

ARTIFICIAL FRUIT

Field of the Invention

The present invention describes an edible product comprising a core composition comprising sucrose and a shell or coating composition comprising at least one dietary fiber or polymer component, wherein the core composition is at least partially coated or encapsulated by the shell composition, a method of production of such an edible product, and its use.

Background of the Invention

It is known that most common refined sugar is table sugar. Table sugar is sucrose, a disaccharide, consisting of glucose and fructose, purified in industrial scale e.g. from sugar beet or sugar cane. Herein sucrose is often referred to as 'Sugar'.

Fast digesting Sugar creates an insulin/cortisol surge and an impact on blood sugar level, it may inhibit fat metabolism. It therefore may contribute to metabolic (e.g. diabetes) and systemic (e.g. cardiovascular) diseases and dietary disorders (e.g. obesity).

On the other hand, it is known that Sugar has hygiene, practical and socio-political advantages: Sugar is a purified source of energy (4 calories per gram.) with cheap unrestricted and standardized availability, anywhere around the world. Sugar is a very (more than 99%) purified industrial product and therefore does not contain pollutants or impurities which may be harmful to health. Sugar production methods are well established and it is very easy to pack, store and transport. Sugar, readily dissolving in water, is very practical to use especially in the formats it is presented (i.e. powder, crystals, cubes, candies etc.). Sugar industry is huge, spread around the world and supports many people in the fields of agriculture, industry, and sales. Sugar and sugar industry may be the main income of some countries and is a major industry in most of the rest. Sugar, its use, its appearance and its taste is unquestionably known to all peoples of the world.

There is thus a need for an improved sucrose product which ameliorates or avoids the known disadvantages of Sugar without losing the advantages of Sugar.

From the prior art, some modified Sugar containing products and methods thereof are known:

The fortification/nutrition/enrichment of Sugar with micronutrients such as vitamin A (Nutrivid 96/1) have been done, where in some cases peanut oil was used as binder and an antioxidant agent was used to protect the oil, in Guatemala, under USAID in cooperation with Roche AG. The fortification of food containing sugar with vitamin, Iron or Zinc has been disclosed in US 6,607,761; Calcium, too in US 4,871,554.

Dietary fiber fortification of foods has also been disclosed in numerous prior art such as US 6,610,347 and US 5,250,308 and US 6,060,519.

Microencapsulation of sugar pellet with a fiber matrix containing a specific anti-fungal agent- to be administered as a pharmaceutical, has been disclosed in US 6,663,901. Encapsulation of sugar with edible fat is disclosed in US 3,976,794. Microencapsulation of vitamins and minerals with a matrix containing oligosaccharides, preferably fructooligosaccharides, has also been disclosed in US 6,468,568. Encapsulation with beta-glucan enriched oats is also known from FI914491.

A number of supplementary products are offered as a remedy for Sugar related health disadvantages, in oral administration –mostly powder- form.

It was therefore an object of the present invention to provide a Sugar product which avoids or ameliorates disadvantages of the prior art.

The problem underlying the present invention was solved by an edible product according to the claims and furthermore as set out in the description below.

Thus it has been surprisingly found that the present invention provides an advantageous Sugar product:

which ameliorates or eradicates the aforementioned health disadvantages of Sugar,
without losing the aforementioned advantages of Sugar,
which will provide further sole or synergetic advantages due to its composition and
structure;
with organoleptic and physical properties equal or superior to Sugar,
which can be, preferably, produced from natural raw materials by physical and mechanical
means with no or minimal need for synthetic alteration or manipulation,
of which-compositions and specifications can be designed and customized according to
raw material cost/availability and consumer needs,
which may be easy to produce.

According to one aspect, the present invention therefore concerns an edible product, which
may be considered as a kind of "artificial micro-fruit", wherein a sucrose containing core
composition is at least partially coated or surrounded by a shell composition comprising at
least one fiber component or polymer, preferably at least one dietary fiber component.

The product of the invention allows to combine the advantages of refined sugar as set out
above with the advantages of a "build-up" of an artificial micro-fruit with a core and a
shell. The edible product, in particular but not necessarily in its shell composition, may
comprise additional components which may also be present in the original source of
sugar, the raw or dried fruits or vegetables, in particular minerals, proteins, enzymes (or
enzyme inhibitors), all sorts of vitamins (including antioxidant agents), sugar alcohols
(such as sorbitol, xylitol, mannitol, etc.), sugars in diversity (i.e. monosaccharides (such as
glucose, fructose, galactose, arabinose, xylose, etc.), disaccharides (such as sucrose,
maltose etc.), polysaccharides - including water insoluble and soluble fibers (such as
cellulose, starch, pectin, gums, etc.) and/or natural or artificial sweeteners.

The edible product of the invention (hereafter referred to also as 'Product', i.e. product of
the invention), preferably is an artificial fruit, and has a core and shell structure. More
than one core and/or more than one shell may be present. The core(s) may have any
regular or irregular shape and any size. Preferred embodiments often include about
spherical cores, e.g. sucrose crystals. Particularly preferred are sucrose crystals as

commonly available as table sugar, i.e. with crystal diameters of between about 0.1 and 10 mm, or larger aggregates or shaped articles of sucrose, e.g. cube sugar, but also powder.

According to a preferred embodiment of the present invention, the core composition comprises more than 50 % by weight, more than 70 % by weight, more than 90 % by weight, preferably more than 95 wt-% or even more of sucrose. According to a particularly preferred embodiment, the core composition essentially (in particular more than 98 wt-% or even more than 99 wt-%) or completely consists of sucrose. The sucrose is preferably in solid particulate form, like crystalline sucrose. According to a particularly preferred embodiment of the present invention, the sucrose is present in the form of refined crystalline sucrose or table sugar, in particular purified white crystalline sugar.

However, according to a further preferred embodiment of the present invention, the core is made of or comprises less refined sugar, in particular sugar with treacle or molasses. Also, a mixture of sugar and treacle or molasses may be advantageously used. The meaning of treacle or molasses is known to the skilled person. In brief, Treacle (or Fancy Molasses as it is popularly called), is a viscous, rich, dark brown color, concentrated sugarcane juice (syrup), manufactured by concentrating the fully matured tropical sugarcane stalks.

