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(54) Title: BIODEGRADABLE APPLIANCE FOR CONTAINING FOOD

(57) Abstract: The present invention relates to a method for producing a biodegradable appliance for containing food. The method comprises the steps of producing a water-based dough and cooking and shaping the dough in a heated mold to produce the appliance in a predetermined shape. The dough is produced by mixing - 30.0 - 70.0 wt. % of vegetable starch, - 20.0-50.0 wt. % of a water based liquid, preferably water, - 1.0-50.0 wt. % of fibers, - the remainder up to 100.0 wt. % being made up by one or more additives - wherein the vegetable starch comprises between 5.0 - 40.0 wt. %, preferably between 10.0 - 30.0 wt. %, more preferably between 10.0 – 25.0 wt. % of potato starch, and 25.0 – 60.0 wt. %, preferably 30.0 - 50.0 wt. %, more preferably 30.0 – 40.0 wt. % of a vegetable starch different form potato starch, the wt% being expressed on the basis of the total dough composition.

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Title: Biodegradable appliance for containing food

The present invention relates to a process for producing a biodegradable appliance for containing food, according to the preamble of the first claim.

The present invention also relates to biodegradable appliances as such and to a mixture for producing such appliance.

At present, disposable packaging materials and/or containers for food products are made of plastic materials, although variants made of wood or bamboo exist. Similarly, disposable utensils such as forks, spoons and knives are often made of plastic materials, wood or bamboo. Although there is an increasing tendency to employ biodegradable plastics or plastic materials that may be recycled or biodegraded, their use presents an increasing ecological scourge. Typical examples of plastic packaged food products include fresh, prepared meals; frozen ready-made meals; packages containing various ingredients such as meat with sauce, fish, cut or whole vegetables; whole or cut fruit; service fast food such as hamburgers, various preparations, drinks; packs for take away for example hamburgers, fried, hot prepared dishes; cold or hot prepared meals for public catering for example in a hospital, prison, school canteen, canteen; cans, cups, beakers for containing hot or cold drinks such as water, coffee, soup and beer. Often, cutlery such as knives, forks, spoons, drinking straws etc. are integrated in or provided with the package.

As an alternative to plastic packaging, packaging materials have been developed which are edible, suitable for consumption or suitable for industrial composting.

AU199216174 discloses a method of forming a container of an edible material for holding foodstuffs such as hot potato chips or any other food products, which should solve the problem that hot potato chips contained therein may better maintain their texture and flavor and absorb less moisture. According to the method of AU199216174 a batter of edible material is supplied to a moulding assembly of male and female moulds, which together define the shape of the container to be formed, and which are heated to cook the batter. The batter is prepared by mixing grain or vegetable flour, powder or flakes with water until the

desired consistency is achieved to enable the mixture to be poured in the mould. The batter is typically prepared from wheat flour, soya flour, corn flour, rice flour, millet flour, sorghum flour, maize flour, barley flour, oat flour, triticale flour, potato flour, pea flour or mixtures thereof. The batter may further contain various additives such as starch, salts, mineral salts, fats or oils, emulsifiers, sweeteners, vegetable gums, thickeners and/or flour treatment agents to provide the end product with desired properties of strength and shelf life and the batter with the desired consistency and properties for being formed into a container. After having been cooked in the mould, a product is obtained which is soft, dense, solid, flat, unexpanded and comparable to a pan cake, which shows poor rigidity and does not keep its shape.

JP5254571 discloses a method for producing an edible food cup according to which water is added to wheat flour, shaped into a cup shape after kneading and baked in a high temperature furnace. If so desired, the cup may be steamed before being baked. Instead of or in addition to wheat flour as the main ingredient, potatoes, sweet potato rice, or other grains such as rice, barley, millet, corn, bean or the like or dry powder of vegetables may be mixed in. The wall thickness of the container bottom is about 4 - 6 mm, while at the top it is about 3 - 4 mm, so that it can be grasped by hand even when it contains hot water. The method disclosed by JP5254571 however presents the disadvantage that the shape and dimensions of the cup may change in a rather unpredictable manner when it is subjected to steaming and baking, and thereby impede reproducibility and sealing of the container as such.

A similar process for producing an edible container in the form of a cone, a cup, a bowl or a dish, is disclosed in WO2017/126726. The edible container is formed by mixing 10-50 wt. % of corroded starch relative to dry matter, with other edible ingredients in the form of powder. Corroded starch is obtained by blending a powder of a corrosion agent with starch. The corrosion agent may be one or more of meat or fish. An appropriate amount of water, liquid corroded milk or milk is added to the blend, and the thus obtained mixture is kneaded into a predetermined shape to provide a pre-form. Thereafter, the pre-form is heated and cooked to fix its shape, and to provide a container suitable for consumption. The mixture from which the container is produced may further contain one or more additives such as

sugars, vegetable oils, salt, and emulsifiers. Meat, anchovy, dried fish, and delinquent organisms can be cut into a predetermined size and added to the mixture, to give the container mix a chewing feeling upon consumption. Corroded starch is obtained by an acid treatment of the starting product. The thus obtained cup, bowl or dish however shows a too high liquid permeability, in particular a too high water permeability which limits its use with liquid food, and which may result therein that the content at least partly adopts the taste of the ingredients used to produce the cup, bowl or dish. Besides this, the products seem to break easily.

