9)	0.215
Fructose (g) beverages	22.7(3.8)	21.7(3.0)	20.9(3.1)	22.6(3.5)	0.977
Fructose(g) Total : Foods Beverages	27.7(4.7)	33.7(3.6)	27.2(3.8)	29.3(4.3)	0.601

Women , 40-60 yrs of age (N=76)					
Least squares means (standard error)					
BMI categories	18.5-25 (n=6)	25-30 (n=20)	30-35 (n=22)	>35 (n=28)	P value*
Fructose (g) Foods	8.4(2.5)	9.6(1.4)	6.7(1.3)	5.0(1.2)	0.968
Fructose (g) beverages	9.2(8.7)	4.8(4.7)	16.4(4.5)	18.6(4.1)	0.146
Fructose(g) Total : Foods Beverages	17.6(9.0)	14.4(4.9)	23.0(4.6)	23.7(4.2)	0.483

* Separate Kruskal-Wallis were done for total fructose, fructose coming from foods and fructose coming from beverages according to BMI categories, adjusted for total energy intake; when p was <0.05, multiple comparison were done using Bonferroni (means not sharing the same superscript were statistically significant ,p<0.05)

Table 7 (suite)

Men , 20 -40 yrs of age(N=195)					
Least squares means (standard error)					
BMI categories	18.5-25 (n=56)	25-30 (n=85)	30-35 (n=43)	>35 (n=11)	P value*
Fructose (g) Foods	5.7(0.8)	7.6(0.6)	7.1(0.8)	6.0(1.6)	0.208
Fructose (g) beverages	33.8(4.6)	30.2(3.7)	36.0(5.2)	28.6(10.3)	0.795
Fructose(g) Total : Foods Beverages	39.5(4.6)	37.9(3.7)	43.1(5.2)	34.5(10.3)	0.825

Men , 40-60 yrs of age (N=64)					
Least squares means (standard error)					
BMI categories	18.5-25 (n=4)	25-30 (n=16)	30-35 (n=33)	>35 (n=11)	P value*
Fructose (g) Foods	4.2(3.0)	6.2(1.5)	6.3(1.0)	8.6(1.8)	0.575
Fructose (g) beverages	0.5(12.0)	24.3(6.0)	18.4(4.1)	15.7(7.2)	0.360
Fructose(g) Total : Foods Beverages	4.6(11.8)	30.5(6.0)	24.8(4.1)	24.2(7.1)	0.297

* Separate Kruskal-Wallis were done for total fructose, fructose coming from foods and fructose coming from beverages according to BMI categories, adjusted for total energy intake; when p was <0.05, multiple comparison were done using Bonferroni (means not sharing the same superscript were statistically significant ,p<0.05)

5.2 Inuit Database

Table 8 shows a description of the Inuit database that includes mean, standard deviation, minimum and maximum of characteristic variables (weight, height, fructose coming only from foods, fructose coming only from beverages, total fructose coming from foods and beverages, energy intake and Goldberg factor). As for the Cree there are four groups in this table: A. women 20-40 years of age, B. women 40-60 years of age, C. men 20-40 years of age, and D. men 40-60 years of age.

The number of younger women is slightly higher than the number of younger men. The number of older women and men are similar. Similar to the Cree database, in both women and men, there are more younger people than older people. The amount of total consumed fructose in younger people is more than in older ones and this amount is less in women than men. The table shows that the minimum and maximum total fructose intake is similar in men and women.

Table 9 shows the distribution of studied variables presented in Table 6 by body mass index categories in the Inuit database.

Table 10 describes sources of fructose in the Inuit database (sources accounting for at least 90% of fructose intake). These sources are alike between different sex and age groups. The principal sources are carbonated cola, vitamin C fortified powdered drink (Tang) and carbonated ginger ale.

Table 11 describes associations between the BMI categories and fructose intake by sex and age groups in the Inuit database. No differences in fructose intake were detected among men or women.

Table 12 shows association between the BMI categories and fructose intake by sex and age groups in the Inuit database, after adjustment for energy intake. Separate Kruskal-Wallis tests were done for total fructose, fructose coming from foods, and fructose coming from beverages according to BMI categories, adjusted for total energy intake, ($p<0.05$). After adjustment for energy intake, there was no difference in fructose intake among men or women.

Table 8: Description of Inuit database (mean, standard deviation, minimum and maximum of characteristic variables)

A. Women , 20 -40 yrs of age					
Variable	N	Mean	Std Dev	Min	Max
Weight (kg)	219	64.5	13.0	43.0	115.0
Height(m)	219	1.57	0.06	1.40	1.80
Fructose(g) foods(g) beverages(g)	219	40.0 3.3 36.7	29.9 4.3 29.9	0.1 0 0	154.4 30.7 153.2
Energy (Kcal)	219	2137	714	1071	4675
Goldberg factor *	219	1.51	0.48	0.88	2.72
B. Women , 40-60 yrs of age					
Weight (kg)	82	67.8	11.0	50.0	98.0
Height(m)	82	1.57	0.06	1.45	1.75
Fructose(g) foods(g) beverages(g)	82	25.3 5.1 20.2	31.9 10.6 31.1	0.1 0.1 0	198.1 87.3 197.6
Energy (Kcal)	82	1961	582	1230	3393
Goldberg factor *	82	1.39	0.43	0.87	2.47

* For evaluation the risk of underestimation of consumption in different BMI groups, Goldberg factor limits 0.87 to 2.75 was selected as threshold for activity factor.

Table 8 (suite)

C. Men , 20 -40 yrs f age					
Variable	N	Mean	Std Dev	Min	Max
Weight (kg)	168	75.5	12.8	50.0	120.0
Height(m)	168	1.69	0.08	1.52	1.93
Fructose(g) foods(g) beverages(g)	168	45.4 3.8 41.6	34.1 5.9 33.5	0.1 0.1 0	175.1 46.0 171.6
Energy (Kcal)	168	2560	744	1424.	4917
Goldberg factor *	168	1.40	0.40	0.87	2.50
D. Men , 40-60 yrs of age					
Weight (kg)	81	76.8	12.3	55.0	113.0
Height(m)	81	1.70	0.07	1.52	1.91
Fructose(g) foods(g) beverages(g)	81	26.2 3.5 22.7	33.2 2.6 33.2	0.7 0.4 0	171.0 11.8 161.6
Energy (Kcal)	81				
Goldberg factor *	81	1.35	0.37	0.87	2.70

* For evaluation the risk of underestimation of consumption in different BMI groups, Goldberg factor limits 0.87 to 2.75 was selected as threshold for activity factor.

Table 9 : Body Mass Index (BMI) categories in Inuit database

BMI= 18.5-25 ,Women, 20 -40 yrs of age					
Variable	N	Mean	Std Dev	Min	Max
Energy(Kcal)	108	2039	657	1071	3482
Fructose(g) foods(g) beverages(g)	108	38.8 2.9 35.9	30.0 3.2 30.1	0.1 0.1 0	137.9 14.0 137.1
Goldberg factor *	108	1.57	0.51	0.88	2.72
BMI= 18.5-25 , Women , 40-60 yrs of age					
Variable	N	Mean	Std Dev	Min	Max
Energy(Kcal)	29	2063	644	1308	3262
Fructose(g) foods(g) beverages(g)	29	32.0 4.4 27.6	41.9 7.0 42.3	0.1 0.1 0	198.1 32.4 197.6
Goldberg factor *	29	1.55	0.49	0.96	2.47
BMI= 18.5-25 , Men , 20 -40 yrs f age					
Variable	N	Mean	Std Dev	Min	Max
Energy(Kcal)	71	2475	704	1424	4220
Fructose(g) foods(g) beverages(g)	71	38.3 3.0 35.3	24.3 2.8 24.5	0.1 0.1 0	92.1 18.4 87.8
Goldberg factor *	71	1.45	0.41	0.89	2.50
BMI= 18.5-25 , Men , 40-60 yrs of age					
Variable	N	Mean	Std Dev	Min	Max
Energy(Kcal)	29	2437	638	1388	3966
Fructose(g) foods(g) beverages(g)	29	23.3 3.2 20.1	33.8 2.1 34.4	1.3 0.4 0	161.3 9.5 160.9
Goldberg factor *	29	1.45	0.37	0.87	2.23

Table 9 (suite)

BMI=25-30 , Women, 20 -40 yrs of age					
Variable	N	Mean	Std Dev	Min	Max
Energy(Kcal)	63	2132	676	1163	3744
Fructose(g) foods(g) beverages(g)	63	37.9 3.4 34.5	27.3 5.4 26.9	0.2 0 0	121.0 30.7 120.7
Goldberg factor *	63	1.48	0.46	0.89	2.65
BMI=25-30 , Women , 40-60 yrs of age					
Variable	N	Mean	Std Dev	Min	Max
Energy(Kcal)	31	1985	611	1230	3393
Fructose(g) foods(g) beverages(g)	31	22.0 7.5 14.5	24.5 15.6 20.1	0.7 0.7 0	107.0 87.3 97.8
Goldberg factor *	31	1.39	0.42	0.88	2.40
BMI=25-30 , Men , 20 -40 yrs f age					
Variable	N	Mean	Std Dev	Min	Max
Energy(Kcal)	69	2592	778	1570	4446
Fructose(g) foods(g) beverages(g)	69	49.7 3.7 45.9	38.9 4.8 38.8	0.9 0.3 0	175.1 23.9 171.6
Goldberg factor *	69	1.39	0.40	0.87	2.48
BMI=25-30 , Men , 40-60 yrs of age					
Variable	N	Mean	Std Dev	Min	Max
Energy(Kcal)	39	2419	717	1597	5087
Fructose(g) foods(g) beverages(g)	39	30.5 3.9 26.6	36.4 3.0 36.3	0.8 0.4 0	171.0 11.8 161.6
Goldberg factor *	39	1.32	0.37	0.87	2.70

Table 9 (suite)

BMI>30 , Women, 20 -40 yrs of age					
Variable	N	Mean	Std Dev	Min	Max
Energy(Kcal)	48	2364	840	1333	4675
Fructose(g) foods(g) beverages(g)	48	45.6 4.2 41.4	32.5 4.8 33.4	0.9 0.5 0	154.4 20.5 153.2
Goldberg factor *	48	1.41	0.46	0.88	2.52
BMI>30 , Women , 40-60 yrs of age					
Variable	N	Mean	Std Dev	Min	Max
Energy(Kcal)	22	1792	420	1275	2540
Fructose(g) foods(g) beverages(g)	22	21.0 2.8 18.2	25.2 2.7 25.2	1.1 0.6 0	72.5 11.3 71.6
Goldberg factor *	22	1.17	0.25	0.87	1.65
BMI>30 , Men , 20 -40 yrs f age					
Variable	N	Mean	Std Dev	Min	Max
Energy(Kcal)	28	2701	756	1797	4917
Fructose(g) foods(g) beverages(g)	28	52.8 5.9 46.9	40.2 11.2 37.4	1.7 0.3 0	150.2 46.0 148.2
Goldberg factor *	28	1.28	0.34	0.87	2.30
BMI>30 , Men , 40-60 yrs of age					
Variable	N	Mean	Std Dev	Min	Max
Energy(Kcal)	13	2492	785	1601	4090
Fructose(g) foods(g) beverages(g)	13	19.7 2.7 17.0	19.1 2.2 18.3	0.7 0.7 0	51.0 7.0 43.9
Goldberg factor *	13	1.25	0.38	0.87	2.07

Table 10: Principal sources of fructose in Inuit database (sources accounting for at least 90% of fructose intake)

Women , 20 -40 yrs of age , N=219		
Fructose(g)	Percent	Food item
19	48%	cola carbonated
9	23%	vitamin C fortified powdered drink(Tang)
6	15%	non-fortified powdered drink
3	7.5%	ginger ale carbonated
	6.5%	others

Women , 40-60 yrs of age, N=82		
Fructose(g)	Percent	Food item
13	51%	cola carbonated
3.5	14%	vitamin C fortified powdered drink(Tang)
1.5	6%	ginger ale carbonated
1.1	4.5%	raisins uncooked
1.1	4.5%	non-fortified powdered drink
1	4%	apple raw
1	4%	syrup corn, light and dark
0.7	3%	apple juice CND
	9%	others