Typical total solids are about 70 to 85 %, the pH is typically between 4.5 to 5.5. The advantage of using such less refined sugar in the core is that less or even no additional components must be added to the dietary fiber containing shell, and the beneficial components in the less refined sugar (e.g. vitamins, probiotics etc.) are well embedded in the core-shell structure and at the same time readily available.

According to a preferred embodiment of the present invention the said core is essentially comprised of sucrose and is encapsulated in or surrounded at least partially with a solid shell.

The said shell comprises preferably at least one dietary fiber or polymer, preferably a water-soluble one. Preferably, at least one or more types of the dietary fibers are selected from the group of celluloses, hemicelluloses, gums, pentosans, glucans, including beta-glucan, mucilages and pectin, particularly water-soluble or water-dispersible dietary fibers, in particular beta-glucan and/or pectin. According to one embodiment of the present invention, synthetic and/or natural fibers (polysaccharides) may be used. This includes also the expanding field of so called modified starches or modified polysaccharides, e.g.

starches or other polysaccharides which have been chemically modified to provide beneficial properties.

Particularly advantageous products are obtained if it further comprises an edible antioxidant agent or a plant extract with an antioxidant capacity, from at least a single plant source, such as but not limited to vegetables, legumes, fruits, grain products, nuts and leaves. According to a preferred embodiment of the present invention Product's total Oxygen Radical Absorption Capacity (Wang et al 1996; Cao et al 1996; Ou et al 2001) is not less than 1 ORAC units = 1 micromol Trolox or gallic acid equivalent / gr.

Particularly advantageous products are obtained if it further comprises at least one water soluble vitamin, particularly B-complex vitamins. Preferably, the Product comprises at least one of the following: Thiamine or equivalent not less than 0.02 mg / 1000 KJoule, preferably not less than 0.05 mg / 1000 KJoule and Riboflavin or equivalent not less than 0.03 mg / 1000 KJoule, preferably not less than 0.07 mg / 1000 KJoule, and Niacin or equivalent not less than 0.04 mg / 1000 KJoule, preferably not less than 0.08 mg / 1000 KJoule, and Calcium not less than 5 mg / g, preferably not less than 15 mg / g of the total dietary fiber content.

Preferably, the said edible antioxidant agent being a carotenoid or a phenolic compound or an anthocyanin or a mineral or an (other) flavonoid or an aminoacid or a lipoic acid.

Preferably, the said product comprises additional components. These additional components may be in particular insoluble dietary fibers (e.g. cellulose and some hemicelluloses), phytonutrients, minerals, amino acids, enzymes, all sorts of vitamins and vitamin precursors (including antioxidant agents), sugar alcohols (e.g. sorbitol, mannitol) and sugars in diversity (monosaccharides (e.g. glucose, fructose, galactose, arabinose), disaccharides (e.g. sucrose, maltose) and polysaccharides).

Preferably, the said product has total dietary fiber content not less than 1% of its sugar content, has a caloric value lower than 4 calories per gram of its solid content and/or has a total lipid content lesser than weight/weight 2% of its total solid content.

Just like in natural fruits, the edible product of the present invention has several advantages:

Thus, the Product allows to combine the aforementioned advantages of Sugar with the advantages of dietary fibers. Moreover, it combines and enhances it with the advantages of antioxidants and with the advantages of B-complex vitamins which have been found to act synergistically in the "structure" of the Product as an artificial micro-fruit (or fruit) with core-shell structure. Preferably, the advantages of additional components in plant extracts may be added.

The Product has the advantage of ameliorating or avoiding the aforementioned health disadvantages of Sugar. Thus, even though it dissolves and tastes like sucrose, Product is found to have lesser Glycaemic Index than the corresponding amount of pure refined sucrose. This converts to a conclusion that: Product is not digested as rapidly as pure refined sugar and therefore does not cause the same insulin/cortisol surge (as Sugar does).

It was also unexpectedly observed that the Products with their core-shell composition may have a higher efficiency of Glycaemic Index lowering effect. Sucrose or another granulated/powdered carbohydrate core is a convenient carrier for the fiber, which allows it to gel (hydrate) very rapidly in water. The reason why the gelling is instant is that it exists as a thin film on the surface of the granule. The full functionality (gelling) of the fiber is therefore realised in seconds (instant) rather than the minutes or hours powdered aggregates normally require to reach maximum viscosity. The invention also avoids the issue of clumping and removes the need for high shear mixing to disperse the gelling agent (fiber). As the gelling is instant the full functionality (e.g. dissolving, taste) of sucrose is also realized without delay and the product looks and tastes like sugar. Therefore, one of the surprising advantages of the present invention can also be observed in the full functionality of the fiber (shell) and sucrose to be realised instantly without delay. Or it can be seen as although it is encapsulated it still looks, tastes and performs like sugar, which is surprising. This indicates that the core-shell structure is a more efficient structure of making use of the Glycaemic Index lowering effect of dietary fibers. This converts into a conclusion that: As Sugar is present with at least a soluble dietary fiber, preferably beta-glucan, in a core-shell structure, where Sugar is in the immediate vicinity of and surrounded by the instantly gelling dietary fiber, the digestion of Sugar core of Product is

more efficiently inhibited by the said dietary fiber as the digestion of Sugar is related to the viscosity of the digestive medium it is in. Therefore, according to a preferred embodiment of the present invention, the fiber is in direct contact with the sucrose in the core and preferably the shell comprising the (dietary) fiber is very thin, in particular below 50 μm , preferably below 10 μm , more preferred below 5 μm , even more preferred below 1 μm , further preferred below 0.1 μm , further preferred below 0.05 μm .

The dietary fibers reduce the absorption of Sugar, furthermore B-complex vitamins increase the conversion of Sugar to energy in-vivo and antioxidants reduce the free radical forming and antioxidant reducing effects of Sugar. Therefore, according to one preferred embodiment of the invention they may be present and they may synergistically ameliorate the health disadvantages previously mentioned.