There is thus a need for a process for the production of a biodegradable appliance for use with food, which is suitable for upscaling to an industrially viable, economically feasible process. Preferably the formed appliance is edible, i.e. suitable for human consumption and/or digestion. Forming a edible appliance allows a consumer to eat an appliance containing a food preparation, e.g. container, plate, or cup, along with the food or drink product. This reduces waste, particularly for take-away food or drink preparations where waste may end up at road-sides. Use of edible appliances (e.g. cups or bowls) further allows chefs to compose complex dishes which benefit from an additional flavor of the container.

The present invention therefore seeks to provide a process for the production of biodegradable and/or edible appliances for use with food, which is suitable for upscaling to an industrially viable, economically feasible process.

Such appliances may be produced according to the present invention with a method showing the technical features of the first claim.

Thereto the present invention relates to a method for producing a biodegradable appliance for containing food, which method comprises the steps of producing a water-based dough and cooking and shaping the dough in a heated mold to produce the appliance in a predetermined shape, characterised in that a water-based dough is produced by mixing

- 30.0-70.0 wt. %, preferably 40.0-60.0 wt. %, of vegetable starch,
- 20.0-50.0 wt. %, preferably 25.0-45. 0 wt. % of a water based liquid, preferably water,
- 1.0-50.0 wt. %, preferably 1.0-25.0 wt%, more preferably 2.0 -10.0 wt. % of fibers,

- the remainder up to 100.0 wt. % being made up by one or more additives,

wherein the vegetable starch comprises a mixture of at least two types of starches, preferably of different plant origin. In a preferred embodiment, the vegetable starch comprises between 5.0 - 50.0 wt. %, preferably between 10.0 - 40.0 wt. %, more preferably between 25.0 – 35.0 wt. % of potato starch, the wt% being based on the total amount of vegetable starch present in the dough, the remainder of the vegetable starch being made up of one or more vegetable starches different from potato starch. Inventors surprisingly found that using said specific mixture of starch allows forming the appliance with a desired set of properties including biodegradability, edibility and/or taste as well as mechanical stability and texture (e.g. crispness and/or mouth feel). Without wishing to be bound to theory inventors find that the potato starch in the mixture of vegetable starch allows for fast expansion of the dough in the mould, contributing to a desired openness, and porous cell structure within the formed product, e.g. pastry. Further the potato starch provides for neutral taste and low allergy risks. The second starch is believed to contribute to firmness of the formed product.

Preferably the formed products do not comprise ingredients from synthetic, e.g, non-natural nature. Use of natural ingredients contributes to ensuring fast biodegradability.

As used herein biodegradability may be understood to include natural biodegradability. Formed products preferably do not need (synthetic) additives and/or an industrial biodegradation process. Biodegradability particularly includes compostability. Compost may be understood to include organic matter that has been decomposed in a process called composting. This process recycles various organic materials otherwise regarded as waste products and produces a soil conditioner (the compost). At a simple level, the process of composting requires making a heap of wet organic matter (also called green waste), such as leaves, grass, and food scraps, and waiting for the materials to break down into humus after a period of months. Formed products were found to be particularly suitable for such composting process, e.g. a natural home/garden compost process without requiring additive input of e.g. oxygen- and carbon- and nitrogen- enriched materials. Bio organisms including earthworms and fungi were found to break up product formed according to the invention in a home compost heap in period of less

than 4 weeks, e.g. within 2 weeks under normal ambient conditions (ambient temperature between 15 and 30 °C and relative humidity between 50 and 95%).

It will be appreciated that the products and dough mixture, are preferably formed without synthetic polymers, plastics or other additives harmful to the composting process or harmful to the soil.

The water-based dough of the present invention generally takes the form of a humid powder.

After forming the dough mixture it is introduced into a cavity of a heated mould in the shape of the appliances to be produced. The product is cooked by heating the mixture in the mold preferably to a temperature of between 150.0 and 260.0 °C for a time suitable to form pastry-based product while preferably subjecting the dough to an elevated pressure. Preferably the cooking temperature is in a range between 170° and 210°C, preferably between 180°C and 200°C. Inventors found that if the temperature is lower, the water in the mixture will evaporate slowly and the product may take a long time to cook. Long cooking times may be disadvantageous for automated production processes. If the mold is above 210 °C, the product may have a tendency to over-cook and may become brittle and/or darken which may negatively affect taste. The thus produced appliance is subsequently removed from the mold.