Table 10 (suite)

Men , 20 -40 yrs of age, N=168		
Fructose(g)	Percent	Food item
19.7	44%	cola carbonated
9.5	21%	vitamin C fortified powdered drink(Tang)
9.5	21%	non-fortified powdered drink
4	9%	ginger ale carbonated
	5%	Others

Men , 40-60 yrs of age, N=81		
Fructose(g)	Percent	Food item
8.7	33%	cola carbonated
5.3	20%	vitamin C fortified powdered drink(Tang)
4.3	16%	non-fortified powdered drink
2.6	9%	syrup corn, light and dark
1.5	5%	ginger ale carbonated
0.8	3%	apple juice CND
0.5	2%	bread white enriched made with non fat dry milk
0.3	1%	Orange juice unsweetened CND
0.3	1%	Biscuits made from mix
	10%	Others

Table 11: Association between BMI categories and fructose intake by sex in Inuit database*

Women , 20 -40 yrs of age (N=219)				
means (standard error)				
BMI categories	18.5-25 (n=108)	25-30 (n=63)	>30 (n=48)	P value *
Fructose (g) Foods	2.9(0.4)	3.4(0.5)	4.2(0.6)	0.126
Fructose (g) beverages	35.9(2.9)	34.5(3.8)	41.4(4.3)	0.524
Fructose(g) Total : Foods Beverages	38.8(2.9)	37.9(3.8)	45.6(4.3)	0.298

Women , 40-60 yrs of age (N=82)				
means (standard error)				
BMI categories	18.5-25 (n=29)	25-30 (n=31)	>30 (n=22)	P value*
Fructose (g) Foods	4.4(2.0)	7.5(1.9)	2.8(2.3)	0.204
Fructose (g) beverages	27.6(5.8)	14.5(5.6)	18.2(6.6)	0.414
Fructose(g) Total : Foods Beverages	32.0(6.0)	22.0(5.7)	21.0(6.8)	0.573

* Separate Kruskal-Wallis were done for total fructose, fructose coming from foods and fructose coming from beverages according to BMI categories ($p<0.05$)

Table 11 (suite)

Men , 20 -40 yrs f age(N=168)				
means (standard error)				
BMI categories	18.5-25 (n=71)	25-30 (n=69)	>30 (n=28)	P value*
Fructose (g) Foods	3.0(0.7)	3.7(0.7)	6.0(1.1)	0.804
Fructose (g) beverages	35.3(4.0)	45.9(4.0)	46.9(6.3)	0.452
Fructose(g) Total : Foods Beverages	38.3(4.0)	49.7(4.1)	52.8(6.4)	0.353

Men , 40-60 yrs of age (N=81)				
means (standard error)				
BMI categories	18.5-25 (n=29)	25-30 (n=39)	>30 (n=13)	P value*
Fructose (g) Foods	3.2(0.5)	3.9(0.4)	2.7(0.7)	0.322
Fructose (g) beverages	20.1(6.2)	26.6(5.4)	17.0(9.3)	0.682
Fructose(g) Total : Foods Beverages	23.3(6.2)	30.5(5.3)	19.7(9.3)	0.513

* Separate Kruskal-Wallis were done for total fructose, fructose coming from foods and fructose coming from beverages according to BMI categories ($p<0.05$)

Table 12: Association between BMI categories and fructose intake by sex in Inuit database (adjusted for energy intake) *

Women , 20 -40 yrs of age (N=219)				
Least squares means (standard error)				
BMI categories	18.5-25 (n=108)	25-30 (n=63)	>30 (n=48)	P value *
Fructose (g) Foods	3.0(0.4)	3.4(0.5)	4.0(0.6)	0.296
Fructose (g) beverages	37.4(2.7)	34.6(3.5)	37.8(4.1)	0.859
Fructose(g) Total : Foods Beverages	40.4(2.6)	38.0(3.5)	41.7(4.0)	0.779

Women , 40-60 yrs of age (N=82)				
Least squares means (standard error)				
BMI categories	18.5-25 (n=29)	25-30 (n=31)	>30 (n=22)	P value*
Fructose (g) Foods	4.0(2.0)	7.4(1.9)	3.5(2.2)	0.183
Fructose (g) beverages	26.3(5.6)	14.2(5.4)	20.4(6.5)	0.443
Fructose(g) Total : Foods Beverages	30.3(5.7)	21.6(5.5)	23.9(6.6)	0.780

* Separate Kruskal-Wallis were done for total fructose, fructose coming from foods and fructose coming from beverages according to BMI categories, adjusted for total energy intake

Table 12 (suite)

Men , 20 -40 yrs of age(N=168)				
Least squares means (standard error)				
BMI categories	18.5-25 (n=71)	25-30 (n=69)	>30 (n=28)	P value*
Fructose (g) Foods	3.1(0.7)	3.7(0.7)	5.7(1.1)	0.901
Fructose (g) beverages	36.9(3.6)	45.4(3.7)	44.4(5.8)	0.722
Fructose(g) Total : Foods Beverages	40.0(3.6)	49.1(3.7)	50.1(5.8)	0.626

Men , 40-60 yrs of age (N=81)				
Least squares means (standard error)				
BMI categories	18.5-25 (n=29)	25-30 (n=39)	>35 (n=13)	P value*
Fructose (g) Foods	3.2(0.5)	3.9(0.4)	2.6(0.7)	0.249
Fructose (g) beverages	20.1(6.1)	26.8(5.2)	16.4(9.1)	0.638
Fructose(g) Total : Foods Beverages	23.3(6.0)	30.7(5.2)	19.0(9.0)	0.437

*Separate Kruskal-Wallis were done for total fructose, fructose coming from foods and fructose coming from beverages according to BMI categories, adjusted for total energy intake

VI. Discussion

VI. Discussion

Among both Cree and Inuit, there were more younger people than older ones. The amount of total fructose consumption in younger people appeared greater than among older ones and this amount was less in women than men. The minimum and maximum amount of fructose was, however, similar in men and women. Younger overweight Cree women had a greater total fructose intake than obese women. Among older Cree women, fructose from beverages appeared to increase with BMI with a statistically significant difference between overweight and morbidly obese women. After adjustment for energy intake however, the difference among women disappeared. No differences in fructose intake were detected among Cree men. In Inuit adults no differences in fructose intake were detected among men or women.

We could not detect any evidence of a relationship between consumption of fructose and increase in body mass index among Cree and Inuit adults. After adjustment for energy intake as a potential cofounding factor, body mass index was associated with total energy intake and not related with the consumption of fructose.

There are suggested mechanisms for relating the consumption of fructose with obesity. The first one is that fructose may not cause a satiety level equivalent to glucose because fructose is not able to stimulate insulin and leptin secretion and also inhibit ghrelin—factors effective in the central nervous system's satiety center (Johnson et al, 2007) . Another suggestion is that the sweetness of fructose can make the foods more palatable and thereby may cause more food intake (Johnson et al, 2007). However, though crystalline

fructose has the sweetest taste with a sweetness mark of 173 compared with crystalline sucrose's mark of 100, this is not valid for fructose in HFCS and the relative sweetness of HFCS-55. The sweetness mark for fructose in the solution is similar to the standard (Forshee et al, 2007). Another suggestion is that fructose probably slows the basal metabolic rate, based on an animal study in which mice that were fed with fructose-sweetened water gained more weight than mice given the same calories as sucrose or diet soft drink (Johnson et al, 2007). The next theory is that fructose can raise uric acid concentration and uric acid is an independent predictor of weight gain (Johnson et al, 2007).

On the other hand, one review reminds us that the rise in obesity is not limited to the Unites States; there has been a sharp rise in the obesity rate in children in France despite the fact that the consumption of sugars is not high there and HFCS use is also limited (Drewnowski and Bellisle, 2007). Another point is that the effects of fructose possibly need about ten years before developing into obesity. It is possible that fructose can have a chronic effect, such as the effects found in rats where it caused leptin resistance (shapiro et al, 2008). But, because there are no long-term clinical studies on this subject in humans, it is unknown if this mechanism is present in humans (Johnson et al, 2009). One study suggests in a meta-analysis of 88 studies relating soft drink consumption and health outcomes including obesity, effect sizes were smaller in studies funded by the food industry compared to non-industry funded studies (Vartanian et al, 2007).

Nevertheles one explanation for the fact that we didn't find a relationship between fructose and obesity in our study may be because the level of fructose intake was not high enough. In the Cree database, the mean fructose intake for women aged 20 to 40 was 29.8 g/day

and 20.6 g/day for women aged 40 to 60. This amount is 39.3 g/day for men aged 20-40 and 24.9 g/day for men aged 40-60 years (Table 3). The mean fructose consumption for the Inuit was higher than the Cree. This level is 40.0 g/day and 25.3 g/day respectively for women 20 to 40 years and women 40 to 60 years. Young Inuit men (20 to 40 years) consume, on average, 45.4 g/day of fructose and the older ones (40 to 60 years) consume 26.2 g/day (Table 8). Therefore, we can suggest that the fructose intake in these populations was not high enough to show its effect on weight gain.

It has been suggested indeed that excessive fructose intake can lead to overweight conditions. 'Excessive' being defined as more than 50 g per day, according to studies that show obesity rates are more than ten percent when the mean consumption of fructose is more than this level (Johnson et al, 2009). A meta-analysis proposed on another hand that with an oral fructose intake of ≤100 g/day there was not any significant effect on body weight when fructose replaced starch, glucose, or sucrose (Livesey and Taylor, 2008). They categorized fructose intake as 0–50, >50–100, and >100–150 g/day on the basis that US adults consume up to 150 g/day fructose and they suggested that 50 g/day (or less) would be a moderate intake and >50–100 g/day would be a high fructose intake (Livesey and Taylor, 2008). In this regard our results are in agreement with this idea.

In our study we did not find an association in adults, but the majority of studies that have shown a relationship between fructose consumption and weight gain are in children or adolescents. Some studies have shown that certain age groups, like adolescent males, are high consumers of soft drinks and their fructose consumption level can reach up to 100 g per day (Havel, 2005). Perhaps as well there may be a difference in utilization of fructose in g per kg of body weight. If this were true, the effect of a same dose of fructose in

children would be greater than in adults. Another question is whether there maybe a threshold for fructose metabolism in the liver? It has been shown that the effects of fructose, including immediate hepatic increases in pyruvate and lactate production, activation of pyruvate dehydrogenase and increase in secretion of very low density lipoprotein (VLDL) are augmented by long-term absorption of fructose, which causes enzyme adaptations that increase lipogenesis and VLDL secretion and results in triglyceridemia, dcreased glucose tolerance and hyperinsulinemia (Mayes, 1993). Acute loading of the liver with fructose causes sequestration of inorganic phosphate in fructose-1-phosphate and diminished ATP synthesis. Subsequently, the inhibition by ATP of the enzymes of adenine nucleotide degradation is removed and uric acid formation accelerates with consequent hyperuricemia (Mayes, 1993). As mentioned before, uric acid is an independent predictor of weight gain (Johnson et al, 2007)

There are some limitations with this study because it is a cross-sectional study and causal inferences cannot be made from cross-sectional studies because they are based on a single point in time (Forshee et al, 2007).

In the Cree database, data collection was done in the summer season (24 June to 16 August, 1991). Summer was chosen because it is the season when the maximum numbers of people are present in the community; the Cree often leave to do different activities like hunting and fishing from September to May.

In Inuit database the data collection was done in fall (September-November, 1998) and winter (February-April, 1999), both for the same 18 communities to avoid underestimation of traditional food intake when a large number of high consumers of traditional food were

out on the land. So this selected times can reduce the effect of seasonal variations in the nutrition of these people.

As the principal source of fructose in these populations is soft drinks, it is not very dependent on seasonal variation and the use of a single 24-hour recall may be sufficient. However, there may have been some limitation in accessibility of a grocery store during the winter months at the time of data collection.

In this study we didn't control for physical activity. However, the potential cofounding effect of physical activity is difficult to estimate. People doing more physical activity are generally found to have a lower BMI but whether they drink sweetened beverages in different amounts is unknown. Therefore, in future studies, controlling for physical activity could be an asset.