The above components of the Product of the invention, including the optional ones, are known to the person skilled in the art as such, however, they may be further illustrated as follows.

Dietary fibers are indigestible, sometimes fermentable polysaccharides, most commonly classified according to their water solubility. Soluble fibers are e.g. some hemicelluloses, variety of gums, pentosans, glucans, including beta-glucan, mucilages and pectin. Insoluble dietary fibers are e.g. cellulose and some hemicelluloses. The sole health advantages of both type of fibers and other components are known:

Found in abundance plants especially in grain products and psyllium husk, soluble dietary fibers form a gel in the gastrointestinal tract, delaying the digestion of carbohydrates. They soften the faeces, ease and regulate the gastrointestinal passage. They bind to organic molecules, such as bile acids, they, especially beta-glucan (from oat products and psyllium husk), are cited for lowering the total and LDL blood cholesterol and being preventive for coronary heart disease and cancer of the gastrointestinal tract. Health benefits of soluble dietary fibers are also reported for diseases of pancreas including diabetis. There are also citations on immune system boosting effect of beta-glucan.

Insoluble dietary fibers also soften and add mass to faeces, inhibit the absorption of fats and speed the gastrointestinal passage. Insoluble fibers are associated with gastrointestinal tract cleaning and prevention of colon cancer.

Unstable radicals, such as peroxy and hydroxyl, characterized with an atom with an unpaired electron in the orbit around the nucleus, are called free radicals and they have a known damaging oxidation effect. Substances which can neutralize free radicals are called antioxidants. Antioxidants are numerous and their list is enlarging every day. Antioxidants have known anti-cancerogenic, anti-aging and life quality rising effects. Glucose is known to increase free radicals and decrease the antioxidant capacity in blood. Plants, in particular fruits and vegetables, are known to be the richest sources of natural antioxidants.

B-complex vitamins: Vitamin B1 (Thiamine), vitamin B2 (Riboflavin), vitamin B3 (Niacin), vitamin B5 (Pantothenic acid), vitamin B6 (Pyridoxine), vitamin B9 (Folate), vitamin B12 (Cobalamin). In this list, especially vitamins listed from Vitamin B1 (Thiamine) through to Vitamin B6 (Pyridoxine) are involved in Energy Metabolism and in particular carbohydrate metabolism. PABA, inositol and choline are often included in this group.

Vitamins are essential organic compounds that the body needs in small quantities for normal functioning. Among being essential for growth and health, some vitamins also have an antioxidant activity. Many compounds have been classified as vitamins. Vitamins A, D, E, and K, the four fat-soluble vitamins, may accumulate in the body. Vitamin C and the eight B vitamins - biotin, folate, niacin, pantothenic acid, riboflavin, thiamin, vitamin B6, and vitamin B12 - dissolve in water, so excess amounts are excreted. Vitamin precursors are inactive form of vitamins to be activated after ingestion. e.g. carotenes, flavin complexes, folates.

Phytonutrients are certain organic components of plants, and these components are thought to promote human health. Fruits, vegetables, legumes, grain products, nuts and leaves are rich sources of phytonutrients. The phytonutrients are also referred to as "phytochemical"s. Some of the common classes of phytonutrients include: Carotenoids, Flavonoids (Polyphenols) including Isoflavones, Inositol Phosphates (Phytates), Lignans

(Phytoestrogens), Isothiocyanates and Indoles, Phenols, Saponins, Sulfides and Thiols, Terpenes. Phytonutrients are suggested to protect and enhance human health probably by means of serving as antioxidants, enhancing immune response, enhancing cell-to-cell communication, altering estrogen metabolism, converting to vitamin A (beta-carotene is metabolized to vitamin A), causing cancer cells to die (apoptosis), repairing DNA damage caused by smoking and other toxic exposures and detoxifying carcinogens through the activation of the cytochrome P450 and Phase II enzyme systems.

Amino acids are the building blocks of proteins and there are known amino acids which the human body cannot synthesize and therefore should be taken up by diet, most of which are found in high levels in plants, especially in legumes.

Enzymes have essential use in digestion. Natural extracts contain useful enzymes which may be beneficial in many ways. e.g. alpha amylase, a major enzyme in sucrose digestion, or its inhibitor can be extracted from plant sources.

Sugar alcohols (e.g. sorbitol) are sweet and low in calories, advised in diabetic diet and widely used as low calorie sweeteners. Sugar alcohols are digested less and slower than sugars. Sugar alcohols don't cause dental decay and may be inhibiting the pathogens of the mouth flora.

Minerals are classified in two groups. 1-Macro minerals: Calcium and Phosphorus are essential for skeletal system. Sodium, Potassium and Chlorine are essential for hemostasis. 2-Micro (or trace) minerals: Magnesium, Manganese, Zinc, Iron, Copper, Iodine and Selenium are essential parts of enzymes, hormones or enzyme activators. Chromium is important for metabolism.

Also, the Product has synergetic health advantages of the above essential and optional components of its composition:

Product composition particularly with the use of diversity of ingredients mimics the composition of plants, particularly of fruits. The composition of plants, particularly the composition of fruits, have synergetic effects which are advantageous for health. To name

a few, human nutritional and cell culture studies link fruit and vegetable consumption to numerous health benefits, such as, to a decreased risk of stroke -- both hemorrhagic and ischemic stroke (Gillman et al. Journal of the American Medical Association. 1995;273;1113); to about a 46% decrease in risk of heart disease relative to men who ranked in the lowest quartile; to about a 70% lower risk of cancer than did their counterparts in the lowest quintile (Gaziano et al. Annals of Epidemiology 1995;5:255 and Colditz et al. American Journal of Clinical Nutrition 1985;41:32); to a decreased risk of prostate cancer (Giovannucci et al. Journal of the National Cancer Institute 1995;87:1767); to a 46% decrease in risk of age-related macular degeneration compared to those in the lowest quintile who consumed vegetables less than once per month (Seddon et al. Journal of the American Medical Association. 1994;272:1413). Also, the association between fruit consumption and lowered cardiovascular heart disease and lowered risk of cancer has been cited by FDA. Plant diets are widely known as a remedy to a number of diseases, including obesity.