The method of the present invention is suitable for producing a wide variety of appliances for containing of food. Within the scope of this invention "appliances for containing food" are understood to comprise appliances suitable for use with food such as packaging for storing food, such as containers, trays, platters, bowls, pans, cups, pots, dishes, and beakers. In some embodiments, the invention also relates to partially compostable and/or edible appliances. Such appliances may be understood to be composites formed of a compostable and/or edible portion and portion formed of a different composition. Such partially compostable and/or edible appliances include cutlery such as knives, spoons, forks but also containers with for example an outside wrapper for use with or containing cold food ingredients as well as hot food ingredients.

"At least partially edible" according to the present invention may be understood to include appliances that may be partly made according to the method of this invention, and that this part may be combined with a non-edible material to

provide an appliance suitable for use with food. For example a container or cup produced with the method of this invention as described above, may be covered with a transparent plastic film or with an aluminum or other film to form a packaging for food and protect the food from the environment. The plastic film is typically not suitable for consumption. According to another example, a part of cutlery for example a knife or fork may be produced according to the method of the present invention, while the remaining part is made of plastic or metal or any other material suitable to be combined with the product obtained with the method of this invention. It shall be clear to the skilled person that other combinations with non-edible materials may exist.

With subjecting the dough to an elevated pressure is meant that a pressure is exerted to the mould, so that expansion of the dough and escape of evaporating water occurs against the mould pressure, and an expanded crunchy, foamed, puffed product is obtained.

The process of this invention results in a product wherein the part made of the dough is edible and shows a puffed, expanded, crispy texture with a crunchy bite, it is pleasant upon eating, and shows sufficient firmness and rigidity and structure to be self standing or self supporting. Typically, a cup as an example of an appliance produced with the method of this invention, is self standing even when containing a cold or hot liquid. An appliance produced according the method of the present invention is capable of maintaining its shape when standing alone or when containing hot food products which may contain water and/or fat, as well as when kept at fridge or freeze temperatures down to -25°C or even lower temperatures. A cross section of the walls of an appliance obtained with the method of this invention, may typically have a honeycomb like structure or the like, or the structure of puffed rice or the like.

An appliance produced according to the method of the present invention has been found capable of resisting temperatures of up to 250°C, and is therefore suitable for use as a container for containing food that needs to be heated in order to render it suitable for consumption. An appliance produced according to the present invention on the one hand has been found suitable for use with traditional ovens or furnaces but also with microwaves, and on the other hand it has been found suitable for being stored at low temperatures, typically fridge temperatures

of 0-7 °C, as well as freeze temperatures down to -22°C or lower conventionally used for storing food. The inventors have further observed that the appliance of this invention is capable of maintaining its attractive texture and rigidity as described above, even when subjected to severe temperature differences, e.g. when heated from the frozen condition up to temperatures of 100°C or more at which food is normally cooked.

The edible part of the appliances obtained with the method of the present invention present the advantage of being compostable and moreover of being degradable in a natural manner as part of garden compost, without requiring an industrial composting process or any treatment in advance of being composted. A few days seem to be sufficient to achieve full degradation. The part of the appliance made of edible ingredients may be ingested by insects, worms and micro-organism present in garden compost, similar to other food present in compost. Industrial compostable products, i.e. the majority of the compostable products on the market on the contrary often require sorting and a certain pretreatment before being compostable, and as a result are almost as energy-consuming as plastic materials to achieve degradation. The method of this invention therefore permits producing a product which is competitive to plastic materials in relation to costs, utility and discarding, and can easily replace it.

If so desired, after having been produced, the appliance obtained with the method of this invention may be left to age at room temperature for a few hours or a few days. In general, this will result in a texture becoming more plastic or supple, that is to say less crispy.

In general, the order in which the ingredients are mixed, is not critical to the invention, although to facilitate processing the skilled person will usually first mix all the dry ingredients and add the water to that mixture. Mixing of the ingredients, i.e. the vegetable starch, fibres, additives and water based liquid gives a crumble-like dough, that shows some, but a limited cohesion.

Heating of the mixture in the mould to a temperature of between 150.0 and 260.0 °C, while subjecting it to an elevated pressure causes the dough to flow and achieve complete filling of the mould cavity, to such an extent that details of the shape of the mould may be filled with dough, and give rise to the formation of e.g. shaped edges. This makes the appliances produced with the method of this

invention suitable for use with fitting counterparts, taking into account that the cooked product shows a sufficiently high rigidity. This way for example a container may be produced which shows a shaped circumferential edge suitable to function as an adhering surface for a plastic film, a container may be produced which shows a profiled circumferential edge suitable for use with a lid with a complementary profile to permit closing of the container, or cutlery may be produced suitable for use with either a handgrip or the functional part of the cutlery made of plastic material. Cooking below a temperature of 150°C risks to lead to flabby products, with an insufficient crunchiness or crispyness, and a rigidity which is insufficient to be self-standing. Cooking at temperatures above 250°C on the other hand risks to burn the product.

