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**SUGAR AND FOOD ADDITIVES AS A PART  
OF FOOD INDUSTRY**

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**ABSTRACT**

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<p>The aim of the thesis was to provide general information about the food industry, as well as the risks and negative side effects associated with its development. Sugar breakdown in the body, huge amount of the names that can be found on the products' labels, food products that it is found in, and ravages of its excessive consumption are significant matters to explain. Food additives, their types, examples and consequences to human are explained.</p> <p>The author's objective is to check and increase society' awareness of the field, understand better and analyze the cause of high level of sugar intake, and also to present the link between growing sugar consumption and higher indicator of civilization diseases.</p> <p>The thesis was written based on the literature, reliable resources, as well as a survey done by the author.</p>		

<p><b>Key words</b></p> <p>Consequences, diet, food additives, food industry, health, sugar.</p>
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## **CONCEPT DEFINITIONS**

**GMO** Genetically Modified Organism

**HFCS** High Fructose Corn Syrup

**MSG** Monosodium glutamate

**WHO** World Health Organization

## **PREFACE**

First, I would like to thank my supervisor, Mrs. Marja-Liisa Kaakko for her understanding, guidance and interest in my topic. Her actions and patience made it possible for me to work on the project according to my, sometimes hesitant, schedule. It was a pleasure to be under your wing.

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## 1 INTRODUCTION

Nutrition and healthy lifestyle are the terms known by majority of people. Different physical activities and a fit diet are promoted by celebrities and idols. However, people live in a hurry, work a lot, and have less and less time to take care of themselves. Over the years, there has been a noticeable change in the cause of peoples' death, and the twenty-first century has led to the emergence of civilization diseases, which become the major reason of it. Plenty of specialists have been wondering about the explanation of this phenomenon. Medicine and pharmaceutical industry evolve tremendously fast, but yet these cannot handle the threats posed by the modern world.

It is known that technologies and businesses are developing continuously. Food industry has made great progress that allows people to enjoy a broader range of products from different parts of the world. Surely, there are further benefits connected to that, however, the customer's eyes have rather recognized the disadvantages. There are people, who believes in the relation between civilization diseases and food industry accomplishments. The truth is, that the world is moving away from nature and its wealth and resources. In the seventies, the trend of low calories food appeared, and the companies started to replace fat with sugar. This was due to the fact that the food did not taste good, and sugar, together with food additives, gave a taste to it. Unfortunately, around the same time, popularity of stated diseases increased. Also, chemicals, antibiotics and other methods, such as food engineering came into force.

The topic is broad and it is challenging to precisely present all the aforementioned aspects. Exactly for this purpose, the following pages are focused on the two main topics, sugar and food additives. The author is concerned by the current worldwide health situation and wants people to better understand the hazards that are present in the food processing industry. Moreover, the associated consequences are shown, as well as some practical advices of how to avoid them are given.

## 2 FOOD INDUSTRY

The food and drink industry in European Union accounts for 16 percent of the whole manufacturing industry turnover, and in 2011 it equalled 956 billion Euro. It gives a job to 4.1 million direct employees and meets the needs of more than 500 million customers in the EU, as well as many international ones. (Fassio 2012.) New technologies are introduced to improve the production lines, their efficiency and effectiveness. Manufacturing companies make the food chain from the farm to peoples' mouth more complex, which requires many steps and workers. The phases' objective is not to improve the quality of the food products, but the amelioration of the image and perception. To achieve the goal, flavour enhancers, preservatives and other food additives are added. Also, different techniques, like filling the meat with some liquid to make up to a double amount of meat products, are applied (Walterska 2008).

Nearly half of the food and drink industry turnover is generated by small and medium size companies, whose turnover represent more than 99 percent out of 274 000 total existing companies (Fassio 2012). Enterprises are established to make money, which is good. However, from the author point of view, the bad thing is, that the vision of profit veils the most important aspect, which is the fact that the race for customers makes the producers and farmers manufacture the food, instead of growing it. Foodstuff is not processed to have more nutritional value for the human, but to meet people senses, such as sight, smell, and taste. It is a tragedy that the whole marketing system is focused on creating a profit, and ignores health impact, which are visible to the naked eye.

Nowadays, industry faces an increasing demand for organic products. Market leaders have built fortunes by producing inexpensive, convenient food, but at the moment they may meet a decrease in revenue. (TABLE 1.) Policy makers link high obesity rates with soda and snacks, what may lead to some limitations. Nevertheless, there is still a great global demand for a cheap and processed foodstuff. (The Year Ahead 2015.)

TABLE 1. Industry leaders and corresponding market share, and sales growth (adapted from The Year Ahead 2015)

<b>NAME</b>	<b>PERCENTAGE OF TO-TOTAL INDUSTRY MARKET SHARE</b>	<b>ESTIMATED SALES GROWTH</b>
Nestle SA	4.6%	-2.02%
PepsiCo Inc	3%	-5.42%
Archer-Daniels-Midland Co	2.9%	-12.27%
JBS SA	2.8%	37.36%
Wilmar International Ltd	2.8%	-0.81%
Tyson Foods Inc	2.10%	-3.62%
Unilever NV	2%	0.80%
Mondelez International Inc	1.9%	-18.65%
Danone SA	1.5%	5.71%
General Mills Inc	1.2%	-5.38%

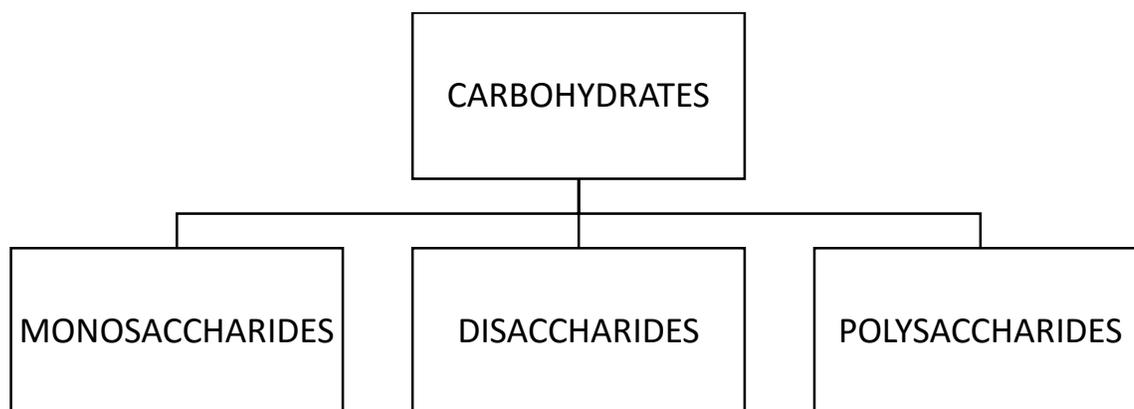
There is a significant drop in sales of some food industry leaders. (TABLE 1.) Mondelez will meet the biggest decrease. It is one of the biggest snacks company that consists of 49 brands, for instance Marabou, Tuc, Oreo, Toblerone, Prince, Philadelphia, Milka, LU, and BelVita (Mondelez International Official Website). The fall might be connected to the amount of sugar and additives that the company's products include. The awareness of people increase, which may reflect in Mondalez sales figures.