Furthermore, the Product has the advantage of having organoleptic and physical properties equal or superior to Sugar. Thus, the Product can be produced from an abundant number of natural sources. According to one possible embodiment of the invention, a neutral (tasteless, odourless) natural extract can be chosen, in order to keep the organoleptic properties of the core content, sucrose, unaltered or alternatively the natural extract's taste and odour can be neutralized or alternatively a natural extract (such as apricot extract) or flavour components with a specific aroma can be used in the composition of Extract to improve the organoleptic properties of the core content, sucrose. The physical properties (e.g. flowability, solubility, texture and appearance as packed) of Product can also be kept similar to Sugar for unskilled person in art.

The Product also has the advantage of not losing the aforementioned known advantages of Sugar and has numerous industrial advantages. Thus, advantageously, the product can easily be produced from natural extract(s) by mechanical/physical means with processes known in the art.

Ingredients can be obtained from commercial sources, synthetic sources and/or from natural sources, in particular from plant sources, e.g. vegetables, legumes, fruits, grain

products, nuts and leaves by mechanical/physical means with processes for obtaining the ingredients or Extract known in the art.

Advantageously, all the aforementioned components (e.g. dietary fibers, phytonutrients, minerals, amino acids, enzymes and sugar alcohols) do exist and coexist in diverse combinations in different plants, thus eliminating the industrial steps for purification/isolation of each component separately and then adding each one by one to the final composition. Product and production design therefore can be tailored according to raw material cost/availability and desired end-product specifications, bound to vary according to the location of the production plant.

According to one embodiment of the invention, the Product, as discussed in detail later in this specification, has only 2 easy steps of production, i.e. preparation of Extract and encapsulation. The automation of production and minimizing environmental impact is easily achievable. Advantageously, the cost of raw materials is a fraction of refined sucrose. Oat (a good source of beta-glucan) for example costs ca. 1/8th of refined sucrose. Advantageously, the Product can be produced from by-products of other industries including the sugar industry and beverage industry. Advantageously, the production of Product can easily be integrated to existing production lines of many industries including the sugar industry and starch industry. Advantageously, all by-products of the production (such as starch) can be commercialised, in most cases, with a higher value than the cost of raw materials.

Furthermore, the Product has structural 'solid core in solid shell' advantages :

The structure of the artificial fruit with a core and a shell, comprising soluble dietary fibers, also presents the advantage of a solid, stable carrier matrix, enabling the addition and preservation of optional natural components (e.g. amino acids, enzymes, minerals or antioxidants) which would be difficult to attach otherwise to sugar or which would otherwise be difficult to dose or stabilize. In fact, in nature, the said additional components, in diverse combination, coexist with each other within plant extract(s), which may be utilized within this invention, thus eliminating the need for nutrification / fortification.

Advantageously, the shell may act as intermediate buffer in release of, especially, fragile molecules such as amino acids and enzymes where controlled release may be necessary.

Advantageously, the shell, having a natural composition therefore superiorly stable by nature and by being dry therefore organic reactions being at least ceased, provides a dry protective matrix which improves the mechanical and chemical stability of Product and components, which otherwise would be or would become unstable for example with an oxidative reaction. A further advantage of the stable structure is its possible use as a vector for prophylactic and therapeutic agents, which would otherwise be difficult to dose, immobilize and stabilize over a naked Sugar surface.

Advantageously, by using colored substances, such as carotenoids, and aromatic substances and suitable tooling, Product can be produced in any form and in any colour and in any aroma or odour.

According to one particular embodiment of the invention, the product of the invention does not contain a drug or medicament. According to a further embodiment, the shell does contain less than 90 wt-%, preferably less than 80 wt-%, more preferably less than 70 wt-%, even more preferably less than 60 wt-% and in particular less than 50 wt-% of pectin. According to a further embodiment, the shell does contain less than 90 wt-%, preferably less than 80 wt-%, more preferably less than 70 wt-%, even more preferably less than 60 wt-% and in particular less than 50 wt-% of erythritol. Such amounts of erythritol may pose problems with retained moisture and humidity of the shell.

Advantageously, the shell can be composed to carry indicators (e.g. pH indicator) to indicate the condition of the product or its components, e.g. regarding pH-value, redox status, degradation products etc.

Another advantage of Product is to ameliorate or avoid known problems and disadvantages of natural fruits. Thus, it is known that fruits have disadvantages: Fruits are not produced but grown, therefore more condition dependant and less standardized to obtain compared to industrial products. Fruits are also difficult to pack, store and transport. Fruits have short shelf life (e.g. few days) in room conditions. Fruits are impractical to use (e.g. you cannot drop an apricot into your coffee or cannot mix an

orange with flour and bake a cake). Some fruits may contain toxins, such as lectins. Fruits may be expensive. Fruits are not standardized.

The following paragraph discloses further preferred embodiments of the present invention which, if combined subsequently, have been found to give particularly advantageous products:

Edible product comprising a solid shell encapsulating at least partially, preferably substantially completely a core comprising sucrose. The said solid shell comprises at least one dietary fiber composition. The said product comprises an edible antioxidant agent or a plant extract with an antioxidant capacity, from at least a single plant source, such as but not limited to vegetables, legumes, fruits, grain products, nuts and leaves. The said product's total Oxygen Radical Absorption Capacity (Wang et al 1996; Cao et al 1996; Ou et al 2001) is not less than 1 ORAC units = 1 micromol Trolox or gallic acid equivalent / gr., preferably not less than 2.6 ORAC units = 2.6 micromol Trolox or gallic acid equivalent / gr. The said product comprises at least Thiamine or equivalent not less than 0.02 mg / 1000 KJoule and Riboflavin or equivalent not less than 0.03 mg / 1000 KJoule and Niacin or equivalent not less than 0.04 mg / 1000 KJoule and Calcium not less than 6 mg / g of the total dietary fiber content. The product has a total dietary fiber content of not less than 1% of its sugar content and a caloric value lower than 4 calories per gram of its solid content and a total lipid content less than 2% weight/weight of its total solid content.