Heating of the dough in the mould to a temperature of between 150.0 and 260.0 °C, while subjecting it to an elevated pressure causes the water to vaporize and to thereby form a spongy, expanded dough, the walls of which show an internal structure similar to a honeycomb structure. The inventors have observed that within that temperature range expansion or foaming mainly takes place in the interior of the dough and that formation of unwanted holes or other imperfections on the visible surface of the appliance may be reduced to a minimum. Such imperfections are unwanted as they could support leakage of liquids contained in the food utensils into and through the material of the food utensils.

The fibers present in the dough impart firmness, ridigity and structure to the end product. Fibers may be understood to include dietary fibers or roughage which are a portion of plant-derived material e.g. food that cannot be completely broken down by human digestive enzymes. Dietary fiber typically comprises non-starch polysaccharides and/or other plant components such as cellulose, resistant dextrins, inulin, lignins, chitins, pectins, beta-glucans, and oligosaccharides. A low amount, e.g. below 1 wt.%, of fibers may result in the formation of a product with a poor firmness and/or rigidity. Excessively large amounts of indigestible fibers, e.g. above 25 wt. % may negatively affect edibility and/or flavor. Inventors found a dough mixture with fiber content between 1 and 4 wt.%, preferably between 1 and 3 wt.%, e.g. between 1 and 2 wt% to result in appliances with good edibility and/or flavor.

In a preferred embodiment, the method further comprises the step of mixing 2.0-5.0 wt. % of an edible wax into the dough. The wax imparts hydrophobicity to the end product and renders it waterproof to a certain extent depending on the amount of wax added, so that the appliance is suitable for use with water based food products such as soup, pudding, fruit or any other food products stored in a water-containing base, at minimum risk to leaking of the water through the material and/or absorption of the water into the material. A particularly preferred wax is bees wax.

Preferably 35.0-65.0 wt. % of vegetable starch is mixed into the mixture, more preferably 40.0-60.0 wt. %, most preferably 50.0-60.0 wt. %. In the mixture of this invention the vegetable starch ensures binding of the fibres, and imparts strength and cohesion to the biodegradable appliance. By varying the amount of vegetable starch in the dough, either a stronger binding of the fibres to each other may be obtained and a cohesive end product, or an end product which is more easy to disintegrate.

At least part of the starch is made up of potato starch. Potato starch shows a fast expansion when compared to starches which originate from other sources, which is important when use of the process of this invention on large, industrial scale is envisaged. Potato starch also ensures plasticization of the mixture as a result of which a layered-like moulded product may be obtained, which may show a prolonged shelf life and a certain impermeability to liquids, for example water based or fat based liquids. Besides this, potato starch shows a minimal risk to allergic reactions upon consumption and it is taste neutral. There is therefore a minimal risk that it will influence the taste of the appliance as such, or the taste of any food contained in the appliance.

Although theoretically the vegetable starch may exclusively be made up by potato starch the dough mixture according to the invention comprises at least a second starch from a plant origin other than potato. In a preferred embodiment the amount of potato starch ranges between 5.0-40.0 wt. %, preferably between 10.0 - 30.0 wt. %, more preferably between 10.0 – 25.0 wt. %, most preferably between 10.0 and 20.0 wt. %, with respect to the total weight of the dough mixture, to ensure that the appliance has a sufficiently high moisture resistance and a sufficiently high impermeability towards water.

The remainder of the vegetable starch may be made up by a vegetable starch different from potato starch. The dough mixture will therefore generally comprise 25.0 - 60.0 wt. %, preferably 30.0 – 50.0 wt. %, more preferably 30.0 – 40.0 wt. %, of a vegetable starch different from potato starch. The starch different from potato starch may be selected from a wide variety of starches known to the skilled person, such as one or more of a cereal starch, a root vegetable starch or a bean starch. The vegetable starch different from potato starch may be selected from a wide variety of commercially available starches such as one or more of the following starches which originate from wheat, cassava, acorns, arrowroot, arracacha, banana, barley, breadfruit, buckwheat, canna, colacasia, katakuri, kudzu, malanga, millet, oats, oca, polynesian arrowroot, sago, sorghum, sweet potatoes, rye, taro, chestnuts, water chestnuts and yams, favas, lentils, mung beans, chickpeas, and peas. Although rice and maize starch may be used as well, their concentration is preferably kept as low as possible to maximize expansion of the dough.

More preferably however the vegetable starch different from potato starch is pea starch, in particular for its ability of forming barrier films upon heating which can improve the hydrophobic character of the appliance obtained with the method of the present invention. Besides this, pea starch shows a higher energy efficiency than potatoes, and has a high protein content. The risk to allergenic reactions upon consumption is minimal, and pea starch has hardly any influence on the taste of an end product containing it.