### 3 SUGAR

In 2012 the average consumption of cane and beet sugar per capita in the European Union was equal to 39.0 kg per year (Sugar consumption EURO). It means around 107,0 g per day. Assuming that a teaspoon contains 4,0 g of sugar, one eats as much as 27,0 teaspoons of sugar every day. These numbers are alarming, and many people do not believe that it can be even possible. It is caused by human's limited knowledge in the field. When one thinks about its sugar consumption a day, usually he or she recalls the sweets eaten during a day, and sugar added to the cups of tea or coffee. Years ago this data was sufficiently precise to self-control the diet. However, over the years, with the development of the food industry, it is just a drop in the ocean of the total sugar delivered to people's bodies. This topic will be described deeper later on, to keep the orderliness. Starting from the beginning, one should clarify, what sugar is.

#### 3.1 What sugar is

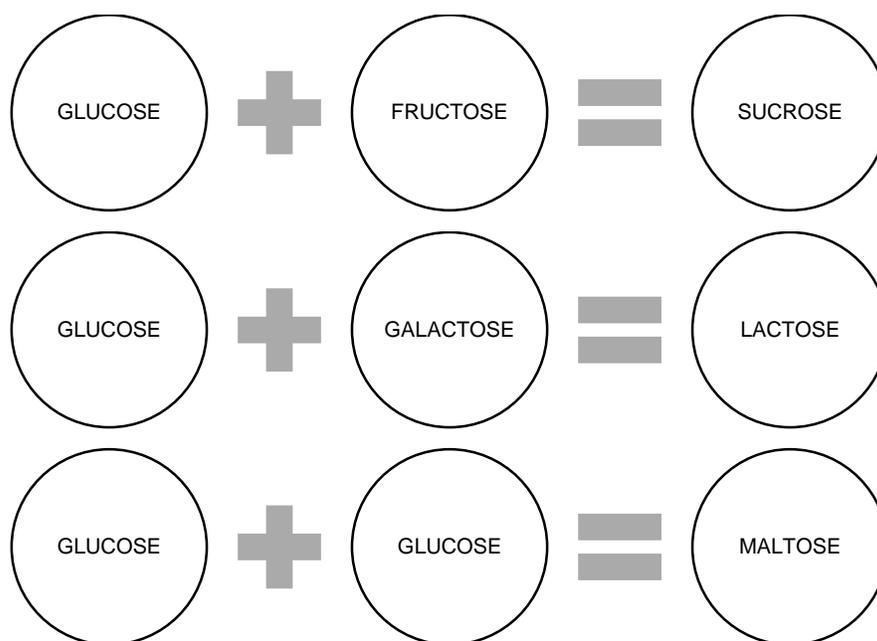
All types of sugar, together with sucrose and glucose, belong to a collection of substances named carbohydrates (Yudkin 1988, 15). The key carbohydrates consist of sugar, starches, and cellulose (O'Shea 2001). A basic division of those is presented below. (GRAPH 1.)



GRAPH 1. Simple division of carbohydrates (Yudkin 1988, 15)

In this section mono- and disaccharides are described, because only these, out of three groups are sugars. Starch and cellulose belongs to polysaccharides group.

Monosaccharides, also named as simple sugars, are the tiniest sugar molecules. They do not hydrolyse into a simpler compounds in a human's body. This group includes glucose (which is also called dextrose), fructose and galactose. Glucose is a primary product of photosynthesis in plants, and when talking about blood sugar one refers exactly to that. (Yudkin 1988, 15). In a people's diet dextrose appears in some fruits and vegetables. At this point it is worth to highlight that many of a basic foods, thanks to the digestive process, are converted into glucose, which is a main source of a fuel for cells (Yudkin 1988, 15). Fructose can be naturally found in fruits and vegetables, and galactose, as a part of lactose, in milk and dairy products. Surprisingly, fructose has no nutritional value and does not play any role in a human's body processes, but it does not mean one should give up on eating fruits and vegetables (Zięba 2014). These, apart from fructose, contain vitamins and minerals, which are needed. (Nordqvist 2014.)



GRAPH 2. Composition of selected disaccharides (Sugar nutrition UK)

Disaccharides, in simple words, are two monosaccharide units joined together (Nordqvist 2014). These are hydrolysed, simplifying broken down into simple sugars as a result of digestion (Sugar nutrition UK). The common disaccharides includes sucrose, maltose and lactose (Yudkin 1988, 16).

Lactose exists in mammalian milk, most commonly obtained from a dairy cow's milk. (GRAPH 2.) Interesting news for some may be the fact that human's milk consists of 6.7% of lactose. This disaccharide is utilized in production of modified milk, food for babies and pharmaceutical products. In big doses it operates as a laxative. (Nordqvist 2014.) According to New World Encyclopaedia, maltose is a product of breaking down the starch (New World Encyclopaedia 2015). For example, it breaks down when it is chewed in the mouth, or when barley starts to germinate (Yudkin 1988, 16). It can be found in grains, for instance barley, alcoholic beverages like beer, glucose syrups for pastry and baking, and many other food products. (Sugar nutrition UK). Sucrose, also called table sugar, is a refined sugar made either from beet or cane. (GRAPH 2.) The problematic point is that the finished product does not contain minerals and vitamins from the plant, because, due to the production process it turns out to be a fractionated, non-natural, and devitalized by-product of the original plant. (O'Shea 2001.) Sucrose can be naturally found in beet, cane, fruits and vegetables (Sugar nutrition UK).

Many sources differentiate sugar into natural and added. Natural sugar is the sugar occurring in unprocessed and valuable foods, like fruits, vegetables, milk and some grains (Family Doctor 2015). On the other hand, added sugar consists of all the industrially manufactured sugars added as an ingredient in processed food products (Rasmussen & Lyhne & Ovesen 1998, 253). Sugars and syrups added to food and drinks during the preparation processes and in the kitchen are in that group too. (Choose my plate 2015). The white sugar one adds to the cup of tea or while preparing a cake is added sugar as well. Surprisingly, alcohol is the fermented sugar of the individual fruit or grain. Depending on a beverage, it comes from certain plants, for instance, in case of wine, sugar usually comes from grapes, beer- barley, whiskey- corn or rye, vodka- wheat (O'Shea 2001).

### 3.2 Sugar names

While defining sugar, one could think it is limited to sucrose, the white crystals found in the sugar bowl on the table (Sugar nutrition UK). Nothing further from the truth. Sucrose is the common sugar consumed by people, added to a cup tea or used for baking. Nevertheless, according to the Institute of Responsible Nutrition, there are 56 different names that describe this sweet product (Institute for Responsible Nutrition). Being aware of those and recognizing them is very important in today's world, and due to this fact, all 56 terms are listed in below. (TABLE 2.)