According to a preferred embodiment of the present invention, the dietary fiber composition comprises at least one or more types selected from the group of hemicelluloses, gums, pentosans, glucans, including beta-glucan, mucilages and pectin.

According to a preferred embodiment of the present invention, the core composition comprises or essentially consists of sucrose in solid state, either in crystalline form or granular form or particulate form or dried syrup form.

According to a preferred embodiment of the present invention, the core composition comprises or essentially consists of refined sucrose.

According to a preferred embodiment of the present invention, the core composition comprises or essentially consists of unrefined or semi-refined or molasses related sucrose in solid form.

According to a preferred embodiment of the present invention, the core composition comprises or essentially consists of sucrose obtained by enzymatic reactions or synthetically.

According to a preferred embodiment of the present invention, the core composition comprises or essentially consists of a single sucrose crystal or a single sucrose granule or a single sucrose particle.

According to a preferred embodiment of the present invention, the core composition comprises or essentially consists of more than one of sucrose crystal or granule or particle, attached or adjacent (glued or un-glued) to each other or to the shell.

According to a preferred embodiment of the present invention, the core composition comprises or essentially consists of sucrose in liquid or semi-solid state, either as a gel or in a saturated solution or in an unsaturated solution.

According to a preferred embodiment of the present invention, at least one dietary fiber is obtained from natural sources such as plant, bacteria, yeast, fungi, animal.

According to a preferred embodiment of the present invention, at least one of the dietary fiber types is artificially produced or obtained from genetically manipulated living sources or by chemical manipulation of carbohydrates.

According to a preferred embodiment of the present invention, at least one of the dietary fiber types is obtained from a multiple sources.

According to a preferred embodiment of the present invention, a plant extract ("Extract") is used for the shell composition and the said plant extract comprises also at least part of the dietary fibers and/or Thiamine and/or Riboflavin and/or Niacin and/or Calcium.

According to a preferred embodiment of the present invention, the product composition further comprises at least one or more additional components selected from the group of insoluble dietary fibers (e.g. cellulose and some hemicelluloses), phytonutrients, minerals, amino acids, enzymes, all sorts of vitamins and vitamin precursors (including antioxidant agents), sugar alcohols (e.g. sorbitol, mannitol) and sugars in diversity (monosaccharides (e.g. glucose, fructose, galactose, arabinose), disaccharides (e.g. sucrose, maltose) and polysaccharides).

According to a preferred embodiment of the present invention, the product composition further comprises at least one or more additional components selected from the group of colour indicators, pH indicators, colouring agents and aromatic agents.

According to a preferred embodiment of the present invention the product composition further comprises at least one or more additional components selected from the group of pharmaceutical and/or health improvement agents and/or nutrification/fortification agents.

According to a preferred embodiment of the present invention, the soluble dietary fiber component, particularly beta-glucan, is derived from either oat products, barley or psyllium husk.

According to a preferred embodiment of the present invention, the antioxidant agent is a carotenoid or a phenolic compound or an anthocyanin or a mineral or an other flavonoid or an amino acid or a lipoic acid.

According to a preferred embodiment of the present invention, the product composition further comprises at least one or more additional vitamins selected from the group of vitamins: Vitamins A, D, E, K, C, B6, B12, biotin, folate and pantothenic acid or their precursors and/or PABA, inositol and choline.

According to a preferred embodiment of the present invention, the product composition further comprises at least one or more additional minerals selected from the group of minerals: Phosphorus, Sodium, Potassium, Chlorine, Magnesium, Manganese, Zinc, Iron, Copper, Iodine, Selenium and/or Chromium.

According to a preferred embodiment of the present invention, the sugar alcohol is sorbitol, in particular from prune.

According to a preferred embodiment of the present invention, the phytonutrients are selected from one or more of the following minerals: Carotenoids, Flavonoids (Polyphenols) including Isoflavones, Inositol Phosphates (Phytates), Lignans (Phytoestrogens), Isothiocyanates and Indoles, Phenols, Saponins, Sulfides and Thiols, Terpenes.

According to a preferred embodiment of the present invention, the core composition is encapsulated by the shell composition at least partially or the core composition is being packed into an edible case comprising the shell composition.

According to a preferred embodiment of the present invention, the core and the shell are attached to each other in such a way that neither core nor shell can move independent from each other.

According to a preferred embodiment of the present invention, the core and the shell are not attached to each other in such a way that the core and the shell can move independent from each other.

According to a preferred embodiment of the present invention, the shell composition is applied to the core composition by wet or dry coating of the shell composition onto the wet or dry core composition.

According to a preferred embodiment of the present invention, at least one essential component of the product composition other than sucrose is obtained from by-products of other industries, such as beverage and food industries, e.g. beer industry or starch industry.

According to a preferred embodiment of the present invention, the product composition has a reduced content of starches and lipids, in particular saturated lipids and substances harmful to health (e.g. intolerable substances (e.g. gluten), toxins (e.g. lectins)) or to product's organoleptic or physical or chemical qualities.

According to a preferred embodiment of the present invention, the product can be in any practical size, shape, colour, odour, texture, depending on the specific use envisaged.

NOTE: I would strongly recommend to keep the process aspects of the invention in. Deleting them would gain nothing but pose problems with enablement and disclosure.

According to a further aspect and possible embodiment of the invention, the present invention concerns a production process for a Product as defined above. A preferred process comprises the following steps:

- a) providing a core composition comprising sucrose, preferably refined sucrose in crystalline form
- b) contacting the core composition with the shell composition in order to apply the shell composition onto the core composition so that the core composition is at least partially surrounded by the shell composition
or, alternatively to b),
- c) packaging the core composition in a case or bag of the shell composition in order to obtain a product wherein the core composition is packaged in an edible package material.

It is particularly advantageous to use a shell composition which comprises an extract (herein "Extract") which is preferably derived from aqueous extraction of a natural source, like a fruit, plant, animal or microbiological source. Such an aqueous extract may preferably be obtained by obtaining the watersoluble components of a natural source, e.g. after grinding, milling, mixing with water, preferably at less than 100 °C, and separation from the water-insoluble fraction, e.g. by filtration or centrifugation or the like. The extract may be further fractionated or components as specified above may be added.