In a preferred embodiment of this invention, the dough is cooked at a temperature of at least 150°C, preferably at least 155 °C, more preferably at least 165 °C, although sometimes a temperature of at least 170°C or even at least 175°C or 180 °C may be preferred. The maximum temperature at which the dough is cooked will generally not be higher than 260°C, preferably maximum 250°C, more preferably 225°C, most preferably maximum 210°C down to 200 °C, to minimize the risk to burning of one or more ingredients of the mixture. Varying the temperature within the indicated ranges will permit to tailor the end product after the cooking has been finalized, and impart a higher crunchiness or obtain a more flexible product.

In a preferred embodiment, the mixture contains 25.0-45.0 wt. % of water based liquid, preferably 30.0 - 40.0 wt. %, so that a dough may be prepared with a cohesion sufficient to be divided in smaller portions which correspond to the amount needed to produce an appliance, and a desired crunchiness. Too much water would lead to a dough which would be too liquid and formation of an appliance with insufficient rigidity. Any water-based liquid considered suitable by the skilled person may be used, for example broth or stock, but preferably water is used.

According to a preferred embodiment of this invention, the mould is subjected to an external pressure, to force expansion of the dough against the external pressure. The maximum clamping pressure of the press is generally about 25 tons. Inventors found that lower pressures in a range between 1 and 7 tons suffice to evenly spread the mixture in the mold. In the absence of pressure, often a flabby, dense cooked dough is obtained which shows insufficient firmness to stay upright when not supported.

The molds used in the present invention are generally designed with vents to allow steam to escape. Bubbles may appear on the product during the cooking if too much steam is still present; therefore mold opening and closing cycles can be foreseen during the cooking to allow excessive steam to escape. These cycles can also be used to remove air trapped-in which would otherwise slow down the spreading of the dough within the mold cavity. In order to avoid also excess product material disappearing through the vents thereby leading to production losses, the vents should preferably be small enough to allow only steam to escape and no product material.

Various shapes and dimensions of products can be made. Typical mold dimensions are 160 mm x 110 mm with a height of 40 mm and 240 mm x 160 mm with a height of 15 mm.

The mixture further preferably contains an edible wax, which preferably is a natural wax, for the purpose of facilitating mould release once the dough has been cooked and increasing the hydrophobicity of the surface of the appliance. Plant as well as animal waxes may be used. Waxes of animal origin typically consist of wax esters derived from a variety of carboxylic acids and fatty alcohols. The composition depends not only on species, but also on geographic location of the organism. The

most commonly known animal wax is beeswax, but other insects release waxes. An example of a preferred animal wax is bees wax. A major component of the beeswax is myricyl palmitate, i.e. an ester of triacontanol and palmitic acid. The melting point of beeswax is typically 62-65 °C. Examples of vegetal waxes suitable for use in this invention are candellila wax and carnauba wax. Candelilla wax consists mainly of hydrocarbons (about 50%, chains with 29–33 carbons), esters of higher molecular weight (20–29%), free acids (7–9%), and resins (12–14%, mainly triterpenoid esters). The high hydrocarbon content distinguishes this wax from carnauba wax. It is insoluble in water and has a melting point of 68.5–72.5 °C. It is mostly used mixed with other waxes to harden them without raising their melting point. Carnauba consists mostly of aliphatic esters (40 wt%), diesters of 4-hydroxycinnamic acid (21.0 wt%), ω-hydroxycarboxylic acids (13.0 wt%), and fatty alcohols (12 wt%). The compounds are predominantly derived from acids and alcohols in the C26-C30 range. Distinctive for carnauba wax is the high content of diesters as well as methoxycinnamic acid. In its pure state, it usually comes in the form of hard yellow-brown flakes. It is obtained from the leaves of the carnauba palm. Many of the above-mentioned waxes have a melting point below the heating temperature of the mould, as a result of which they are molten in the course of the moulding process and solidify upon cooling of the appliance to provide a water impermeable coating to the walls of the appliance. The combination of beeswax and a vegetable fiber provides an appliance with a slightly glossy side whereby it is not necessary to provide an additional film coating on the product thereby reducing production costs.

Preferred fibers used in the method of this invention are one or more selected from the group of pea fibers, hemp fibers, flax fibers and residues of cereals, preferably cereals used in the brewing of beer. The latter are often discarded and used as animal feed, but have been found to be suitable for use with human food as well. The residues are preferably mainly produced from hops, barley, wheat or maize. Instead of or in addition hereto, other types of edible fibers considered suitable by the skilled person may be used as well. Pea fiber finds little use in the food industry, and is usually discarded. Pea fibers however show a high hemicellulose and pectin content, and a good water and oil retention ability. The fibers ensure dimensional stability and good firmness of the appliance, even after