Underreporting of socially undesirable foods may be a limitation of the data analyzed in this study. However, given that these two databases were collected at a time when the relationship between consumption of fructose and obesity was not paid much attention, it is unlikely that people underestimated their consumption of foods containing fructose.

As mentioned in the methodology, for the Cree we noted the name of the consumed food, the given codes of CNF1991, and then we matched corresponding codes of 1997. We then extracted the amount of fructose per 100 grams of food from the Canadian Nutrient File (CNF) 1997. Many items had no values in CNF 1997. For the amounts missing in CNF 1997, we used CNF 2007, and for the amounts that were still missing we imputed the appropriate amount in the base of similar foods. The final food composition database we

created is included in the Annex. The existent amounts of fructose from CNF 1997 were for 115 food items. The extracted amounts of fructose from CNF 2007 were for 290 food items. We imputed the amount for 133 items from the existent amounts. For Inuit, we had a list of 244 foods consumed by Inuit in the form of g/person/day and we extracted the amount of fructose in each food item according to Canadian Nutrient File (CNF) 2007. For the food items without an amount in CNF 2007, we replaced the value from CNF 1997. For the rest, we imputed the values from the existing amounts. Imputed values were more likely to increase the variance of our estimates rather than to bias them.

The obesity is a condition very likely multifactorial but according to our results; fructose does not appear to be one of them, at least among adults and in this consumption level.

In conclusion, in spite of the fact that we did not find enough evidence to support the idea of a relationship between consumption of fructose and risk of obesity, we suggest due to missing and inaccuracies in the fructose food database that this study may have limited abilities to detect an association if present. Further research, especially large prospective cohort studies with long term follow-up in different ages and different levels of consumption could be helpful. Clinical studies to identify the mechanism by which fructose may affect body weight and particularly to know the difference of effect of fructose in adults and children could also lead to additional insights.

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VIII. Annex

Annex 1: Population distribution that responded to the 24h recall according to the sex, age, sub-region, village isolation, stay duration in the wood, Cree population 18-74 y/o (Santé Québec, 1991)

characteristics	%	Number of participants
Male	47.5	406
18-34 y/o	59.9	243
35-49 y/o	23.4	95
50-74 y/o	16.8	68
Female	52.5	449
18-34 y/o	58.8	264
35-49 y/o	23.2	104
50-74 y/o	18.0	81
Sub-region		
Coterie	62.7	536
interior	37.3	319
Village isolation		
Yes	35.3	302
No	64.7	553
Stay duration in the wood		
4 months and more	22.5	192
Less than 4 months	77.5	663
Total	100.0	855

Annex 2: Cree food composition database (amounts of fructose in g/100g)

FCOD	FCOD 1997	LABEFCOD	CNF 1997	CNF 2007	Imputed amounts
11829		11829			
11830		11830			
1663	90021	abricots, crus	0.70	0.94	
1674	90032	abricots, séchées, sulfurés, non cuits	.	12.47	
2626	120086	acajou (cajous, anacardes), noix d', rôties à l'huile	.	0.08	
4060		acide ascorbique		.	
2210	113215	ail, cru	.	.	
2616	120065	amandes, rôties à l'huile, non blanchies	.	0.00	
2614	120062	amandes,séchées,blanchies	.	0.00	
2613	120061	amandes,séchées,non blanchies	.	0.00	
450	190007	amuse-gueules (à base de mais), onyum, bugles, whissles, etc	.	.	
317	196011	ananas,confit		.	5.90
1836	93266	ananas,cru	2.10	2.05	
1900	93268	ananas, en conserve, +jus, solides+liquide	6.50	6.50	
3036	150002	anchois européen, en conserve, dans l'huile d'olive, égoutté	.	0.00	
3310	160090	arachide, tous les types, grillée à sec, sel ajouté	0.00	.	
3404	163389	arachide, tous les types, grillées à l'huile	0.00	0.08	
1881	93040	bananes,crues	2.70	4.85	
640	20003	Basilica,moulu	.	0.75	
3386	163398	beurre d'arachide, crémeux, m.g. et sucre ajouté	.	0.00	
3317	160097	beurre d'arachide, croquant, m.g, sucre et sel ajouté	.	0.00	
3403	163098	beurre d'arachides, crémeux, m.g, sucre et	.	0.00	

		sel ajouté			
599	13001	Beurre salé	.	0.00	
494	10002	Beurre,fouetté	.	.	
581	10145	Beurre,non salé	.	0.00	
2996	141003	bière ordinaire,5% alcool/volume	0.20	0.00	
173	180177	biscuits à la mélasse	.		0.60
443	180178	biscuits à l'avoine, sans raisins secs	.	0.60	
175	180185	biscuits, aux arachnids	.		0.60
176	180191	biscuits, aux raisins secs	.		2.30
172	183009	biscuits,à la guimauve	.	2.30	
167	180204	biscuits, à la noix de coco	.		2.30
174	180184	biscuits, à l'avoine avec raisins secs	.		2.30
162	183009	biscuits,assortis,emballage commercial	.		2.30
166	180160	biscuits,au chocolat	.		2.30
430	180160	biscuits, aux brisures de chocolat, commercial	.		2.30
168	180170	biscuits,aux figues	.		2.30
3905	186010	biscuits,digestive	.	0.60	
170	180423	biscuits,doigts de dame	.		0.60
181	180212	biscuits, gaufrettes à la vanille	.		0.60
178	180192	biscuits,sablés	.		0.60
177	180210	biscuits,sandwich	.	0.50	
3904	180150	biscuits,thé social	1.00	.	
1883	93054	bleuets,congelés,non sucrés		.	3.60
1882	93050	bleuets,crus	3.60	4.97	
1685	90052	bleuets, en conserve, sirops épais, solides+liquide		.	5.90
2755	133348	boeuf salé,corned beef,en conserve	.	0.00	
2842	133236	boeuf, bifteck d'aloyau gros filet, maigre.1/4", grillé	.	0.00	
4224	6303411	boeuf,corned beef hash,cnd,w/potato	.	.	

2822	133118	boeuf, cote, bifteck de cote, maigre, 1/4" paré, grillé	.	0.00
2820	133106	boeuf, cote, bifteck de cote, maigre+gras, 1/4"paré, grillés	.	0.00
2814	133091	boeuf, cote, roti de cote nature, maigre, 1/4"paré, roti	.	0.00
2724	130016	boeuf, coupes diverses, maigre, 1/4"paré, cuit	.	0.00
2836	133213	boeuf, cuisse, bifteck d'intérieur de ronde, m+g, 1/4", grill	.	.
2838	136188	boeuf, cuisse, bifteck d'intérieur de ronde, maigre, 1/4", gr	.	0.00
2864	136154	boeuf, cuisse, roti de croupe, m+g, 1/4" paré, roti	.	0.00
2866	136158	boeuf, cuisse, roti de croupe, maigre, 1/4" paré, roti	.	0.00
2830	133188	boeuf, cuisse, roti de noix de ronde, maigre, 1/4"paré, roti	.	0.00
2856	136038	boeuf, épaule, boeuf à ragout, m+g, 1/4", mijoté	.	.
11765	136378	boeuf, épaule, boeuf à ragout, maigre, 0" paré, mijoté	.	.
2858	136046	boeuf, épaule, boeuf à ragout, maigre, 1/4"paré, mijoté	.	.
2800	133046	boeuf, épaule, roti de cotes croisées, m+g, 1/4", à couvert	.	.
2801	133045	boeuf, épaule, roti de cotes croisées, maigre, 1/4", crue	.	0.00
2743	40001	boeuf,graisse fondue (suif)	.	.
2774	131295	boeuf,haché,maigre,cru	.	0.00
2776	131297	boeuf, haché, maigre, cuit au four, bien cuit	.	0.00

2778	131299	boeuf, haché, maigre, grillé, bien cuit	.	0.00	
2777	131298	boeuf, haché, maigre, grillé, medium	.	0.00	
2781	131302	boeuf, haché, mi-maigre, cru	.	0.00	
2782	131303	boeuf, haché, mi-maigre, cuit au four, médium	.	0.00	
2785	131306	boeuf, haché, mi-maigre, grillé, bien cuit	.	0.00	
2784	121305	boeuf, haché, mi-maigre, grillé, médium	.	0.00	
2788	133309	boeuf,haché,ordinaire,cru	.	0.00	
2792	131313	boeuf, haché, ordinaire, grillé, bien cuit	.	0.00	
2791	131312	boeuf, haché, ordinaire, grillé, medium	.	0.00	
2840	133234	boeuf, longe, bifteck d'aloyau gros filet, M+G, 1/4", grillé	.	.	
2844	133266	boeuf, longe, bifteck de contre-filet, m+g, 1/4", grillé	.	.	
2846	133274	boeuf, longe, bifteck de contre-filet, maigre, 1/4", grillé	.	0.00	
2848	133283	boeuf, longe, bifteck de haut de surlonge, m+g, 1/4", grillé	.	.	
2754	133347	boeuf, salé, corned beef, pointe de poitrine, cuit	.	.	
2761	133355	boeuf,salé,pastrami	.	.	
3019	141323	boisson à l'orange, +vit C, en boîte	0.00	.	
3011	141266	boisson à saveur de punch aux fruits, +vit C, poudre+eau	4.20	.	
3023	141407	boisson à saveur d'orange, +vitamine C, poudre		.	52.9
2942	140263	boisson au jus d'agrumes, concentré congelé+eau		.	4.20
2976	140406	boisson au jus de fruits, punch, concentré congelé+eau		.	4.20
2958	140327	boisson au jus d'orange et abricot, en boite		.	4.20
2949	141305	boisson au malt, bière désalcoolisée (<0,5	.	.	

		% alcool par v			
3013	141277	boisson au raisin, + vitamine C, en boite		.	4.20
3921	141267	boisson aux fruits, fruité (utilisée entre 1990-91, Québec)	3.70	.	
4098	141267	boisson aux pommes	3.70	.	
2971	140382	boisson désaltérante (type gatorade), en bouteille	2.10	.	
3033	146296	boisson, à saveur de limonade, en poudre		.	52.9
3032	146266	boissons à saveur de punch aux fruits en poudre + eau		.	4.20
3014	141277	boissons au jus de raisin+vitc,en boîte		.	4.20
2974	140400	boissons gazeuses cola	4.40	6.10	
2908	140145	boissons gazeuses, soda au citron et à lalime	6.10	5.19	
2912	140157	boissons gazeuses, soda racinette	3.20	.	
2979	140416	boissons gazeuses, cola, édulcoré à l'aspartame	.	.	
2909	140150	boissons gazeuses, soda à l'orange		.	6.10
2907	140142	boissons gazeuses, soda au raisin		.	6.10
2991	140537	boissons gazeuses, soda non cola, édulcorées à l'aspartame	0.00	.	
2906	140136	boissons gazeuzes, soda au gingembre	3.70	3.70	
4089	190135	bonbons,barre Mars	.		0.20
102	190070	bonbons,caramel écossais	.		0.20
103	190152	bonbons, caramels, ordinaires ou au chocolat	.		0.20
105	190076	bonbons, caramels, rouleau à saveur de chocolat	.		0.20
4059	19134	bonbons, céréales avec chocolat au lait	.		0.20
109	190127	bonbons, chocolat au lait, ordinaire	.		0.20
107	190780	bonbons,chocolat,semi-sucré	.		0.20
130	190107	bonbons,durs (sucre d'orge)	.		0.20