TABLE 2. Names of sugar (adopted from Bjarnadottir 2015)

1. Sucrose	2. High-Fructose Corn Syrup (HFCS)	3. Agave nectar
<b>SUGARS WITH GLUCOSE AND FRUCTOSE</b>		
4. Beet sugar	5. Blackstrap molasses	6. Brown sugar
7. Buttered syrup	8. Cane juice crystals	9. Cane sugar
10. Caramel	11. Carob syrup	12. Castor sugar
13. Coconut sugar	14. Confectioner's sugar	15. Date sugar
16. Demerara sugar	17. Evaporated cane juice	18. Florida crystals
19. Fruit juice	20. Fruit juice concentrate	21. Golden sugar
22. Golden syrup	23. Grape sugar	24. Honey
25. Icing sugar	26. Invert sugar	27. Maple syrup
28. Molasses	29. Muscovado sugar	30. Panela sugar
31. Raw sugar	32. Refiner's syrup	33. Sorghum syrup
34. Sucanat	35. Treacle sugar	36. Turbinado sugar
37. Yellow sugar		

(Continues)

TABLE 2. Names of sugar (Continues)

<b>SUGARS WITH GLUCOSE</b>		
38. Barley malt	39. Brown rice syrup	40. Corn syrup
41. Corn syrup solids	42. Dextrin	43. Dextrose
44. Diastatic malt	45. Ethyl maltol	46. Glucose
47. Glucose solids	48. Lactose	49. Malt syrup
50. Maltodextrin	51. Maltose	52. Rice syrup
<b>SUGARS WITH FRUCTOSE</b>		
53. Crystalline fructose	54. Fructose	
<b>OTHER SUGARS</b>		
55. D-ribose	56. Galactose	

The names are divided into a few groups. The biggest one includes sugars with fructose and glucose. It means that the terms under the numbers 4-36 contain both ingredients, but in distinctive proportions. The other groups are composed of sugars made of only dextrose or only fructose, or other sugars that does not consist of any of those. High Fructose Corn Sugar is the most common sweetener in great number of soft drinks and processed products, and in 1984, Coke and Pepsi replaced cane sugar into HFCS (O'Shea 2001). The amount of different positions of sugar seen on the list of ingredients of the products from grocery stores is enormous. At this point, it is worth to mention that apart from sugar, there are many sweeteners found in foodstuffs, but those are explained in more detail in the next chapter.

### **3.3 What happens in the body after eating sugar?**

Knowing the simple process of decomposition of sugar in the body may help to understand the risk connected to eating too much of it. To visualize better the steps, the breakdown of sucrose, which consists of simple carbohydrates, will be explained. It is known the digestive system has its beginning in the human mouth, and it is the place where the digestive process begins (Salomon & Berg & Martin & Villee 1993, 136).

When one take a bite or sip of a product that contain sugar, the salivary glands start to work and through the process of saliva amylase, long chains of sugar are divided into shorter ones. After pasting through another parts of digestive system food is getting to a small intestine and there again the chains are cut into smaller pieces, specifically glucose. Then the dextrose is absorbed by the blood vessels and at this point significant for the topic process begins. (Salomon et. al. 1993, 972.)

At the moment when glucose gets into the blood, there is a boost of this sweet substance in the body, and to deal with it, a pancreas starts to produce insulin. It is to decrease the level of a dextrose. However, human's body is not perfect, and even though the level is already optimal, the pancreas still works and releases insulin. Consequently, when the glucose level is too low, people feel like eating something sweet again, so once more the process begins. Dangerous phenomenon occurs, because every time one eats simple carbohydrates (there is a boost of glucose), body cells get used to the insulin that reduces it. In a long period of time, the pancreas cannot produce enough amount of insulin, what causes many problems. (Zięba 2014.)

### 3.4 Sugar in a diet

Added sugar is hidden in a food products one would never think to check. In the United States, 80% of food articles in grocery stores comprise added sugar. (Olson 2014.) Few selected products with their sugar content are presented below. (TABLE 3.)

TABLE 3. Sugar content in selected products (adapted from British Dental Health Foundation 2015)

PRODUCT	SUGAR CONTENT PER 100G
Instant Sweetened Lemon Tea	95.3g

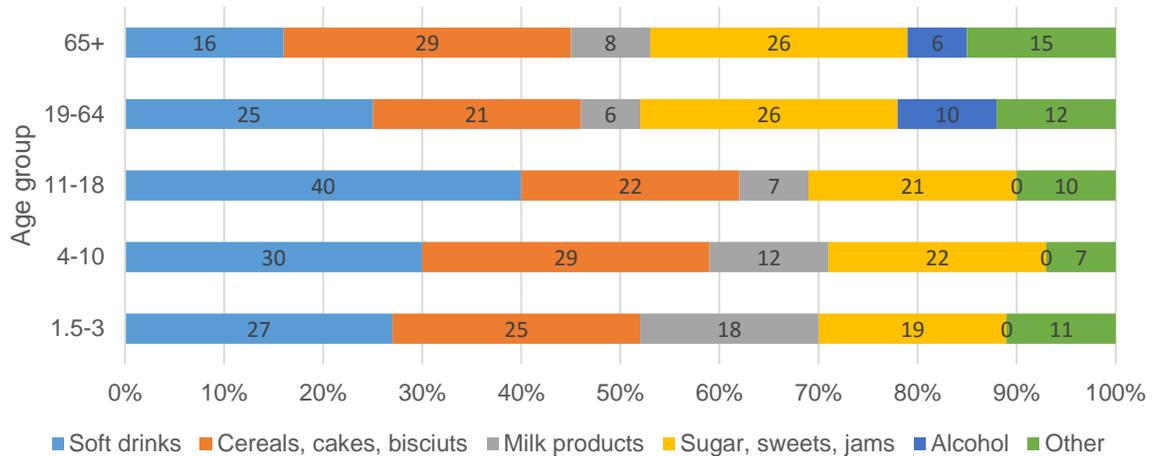
(Continues)

TABLE 3. Sugar content in selected products (Continues)

Skittles	76g
Baby food snack Gerber Graduate	68.7g
After Eight Mints	67g
Snickers Bar	54.5g
Milk Chocolate	52.8g
Jam	52.3g
Chocolate Spread	50g
Chocolate Digestive Biscuit	29.2g
Tomato Ketchup	23.7g
Ice Cream - vanilla	21g
Brown Sauce	19g
Sweet & Sour Sauce	19g
Salad Cream	17.5g
Fruit Yoghurt	13g
Cranberry Juice	11.6g
Coca Cola	10.6g
Cornflakes	8g

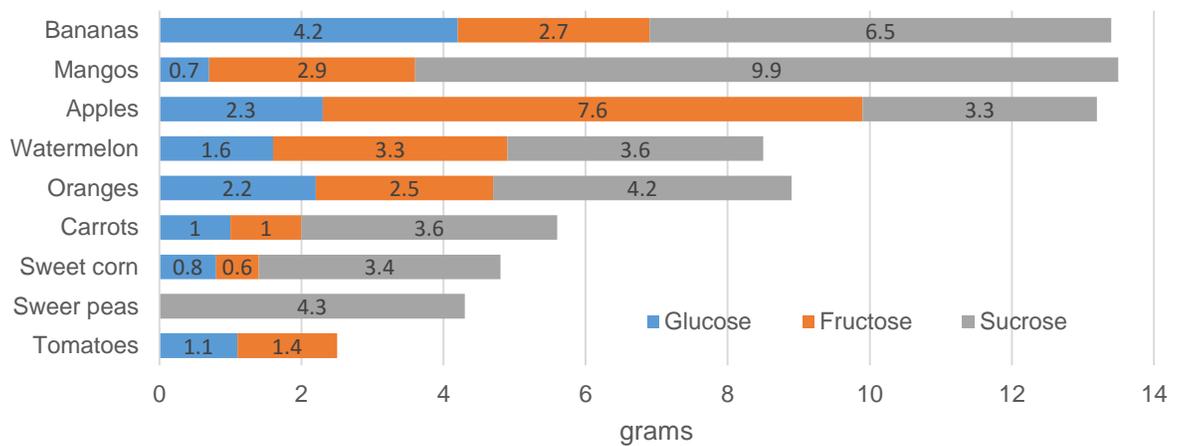
The author asked few families from different countries a simple question: *What do your kids eat for breakfast, including drinks and what do they have for snacks?* The most common answer was cereals with milk and juice, and white bread sandwich with instant chocolate drink for breakfast. As a snack, they eat biscuits, gummy bears and sometimes fruit – most likely banana. On first sight, cereals with milk seem to be quite healthy. When having a look at the labels, it gets much worse. Kellogg's cereals consists up to 56% of sugar (Whitbread & House). The same brand's Fruit and Nut Muesli, which is believed to be healthy and nutritious is made of 31% of sugar. Instant chocolate is made of almost 60% of sugar, gummy bears – up to 51%. These are just examples, and certainly one can find similar products with less sugar content. (Whitbread &

House.) Depending on the age groups, there are different sources on a sugar in a diet. (GRAPH 3.)