having been used. Hemp fibers were found to particularly improve firmness, ridigity of the formed product, and provides a stronger structure to the final product thereby offering better resistance to handling, even at low contents e.g. at levels as low as 1 or 2 wt.%. The addition of a vegetable fiber such as hemp also improves the resistance to moisture; the obtained appliance can hold cold and hot liquids for several hours without being deformed. Resistance to hot liquids may vary depending on the amount of fiber used: with a 2 wt% quantity resistance can reach up to 60°C, with a 4 wt% quantity resistance can go up to 80°C. In a preferred embodiment, raw fibers are pre-cut or shredded before being added to the mixture. Pre-cutting and/or shredding the fibers into smaller pieces, e.g. pieces with a dimension up to 5 cm or smaller, e.g. in a range up to 3 cm or 2 cm improves homogeneous dispersion of the fibers in the mixture. It will be appreciated that the dimension of the fibers depends on size and/or shape of products to be formed with the mixture. Longer fibers may negatively affect mixing and/or flow of the mixture in the mould. Shorter fiber may, on a per mass basis, contribute less to dimensional stability and/or firmness of formed product. For example a mixture for use with a mould for comparatively shallow plate or platter with a diameter of for example 24 cm, may preferably have longer fibers (e.g. between 3 and 5 cm) than a mixture for a mould for forming a cup with a diameter of 2 cm.

The mixture used in the method of this invention may further comprise one or more of the following additives : activated carbon, spirulina, shell of cocoa beans, herbs, flavors, proteins, etc. Incorporation of activated carbon may be preferred for its purifying properties, in particular its ability to heal intoxications, reduce flatulence, ability to reduce the blood cholesterol level. Besides that, activated carbon is hydrophobic and thereby assists in implying hydrophobicity to the end product. Charcoal can also be used as a natural black pigment. The mixture used in the method of this invention may contain cocoa shell for its taste and pigmentation. Cocoa shell is currently an edible waste not valued by chocolate companies. If an appliance with a certain taste is to be produced, the mixture may contain one or more spices or herbs or flavouring agents. In addition, certain spices (like turmeric) have been found beneficial for health. The mixture may further contain proteins, as they are beneficial to the health and serve as a dietary supplement for those feeling hungry.

When the appliance is intended for being used as a packaging material, for example a container, the thickness of the walls of the container will usually be at least 0.5 mm, preferably at least 1 mm. The maximum thickness will generally not be more than 5 mm, preferably not more than 2.5 mm, more preferably not more than 1 mm.

The present invention also relates to a packaging comprising a container obtained with the method described above, wherein the container has a circumferential wall enclosing an inner volume containing one or more food products containing water and/or fat, wherein the circumferential wall comprises an upper circumferential edge with a sealing surface sealed to a plastic film covering the inner volume of the packaging. The packaging may take any shape considered suitable by the skilled person and may for example be mainly rectangular or cylindrically shaped, or may have any other shape considered suitable by the skilled person. Instead of a plastic film, the inner volume may be covered with a lid with a higher rigidity or any other cover considered suitable by the skilled person.

The present invention also relates to a dough composition for producing a biodegradable appliance, comprising

- 30.0-70.0 wt. %, preferably 40.0-60.0 wt. %, of vegetable starch,
- 20.0-50.0 wt. %, preferably 25.0-45. 0 wt. % of a water based liquid, preferably water,
- 1.0-50.0 wt. %, preferably 1.0-25.0 wt. % of fibers,
- the remainder up to 100.0 wt. % being made up by one or more additives;

wherein the vegetable starch comprises between 5.0 - 40.0 wt. %, preferably between 10.0 - 30.0 wt. %, more preferably between 10.0 – 25.0 wt. % of potato starch, and 25.0 – 60.0 wt. %, preferably 30.0 - 50.0 wt. %, more preferably 30.0 – 40.0 wt. % of a vegetable starch different from potato starch, the wt% being expressed on the basis of the total dough composition.

A particular advantage associated with the use of the appliances of the present invention relates to the risk of damaging packaging materials during transport and handling, where there is a risk that pieces of the packaging material end up in the food contained therein. Once plastic / aluminum / ceramic containers are filled with culinary preparations, they are transported to different distribution

points and may be subjected to damage and breaking. By using the biodegradable appliances of this invention, industry is no longer exposed to the problems associated with risk insurance as ingestion of a portion of the utensil will not impart health risks.

Another advantage associated with the use of the utensils of this invention relates to their use in storing and cooking food: fresh, frozen, pastry, culinary preparations must be reheated (traditional oven or microwave) by the end consumer in order to render them suitable for consumption. Reheating plastic or aluminum always entails health risks which are not presented by the utensils obtained with the method of this invention.

The appliances obtained with the method of this invention are suitable for replacing disposable packaging. By varying the shape and dimensions of the mould, the shape and dimensions of the appliances may be varied accordingly.