115	190101	bonbons, enrobés de chocolat, centre à la noix de coco	.		0.20
119	190105	bonbons, enrobés de chocolat, dur alvéole, avec arachides	.		0.20
114	190101	bonbons, enrobés de chocolat, fudge au chocolat avec noix	.		0.20
118	190102	bonbons, enrobés de chocolat, fudge avec arachides+caramel	.		0.20
117	190102	bonbons, enrobés de chocolat, fudge avec caramel+arachides	.		0.20
120	190076	bonbons, enrobés de chocolat,nougat et caramel	.		0.20
121	190126	bonbons,enrobés dechocolat,arachides	.		0.20
124	190099	bonbons,fondant	.		0.20
132	190116	bonbons,guimauves	.		0.20
4081	190109	bonbons,Kit Kat	.	0.20	
4093	190151	bonbons, Reese’s avec beurre d'arachides	.		0.20
1443	73005	boudin	.	.	
4048	181376	breading for baked or fried chicken	.	.	
2534	113091	brocoli,bouilli,égoutté	.	0.74	
2533	113090	brocoli,cru	0.70	0.68	
160	190166	cacao, en poudre,à déjeuner,Dutch process	0.80	.	
161	140192	cacao,en poudre,faible en gras	.	.	
2926	140209	café infusé	.	0.00	
2928	140215	café instantané, en poudre+eau	.	.	
2925	140208	café, infusé, fait avec de l'eau distillée	.	.	
2931	140222	café, instantané, avec chicorée, en poudre	.	.	
2929	140218	café, instantané, décaféiné, en poudre	.	.	
2930	140219	café, instantané, décaféiné, en poudre+eau	.	.	
2927	140214	café, instantané, ordinaire, en poudre	.	.	
1094	50158	caille,chair seulement,crue	.	0.00	
4174	50157	caille,cuite	.	0.00	

4066		calcium ajouté		.	
1076	50140	Canard domestique, chair et peau, roties	.	0.00	
1078	50142	Canard domestique, chair seulement, rotie	.	0.00	
1081	50145	canard sauvage, poitrine, viande seulement, crue	.	0.00	
647	20010	cannelle,moulue	.	1.11	
458	190364	caramel,tartinade	.		
452	170163	caribou,cuit	.	0.00	
2539	113125	carottes,bouillies,égouttées	1.00	0.36	
2538	110122	carottes,crues	.	0.55	
2160	113128	carottes, en conserve, solides, égouttées	0.60	.	
157	196004	Cedrat,confit	.	.	
2543	113144	céleri,bouilli,égoutté	.	0.66	
2542	113143	céleri,cru	0.40	0.51	
1517	86549	céréale gruau, régulier/rapide/1 minute, sec	.		0.90
11731	86043	céréale prête à manger, oh, noix et miel	.		0.90
1559	86505	céréale, crème de blé 5 minutes, enrichie de fer, cuite	.		0.90
1565	86523	céréale, gruau, prêt à servir, régulier, préparé	.		0.90
1518	86550	céréale, gruau, régulier/rapide/1 minute, cuit			0.90
1519	87001	céréale, prête à manger, all bran	.		0.90
1520	86002	céréale, prête à manger, alpha-bits	.		0.90
1581	86004	céréale, prête à manger, bran flakes, Kellog's	0.90	0.90	
11714	87060	céréale, prête à manger, common sense oat bran, avec raisins	.		0.90
1632	86074	céréale, prête à manger, common sense, oat bran	.		0.90
1529	86020	céréale, prête à manger, corn flakes	2.40	2.40	

1597	86019	céréale, prête à manger, croque nature, + raisins secs/dattes	.		0.90
1625	86015	céréale, prête à manger, fruit et fibre, fruits champêtres	.		0.90
1642	86280	céréale, prête à manger, muslix, muesli croustidorée	.		0.90
1546	87060	céréale, prête à manger, raisin bran	.		0.90
1548	86065	céréale, prête à manger, rice krispies	0.40	0.40	
1525	87013	céréales, prêtes à manger, cheerios	.		0.90
1540	86045	céréales, prêtes à manger, cheerios au miel et aux noix	.		0.90
1541	86046	céréales, prêtes à manger, honey-comb	.		0.90
1539	86043	céréales, prêtes à manger, honey-nuts corn flakes	.		0.90
1533	87031	céréales, prêtes à manger, mini-wheats, givrés	.		0.90
1601	86025	céréales, prêtes à manger, pac-man	.		0.90
1550	86067	céréales, prêtes à manger, spécial K	.		0.90
1554	86073	céréales, prêtes à manger, sugar crisp	.		0.90
141	196003	cerises confites		.	5.9
1698	90070	cerises sucrées (guignes),crues	6.20	5.37	
1699	90071	cerises sucrées (guignes),en conserve,+ eau,sol+liq		.	2.7
1700	90072	cerises sucrées (guignes), en conserve,+jus		.	2.7
1693	90063	cerises sures (griottes), rouges, crues	3.30	3.51	
142	196002	cerises, au marasquin, en bocal, solides et liquide		.	5.9
1694	90064	cerises, sures (griottes), rouges, en conserve, + eau, sol+liq	.	2.70	
1884	93073	cerises, sures (griottes), rouges, en conserve, + sirop léger		.	5.9
2246	113260	champignons crus	0.40	0.17	
2247	110261	champignons,bouillis,égouttés	.	.	

2550	113264	champignons, en conserve, solides, égouttés	.	.	
2456	110588	chataignes d'eau,chinoises,crues	.	.	
2457	110590	chataignes d'eau, chinoises, en conserve, solides et liquide	.	.	
150	190078	chocolat, amer ou à cuire	0.40	.	
2149	110112	chou rouge,cru	2.30	1.48	
2537	112110	chou,bouilli,égoutté	.	.	
2536	112109	chou,cru	0.80	1.65	
2541	110142	chou-fleur,bouilli,égoutté	.	.	
2540	113135	chou-fleur,cru	0.80	.	
1763	90151	citron,cru,avec pelure	.	.	
1767	90156	citron,zeste de,cru	.	.	
648	20011	clou de girofle,moulu	.	1.07	
1724	90097	cocktail de fruits, en conserve, +jus, sol+liq	6.00	.	
1726	90099	cocktail de fruits, en conserve, sirop léger, sol+liq	.	.	
2729	130322	coeur de boeuf,mijoté	.	.	
541	13069	colorant à café (non laitier), en poudre	.	.	
540	10067	colorant à café (non laitier), liquide congelé	.	.	
2548	112205	concombre,cru	0.90	0.87	
4230	112205	concombre,paré	0.90	.	
234	190297	confitures et conserves	6.90	.	
4196	190303	confitures, en conserve, marmelade, réduite en sucre		.	6.90
3210	6203420	coregone de lac, espèces diverses, cru	.	.	
3145	150131	coregone de lac, espèces diverses, fumé	.	0.00	
232	180272	cornets à crème glacée (cornet seulement)	.	.	
4188	18425	crackers,saltines,low sodium	.	.	

4108	183220	crackers,toast thins (rye,wheat,white flour)	.	.	
198	180214	craquelins au fromage	.		0.51
197	180155	craquelins,au beurre	.		0.51
453	186010	craquelins, biscuits pilote de péniche	.		0.51
205	180235	craquelins,de blé entier	.		0.51
200	183220	craquelins,graham,nature	.		0.51
203	180215	craquelins,sandwich,arachides-fromage	.	0.51	
204	180228	craquelins,soda	.		0.51
610	14050	Crème à café (de table) ,18% m.g.	.	.	
623	16050	Crème à café (de table) ,15% m.g.	.	.	
622	16049	Crème à céréales (moitié-moitié) ,10% m.g.	.	.	
611	14052	Crème à fouetter, 32% m.g.	.	.	
612	14053	Crème à fouetter, 35% m.g.	.	.	
536	190095	Crème glacée à la vanille, ferme, 10% M.G.	0.90	.	
537	190089	crème glacée à la vanille, riche, ferme, 16% m.g.		.	0.90
613	14056	Crème sure, de culture, 14% m.g.	.	.	
534	10054	crème, garniture fouettée, sous pression (en bombe)	.	.	
3213	152149	crevette,espèces diverses,crue	.	.	
3163	153152	crevette, espèces diverses, en conserve	.	.	
2584	190042	croustilles	.	.	
491	180242	croutons	.	.	
1714	93087	Dattes, domestiques, naturelles et séchées	.	19.56	
1158	50194	dinde à griller, cuisse, viande et peau, roties	.	0.00	
1156	50220	dinde à griller, poitrine,viande seulement,rotie	.	0.00	
1504	73081	dinde, roulé de dinde, viande blanche	.	.	
1132	50196	dinde, toutes catégories, aile, viande et	.	0.00	

		peau, roties		
1104	50168	dinde, toutes catégories, chair seulement, rotie	.	0.00
1130	50194	dinde, toutes catégories, cuisse, viande et peau, roties	.	0.00
1126	50190	dinde, toutes catégories, dos, viande et peau, roties	.	0.00
1109	50173	dinde, toutes catégories, gésier, cru	.	0.00
1110	50173	dinde, toutes catégories, gésier, cru	.	0.00
1128	50192	dinde, toutes catégories, poitrine, viande+peau, roties	.	0.00
3900	36242	Dinner macaroni et fromage (Kraft dinner)	.	.
3201	152064	doré (doré jaune/blanc), cru	.	0.00
2972	140384	eau minérale, en bouteille, Perrier	.	0.00
2973	140385	eau minérale, en bouteille, Poland Springs	.	0.00
2986	140429	eau municipale	.	0.00
11		eau pour les recettes		.
2512	110677	échalottes,crues	0.30	.
3914	4834	egal (édulcorant hypocalorique)	.	.
2377	110463	épinard,congelé,nature	.	0.30
3124	150104	esturgeon,espèces diverses,cru	.	0.00
463	20050	Extrait de vanille	.	.
3332	160117	farine de soja,dégraissée	.	.
3330	160115	farine de soja, non dégraissée, nature	.	.
4069	5899	foie,poisson,cru	.	.
1872	90320	Fraises,congelées,sucrées,tranchées	.	.
1909	93316	Fraises,crues	2.50	2.44
1907	93302	framboises,crues	3.20	2.35
506	13015	fromage cottage (2% m.g.)	.	.
514	10027	fromage mozzarella (48% humidité; 25% m.g.)	.	0.15
515	10027	fromage mozzarella, part écrémé (49%	.	.

		eau, 17% m.g.)			
507	10017	fromage,à la crème	0.00	.	
4212	10029	fromage, américain, faible en matières grasses et en sodium	.	.	
4170	10029	fromage, américain, traité, faible en matières grasses	.	.	
497	10005	fromage,brick	.	.	
592	13009	fromage,cheddar	0.00	.	
502	10011	fromage,colby	.	.	
584	10150	fromage, fondu, à tartiner, cheddar	.	.	
528	13042	fromage,fondu,cheddar	.	.	
583	10149	fromage, fondu, préparation pasteurisé de, cheddar	0.00	.	
530	10047	fromage,fondu,suisse	.	.	
588	11022	fromage,gouda	.	.	
590	11028	fromage, mozarella, part écrémé (52% eau, 16,5% m.g.)	.	.	
518	10032	fromage,parmésan,rapé	.	0.15	
522	10036	fromage, ricotta, fait de lait entier	0.00	.	
2796	131317	galette de boeuf haché, congelé, grillé, medium	.	0.00	
542	10070	garniture à dessert, en poudre, base de produit non laitier	.	.	
545	10073	garniture à dessert, semi-solide, congelée, non laitier	.	.	
44	180089	Gateau des anges,maison		.	0.6
69	180096	Gateau du diable avec glace au chocolat, congelé, commercial		.	0.6
399	180365	gauffres congelées		.	0.6
223	190173	gélatine, dessert à la poudre, fait avec de l'eau	.	.	
235	190300	Gelées	16.20	.	