GRAPH 3. Sources of sugar in the diet of different age groups (adapted from Jeavans 2014)

The soft drinks do not have any nutritional value and these are the major sugar source in a kids and teenagers' diet (Nigel 2014).

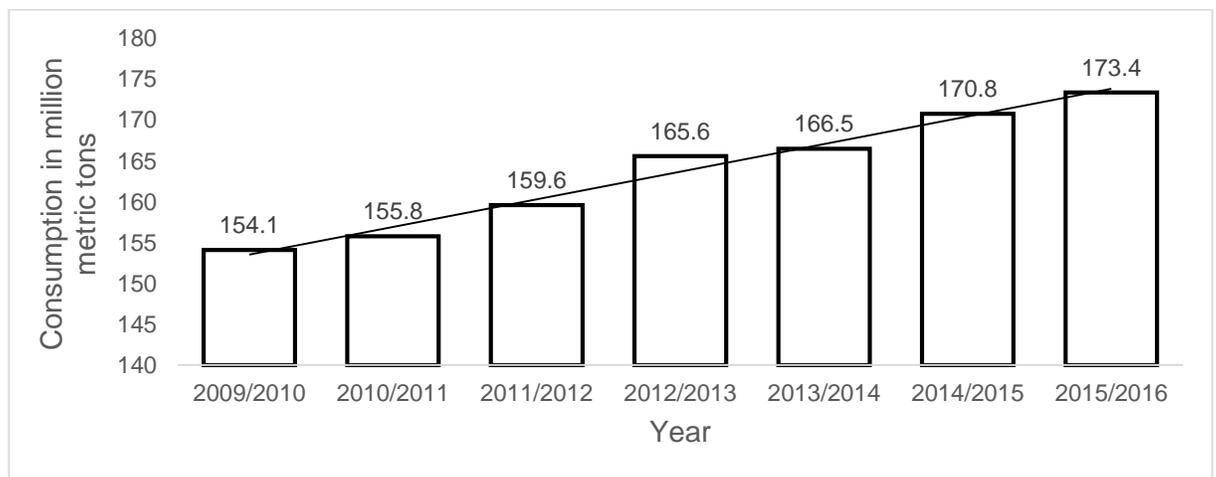


GRAPH 4. Amount of sugar in fruits per 100g (adapted from Canadian Sugar Institute)

Fruits and vegetables also contain sugar. (GRAPH 4.) However it affects the body in different way, because those consist of fibre that slows down the absorption of glucose.

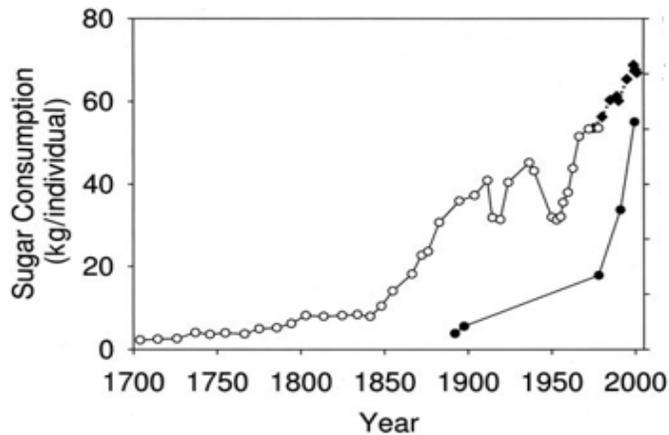
### 3.5 Sugar intake

Food concerns are doing their best to add sugar wherever possible. It translates into greater and greater amounts of sugar consumed every year in the world. (GRAPH 5.)



GRAPH 5. Total sugar consumption worldwide (adapted from The Statistics Portal 2016)

According to The Statistics Portal, since 2009 until now (amount of sugar consumed in 2015/2016 is estimated) sugar intake worldwide increased by 19.3 million metric tons, which is over 12.5% of growth (The Statistics Portal 2016). The ten major sugar consuming countries represent approximately two thirds of total world sugar intake (Groupe Sucres et Denrees).



GRAPH 6. Sugar intake over the years (adapted from Johnson 2007)

Taking into account that for many years there has been an upward trend, one can assume that the following years will indicate higher numbers. (GRAPH 6.) The average European eats 36.7kg of sugar per year (Groupe Sucres et Denrees). However the amount varies widely depending on the country, for instance, in United States, which is the world leader of sugar consumption, the average of sugar eaten is 126.4 grams a day, in Finland (9<sup>th</sup> place) is equal to 91.5 grams a day, and in Poland (25<sup>th</sup> place) – 56.8 grams a day (Ferdman 2015).

Due to worrying amount of sugar consumed and the link between added sugars intake and body weight and dental caries, in 2015, WHO published a report that includes new guidelines with some recommendations. The strong recommendation is to reduce the intake of added sugars to less than 10% of total energy intake and it is supported by the evidence from observational studies of dental caries. Research shows that the downsized dose of added sugars was interrelated with a decrease of body weight. Analogically, the increased consumption of added sugars was linked to weight gain. Moreover, the organization suggests an additional reduction of added sugar consumption to less than 5% of total energy intake. There is also information for countries with low consumption of added sugars not to increase the levels. According to the WHO report, which is prepared by specialists, there is no evidence for damage connected to the reduction of added sugar consumption to a smaller amount than 5% of total energy

intake. Furthermore, regarding people with deficient energy intake, WHO informs that eating sugar is not a right way to deal with a problem, if some other options are obtainable. (WHO Guideline 2015, 16-17.)

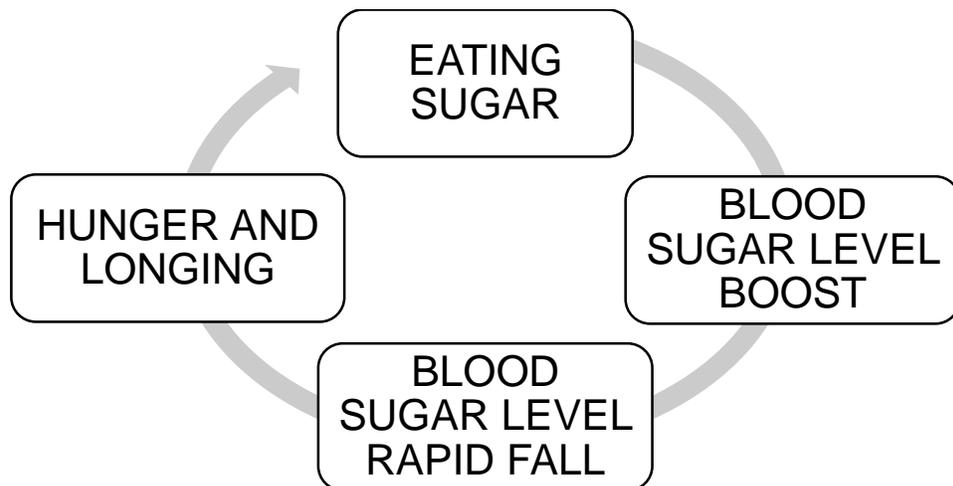
Another source claims that the daily dose of total sugar, so not only the sugar added to the products during the production or preparation process, but also sugar from fruits, vegetables, and carbs, should be accordingly for man – 36g, for woman – 24g, and for kids – 16g (Nigel 2014). If one compares the above norms with the actual consumption, the outcomes show that a man in Finland eats almost 250% of the norm given, while in Poland nearly 160% of the norm. Mr. O'Shea states that in a normal bloodstream that is around 5 litres of blood, thus, there should be more or less 2 teaspoons of a glucose at one time, and one can of coke contains even 10 teaspoons of sugar, which means it increases the blood sugar to five times its standard level (O'Shea 2001).