Typical challenges that may be met by the appliances of the present invention is that they are able to fulfil requirements imposed in relation to hygiene, they are water resistant and suitable for containing water-based and oil or fat containing food ingredients for longer periods of time of at least a few days, they are able to resist low temperatures typical for food preservation as well as high temperatures typical for cooking or heating the food contained therein to render it suitable for consumption.

Fig. 1 shows a view of an example of an appliance obtained with the method of this invention, in the form of a rectangular packaging.

Fig. 2 shows a cross section of the container of fig. 2.

The container (1) shown in fig. 1 and 2 comprises a bottom (2), and upright side walls (3). In the upright side walls reinforcements (7) are provided to ensure a sufficient strength and rigidity of the container. An upper edge of the container may be delimited by a circumferential rim (5) provided with one or more profiles (4) which protrude from the circumferential rim and which provide for example a fastening edge for fastening a cover or a plastic foil to provide a closeable packaging. In the upright sidewalls reinforcing members (7) may be provided to improve the strength and/or rigidity thereof. Furthermore the packaging may be provided with support member (8) which extend from the bottom (2).

The invention is further illustrated in the examples below.

Comparative experiment A.

A pastry was produced by mixing 145 g of potato starch and 45 g of red beet fibres with 140 g of water and 9 g of bees wax granules. A quite dry crumble-like pastry was obtained, which did not show good adhesion.

About 30 g of the pastry was poured in the female part of a mould in the shape of rectangular container of 10 X 15 X 4 cm, as shown in fig. 1. The mould was closed with the corresponding male part. The mould had a temperature of approximately 140°C, and was not subjected to external pressure. After 1 minute a baked product was obtained, which was flabby, rubbery, with a granular appearance without however disintegrating into crumbles.

Comparative experiment B.

Comparative experiment A was repeated, except that the mould was heated in an oven kept at a temperature of 250°C, and the pastry was left to bake for 1.5 minutes, while exerting a small external pressure to the mould to keep it closed, by positioning a weight of 1 kg on top of the upper mould half.

After 1.5 minute a baked product was obtained, composed of a soft, non-expanded baked pastry with a nice brown colour. Homogeneous melting of the wax could be observed.

Comparative experiment C.

Comparative experiment A was repeated, except that the mould was heated to a temperature of 180°C, and 40 g of the pastry was left to bake for 1 minute, without exerting an external pressure to the mould.

After 1 minute a baked product was obtained, made of a non-expanded baked pastry with a nice brown colour. Homogeneous melting of the wax could be observed.

Comparative experiment D.

A pastry was produced by mixing 190 g of potato starch and 5 g of bees wax granules with 140 g of water. The amount of water seemed to be in excess of the potato starch, and a small volume of water separated on top of the pastry.

About 30 g of pastry was poured in the female part of a mould in the shape of rectangular container of 10 X 15 X 4 cm, as shown in fig. 1. The mould was closed with the corresponding male part. The mould had a temperature of approximately 110°C, no external pressure was exerted to the mould.

After 30 seconds a baked product in the shape of a container could be released upon opening of the mould. The baked pastry had a soft gelatinous texture, and did not show any expansion.

Comparative Example E.

A pastry was produced by mixing 190 g of potato starch, 23 g of beetroot fibres and 5 g of bees wax granules with 140 g of water.

About 125 g of pastry was poured in the female part of a mould in the shape of rectangular container of 10 X 15 X 4 cm, as shown in fig. 1. The mould was closed with the corresponding male part. The mould had a temperature of approximately 180°C, no pressure was exerted to the mould.

After 2 minutes a baked product in the shape of a container could be released upon opening of the mould. The baked product had an expanded texture, somewhat soft. The thin parts of the baked pastry showed a hard texture.

Comparative Example F.

A pastry was produced by mixing 167 g of potato starch, 23 g of fibres, 5 g of bees wax powder with 100 g of water. The water served to gel the potato starch and was fully absorbed.

About 40 g of pastry was poured in the female part of a mould in the shape of rectangular container of 10 X 15 X 4 cm, as shown in fig. 1. The mould was closed with the corresponding male part. The mould had a temperature of approximately 180°C, no pressure was exerted to the mould.

After 2 minutes a baked product in the shape of a container could be released upon opening of the mould. The baked product had an expanded honeycomb like texture and showed a crunchy, crispy bite, but still soft texture.

Comparative Example G.

A pastry was produced by mixing 160 g of potato starch, 30 g of red beet fibres, 5 g of bees wax powder with 120 g of water. The water served to gel the potato starch and was fully absorbed.

A piece of about 80 g of pastry was put in the female part of a mould in the shape of rectangular container of 10 X 15 X 4 cm, as shown in fig. 1. The mould was closed with the corresponding male part. The mould had a temperature of approximately 180°C, and the female and male part were connected using brackets to prevent opening of the mould but permit vapour produced in the course of the baking of the pastry to escape from the mould.