3564	170164	gibier, viande de chevreuil, crue	.	0.00	
3563	170163	gibier, viande de caribou (renne), rotie	.	0.00	
3553	170151	gibier, viande de castor, rotie	.	0.00	
3581	170181	gibier, viande de lapin sauvage, mijotée	.	.	
3562	170162	gibier, viande de, caribou (renne), crue	.	0.00	
3579	170179	gibier, viande de, lapin apprivoisé, coupes diverses, mijotées	.	.	
3572	170172	gibier,viande d'orignal,crue	.	0.00	
3551	170147	gibier,viande d'ours,mijotée	.	0.00	
3573	170173	gibier,viande orignal,rotie	.	0.00	
3005	141049	gin (40% alcool par volume)	.	0.00	
143	190163	gomme à macher	.	.	
3720	203081	grain céréalier, farine de blé blanc, tout usage	0.30	.	
3723	200084	grain céréalier, farine de blé, blanche, farine à gateau		.	0.30
3722	200083	grain céréalier, farine de blé, blanche, farine à pain		.	0.30
3679	203080	grain céréalier, farine de blé, grain entier		.	0.30
3639	200016	grain céréalier, farine de mais (jaune), grain entier		.	0.30
3665	200064	grain céréalier, farine de seigle, moyenne		.	0.30
3644	200027	grain céréalier, fécule de mais		.	0.30
3629	200005	grain céréalier, orge, perle, cru		.	0.30
3712	200453	grain céréalier, riz blanc, grain court, cuit		.	0.30
3708	200447	grain céréalier, riz blanc, grain long, à l'étuvée, cuit	.	0.02	
3707	200446	grain céréalier, riz blanc, grain long, à l'étuvée, sec	.	0.02	
3705	200444	grain céréalier, riz blanc, grain long, ordinaire, cru		.	
3706	203545	grain céréalier, riz blanc, grain long,	.	.	

		ordinaire, cuit		
3719	201049	grain céréalier, riz blanc, grain long, p-a-s, enrichi, prépa	.	0.00
3718	201048	grain céréalier, riz blanc, grain long, p-à-s, enrichi, sec	.	0.02
3709	200450	grain céréalier, riz blanc, grain moyen cru	.	.
3710	200447	grain céréalier, riz blanc, grain moyen, cuit	.	.
3656	200041	grain céréalier, riz brun, grain moyen, cuit	.	.
3682	200089	grain céréalier, riz sauvage, cuit	.	0.20
3649	203033	grain céréalier, son d'avoine, cru	.	.
661	66008	graines de moutarde,jaune	.	0.02
3089	6203450	grand brochet,cru	.	0.00
857	40001	gras animal, boeuf, graisse fondue (suif)	.	0.00
890	40574	gras animal,canard	.	0.00
891	40575	gras animal,dinde	.	0.00
892	40576	gras animal,oie	.	0.00
889	40542	gras animal,poulet	.	0.00
897	43002	gras animal,saindoux	.	0.00
872	10003	gras, animal, huile de beurre, anhydre	.	0.00
1734	90107	groseilles à maquereau,crues	.	3.53
3401	163029	haricot rouge, tous les types, en conserve, solides+liquide	.	0.00
3399	160010	haricots au four (fèves au lard), en conserve, +lard+sauce	1.40	1.26
3400	163009	haricots au four (fèves au lard), en conserve, au lard	.	.
3237	160008	haricots au four, en conserve, à la saucisse	0.90	.
2527	113053	haricots, jaunes ou verts, bouillis, égouttés	1.00	1.00
2128	113052	haricots, jaunes ou verts, crus	1.20	.
2528	113056	haricots, jaunes ou verts, en conserve, solides, égouttés	0.50	0.33

2122	110044	haricots, mungo, secs, germes+graines, bouillis, égouttés	.	.	
861	40042	huile végétale,arachide	.	0.00	
894	40582	huile végétale,canola (colza)	.	0.00	
877	40511	huile végétale, carthame, 70% ou plus d'acide oléique	.	0.00	
874	40502	huile végétale,cotton	.	0.00	
881	40518	huile végétale,mais	.	0.00	
863	40047	huile végétale, noix de coco	.	0.00	
865	40053	huile végétale,olive	.	0.00	
878	40055	huile végétale,palme	.	0.00	
866	40055	huile végétale,palmier	.	0.00	
862	40044	huile végétale,soja	.	0.00	
875	40506	huile végétale, tournesol, 60% ou plus d'acide linoléique	.	0.00	
868	40060	huile végétale, tournesol, moins de 60% d'acide linoléique	.	0.00	
1465	70029	jambon, tranché (app 11% m.g.)	.	.	
1464	70028	jambon, tranché, très maigre (approx 5% m.g.)	.	.	
1840	90275	jus d'ananas, concentré congelé, dilué	.	.	
1838	90273	jus d'ananas, en conserve, +vitamine C	.	3.81	
1765	90153	jus de citron, en conserve ou en bouteille		.	1.10
1764	90152	jus de citron,frais	1.10	1.10	
2569	113578	jus de légumes, cocktail, en conserve	1.90	.	
4225	90048	jus de mûres, cnd, non sucré		.	3.0
1886	93123	jus de pamplemousse, en conserve, non sucré		.	3.0
1745	90124	jus de pamplemousse, en conserve, sucré		.	4.4
1661	90018	jus de pomme, concentré congelé, dilué, vit C non ajoutée		.	5.6
1659	90016	jus de pomme, en conserve/bouteille, vit C	5.60	5.60	

		non ajoutée			
1911	96016	jus de pommes, en conserve/bouteille, vit c ajouté	5.60	5.60	
1751	90135	jus de raisin, en conserve ou en bouteille		.	4.40
1890	93137	jus de raisins, concentré congelé, sucre, dilué, +vit C	4.40	.	
2567	113540	jus de tomate, en conserve	1.90	1.54	
1893	93207	jus d'orange en conserve		.	4.6
1894	93215	jus d'orange, concentré congelé, dilué	4.60	2.56	
1794	90206	jus d'orange,frais	3.00	.	
1760	90148	kiwi,crus	4.40	4.35	
559	10103	lait au chocolat, liquide, partiellement écrémé, 2% m.g.	.	0.01	
538	190096	lait glacé à la vanille, ferme ou mou	.	.	
11811	15096	lait, concentré, entier, dilué (pour aliments Inuit)	.	.	
614	15096	lait, concentré, entier, en conserve, non dilué, 7,8% M.G.	.	.	
625	15096	lait, concentré, non dilué, 2% M.G.	.	.	
555	10095	lait, concentré, sucré, en conserve	.	.	
593	12085	lait,écrémé,liquide	0.00	0.00	
600	12077	lait, entier, liquide, homogénéisé, pasteurisé, 3,3% M.G.	0.00	0.00	
549	10082	lait, partiellement écrémé, liquide, 1% m.g.	.	0.00	
547	10079	lait, partiellement écrémé, liquide, 2% M.G.	.	0.01	
2549	113252	laitue pommée (iceberg),crue	0.80	1.00	
2239	110251	laitue romaine,crue	.	0.80	
2454	110584	légumes, macédoine, congelée, bouillie, égouttée	.	.	
2452	113581	légumes, macédoine, en conserve, solides,	.	.	

		égouttées			
464	186001	levure chimique,action continue	.	.	
411	180375	levure de boulangerie,sèche	.	.	
2946	140293	limonade, blanc, concentré congelé+eau	3.50	.	
3018	141297	limonade, boisson à saveur de, vitamine C, en poudre+eau		.	3.50
2943	140287	limonade, en poudre (avec jus de citron)	0.00	.	
2977	140414	liqueur au café (26,5% alcool par volume)	3.60	4.47	
323	190034	mais à souffler, soufflé, nature	.	0.07	
2186	110168	mais sucré, avec ou sans épi, bouilli, égoutté	0.30	0.43	
2544	113174	mais sucré, en conserve, en crème	.	0.23	
2545	113176	mais sucré, en conserve, sous vide, niblets	.	0.25	
936	43092	margarine molle, huile de mais, avec déclaration	.	.	
900	43094	margarine molle, huile de soja	.	.	
935	43094	margarine molle, huile de soja, avec déclaration	.	.	
902	43128	margarine molle, huile végét n précis, hypocalorique	.	.	
933	46800	margarine molle, huile végétale/animale non précisée	.	.	
903	43130	margarine molle, huiles végétales non précisées	.	.	
920	46801	margarine molle, tournesol+huile végét n précis, interestérifi	.	.	
904	43132	margarine, batonnets ou pains, huiles végét n précis	.	.	
899	43092	margarine, molle, huile de mais	.	.	
279	110945	marinades,chowchow,sucre	.	.	
2578	113937	marinades,cornichons à l'aneth	.	0.44	
2522	110940	marinades,cornichons,sucrés	.	8.81	

281	110945	marinades, relich, coupée ou hachée fin, sucrée	.	.
243	190303	marmelade,confitures aux agrumes	.	.
4203	46826	mayonnaise, faible en sodium, faible en calorie ou diète	.	0.85
2915	140193	mélange à saveur de chocolat (qik), en poudre	.	.
2922	140192	mélange de cacao, non enrichi, en poudre	.	.
244	190304	mélasse,qualité fantaisie	12.90	12.79
1876	90326	melon d'eau (pastèque),cru	3.30	3.36
1891	93181	melons,cantaloup,frais	.	1.87
229	190296	miel,filtre ou extrait	39.70	40.94
3901	45025	miracle whip, légère, (sans cholestérol)	.	.
4159	43002	morceaux de lard, sans viande	.	.
3194	152015	morue de l'atlantique,crue	.	0.00
3093	150067	morue du pacifique occidental, cuite au four ougrillée	.	0.00
255	66008	moutarde,préparée,jaune	.	.
662	20025	muscade,moulue	.	.
2440	113564	navets,crus	.	0.29
2650	120123	noisettes/avelines/coudres, roties à l'huile, non blanchies	.	.
2648	120121	noisettes/avelines/coudres, séchées, blanchies	.	0.07
2623	120078	noix de Brésil, séchées, non blanchies	.	0.00
2638	120108	noix de coco, desséchée, non sucrée	.	.
2639	120109	noix de coco, déssechée, sucrée, flocons, en paquet	0.20	0.10
2671	120155	noix de grenoble,séchées	.	0.09
601	13123	oeuf de poule entier, frais ou congelé, cru	.	0.11
570	13124	oeuf de poule, blanc, frais ou congelé, cru	.	0.07
605	13129	oeuf de poule, entier, bouilli à la coque,dur	.	0.08

607	13131	oeuf de poule, entier, poché	.	0.11	
572	10133	oeuf de poule, entier, séché	.	.	
602	13125	oeuf de poule, jaune, frais, cru, + petite quantité de blanc	.	0.07	
576	10137	oeuf de poule, jaune, séché	.	.	
1083	50147	oie domestique, chair et peau, roties	.	0.00	
1085	6403412	oie domestique, chair seulement, rotie	.	0.00	
3912	640318	oie, cou, viande seulement, rotie	.	.	
3909	6403413	oie, cuisse, viande+peau, roties	.	.	
3910	6403414	oie, épaule, viande+peau, roties	.	.	
3908	6403412	oie, poitrine, viande+peau, roties	.	.	
3911	6403416	oie, viande de dos, peau, roties	.	.	
4232	113282	oignons de printemps,blancs	0.90	.	
2272	113296	oignons en rondelles, panés, congelés, chauffés au four	.	.	
2551	113283	oignons,bouillis,égouttés	.	1.23	
2262	113282	oignons,crus	0.90	1.16	
2269	110291	oignons,verts,crus	.	.	
256	5391	olives, marinées, en conserve ou bocal, vertes	.	.	
1788	90193	olives, mures, en conserve, petites à extra-larges	.	.	
3025	141424	orange, boisson type déjeuner, concentré congelé	.	.	
1793	90205	oranges,avec pelure,crues		.	2.50
1792	90203	oranges,Floride,crues		.	2.50
1892	93200	oranges, toutes variétés commerciales,	2.50	2.50	

		crues			
664	20027	origan,moulu	.	1.13	
2664	120144	pacanes,roties à l'huile	.	0.04	
2662	120142	pacanes,séchées	.	0.04	
140	13009	pailles au fromage	0.00	.	
423	180071	pain blanc, (1 à 2% poudre de lait écrémé)		.	2.00
424	180071	pain blanc, (3 à 4% poudre de lait écrémé)		.	2.00
425	180071	pain blanc, (5 à 6% poudre de lait écrémé)		.	2.00
34	180074	pain blanc, 1 à 2% lait en poudre, grillé		.	2.00
426	183342	pain de blé entier, (2% de poudre de lait écrémé)		.	2.00
38	183076	pain de blé entier, fait avec de l'eau, grillé	2.30	.	
422	183060	pain de seigle,pale		.	2.00
1475	70045	pain de viande, porc, en conserve		.	2.00
30	180047	pain,aux raisins		.	2.00
36	180072	pain, blanc, (5% à 6% poudre de lait écrémé), grillé		.	2.00
39	181376	pain,chapelure,séche,émiettée	.	2.46	
427	183075	pain, de blé entier, fait avec de l'eau	2.00	.	
27	183029	pain,français ou viennois		.	2.00
41	183081	pain, préparation pour farce, sec		.	2.00
441	183230	pain,toast melba		.	2.00
348	180350	pains,petits,commercial,nature,hot-dog/hamburger	.	2.27	
665	20028	Paprika		6.71	
1482	70055	paté de foie, sans précision, en conserve	.	.	
4031	110546	pate de tomate, en conserve, avec sel ajouté	1.30	.	
2432	110546	pate de tomates, en conserve	1.30	5.00	
3699	203100	pate,macaroni (coudes), cuit	.	0.03	
3732	203100	pate, macaroni (coudes), enrichi, cuit	.	0.03	
3731	203100	pate, macaroni (coudes), enrichi, cuit	.	0.03	