### **3.6 Addictive or not, it isn't a question**

Sugar is a very addictive substance and this section, supported by reliable resources proves it. In 1998, DesMaisons stipulated the idea of sugar addiction, and she asserted that it was a calculable physiological state. Her analyses showed sugar imitated an analgesic drug. From that time there has been more and more signals that confirm her thinking. (Alpert 2012.)

The research done in Princeton University showed that rats can become sugar dependent. It supports the theory that, an access to sugar can lead to behavioural and neurochemical modifications that resemble the consequences of a drug. Sugar addiction was checked by tests for bingeing, withdrawal signs, craving and cross-sensitization to amphetamine and alcohol. The results prove that the brain changes and behaviour is similarly modified in both, rats with access to sugar and rats addictive to drugs. This is an evidence that sugar can be addictive. (Avena & Rada & Hoebel 2007.)

The next source shows that there is a comparable dopamine change in the brain of rats that were fed with sugar, which also exists in drug addicts (Alpert 2012). Dr. Mark Hyman said that a research proved the sugar is eight times more addictive than cocaine (Origins 2014). Knowing how harmful sugar can be, one might wonder the reason of it being available everywhere and advertised so much in television and other media worldwide. Cocaine is prohibited and sugar is given to the children on a large scale. Seems that there is some problem with the assessment of the situation. Dr. Lustig just proves with his words the theory, saying that the more sugar you get, the more you want (Asia News Monitor 2015). The process of getting addicted is closely connected to the one explained in the section titled *what happens in the body after eating sugar?* (GRAPH 7.)



GRAPH 7. Never ending cycle of sugar addiction (based on Zięba 2014)

It is very simple. People eat sugar, because they like it and it is added to a huge amount of products. When eating it, their blood sugar level rapidly raise and the dopamine is liberated in the brain. Also insulin is produced to reduce the blood sugar level, what leads to its quick fall under the normal level. A low sugar level makes persons feel hungry for sugar again, so they take a sweet and the cycle repeats. (Zięba 2014.)

### 3.7 Consequences

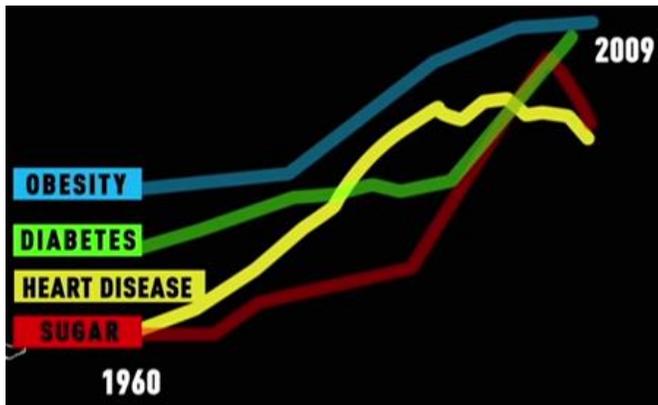
It was already mentioned that sugar is hidden in the food under plenty of different names and it is eight times more addictive than cocaine.

There is reason to believe that it is the fructose part of sucrose that is responsible for many of the undesirable effects of sucrose in the body. (Yudkin 1988, 16.)

Assuming that Mr. Yudkin words are true, taking into consideration that 36 out of 56 mentioned names of sugar are made up of fructose, and knowing that the food companies are adding sugar to the glut of products (not just sweets), one can realize that people nowadays are in danger. There is a risk even though they minimize the amount of sugar added directly on the plate. This section describes the unpleasant and harmful consequences of consuming too much of sugar. The bad effects are not visible in few days, but in a long term period. However, some of them appear earlier than the others and are affecting not only adults, but also children.

First issue is type 2 diabetes. A research carried at the University of California-San Francisco shows that sugar consumption is directly linked to type 2 diabetes. Big doses of sugar makes people's bodies be resistant to insulin produced by the pancreas. After some time, one gets to the point when the pancreas is not able to generate a sufficient amount of insulin to decrease a level of glucose in the blood and this is when type two diabetes starts. The second and most commonly known problem is that sugar causes obesity, which is indicated by the research conducted by scientists at the Medical Research Council. It takes place when one's weight exceeds 35% of normal body mass. The process is simple. Sugar converts into fat. Overabundance of dextrose is transformed to fatty acids, later to triglycerides, and finally stored in a body as adipose tissue. The percentage of obese people increase almost every year. It is connected to another effect of consuming too much sugar- heart disease. A study published in the Journal of the American Medical Association suggest that persons with 25% or more calories intake from added sugar are more than three times bigger probability of heart disease, heart attack or stroke, than persons with less than 5% of calories intake from sugars. According to the research presented at the American Heart Association's 63rd High

Blood Pressure Research Conference, a diet high in fructose elevates the blood pressure. Another thing to mention is tooth decay, which, according to different sources, is closely linked with sugar. Dental plaque is a clingy film composed of food particles, mucous and bacteria. The bacteria in dental plaque develops in a company of sugars and heads to the production of acids, which crack up the enamel and lead to the tooth decay. In New Zealand children's tooth are extracted because of too big destruction by added sugar. Different resources, as a consequences of high sugar intake, or fat that sugar transforms to, also point out: non-alcoholic fatty liver disease, high blood pressure, elevated cholesterol levels, hyperactivity in children, accelerated aging, digestive disorders, weakens the immune system, asthma, osteoporosis, food allergies, migraines, blood clots, depression, kidney damage, and mineral deficiencies. (Victoria State Government; Asia News Monitor 2015; Nordqvist 2014; Sugar Science; Tacio 2014; O'Shea 2001; Zięba 2014; Nigel 2014.)



GRAPH 8. Relation between the amount of sugar eaten and social diseases (adapted from The fifth estate. The secrets of sugar. 2013.)

The secrets of sugar documentary presents quite impressive picture, which shows the relation between increased amount of sugar consumption and growing level of social diseases, such as obesity, diabetes and heart disease. (GRAPH 8.) As mentioned before, fat have started to be replaced with sugar in 1970. One can notice, that the upswing of data begins after year 1960. It suggest the connection of food industry development and rate of diseases that affects more and more people over the world.

## 4 FOOD ADDITIVES

Food additives are all the substances, which are added to the products during the manufacturing process (Henochowicz 2014). Different source defines food additives as:

Any substance not normally consumed as a food in itself and not normally used as a characteristic ingredient of food, whether or not it has nutritive value (Andrews).

Numerous resources divide them into direct and indirect additives. In simple words, direct additives get to the food in the processing, to make it stay fresh for longer, add some nutrition to it, or create it more attractive for the customers (Direct additives, US National Library of Medicine). According to U.S. Food and Drug Administration indirect additives are not intentionally appearing in the foodstuff, and usually it occurs in the process of packaging, transportation or holding (Indirect additives, FDA). Food Standard Agency divides food additives into six main groups, which are presented in a sub sections below (Food Standard Agency 2014). By summing all the groups together, one can see that European Union committed to use 312 of E numbers, which indicate additives. The list of those can be found on the official website of European Food Information Council.