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A preferred process is as defined in claim 37 below. Thus, according to a preferred embodiment, sugar particles (sucrose) are encapsulated with a soluble fiber containing extract. The process preferably comprises the following steps:

- a) providing a core composition comprising sucrose, preferably refined sucrose in crystalline form
- b) preparation of an extract, preferably of a plant source in milled or ground form, like a cereal flour, by mixing it with cold water (e.g. 0 to 4 °C), ice/water mix or sprayed cold water (preferably reduced from soluble starches by means of the above removal of starches with ice-water mix and sprayed cold water), separation of a supernatant and a (residual) filtrate through a membrane filter or the like (centrifugation etc.). Thus, Recovery of soluble fibers from the supernatant and the starches from the precipitate to be further refined. It has been surprisingly found that the best Extracts (and shell compositions therefrom) are obtained if the above extraction is performed with an ice/water mix. Apparently, this helps to optimise the separation of the desired and undesired components into the supernatant and the (residual) filtrate, respectively.
- c) advantageously, but optionally, extracting more soluble fibers from the filtrate using the supernatant as diluent and preferably homogenizing, membrane filtering under mild pressure and in RT. Surprisingly, this has been found to optimise the composition of the Extract to be used in the present invention
- d) advantageously, but optionally, preparation of a second extract from a non-starch or low-starch containing plant source (i.e. not a starch storing plant source), preferably in RT or below by means of mixing and/or homogenizing in water base
- e) optionally, mixing of the extracts
- g) encapsulating the sucrose core into a solid shell, preferably by by means of recrystallizing sucrose in the prepared extract by continuously removing water from the sucrose containing mixture with the extract(s), or encapsulating the sucrose core into a solid shell made essentially of dietary fibers by means of spraying the extract from a fixed

point to the continuous and circulating flow of sugar, in such a way that in each pass sugar particules are thin filmed once and immediately dried by the spray propellent dry, warm air. Therefore in each pass, the same sugar particule is re-sprayed an other layer of thin film, until the desired product specifications are achieved.

It has been surprisingly found that the above coating or encapsulation process (step i), second alternative) wherein more than one layer of the coating/shell is sprayed onto the core in more than one pass (one thin film layer per pass) is very beneficial to the stability of the shell composition. This surprising effect has been observed irrespective of the specific shell composition and core composition used. It is therefore of general interest and applicability as an encapsulation process (improvement) for all types of shell-core type compositions.

i) optionally, recycling the water and vacuumed steam, using minimal heating, short process time, no chemical extraction techniques therefore creating minimal environmental impact.

Advantageously, but optionally, all by-products are recovered in commercially value added manner and therefore no waste is produced.

According to a further aspect, the present invention also concerns another production process, wherein at least a soluble fiber (oat bran soluble-fiber, containing beta-glucan) and a sugar alcohol (sorbitol from prune) are used and a vitamin and/or an antioxidant agent (beta-carotene from prune or apricot) can be added to produce an all-natural, water-soluble and edible package material, either paper or plastic like.

Preferably, the shell composition is wet-coated over a dry core composition. Methods for applying or coating the shell composition onto/around the core composition are known to the expert in the art. Conventional mixing or coating equipment may be used.

The edible product of the invention may be considered as a re-naturalized sugar. In other words, it is an artificial micro-fruit. It eliminates all the disadvantages of both refined sugar and natural fruits while combining the advantages of both.

The process of the invention is simple, cheap and dietary safe.

The embodiment of the present invention, wherein the core composition is packaged in a case or bag of the shell composition, allows a choice between using only a refined sugar (by opening and discarding the package material) or using re-naturalized sugar (by dropping the unopened package into e.g. a drink like tea or coffee). By combining refined sugar, soluble fibers and, optionally, additional components like vitamins, using the method defined herein, a re-naturalizing of refined sugar can be achieved without diminishing the sensitive properties of table sugar.

A re-naturalized sugar will exhibit all the —combined- advantages of both refined sugars and fruits without compromising physical properties, taste and cost of the table sugar significantly. Moreover, all disadvantages will be ameliorated or eliminated.

Also surprising and undone before is the method of production according to the present invention: encapsulation of a wet or dry fiber component containing optionally sugar alcohol and vitamins onto dry sugar crystals, without loosing physical properties of sugar or clamping or dissolving.

A further aspect of the present invention is directed to the use of an edible product as defined herein, in particular an edible product comprising a core composition comprising sucrose and a shell or coating composition comprising at least one soluble fiber or polymer, wherein the core composition is at least partially coated or encapsulated by the shell composition. A preferred use is as a replacement or alternative product to (conventional) sucrose, in particular crystalline sucrose like table sugar. A preferred use is as an additive or ingredient to solid or liquid food, like coffee, tea or other drinks, bread, sweets, cold and warm meals, as a sweetener or the like. Thus, a preferred aspect of the invention is also to a method of using the edible product of the invention in an edible composition or recipe as a replacement for (conventional) sucrose, in particular crystalline sucrose like table sugar. The preferred edible composition may be a solid or liquid food, like coffee, tea or other drinks, bread, sweets, cold and warm meals, in particular as a sweetener or the like.

The invention is now further illustrated by the following non-limiting example.

EXAMPLE

The production of the Product comprises two main processes: 1- extraction, 2- microencapsulation or encapsulation. Extraction has two main types: extraction of soluble fibers and extraction of phytonutrients and water-soluble plant ingredients.

Extraction of soluble fibers:

What is to be extracted from which natural source is a decision to be made according to the desired specifications of the final product. Given here is a general extraction procedure applicable to all grain products and legumes or to any plant source where the source is rich of both soluble fibers and starch. In cases where starch content is not a concern, the starch extraction steps can be omitted.