3714	203099	pate,macaroni (coudes),sec	.	0.11	
3703	200121	pate,spaghetti,cuit	.	0.03	
3742	205123	pate,spaghetti,enrichi,cuit	.	0.03	
3738	200110	pates, nouilles aux oeufs, enrichies, cuites	.	0.00	
1897	93236	pêches,crues	1.30	1.53	
1810	90238	pêches, moitié/tranchées en conserve, +jus, solides+liquide	5.90	.	
1813	90243	pêches, moitié/tranchées en conserve, +sirop épais, sol+liq		.	5.90
1812	90239	pêches, moitiées/tranchées en conserve, +sirop léger, sol+l		.	5.90
1484	70057	pepperoni,porc,boeuf	.	.	
2273	113297	persil,cru	.	.	
666	20029	persil,séché	.	0.42	
347	180242	petits pains, commerciaux, p-à-s, durs (croutés)	.	.	
2553	113308	petits pois (vert), en conserve, solides, égouttées	0.00	0.13	
2552	113305	petits pois (verts), bouillis, égouttés	0.10	0.41	
2554	110327	petits pois (verts), congelés, bouillis, égouttés	.	0.14	
2283	110302	petits pois (verts), congelés, nature	.	0.37	
2280	113304	petits pois (verts),crus	0.00	0.39	
2524	113943	piment de la Jamaique, en conserve	.	.	
638	20001	piment de la jamaique, moulu	.	.	
668	20031	piment rouge ou de cayenne	.	.	
1898	93252	poires,crues,avec pelure	6.40	6.23	
1824	90254	poires, moitié en conserve, +jus, solides+liquide	5.80	5.80	
1828	90258	poires, moitié en conserve, +sirop extra épais, sol+liq		5.90	5.90

1826	93256	poires, moitié en conserve, +sirops légers, solides+liquide	5.10	5.10	
2286	110318	pois et carottes, en conserve, solides et liquide	.	.	
2277	113305	pois mange-tout, bouillis, égouttés	0.10	.	
669	20032	poivre,blanc	.	.	
667	20030	poivre,noir	.	.	
2519	113823	poivrons rouges,bouillis,égouttés	.	.	
2517	113821	poivrons rouges,crus	.	2.26	
2293	113334	poivrons verts,bouillis,égouttés	.	1.59	
2555	113333	poivrons,verts,crus	1.10	1.12	
2570	113674	pommes de terre, au four, chair et pelure	0.40	0.34	
2304	113363	pommes de terre, au four, chair seulement	0.40	.	
2305	113364	pommes de terre, au four, pelure seulement	0.40	.	
2343	113402	pommes de terre, batonnets de	.		0.3
2306	113365	pommes de terre, bouillies avec la pelure, chair, égoutté	.	0.30	
2583	116365	pommes de terre, bouillies avec la pelure, chair+pelure	.		0.3
2556	110408	pommes de terre, bouillies sans la pelure, chair, égoutté	.	0.30	
2302	113352	pommes de terre, crues, chair	.	0.27	
2557	113376	pommes de terre, en conserve, solides égouttés	.		0.3
2323	113386	pommes de terre, en escalopes, mélange sec, nature	.		0.3
2315	113378	pommes de terre, en purée, flocons sans lait, secs	.	0.98	
2521	110929	pommes de terre, en purée, granules, prép+lait ou margarine	.	0.00	
2335	113402	pommes de terre, frites, congelées, nature	.	.	

2325	113390	pommes de terre, rissolées, congelées, nature	.	.	
1878	93003	pommes,crues,avec pelure	7.60	5.90	
1648	93004	pommes,crues,sans pelure	.	6.03	
1651	90008	pommes, en conserves, sucrées, tranchées, chauffées	.	.	
1880	93020	pommes, purée de, en conserve, sucrée	7.50	7.50	
1654	90011	pommes, séchées, sulfurées, non cuites		.	7.60
2558	113403	pommmesde terre, frites, congelées, maison, prép au four	.	0.00	
4063	190040	popcorn, soufflé, à saveur de fromage	.	.	
4051	190283	Popsicles	.	0.34	
2023	103089	porc frais, cotes levées, maigre+gras, braisés	.	.	
2078	100078	porc frais, épaule, picnic, maigre, braisé	.	0.00	
2006	100036	porc frais, milieu de longe, maigre+gras, crus	.	.	
2036	100002	porc, frais, composé, cuisse+longe+épaule, maigre, cru	.	0.00	
2083	10093	porc, frais, composé, cuisse+longe+épaule, maigre, rotis	.	0.00	
1999	100013	porc, frais, cuisse, croupe, m+g, roti	.	.	
2040	100011	porc, frais, cuisse, entière, maigre, roti	.	0.00	
2074	100071	porc, frais, épaule entière, maigre+gras, rotis	.	0.00	
2073	100070	porc, frais, épaule, entière, maigre+gras, crus	.	0.00	
2054	103031	porc, frais, longe, bout des cotes, m+g, roti	.	.	
2004	103032	porc, frais, longe, bout des cotes, maigre, cru	.	.	
2005	105034	porc, frais, longe, bout des cotes, maigre, grillé	.	.	

2056	103035	porc, frais, longe, bout des cotes, maigre, roti	.	.
2002	103028	porc, frais, longe, bout des cotes, maigre+gras, crus	.	.
2011	100213	porc, frais, longe, bout du filet, maigre+gras, roti	.	0.00
2063	100196	porc, frais, longe, cote centrale, m+g, grillés	.	.
2066	100200	porc, frais, longe, cote centrale, maigre, braisé	.	.
2065	100199	porc, frais, longe, cote centrale, maigre, cru	.	.
2067	100201	porc, frais, longe, cote centrale, maigre, grillé	.	.
2068	100203	porc, frais, longe, cote centrale, maigre, roti	.	.
2061	104062	porc, frais, longe, cote centrale, maigre+gras, crus	.	.
2064	100198	porc, frais, longe, cote centrale, maigre+gras, rotis	.	.
11735	104065	porc, frais, longe, cotelette composée, m+g, rotie	.	.
11733	104186	porc, frais, longe, cotelette composée, m+g, sauté	.	.
11732	104186	porc, frais, longe, cotelette composée, m+g, sautée	.	.
11739	104067	porc, frais, longe, cotelette composée, maigre, braisée	.	.
11737	104068	porc, frais, longe, cotelette composée, maigre, grillée	.	.
#####	104181	porc, frais, longe, cotelette composée, maigre, sautée	.	.

2027	104063	porc, frais, longe, cotes levées de dos, maigre+gras, braisée	.	.
2047	100022	porc, frais, longe, entière, m+g, grillé	.	0.00
2048	100027	porc, frais, longe, entière, m+g, roti	.	0.00
2050	100025	porc, frais, longe, entière, maigre, braisé	.	0.00
2052	100027	porc, frais, longe, entière, maigre, roti	.	0.00
2025	104069	porc, frais, longe, filet, maigre, roti	.	0.00
2007	106039	porc, frais, milieu de longe, m+g, roti	.	.
2008	106040	porc, frais, milieu de longe, maigre, cru	.	.
2009	106043	porc, frais, milieu de longe, maigre, roti	.	.
2058	100038	porc, frais, milieu de longe, maigre+gras, grillés	.	.
1932	100109	porc,frais,panne,cru	.	0.00
1989	100173	porc,frais,pieds,mijotés	.	0.00
1931	43002	porc,frais,saindoux	.	.
1946	100124	porc, salé, bacon, grillé, sauté ou roti	.	.
1956	103134	porc, salé, jambon désossé, maigre (5% m.g.), roti	.	.
1992	100182	porc, salé, jambon désossé, maigre et régulier non réchauff	.	.
1993	100183	porc, salé, jambon désossé, maigre et régulier, roti	.	.
1995	100185	porc, salé, jambon en conserve, maigre et régulier, roti	.	.
1973	100151	porc, salé, jambon entier, maigre+gras, rotis	.	.
4130	190042	potato chips,barbecue	.	.
15	4006	poudre à pate, maison, crème de tartre	.	.
657	20020	poudre d'ail	.	.
585	13154	poudre de lait,écrémé	0.00	.
553	10090	poudre de lait,entire	0.00	.
1045	50108	poulet à griller/frire, aile, viande	.	.

		seulement,ragout		
1037	50100	poulet à griller/frire, aile, viande+peau, crues	.	0.00
1041	50104	poulet à griller/frire, aile, viande+peau, ragout	.	.
1040	50103	poulet à griller/frire, aile, viande+ peau, roties	.	0.00
4044	50106	poulet à griller/frire, ailes, viande seulement, frites	.	0.00
952	50014	poulet à griller/frire, chair seulement, ragout	.	.
951	50013	poulet à griller/frire, chair seulement, rotie	.	0.00
944	50006	poulet à griller/frire, chair+peau, crues	.	0.00
1024	50087	poulet à griller/frire, cou, viande+peau, mijotées	.	.
1017	50080	poulet à griller/frire, cuisse, viande seulement, crue	.	0.00
1020	50083	poulet à griller/frire, cuisse, viande seulement, ragout	.	.
1019	50082	poulet à griller/frire, cuisse, viande seulement, rotie	.	0.00
1016	50079	poulet à griller/frire, cuisse, viande+peau, ragout	.	.
1015	50078	poulet à griller/frire, cuisse, viande+peau, roties	.	0.00
4045	50054	poulet à griller/frire, dos, viande seulement, frite	.	.
984	53047	poulet à griller/frire, gras détachable, cru	.	0.00
1031	56094	poulet à griller/frire, haut cuisse, viande+peau, roties	.	.
1032	56095	poulet à griller/frire, haut de cuisses, viande+peau, ragout	.	.

957	53019	poulet à griller/frire, peau seulement, ragout	.	.
1011	56074	poulet à griller/frire, pilon, viande seulement, ragout	.	.
1002	56073	poulet à griller/frire, pilon, viande seulement, rotie	.	.
1010	56073	poulet à griller/frire, pilon, viande seulement, rotie	.	.
4042	50072	poulet à griller/frire, pilon, viande, frit	.	0.00
1003	56066	poulet à griller/frire, pilon, viande+peau, crues	.	.
1007	56070	poulet à griller/frire, pilon, viande+peau, ragout	.	.
1006	56069	poulet à griller/frire, pilon, viande+peau, roties	.	.
1001	56064	poulet à griller/frire, poitrine viande seulement, rotie	.	.
999	56062	poulet à griller/frire, poitrine, viande seulement, crue	.	.
998	56061	poulet à griller/frire, poitrine, viande+peau, ragout	.	.
997	56060	poulet à griller/frire, poitrine, viande+peau, roties	.	.
978	50041	poulet à griller/frire, viande blanche seulement, rotie	.	0.00
966	50029	poulet à griller/frire, viande blanche+peau, crues	.	0.00
969	50032	poulet à griller/frire, viande blanche+peau, roties	.	0.00
982	50045	poulet à griller/frire, viande brune seulement, rotie	.	0.00
974	50037	poulet à griller/frire, viande brune+peau,	.	0.00

		roties			
990	56053	poulet à griller/frire, viande de dos seulement, crue	.	.	
992	56055	poulet à griller/frire, viande de dos seulement, rotie	.	.	
988	56051	poulet à griller/frire, viande de dos+peau, roties	.	.	
947	50009	poulet à grillet/frire, chair+peau, roties	.	0.00	
1055	50118	poulet à rotir, viande blanche seulement, rotie	.	0.00	
4041	50063	poulet grillé/frit, poitrine, viande seulement, friture	.	.	
4043	50081	poulet, grillé/frit, cuisse, viande seulement, frit	.	.	
4047	210040	poulet, peau, frit, sans gras absorbé	.	.	
182	180152	préparation pour biscuits, carrés au chocolat, complet, sec			0.86
265	180289	préparation pour crêpes et gaufres, nature/babeurre, sec			0.86
88	180137	préparation pour gateau blanc, sec			0.86
71	180087	préparation pour gateau des anges, sec			0.86
80	180137	préparation pour gateau du diable, sec			0.86
75	180137	préparation pour gateau, casse-croute, sec			0.86
90	180144	préparation pour gateau, doré, sec			0.86
84	180114	préparation pour gateau, miel et épices, sec			0.86
333	190188	préparation pour pouding, amidon, chocolat, instant, sec	.		
1904	93279	prunes,crues	1.80	3.07	
4054	190202	pudding mix,vanilla,dry,instant	.		
3012	141267	punch aux fruits, boisson+vitamine C, en boite	3.70	.	