### 4.1 Colours

A colour is considered as any pigment, dye or a substance that is able to impact, alone or by the reaction with other element, a colour of a product when added. There are many reasons for colour additives to be used in food products. Firstly, to recompense eventual colour loss caused by the contact with light, air, some temperature extremes, humidity, or storing conditions. Secondly, to correct naturally occurring distinctions in colour of a product. Moreover, to intensify natural colours, and also, to bring colours to a drab and 'joy' foods. To visualize a role of colour additives, few examples of lacking those are given: a coke would not be brown, mint ice cream would not be green, and margarine would not be yellow. (Food and Drug Administration 2010.) In European

Union, there are 40 authorized colour additives, which consist of certified colours and colours that exempt from certification (Food Standard Agency 2014).

Certified colours are manufactured synthetically and used commonly. These are cheaper, give an intense, unitary colour and combine easier to generate a diversity of tints (example E110- Sunset Yellow FCF). Exempt from certification colours embrace dyes from natural sources, for instance vegetables. Natural colours are usually more expensive than certified ones and may unintentionally add flavour to foodstuff (example E160a- Beta-carotene). Food and Drug Administration is in charge of ensuring that both categories are approved for use in food and safe to eat. (Food and Drug Administration 2010.)

## **4.2 Preservatives**

Preservatives are the chemicals added to food stuff to avoid or delay spoilage that is caused by various chemical changes, for instance, oxidation or the growth of mould (Encyclopaedia Britannica 2015). Also, to prevent or delay changes in flavour, colour and texture, maintain freshness, and delay rancidity (Food and Drug Administration 2010). Preservation has been known for many years. There are different ways with similar effectiveness that does not require additives to be used. Home or traditional solution may be freezing, boiling, refrigeration, pasteurizing, and dehydrating. As a preservative one can use sugar or salt. Food industry also uses other methods, such as nuclear radiation, vacuum or hypobaric packing. (Food Additives 2013.) The list of additives in UE includes 35 preservatives.

### 4.3 Antioxidants

Antioxidants are extremely important in everyone's life. These are helping to fight or clean out free radicals that are hazardous to health. Free radicals, in simple words, kill people's good cells, and at the moment, when one have more bad cells (free radicals) than good ones, the disease affects. It is due to fact the organism is not strong enough to protect itself. This is a reason of antioxidants being crucial for humans in a diet. One can find them naturally in fruits and vegetables. Antioxidants are used in food stuff for the same reason – to prevent or postpone the damage of some cells caused by oxidation. (Mandal 2013). The process of oxidation occurs for example when apple becomes to be brown, and the task of antioxidants is to extend its lifetime. The most known antioxidant is ascorbic acid (vitamin C). There are 18 antioxidants that can be added to a foodstuff in EU. (Antioxidants 2013.)

### 4.4 Sweeteners

Sweeteners add sweetness to products, depending on components, with or without extra calories (International Food Information Council Foundation 2010). Furthermore, these are used to regulate the bitterness or to adjust the tartness of food (Sugar nutrition UK). The most widely used sweetener is aspartame, which is dangerous substance utilized in diet soft drinks etc (O'Shea 2001). Therefore, it is essential to be aware of its ingredients.

Aspartame is made out of three elements: aspartic acid, phenylalanine and methanol. Its symbol on the packages is E951. Aspartic acid is a neurotoxin that damages nerves by generating free radicals. It is hazardous, especially for infants, because their nervous systems are not formed yet and their defence system is not developed. Phenylalanine is an amino acid, which is needed for human's brain function. It decreases a level of serotonin, called happiness hormone, and might cause depression. Methanol is a wood alcohol and according to Environmental Protection Agency its consumption limit

per day is 7.8mg. Shockingly, a bottle (1l) of diet soda consists of 56mg of it. Aspartame was approved by Food and Drug Administration in 1974, and since that dozens of companies, such as Monsanto, started to add it to food products. (O'Shea 2001.)

#### **4.5 Emulsifiers, stabilisers, thickeners and gelling agents**

Emulsifiers stop separation of ingredients and enable a smooth mixing of the products that are usually difficult to combine (for example oil and water). Also, these are lowering the stickiness, controlling crystallization, keeping the emulsified products steady, and helping them to dissolve effortlessly. An example of emulsifiers is soy lecithin. Stabilisers prevent mixed products from partition (e.g. E415). Thickeners generate a uniform consistency and work similarly to a flour in a homemade sauces (e.g. E466). Gelling agents, as the name suggest, are making food more jelly (the most popular is pectin). This group of additives is commonly used in manufacturing of low fat dressings, ice creams, jams, spreads and many others. (Food and Drug Administration 2010; Food Additives and Ingredients Association, 2012.)

#### **4.6 Other**

This group represents a wide range of food additives and consists of:

- acidity regulators,
- anti-foaming agents,
- anti-caking agents,
- bulking agents,
- carriers and carrier solvents,
- emulsifying salts,
- firming agents,
- flavour enhancers,
- flour treatment agents,

- foaming agents,
- glazing agents,
- humectants,
- modified starches,
- packaging gases,
- propellants,
- raising agents,
- sequestrants.

'Others' group of approved by European Union food additives includes 155 positions. (Food Standard Agency 2014.)

#### 4.7 Examples

To visualize how many distinct food additives end up in people's fridge or on a kitchen shelf, here are a few examples of the products from grocery shop that are put under a magnifying glass. (TABLE 4.)

TABLE 4. Products ingredients lists with its brief clarification of additives types

PRODUCT	INGREDIENTS	EXPLANATION
Coca Cola zero	Water, carbon dioxide, E150d <sup>1</sup> , E338 <sup>2</sup> , E331 <sup>3</sup> , aspartame <sup>4</sup> , acesulfame-K <sup>5</sup> , natural flavour, plant extracts	Colours <sup>1</sup> , acidifying agent <sup>2</sup> , artificial flavour <sup>3</sup> , sweetener <sup>4</sup> , sweetener <sup>5</sup>
Kiwi-lime juice drink	Water, sugar, kiwi and lime juice from concentrate, citric acid <sup>1</sup> , flavour, E433 <sup>2</sup> , E141 <sup>3</sup> , saflor extract	Flavour <sup>1</sup> , emulsifier <sup>2</sup> , colour <sup>3</sup>

(Continues)

TABLE 4. Products ingredients lists with its brief clarification of additives types (Continues)

Barbecue sausage (makkara)	Pork meat, water, potato starch, natural casing, salt, meat protein preparation (pork), E331 <sup>1</sup> , citric acid <sup>2</sup> , glucose, E450 <sup>3</sup> , E425i <sup>4</sup> , celery flavor, yeast extract, potato fiber, ascorbic acid <sup>5</sup> , cumin, E250 <sup>6</sup>	Flavour <sup>1</sup> , flavour <sup>2</sup> , thickener/stabilizer <sup>3</sup> , thickener/stabilizer/emulsifier <sup>4</sup> , antioxidant <sup>5</sup> , preservative <sup>6</sup>
Chocolate cereals (Weetabix)	whole grain wheat 41%, sugar, wheat flour, calcium carbonate, iron, nicotinamide <sup>1</sup> , thiamine hydrochloride <sup>2</sup> , maltodextrin <sup>3</sup> , cocoa powder, rapeseed oil, milk powder, salt, potassium chloride <sup>4</sup> , flavors	Vitamine <sup>1</sup> , vitamine <sup>2</sup> , sweetener <sup>3</sup> , firming agent <sup>4</sup>

Some of the substances are problematic to unscramble, due to a limited amount of information available to the public (Winter 2009.).