- Full oat grain was grounded to a flour with particle size of 400 micrometer or smaller.
- 100 g of said flour was placed in a homogenizer.
- 1000 cc of ice-water mix in 2 degrees C. was added to the homogenizer.
- Homogenized for 10 minute in 480 rpm in maintained 2-4 °C.
- Immediately filtered through a membrane filter with pore size of 200 micrometer under pressurized continuous spray water at 4 °C for approximately 10 minutes
- Filtrate suspended in 500 cc water at 40 °C for 5minutes with gentle stirring.
- Suspension centrifuged for 10 minutes
- The supernatant liquid was used to encapsulate table sugar.
- Encapsulation was carried out in a heated pan by constant mixing of crystalline sugar with the supernatant liquid (extract) under blown warm dry air.

Extraction of phytonutrients and water soluble plant ingredients:

What is to be extracted from which natural source is a decision to be made according to the desired specifications of the final product. Given here is a general extraction procedure applicable to all plants, raw or dry or processed.

- Prunes, deseeded, were rinsed in cold water and wiped dry to remove impurities and homogenized into a paste.
- 20 g of said paste was placed in a homogenizer.
- 200 cc of water in RT was added to homogenizer.
- Homogenized for 10 minutes in 2400+ rpm at RT.
- The slurry was filtered through a sieve with pore size of 160 micrometers under mild pressure.
- The filtrate was further processed as diet ingredient.
- The filtered liquid was evaporated in RT under vacuum to 50 cc and was immediately homogenized with dietary fiber extract and 30 mg of Calcium in RT.

Higher temperatures (over 60 degrees C) will start the gelatinisation of starches and therefore will increase the carbohydrate content and the caloric value of the extract. Lowering the temperature will result in less solubilization and therefore less fiber content in the extract.

Different extracts obtained with above process will be compatible with each other. So, they can be mixed in pre-determined ratio, using a homogenizer, e.g. in 3.600 rpm and in RT for 4 minutes.

In case of raw plant use, the dilution value should be altered according to the water content of the source using the samples above for dry weight to volume ratio, 1:20 for oat and 1:10 for prune.

Final ratios should be adjusted according to desired end product specifications.

In all cases the total process time should be kept as short as possible and further attention should be given to process time, which happens to be the transitional time for componets between their natural state and dry state.

The final plant extracts prepared as above were immediately used for encapsulation.

The encapsulation:

Three methods were used. Known apparatus and methods familiar to the skilled person may be used.

Method 1:

The aforementioned 120 cc final extract was further evaporated to 60 cc under vacuum and mixed to 200 gr of commercially available crystalline sucrose either in a continuous mixer under vacuum until dry again or placed in molds and dried to harden in different shapes such as cube.

Method 2:

The aforementioned 120 cc final extract was sprayed to 200 gr of commercially available crystalline sucrose using dry, pressurized air in 35 degrees C. The sugar was constantly circulated through the spray zone and dried with 35 degrees C. dry air in between each pass.

This method can also be used for pre-formed Sugars such as cube sugar.

Method 3:

Alternatively the final extract can be sprayed and dried in sheet format, to be used as an edible packing film, in this case presence of sugar alcohols in concentrations above 0.5% will plasticize the film and increase the tensile strength.

CLAIMS

- 1- Edible product comprising a solid shell encapsulating at least partially a core comprising sucrose.
- 2- Product according to claim 1, wherein the said solid shell comprises at least one dietary fiber composition.
- 3- Product according to any one of the proceeding claims, characterized in that said product further comprises an edible antioxidant agent or a natural extract, preferably a plant extract with an antioxidant capacity, from at least a single plant source.
- 4- Product according to any one of the proceeding claims, characterized in that the plant source is selected from vegetables, legumes, fruits, grain products, nuts and leaves.
- 5- Product according to any one of the proceeding claims, characterized in that the said product's total Oxygen Radical Absorption Capacity is not less than 1ORAC units = 1micromol Trolox or gallic acid equivalent / gr.
- 6- Product according to any one of the proceeding claims, characterized in that said product further comprises at least Thiamine or equivalent not less than 0.02 mg / 1000 KJoule , Riboflavin or equivalent not less than 0.03 mg / 1000 KJoule and Niacin or equivalent not less than 0.04 mg / 1000 KJoule and/or Calcium not less than 5 mg / g of the total dietary fiber content.
- 7- Product according to any one of the proceeding claims, characterized in that the total dietary fiber content is not less than 1% of the sugar content of the product.
- 8- Product according to any one of the proceeding claims, characterized in that it has a caloric value lower than 4 calories per gram of its solid content and a total lipid content of less than 2%weight/weight of its total solid content.

- 9- Product according to any one of the proceeding claims, characterized in that the dietary fiber composition comprises at least one or more types selected from the group of hemicelluloses, gums, pentosans, glucans, including beta-glucan, mucilages and pectin.
- 10- Product according to any one of the proceeding claims, characterized in that the core composition comprises or essentially consists of sucrose in solid state, either in crystalline form or granular form or particulate form or dried syrup form.
- 11- Product according to any one of the proceeding claims, characterized in that the core composition comprises or essentially consists of refined sucrose.
- 12- Product according to any one of the proceeding claims, characterized in that the core composition comprises or essentially consists of unrefined or semi-refined or molasses related sucrose in solid form.
- 13- Product according to any one of the proceeding claims, characterized in that the core composition comprises or essentially consists of sucrose obtained by enzymatic reactions or synthetically.
- 14- Product according to any one of the proceeding claims, characterized in that the core composition comprises or essentially consists of a single sucrose crystal or a single sucrose granule or a single sucrose particle.
- 15- Product according to any one of the proceeding claims, characterized in that the core composition comprises or essentially consists of lumps of sucrose crystals or granules or particles, glued or un-glued to each other or to the shell.
- 16- Product according to any one of the proceeding claims, characterized in that the core composition comprises or essentially consists of sucrose in liquid or semi-solid state, either as a gel or in a saturated solution or in an unsaturated solution.