2433	110547	purée de tomate, en conserve	3.40	2.38	
2354	113429	radis,crus	0.60	0.80	
1712	90085	raisins de corinthe (zanthe), secs		.	33.80
1906	93298	raisins secs, sans pépins (sultana)	33.80	29.68	
1888	93132	raisins, type européen, peau adhérante,crus	7.60	8.13	
3098	150072	rogue (oeufs de poisson), espèces diverses, crue	.	.	
1730	93103	salade de fruit, en conserve, +jus, solides+liquides		.	5.9
1731	90099	salade de fruits, en conserve, +sirops légers, solides+liquide		.	5.9
1492	73069	salami, boeuf et porc, cuit	.	.	
676	20039	sarriette,moulue	.	.	
4073	110159	sauce à salade,chou	.	.	
914	45025	sauce à salade, commerciale, mayonnaise,>65% d'huile	.	.	
910	45018	sauce à salade, commerciale, type mayonnaise,> 35% d'huile	.	.	
4193	46825	sauce à salade, type mayonnaise, faible en calorie	.	0.85	
2568	113549	sauce de tomate, en conserve	1.80	1.66	
2435	113551	sauce de tomates avec champignons, en conserve	.	.	
1339	60150	sauce, prête-à-servir, barbecue	.	.	
386	66003	sauce,tartare	.	.	
1317	60110	sauces,déshydratées,aigre-douces	.	.	
1324	60118	sauces,déshydratées,boeuf	.	.	
1312	60103	sauces,déshydratées,fromage	.	.	
1333	60127	sauces,déshydratées,non précisées	.	.	
1330	60124	sauces,déshydratées,porc	.	.	
1326	60120	sauces,déshydratées,poulet	.	.	
1323	60116	sauces,en conserve,boeuf	.	.	

1327	60121	sauces,en conserve,champignons	.	.	
1325	60119	sauces,en conserve,poulet	.	.	
1488	73064	saucisse au porc, fraiche, cuite	.	0.00	
1489	70065	saucisses au porc et boeuf, fraiches, cuites	.	.	
1458	73022	saucisses fumées,boeuf	.	0.00	
1459	70075	saucisses fumées, boeuf et porc	.	.	
1460	73024	saucisses fumées,poulet	.	.	
1446	73008	saucisson de bologne, boeuf et porc	.	.	
1448	73011	saucisson de bologne,dinde	.	.	
1447	70010	saucisson de bologne,porc	.	.	
1470	73037	saucisson kielbasa, porc, boeuf, +lait écrémé en poudre	.	.	
675	20038	sauge moulue	.	.	
3105	153080	saumon keta, en conserve, égoutté, avec arête, sel ajouté	.	0.00	
3206	153084	saumon rose, en conserve, chair+arête+liquide, sel ajouté	.	0.00	
361	20047	sel de table	.	0.00	
446	186012	shake and bake,sec	.	.	
11710	46824	shortening, domestique, huile végétale non précisée	.	0.00	
921	46805	shortening, domestique, huilesvégétales+animales non préci	.	0.00	
927	46811	shortening,industriel,patisserie,canola	.	0.00	
929	56813	shortening, industriel, tout usage, soja et palme	.	0.00	
369	190350	sirop de table, principalement de mais, clair et foncé	2.20	.	
366	190361	sirop,de canne		.	2.2
370	190361	sirop, de table, canne et érable		.	2.2
4057	190350	sirop, de table, mais et 2% érable	2.20	.	
367	190353	sirop, d'érable	1.10	.	

3903	140311	slim-fast (substitut de repas)	.	.
4110	190007	snacks salés,à base de mais,corn chips	.	0.32
466	4005	soda à pate (bicarbonate de soude)	.	.
539	190283	sorbet à l'orange	.	.
1334	60128	soupe déshydratée, poulet et nouilles	.	0.00
1249	60008	soupe en conserve, bouillon de boeuf ou consommé, p-a-s	.	.
1291	60077	soupe, déshydratée, boeuf et nouilles	.	.
1289	60075	soupe, déshydratée, bouillon de boeuf ou consommé	.	.
1294	60080	soupe, déshydratée, bouillon de poulet	.	.
1310	60101	soupe, déshydratée, crème de légumes	.	.
1309	60100	soupe, déshydratée, légumes et boeuf	.	.
1303	60092	soupe,déshydratée,minestrone	.	.
1432	63094	soupe,déshydratée,oignon	.	0.00
1298	60086	soupe, déshydratée, poulet et légumes	.	.
1307	60098	soupe,déshydratée,tomate	.	.
1308	60099	soupe, déshydratée, tomates et légumes	.	.
1255	60016	soupe, en conserve, crème de poulet, condensée	.	0.00
1250	60009	soupe, en conserve, boeuf et nouilles, condensée	.	.
1253	60013	soupe, en conserve, bouillon de poulet, condensé	.	.
1271	60043	soupe, en conserve, crème de champignons, condensée	.	.
1283	60067	soupe, en conserve, légumes,Chunky,p-à-s	.	.
1269	60040	soupe, en conserve, minestrone, condensée	.	.
1429	63050	soupe, en conserve, pois cassés et jambon, Chunky.p-à-s	.	.
1430	63051	soupe, en conserve,pois cassés jaunes,condensée	.	.

1284	60068	soupe,en conserve,potage végétarien,condensé	.	.	
1261	60024	soupe,en conserve,poulet et légumes,Chunky,p-à-s	.	.	
1257	60018	soupe, en conserve, poulet et nouilles,"chunky", p-a-s	.	.	
1258	60019	soupe, en conserve, poulet et nouilles, condensée	.	0.00	
1260	60023	soupe, en conserve, poulet et riz condensé	.	.	
1259	60022	soupe, en conserve, poulet et riz, Chunky, p-à-s	.	.	
1279	60063	soupe, en conserve, tomates et riz, condensée	.	.	
1433	63159	soupe, en conserve, tomates, condensée	.	.	
1286	60072	soupe, en conservelégumes+bouillon boeuf, condensé	.	.	
3917	4834	Sucaryl (édulcorant hypocalorique)	.	.	
1335	60134	sauces, prête-à-servir, soja	.	.	
379	190335	sucre de betterave ou de canne, granulé, blanc		.	0.40
378	190334	sucre, de betterave ou de canne, brun (cassonade)	0.40	0.40	
380	190335	sucre, de betterave ou de canne, en poudre		.	0.40
381	190335	sucre,dextrose,anhydre	.	.	
3916	4834	Sugar twin, avec aspartame (édulcorant hypocalorique)	.	.	
858	40030	tartinade pour sandwich, commerciale, huiles non précisées	4.00	.	
2963	140355	thé infuse	0.00	0.00	
2994	140544	thé infusé, fait avec eau distillée	.	.	
2968	140370	thé instantané, +sucre, saveur de citron, en poudre	.	.	

2964	140366	thé instantané, non édulcoré, en poudre	.	.
2966	140368	thé instantané, non édulcoré, saveur de citron, poudre	.	.
3138	150126	thon, chair pale, en conserve dans l'eau, égoutté, +sel	.	0.00
3137	152119	thon, chair pale, en conserve dans l'huile, égoutté, +sel	.	0.00
2970	140381	tisane infusé	.	.
2577	113935	tomates,Ketchup	3.60	8.25
2563	113529	tomates,rouges,mures,crues	1.40	1.37
2565	113531	tomates, rouges, mures, en conserve, entières	1.20	1.37
2566	113533	tomates, rouges, mures, en conserve, mijotées	.	2.37
2372	113455	tomates, sauce à spaghetti, en conserve	.	.
4064	190056	tortilla chips	.	0.07
3209	150240	truite, arc-en-ciel, crue	.	.
3134	150241	truite, arc-en-ciel, cuite au four ou grillée	.	0.00
3208	6203430	truite,espèces diverses,crue	.	0.00
3544	170140	veau, cube à ragout (cuisseau+épaule), maigre, cru	.	0.00
396	2406	vinaigre,de cidre	.	0.30
397	2407	vinaigre,distillé	.	.
916	45120	vinaigrette,commerciale,francaise	.	5.36
911	45020	vinaigrette,commerciale,française (hypocalorique)	6.60	.
915	45114	vinaigrette,commerciale,italienne	.	3.64
909	45017	vinaigrette,commerciale,mille iles	.	4.00
3902	45018	vinaigrette,miracle whip (régulière)	.	.
2897	140051	vodka (40% alcool par volume)	.	0.00
1213	50277	volaille, produit de : poulet en conserve,	.	0.00

		désossé, +bouillon		
2895	140037	whisky (40% alcool par volume)	.	0.00
634	16117	yogourt, aux fruits, brassé ouà la suisse	.	
620	15122	yogourt, fruits au fond, 2% à 4% m.g.	.	
615	15116	yogourt, nature, 2 à 4% m.g,	.	.

Annex 3: Inuit food composition database (amounts of fructose in g/100g)

CODE	NAME	Fructose
8	ALMONDS DRIED	0
13	APPLE RAW	6.03
27	APPLEJUICE CND	5.6
29	APPLESAUCE SWEETENED CND	7.5
64	AVOCADO RAW	0.12
126	BACON CURED CKD DRAINED	0
141	BANANA RAW	4.85
155	BEANS WHITE BOILED	0
156	BEANS BAKED CND W/ PORK&TOMATO SAUCE	1.03
161	BEANS KIDNEY RED CND SOL&LIQ	0
183	BEANS, SNAP GREEN BOILED SMALL AMT H2O DRAINED	1
186	BEANS, SNAP GREEN CND DRAINED	0.33
192	BEANS, SNAP GREEN FRZN BOILED DRAINED	0.21
229	BEEF CHUCK BLADE ROAST BRAISED 72/28	0
353	BEEF ROUND BROILED	0
370	BEEF HAMBURGER REG GND BROILED MEDIUM	0
371	BEEF&VEG STEW HOMEMADE CKD	0
377	BEEF CORNED CND	0
379	HASH, CORNED BEEF, CND	0
380	BEEF CURED THIN-SLICED	0
383	BEEF POTPIE COM FROZEN	0
387	BEETS RED CND DRAINED	0.2
394	BEER 4.5 ALCOHOL BY VOL	0
396	DISTILLED SPIRIT: WHISKEY 86 PROOF	0
400	WINE: DESSERT SWEET 18.8 ALCOHOL BY VOL	5.15
401	WINE: TABLE ALL 11.5 ALCOHOL BY VOL	0.47
404	COLA CARBONATED	6.1
407	GINGERALE CARBONATED	3.7