#### 4.8 Consequences

Not all of the food additives are harmful to humans. They are natural substances as well as antioxidants, which do not cause problems when eaten. However, out of 330 approved additives, the majority may affect people in a bad way. Resources warn against several food additives in particular.

Aspartame is considered to be dangerous, mostly for the nervous system. In the report published in 1994 more side effects were listed: weight gain, nausea, muscle spasms, numbness, rashes, fatigue, depression, rapid heartbeat, excitability, vision problems, insomnia, hearing loss, slurred speech, anxiety attacks, loss of taste, ringing in the ears, arthritis, memory loss, vertigo, multiple sclerosis, brain tumours, epilepsy, Parkinson's disease, chronic fatigue, Alzheimer's, lymphoma, mental retardation, birth defects, diabetes, and fibromyalgia. (O'Shea 2001.)

A study from the Journal of Attention Disorders shows that the intake of sodium benzoate (E211) may be connected to ADHD. Monosodium glutamate (also called MSG,

E621), as written in journal Nutrition, supposedly causes higher incidence of snoring and sleep-disordered breathing. A different study relates it to headaches and high systolic blood pressure. Nitrates (E251, E252) may raise the risk of thyroid cancer. (Enos 2013.)

Sodium nitrite (E250) can be found in processed meat, such as hot dog sausages. When heated, it mixes with amines, and the outcome can be carcinogenic. Butylated Hydroxytoluene (E321) is believed to be endocrine-disrupting. According to California's Proposition 65 butylated hydroxyanisole (E320) is carcinogenic, may cause hyperactivity and allergic reactions. Phosphates are causing heart disease and European Food Safety Authority is reevaluating whether it should be allowed to be added to the products or not. Propyl gallate (E310) is considered as causing tumours. Diacetyl may induce Alzheimer's disease. Aluminium that is present in some additives accumulate in the bones and it may provoke changes in behaviour and motor responses. Natural and artificial flavours- this name on the label can hide hundreds of additives that are genetically engineered or toxic. (Mercola 2015.)

The above side effects shows, that the grocery stores offer plenty of products that are not considered as harmful to human. One should remember that chemicals can intensify one another and combined, cause unfavourable effects.

## 5 OTHER ASPECTS

Sugar and food additives are only examples of many unnatural and dangerous substances and techniques used in the food industry. Fruits and vegetables are treated with pesticides. Pesticides are the toxic substances that kill or manage pests. The most popular are herbicides, which kill weeds, and insecticides that kill insects. These are used worldwide and people may not realize that the substances stay in the environment. Soil, air and water are the places where pesticides remain. Moreover, these chemicals are harmful to human and can cause cancers, poisonings, headache, skin irritation, nausea and many others. Animals and human are not able to break down some of them, so they stay and accumulate in the body. One can find more consequences of pesticides usage, but logically thinking the substance that kills living beings cannot be safe for other living beings - human. (Toxic Action Center 2015.)

Genetically Modified Organisms are another peril. Their DNA is changed by mixing it with DNA from different foreign organisms (Latham 2015). GMO is unsafe for many reasons. Genes inserted into genetically modified food can transfer into the bacteria that lives in human. Consequently the toxins are in peoples' blood and can cause serious problems, for instance immune system disorders, gastrointestinal, infertility, and accelerated aging. GMO's are more pesticides tolerant, which means that to protect the plant, one uses greater amounts of a chemicals. Mixing genes may lead to the production of new allergens, toxins, or carcinogens. The most affected GMO crops are soybeans, corn, papaya, cotton, and canola (Latham 2015). And unfortunately in many countries, appropriate GMO labels' designation are not required, so people do not know whether the product they eat contains GMO or not. (Smith 2011.)

There are also antibiotics used in food-producing animals. These are found hazardous because the resistant bacteria that remain in food-producing animals, through the eating process, is transmitted to a human body. Furthermore it can cause infections, which therefore may result in negative for human health consequences. According to Center for Disease Control and Prevention, approximately one out of five resistant infections

are caused by germs from food and animals. (Centers for Disease Control and Prevention 2014.)

The above described dangers are just part of the total risks that food industry exposes on people. One needs to remember that it is nearly impossible to know what is in processed food. There are minimum limits for the substances, which when not exceeded, exempt manufacturers from adding the information on the label. Vegetables and fruits are also a riddle. Plants do not have a liver to somehow get rid of toxins. Everything that is sprayed on them or added, remain, and probably none of the producers place the information about treatment on the label.

## 6 PEOPLE'S AWARENESS

The author decided to make a survey to check people's awareness on the food industry issue. The questionnaire was published in social media (the author's profile) in January 2016, so the group of receivers was limited to her friends and classmates. It was titled conscious nutrition and collected 231 participants in different age groups (see APPENDIX 2.). Due to fact that 86.5% of the total interviewed are in the age of 21-25 years old, and 85% of those claims that eat healthy, those are the subject of the analysis.

As many as 8% of examined buys a light products, which have minimized amount of fat and very likely added sugar or sweeteners, only 14% read the list of ingredients on the products' label, but one can assume that it is done just for curiosity reasons, because nearly 71% of those, still buys the products with the ingredients they do not recognize. The questioned were given simple questions with the frequency of consumption of certain products. As for people, who say that have a healthy diet, the results are not satisfactory. Sweetened drinks, such as coke or juices, as well as fast food, are drunk few times a week by 86% of the chosen ones. For sweets, the result is even greater and is equal to 3% for everyday consumption and almost 92% for few times a week intake. Similar situation is with appetisers. Even 83% of questioned eats salty snacks few times a week. Surprisingly, there were 88% positive answers for sugar in the question *what do you avoid in your diet*, and 93% for *is sugar needed in a diet*. The participants are aware that majority of food contains food additives, but they still buy them.

The results of the research suggest that people have not enough knowledge connected to healthy nutrition. It seems to them, that their diet is good, however, according to the answers given one can notice that it is not true. In pursuance of the author's knowledge, which is supported by reliable resources, healthy nutrition does not consist of sweets, sweetened beverages and fast foods few times a week, as it is in case of majority of interviewed. Awareness of examined, which represents society, leaves much to be desired and needs to be changed.

## 7 ADVICES

There is no way to avoid all of the dangers that food industry comes up with, unless one has its own garden or a farmer nearby. However, there are some things people can do to choose the lesser evil, have better health of their own and their children. Luc Tappy, who is a psychologist at the University of Lausanne in Switzerland said a very significant sentences that should hit the largest possible number of recipients.

You cannot live without essential fats. You cannot live without protein. It's going to be difficult to have enough energy if you don't have some carbohydrate. But without sugar, there is no problem. It's an entirely dispensable food. (Tacio 2014.)

The first thing humans can do to improve their diet, and consequently health, is to eliminate or minimize sugar intake. The study conducted by Dr. Robert Lustig, a paediatric endocrinologist at UCSF Benioff Children's Hospital in San Francisco, shows that eliminating most of the sugar from kids' diet improves their health immediately. Researchers had a group of forty three obese children, and put them on a nine days diet. The amount of calories and carbohydrates was the same as before, but sugar was replaced with starchy products. After a nine days on sugar-limited diet, practically every aspect of the kid's metabolic health got better. High blood pressure started to move in the direction of normal, the level of bad cholesterol decreased, and there was an improvement in blood sugar. (Asia News Monitor 2015.) Probably, research on adults would give comparable results.