- 17- Product according to any one of the proceeding claims, wherein at least one dietary fiber is obtained from natural sources such as plant, bacteria, yeast, fungi, animal.
- 18- Product according to claim 2, wherein at least one of the dietary fiber types is artificially produced or obtained from genetically manipulated living sources or by chemical manipulation of carbohydrates.
- 19- Product according to claim 2, wherein at least one of the dietary fiber types is obtained from multiple sources.
- 20- Product according to any one of the proceeding claims, characterized in that the said plant extract comprises also at least part of the dietary fibers and/or Thiamine and/or Riboflavin and/or Niacin and/or Calcium.
- 21- Product according to any one of the proceeding claims, characterized in that the product composition further comprises at least one or more additional components selected from the group of insoluble dietary fibers (e.g. cellulose and some hemicelluloses), phytonutrients, minerals, amino acids, enzymes, all sorts of vitamins and vitamin precursors (including antioxidant agents), sugar alcohols (e.g. sorbitol, mannitol) and sugars in diversity (monosaccharides (e.g. glucose, fructose, galactose, arabinose), disaccharides (e.g. sucrose, maltose) and polysaccharides).
- 22- Product according to any one of the proceeding claims, characterized in that, the product composition further comprises at least one or more additional components selected from the group of colour indicators, including pH indicators, colouring agents and aromatic agents.
- 23- Product according to any one of the proceeding claims, characterized in that the product composition further comprises at least one or more additional components selected from the group of pharmaceutical and/or health improvement agents and/or nutrification/fortification agents.

24- Product according to any one of the proceeding claims, characterized in that the soluble dietary fiber component, particularly beta-glucan is derived from either oat products, barley or psyllium husk.

25- Product according to claim 1, the antioxidant agent being a carotenoid or a phenolic compound or an anthocyanin or a mineral or an (other) flavonoid or an aminoacid or a lipoic acid.

26- Product according to any one of the proceeding claims, characterized in that the product composition further comprises at least one or more additional vitamins selected from the group of vitamins: Vitamins A, D, E, K, C, B6, B12, biotin, folate and pantothenic acid or their precursors and/or PABA, inositol and choline.

27- Product according to any one of the proceeding claims, characterized in that the product composition further comprises at least one or more additional minerals selected from the group of minerals: Phosphorus, Sodium, Potassium, Chlorine, Magnesium, Manganese, Zinc, Iron, Copper, Iodine, Selenium and/or Chromium.

28- Product according to any one of the proceeding claims, wherein the sugar alcohol is sorbitol, in particular from prune.

29- Product according to any one of the proceeding claims, wherein the phytonutrients are selected from one or more of the following minerals: Carotenoids, Flavonoids (Polyphenols) including Isoflavones, Inositol Phosphates (Phytates), Lignans (Phytoestrogens), Isothiocyanates and Indoles, Phenols, Saponins, Sulfides and Thiols, Terpenes.

30- Product according to any one of the proceeding claims, characterized in that the core composition is encapsulated by the shell composition at least partially or the core composition is being packed into an edible case comprising the shell composition.

- 31- Product according to any one of the proceeding claims, characterized in that the core and the shell are attached to each other in such a way that neither core nor shell can move independent from each other.
- 32- Product according to any one of the proceeding claims, characterized in that the core and the shell are not attached to each other in such a way that the core and the shell can move independent from each other.
- 33- Product according to any one of the proceeding claims, characterized in that the shell composition is applied to the core composition by wet or dry coating of the shell composition onto the wet or dry core composition.
- 34- Product according to any one of the proceeding claims, characterized in that at least one essential component of the product composition other than sucrose is obtained from by-products of other industries, such as beverage and food industries, e.g. beer industry or starch industry.
- 35- Product according to any one of the proceeding claims, characterized in that the product composition has a reduced content of starches and lipids, in particular saturated lipids and substances harmful to health (e.g. intolerable substances (e.g. gluten), toxins (e.g. lectins)) or to the product's organoleptic or physical or chemical qualities.
- 36- Product according to any one of the proceeding claims, characterized in that the product can be in any practical size, shape, colour, odour, texture.
- 37- Product according to any one of the proceeding claims, characterized in that the product composition further comprises at least one natural or artificial sweetener.
- 38- Product according to any one of the proceeding claims, characterized in that the core comprises or is made from less refined sugar comprising treacle and or molasses, or a mixture of highly refined sugar and treacle and/or molasses.

39- Process for preparing a product as claimed in any of the preceeding claims, comprising the following steps:

- a) providing a core composition comprising sucrose, preferably refined sucrose in crystalline form
- b) preparation of an extract, preferably of a plant source in milled or ground form, like a cereal flour, by mixing it with cold water (e.g. 0 to 4 °C), ice/water mix or sprayed cold water, separation of a supernatant and a (residual) filtrate through a membrane filter or the like
- c) advantageously, but optionally, extracting more soluble fibers from the filtrate using the supernatant as diluent and preferably homogenizing, membrane filtering under mild pressure and in RT
- d) advantageously, but optionally, preparation of a second extract from a non-starch or low-starch containing plant source (i.e. not a starch storing plant source), preferably in RT or below by means of mixing and/or homogenizing in water base
- e) optionally, mixing of the extracts
- g) encapsulating the sucrose core into a solid shell, preferably by means of recrystallizing sucrose in the prepared extract, or encapsulating sucrose core into a solid shell made of essentially dietary fibers by means of spraying the extract from a fixed point to the continuous and circulating flow of sugar, in such a way that in each pass sugar particules are thin filmed once and immediately dried by the spray propellent dry, warm air, and in each pass, the same sugar particule is re-sprayed with another layer of thin film coating, until the desired product specifications are achieved
- i) optionally, recycling the water and vacuumed steam, using minimal heating, short process time, no chemical extraction techniques therefore creating minimal environmental impact.

40- Use of an edible product comprising a core composition comprising sucrose and a shell or coating composition comprising at least one soluble fiber or polymer, wherein the core composition is at least partially coated or encapsulated by the shell composition, as a replacement or alternative product to sucrose, in particular crystalline sucrose like table sugar.

41- Use according to claim 38 as an additive or ingredient to solid or liquid food, like coffee, tea or other drinks, bread, sweets, cold and warm meals, as a sweetener or the like.