416	BISCUITS MADE FROM MIX	0.6
	SOUP, BEEF BROTH OR BOUILLON, POWDER,	
434	DRY	0
439	WHEAT BRAN, CRUDE	0.64
444	BREAD CRACKED WHEAT	0.64
446	BREAD FRENCH ENRICHED	0.64
452	BREAD RAISIN ENRICHED	0.64
454	BREAD RYE AM 1/3 RYE & 2/3 FLOUR	0.64
	BREAD WHITE ENRICHED MADE W/ 3 4 NONFAT	
461	DRY MILK	0.64
	BREAD WHOLE WHEAT MADE W/ 2 NONFAT	
471	DRY MILK	0.64
484	BROCCOLI BOILED DRAINED NO SALT	0.74
505	BUTTER	0
512	CABBAGE RAW	1.65
513	CABBAGE SHREDDED BOILED SMALL AMT H2O	1.2
531	CAKE FRUITCAKE DARK	0.6
539	CAKE POUND	0.6
547	CAKE DEVILS FOOD W/ CHOCOLATE ICING	0.6
550	CAKE ANGELFOOD	0.6
554	CAKE COFFEECAKE MADE W/ EGG, MILK	0.6
569	CAKE YELLOW W/ CHOCOLATE ICING	0.6
581	CARAMELS PLAIN OR CHOC	0.2
587	CHOCOLATE PLAIN MILK, CANDY	0.2
619	CARROTS RAW	0.55
620	CARROTS BOILED DRAINED	0.36
628	CASHEWS	0.08
643	CHEESE BLUE OR ROQUEFORT	0.15
646	CHEESE CHEDDAR	0.15
647	CHEESE COTTAGE CRMD	0.15
649	CHEESE CREAM	0.15
653	CHEESE AM PAST	0.15

689	CHICKEN FRYERS FLESH&SKIN FRIED	0
747	CHICKEN CND BONED	0
749	CHICKEN FRICASSE HOMECKD	0
756	CHILI CON CARNE W/ BEANS CND	0.5
757	CHILI CON CARNE W/O BEANS CND	0.5
760	CHOCOLATE SYRUP W/O ADDED NUTRIENTS	7.6
764	CHICKEN CHOW MEIN HOMECKD W/O NOODLES	0
765	CHICKEN CHOW MEIN CND	0
775	CLAMS CND DRAINED SOLIDS	0
780	COCOA MIX FOR HOT CHOC. W/O ADDED NUTR., POWDER	0
789	COCONUT MEAT FRESH	0
800	COFFEE INSTANT PREPARED WITH WATER	0
807	COLLARDS BOILED SMALL AMT H2O DRAINED	0
812	COOKIES ASSORTED	0.1
820	COOKIES FIG BARS	2.01
845	CORN SWEET WHITE&YELLOW BOILED DRAINED	0.43
847	CORN SWEET WHITE&YELLOW CND CREAM STYLE	0.23
850	CORN SWEET WHITE&YELLOW CND DRAINED	0.23
857	CORN SWEET FRZN BOILED DRAINED	0.46
863	CORN GRITS DEGERMED ENRICHED CKD	0.23
866	CORN FLAKES ADDED NUTRIENTS	2.4
876	CORNBREAD DEGERMED CORNMEAL	0.18
879	CORNPONE WHOLEGROUND CORNMEAL	0.18
886	CORNMEAL DEGERMED ENRICHED CKD	0.18
897	COWPEAS IMMATURE BOILED DRAINED NO SALT	0
914	CRACKERS GRAHAM	0.51
916	CRACKERS SALTINE	0.51

928	CREAM HALF&HALF	0
929	CREAM LIGHT COFFEE OR TABLE	0
943	CUCUMBERS RAW PARED	0.75
957	DOUGHNUTS CAKE TYPE	0
958	DOUGHNUTS YEAST TYPE	0
974	EGGS WHOLE HARD-BOILED	0.08
977	EGGS WHOLE SCRAMBLED	0.08
992	FARINA ENRICHED CKD	0
999	FAT VEGETABLE COOKING	0
1017	FISHSTICKS FRZN CKD	0.27
1032	GELATIN DESSERT PLAIN	0
1053	GRAPEFRUIT RAW	1.77
1071	GRAPEFRUIT JUICE UNSWEETENED CND	1.77
1100	FISH, BATTERED FRIED	0.27
1104	HALIBUT COOKED DRY HEAT	0
1134	HONEY	40.94
1140	ICE CREAM	0.9
1149	JELLIES	16.2
1190	LAMB LEG EP ROASTED 84/16	0
1241	LARD	0
1246	LEMON JUICE CND	1.1
1252	LEMONADE FRZN DILUTED	1.1
1258	LETTUCE CRISPHEAD RAW	0.8
1267	LIVER BEEF PAN-FRIED	0
1304	MACARONI CH	0.03
1317	MARGARINE	0
1320	MILK WHOLE	0
1322	MILK SKIM	0
1323	MILK PART SKIM &2 NONFAT SOLIDS	0
1324	MILK EVAP CND	0
1328	MILK DRY NONFAT SOLIDS INST	0
1340	MOLASSES MED	12.79

1343	MUFFINS ENRICHED FLOUR HOMEMADE	0
1355	MUSHROOMS CND DRAINED	0
1358	CANTALOUPE RAW	1.87
1367	MUSTARD GREENS BOILED DRAINED	0.02
1369	MUSTARD GREENS FRZN BOILED DRAINED	0.02
1373	MUSTARD YELLOW	0.02
1378	NOODLES EGG ENRICHED CKD	0
1391	OATS, ROLLED OR OATMEAL, CKD NO SALT	0
1406	OLIVES RIPE CANNED (SMALL-EXTRA LARGE)	0
1413	ONIONS BOILED DRAINED NO SALT	1.23
1420	ORANGE RAW	2.5
1425	ORANGE JUICE RAW	2.56
1432	ORANGE JUICE CND UNSWEETENED	2.56
1437	ORANGE JUICE FRZN CONC DILUTED	2.56
1445	OYSTER FRIED DIPPED IN EGG MILK BRDCRMS	0
1446	OYSTER CND SOL&LIQ	0
1457	PANCAKES MADE W/ EGG MILK	0
1479	PEACH RAW	1.53
1480	PEACHES CND SOL&LIQ H2O PACK	1.53
1483	PEACHES CND HEAVY SIRUP	1.53
1493	PEANUTS ALL TYPES RAW	0
1497	PEANUT BUTTER SMOOTH W/ ADDED FAT SUG SALT	0
1516	PEAS GREEN IMMATURE BOILED DRAINED	0.41
1518	PEAS GREEN IMMATURE CND DRAINED	0.41
1530	PEAS GREEN IMMATURE FRZN BOILED DRAINED	0.41
1545	PEPPERS SWEET GREEN RAW	1.12
1546	PEPPERS SWEET GREEN BOILED DRAINED NO SALT	1.59
1558	PICKLES CUCUMBER DILL	0.44
1561	PICKLE CUCUMBER SWEET	8.81

1566	PIE APPLE	0.69
1584	PIE PUMPKIN	0.69
1611	PINEAPPLE RAW	2.05
1616	PINEAPPLE CND HEAVY SIRUP	7.2
1619	PINEAPPLE JUICE CND UNSWEETENED	6.5
1633	PIZZA W/ CHEESE FRZN BAKED	1.2
1636	FROZEN DINNER, FRIED CHICKEN, MASHED POT, MIXED V	0
1637	FROZEN DINNER, MEATLOAF W/ TOM SAUCE, MASHED POT,	0
1638	FROZEN DINNER, TURKEY, MASHED POT, PEAS	0
1654	POPCORN POPPED	0.07
1683	PORK LEAN CUTS MED FAT EP ROASTED 77/23	0
1783	PORK HAM CND	0
1786	POTATOES BAKED IN SKIN	0.34
1788	POTATOES BOILED PARED BEFORE COOKING	0.3
1789	POTATOES FRENCH FRIED	0.25
1793	POTATOES MASHED MILK&FAT ADDED	0.25
1809	POTATO CHIPS	0.25
1826	PUDDING FROM MIX W/ MILK	0
1846	RAISINS UNCOOKED	29.68
1870	RICE BROWN MEDIUM-GRAIN CKD	0
1872	RICE WHITE MED-GRAIN ENRICHED CKD	0
1936	SALAD DRESSING ITALIAN	3.64
1938	MAYONNAISE	0.85
1940	SALAD DRESSING MAYONNAISE TYPE	0.85
1949	SALMON SOCKEYE CND DRAINED SOL W/BONE	0
1958	SALMON SOCKEYE CKD DRY HEAT	0
1960	SALMON CHINOOK SMOKED	0
1963	SALT TABLE	0
1964	SALT PORK RAW	0
1972	SARDINE CND IN OIL DRAINED SOL W/ BONE	0

1999	FRANKFURTERS CKD	0
2003	LIVERWURST	0
2014	PORK SAUSAGE CKD	0
2018	SALAMI CKD	0
2041	SHERBET ORANGE	0
2046	SHRIMP FRIED DIPPED IN EGG MILK BRDCRMS	0
2049	SIRUP MAPLE	0.34
2051	SIRUP CORN LIGHT AND DARK	39.9
2075	SOUP CRM CHIC W/ EQ MILK	0
2079	SOUP CHIC NOODLE W/ EQ H2O	0
2097	SOUP SPLIT PEA W/ EQ H2O	0
2099	SOUP TOMATO W/ EQ H2O	2.51
2104	SOUP VEG BEEF W/ EQ H2O	0
2136	SOYBEANS IMMATURE BOILED DRAINED	0
2156	SOY SAUCE	0
2159	SPAGHETTI ENRICHED CKD	0.03
2164	SPAGHETTI IN TOM SAUCE W/ CHEESE CND	0.03
2165	SPAGHETTI W/ MEAT BALLS&TOM SAUCE HOMECKD	0.03
2169	SPINACH RAW	0.15
2170	SPINACH BOILED DRAINED	0.15
2172	SPINACH CND DRAINED	0.15
2178	SPINACH FRZN BOILED DRAINED	0.09
2192	SQUASH, SUMMER BOILED DRAINED	0.94
2212	SQUASH, SUMMER OR CROOKNECK FRZN BOILED DRAINED	0.94
2229	SUGAR BROWN BEET OR CANE	0.4
2230	SUGAR GRANULATED BEET OR CANE	0.4
2249	SWEETPOTATOES BAKED IN SKIN	0.5
2252	SWEETPOTATOES CND IN SIRUP	0.5
2277	TEA INSTANT UNSWEETENED PREPARED W/ WATER	0

	TOMATOES RED RIPE RAW YR ROUND	
2282	AVERAGE	1.31
2283	TOMATOES RED RIPE BOILED NO SALT	1.31
2284	TOMATOES CND SOL&LIQ	1.37
2286	CATSUP	8.25
2322	TUNA YELLOWFIN RAW	0
2324	TUNA LIGHT CND IN OIL DRAINED SOL	0
2328	TURKEY EP ROASTED	0
2353	TURNIPS BOILED DRAINED	0.29
2382	VEAL LOIN EP BRAISED 83/17	0
2404	VEG MIXED FRZN BOILED DRAINED	0
2421	WALNUTS PERSIAN OR ENGLISH	0.09
2439	WHEAT FLOUR WHITE ENRICHED ALL PURPOSE	0.3
2447	WHEAT GERM, CRUDE	0
2449	WHEAT CEREAL CKD	0.9
2456	WHEAT FLAKES ADDED NUTRIENTS	0.9
2470	WHITE SAUCE MEDIUM	0
2500	SHRIMP BOILED	0
2510	CHEESE SAUCE	0
2600	GRAVY MEAT BROWN	0
2602	TAMALES,CND	0.17
2657	TORTILLA LIME TREATED YELLOW CORN	0.07
2701	OIL CORN	0
2702	OIL OLIVE	0
2705	OIL COTTONSEED	0
2707	OIL SOYBEAN	0
2708	OIL CANOLA	0
3000	INSTANT BREAKFAST, ALL FLAVORS	0
3010	GRANOLA	2.01
3020	MILK SHAKE, ALL FLAVORS	0
3030	CREAM, WHIPPED	0
8001	bake apple(jam)	4.97

4046	Blackberry(raw)	2.4
4047	Blueberry(raw)	4.97
4192	Cranberry(raw)	0.63
5501	Cranberry(jam)	0.63
4220	Cloudberry(raw)	4.97
3500	Vit C fortified powdered drink(Tang)	4.97
3501	Coop fortified powdered drink	4.97
3502	Non-fortified powdered drink	4.97
3504	Sunny delight	4.97