To reduce the sugar consumed, not only from the products available in the grocery stores, but also during meals prepared at home, people may try some less unhealthy alternatives. Nowadays stevia is considered, as a healthy substitute and it is 200 times sweeter. It is a leafy, green plant with no calories. Some resources report this herb is used in traditional medicine and cures burns, stomach problems, as well as colic. A study conducted on 174 Chinese people suggests that the plant can lower a blood pressure. They were given stevia, or placebo and the outcome show group, which was taking herb had improvement in the results. Stevia does not have glycaemic influence,

which suggests that is appropriate for diabetics. However, there were no proper studies made to state, whether it is fully safe, and its consumption does not lead to health problems in a long time period, or not. Also, one needs to realize that there is a difference between stevia leaves and refined crystals made out of it. (Cox 2013; Gunnars 2015.)

In the case, someone would like to go further with restricting sugar, the author suggests to check the glycaemic index of the food eaten. It is a kind of classification that helps people to verify products that cause the rise of glucose in blood. The higher glycaemic index a product has, the greater concentration of dextrose in the blood is. The table of the products with its glycaemic index can be easily found (see APPENDIX 1). (Nielsen 2013.)

It is immensely important to read the labels, before making decision, whether to buy the product or not. Then to check the amount of added sugar and list of ingredients. One should not purchase anything that contains harmful additives and large quantities of sugar. People need to be doubly cautious and absolutely not consume products containing aspartame. To memorize all fifty-six names of sugar is time consuming and not everyone is willing to do it, but there is a useful rule of recognizing it. Most probable, the ingredients that are syrups or end with -ose are sugars, so one can recognize the majority of them without memorizing the terms (Nordqvist 2014).

## 8 CONCLUSION

Food industry makes continues progress, introduce new products, and uses innovation technologies. These actions lead the companies to earn more and more money. The concerns want people to buy as many products as possible, and through the advertisement and marketing, they are trying to sell low quality foodstuff. Unfortunately, quite a lot of persons are not familiar with essential knowledge of what is behind the attractive looking food products. Consequently, less conscious customers fall for low prices, and manipulate ads, and buy this junk food. Sugar and additives that it consist of have extremely negative influence on human's health. The majority of European Union countries badly exceed the norms of sugar intake, which goes hand in hand with civilization diseases.

The father of medicine said wise and worth remembering phrase.

Let the food be the medicine, and the medicine be the food. - Hippocrates  
Customers control the demand, customers have power to change the trend from garbage to organic and nutritious, and customers should not hesitate to use that power and not let, inaccurately tested substances, land on their plates. There is a handy rule for decision making process in a grocery shop. If one is not able to pronounce the ingredients from the label, most likely the product is not worthy to get into the person's mouth. Sugar is highly addictive, thus it should be avoided. The little survey results point to the conclusion that people's awareness concerning sugar and food additives topics is not sufficient and needs to be improved.

Knowing the destructive aspects of the food industry activities, the author wholeheartedly encourage everyone to eat food in its whole, natural state. This will allow to get rid of side effects of chemically processed food that has no nutritional value, and come back to the origins, when the nature was greatly appreciated. After all, human's body is not a machine created to run on synthetic substances!

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## EXAMPLES OF FOOD PRODUCTS BY GLYCAEMIC INDEX

### LOW GI FOODS

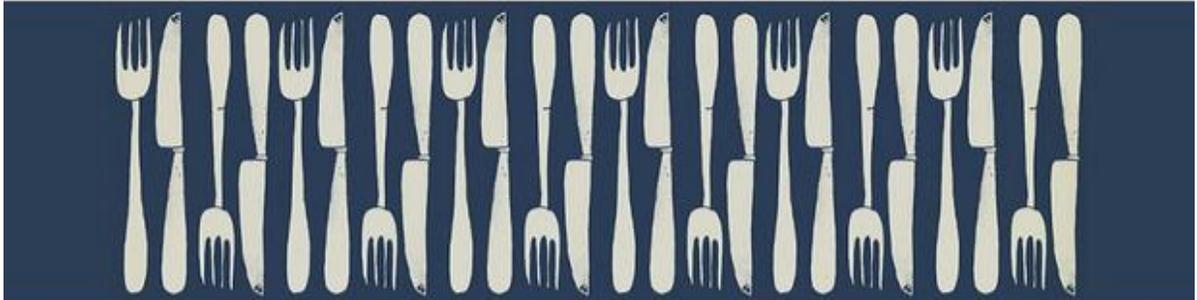
0	Eggs
0	Seafood
0	Fish
10	Avocado
14	Roasted and salted peanuts
15	Onion
15	Spinach
22	Cherries
25	Grapefruit
25	Raspberries, strawberries
26	Red lentils
27	Whole milk
30	Raw carrot
30	Tomato
35	Grenade
35	Orange

### MEDIUM GI FOOD

40	Red kidney beans
40	Buckwheat
40	Peanut butter
40	Raw oat flakes
40	Spaghetti al dente
45	Rye bread
45	Cranberries
45	Whole meal cornflakes
45	Pineapple
50	Sweet potato
50	Kiwi
50	Brown rice
50	Apple juice (fresh, unsweetened)
50	Muesli (unsweetened)
50	Mango
50	Durum wheat pasta

**HIGH GI FOOD**

55	Ketchup
55	Spaghetti
60	Ripe bananas
60	Porridge
65	Whole meal bread
70	White rice
70	Crisps
70	Cooked potatoes
75	Pumpkin
80	Cooked carrots
85	Cornflakes
85	White flour
90	White bread
90	Potato flour
95	Baked potatoes
100	Dextrose



## Conscious nutrition

**\*Required**

**Sex \***

- Male
- Female

**Age \***

- <15
- 15-20
- 21-25
- 26-30
- 31-35
- >35

**According to your knowledge, do you think you eat healthy? \***

- Yes
- No
- I don't know

**Do you buy products with reduced amount of fat (light products)? \***

- Yes
- No

**When shopping, do you read ingredients' list of the products? \***

- Yes
- No

**If yes, do you buy products with unknown (to you) ingredients?**

- Yes
- No

**When shopping, you pay the greatest attention to: \***

- Ingredients
- Calorific value (kcal)
- Fat content
- Sugar content
- Quality
- Country of origin

**How often do you drink sweetened or carbonated beverages such as coke, fanta, fruit juices? \***

- Every day
- Few times a week
- Few times a month
- Fewer

**How often do you eat fast food? \***

- Every day
- Few times a week
- Few times a month
- Fewer

**How often do you eat sweets? \***

- Every day
- Few times a week
- Few times a month
- Fewer

**How often do you eat salty snacks, such as crisps, crackers etc? \***

- Every day
- Few times a week
- Few times a month
- Fewer

**What do you avoid in your diet? \***

- Fats
- Sugars
- Carbohydrates
- Proteins
- None of above

**According to your knowlegde, is sugar needed in a diet? \***

- Yes
- No
- I don't know

**If yes, in what quantities?**

tsp = teaspoon

- 1-3 tsp
- 4-6 tsp
- 7-9 tsp
- 10-12 tsp
- More

**Are you aware that plenty of food products contain food additives? \***

- Yes
- No

**Do you think that food industry offers healthy and nutritious products?**

- Yes
- No

**Why?**