After 2 minutes a baked product in the shape of a container could be released upon opening of the mould. The baked product had an expanded honeycomb like texture and showed a crunchy, crispy bite, showed a good rigidity and hardness.

Comparative Example H.

A pastry was produced by mixing 80 g of potato starch, 15 g of beetroot fibres, 2.5 g of modified oil with 60 g of water. The water served to gel the potato starch and was fully absorbed.

A piece of about 50 g of pastry was put in the female part of a mould in the shape of rectangular container of 10 X 15 X 4 cm, as shown in fig. 1. The mould was closed with the corresponding male part. The mould had a temperature of approximately 180°C, and the female and male part were connected using brackets to prevent opening of the mould but permit vapour produced in the course of the baking of the pastry to escape from the mould.

After 2 minutes a baked product in the shape of a container could be released upon opening of the mould. The baked product had an expanded honeycomb like texture and showed a crunchy, crispy bite, showed a good rigidity and hardness.

Example 5.

A dough was produced by mixing 140 g of potato starch and 40 g of pea starch with 150 g of water. After a homogeneous mixture had been obtained 36 g of

pea fibres was added and 45 g of hops remainders recycled from beer brewing, 22 g of bees wax.

About 40 g of dough was poured in the female part of a mould in the shape of rectangular container of 10 X 15 X 4 cm, as shown in fig. 1. The mould was closed with the corresponding male part. The mould had a temperature of approximately 180°C, and was subjected to a pressure of 1.5 ton for 40 seconds. The dough flew in the mould cavity and filled the entire cavity, and started to expand. The vapour produced thereby was permitted to escape. The pastry started to harden. After 40 seconds a container could be released upon opening of the mould. The container was left to cool for 2 hours at room temperature. The walls of the container showed an expanded, honeycomb-like texture, with a desired porosity, which was sensed as crispy and crunchy upon eating and which showed a crunchy bite.

9 containers were produced according to the process above.

When disposing of the container complete degradation after 7 days was observed.

A container was filled with a cake pastry and heated in an oven at 200 °C for 1 hour. The cake could easily be demoulded, the container maintained its integrity and colour and was suitable for re-use.

A container was filled with a meat preparation, type baked chicken in meat sauce and stored at a temperature of -22°C. The container was removed from the freezer and put in an oven at 250°C for 30 minutes. The chicken preparation was sufficiently hot for consumption, the container maintained its integrity. Penetration of the sauce into the material of the container walls was negligible.

Example 6.

A dough was produced by mixing 60 g (19 wt%) of potato starch and 120 g (38 wt%) of pea starch, 6.5 g (2 wt%) of hemp fibre, and 12 g (4 wt%) of bees wax with 120 g of water. After mixing the dry ingredients in an automated mixer for about 10 to 15 minutes the water was added followed by an additional mixing for at least about 30 minutes. Fibers and wax were cut beforehand to smaller pieces (smaller than about 2 cm) so that everything mixed more homogeneously and fitted better in the mixer. Upon completion of the mixing procedure a damp (slightly wet)

powdery composition was obtained. Larger clumps (balls), if any, were broken before inserting the dough in the mold for cooking. Depending on the desired shape and dimensions of the appliance, the necessary amount of mixture was weighed. For example, for a bowl, 33 gr of the mixture was weighed.

The pre-determined amount of mixture was inserted in a mold that was pre-heated at a temperature between 180°C and 200°C. Inventors found that if the temperature is lower, the water will not evaporate quickly and the product may take a long time to cook. Long cooking times may be disadvantageous for automated production processes. If the mold is above 200 ° C, the product will have a tendency to over-cook and may darken and/or become brittle.

With the mold at temperature, the mixture was spread in the cavities of the mold. The mold was closed and pressurized to spread the mixture. Cooking was ready once steam ceased to escape from openings in the mold. The cooking time for 16 bowls for example was found to vary from 1 to 2 minutes. Preparation time of 1 minute 30 seconds resulted in formation of well cooked products without dark brown color and burnt flavours.

The molds used to prepare the appliance comprise a male and female part and have several imprints depending on the type of appliance (product). For example, 16 imprints for simultaneous manufacture of 16 bowls or 6 imprints for simultaneous manufacture of 6 trays.

Parts of the mold are pressed using a hydraulic press provided with 2 hotplates heated by a system of heating bar serving as a heat sink.

After 2 minutes a baked product in the shape of the mold could be released upon opening of the mould. No additional release promotors, e.g. oils, films or wax were needed for proper release of the product. The baked product had an expanded honeycomb like texture and showed a crunchy, crispy bite, showed a good rigidity and hardness.

Inventors found that appliances, e.g. bowls with about 2% fiber quantity, were able to resist hot food and hot liquid preparations with a temperature of 60 °C for at least 1 hour.

Containers, e.g. bowls, prepared using this recipe were successfully used to store food preparations in the refrigerator and/or freezer. Said food preparations were re-heated in the same container using a microwave oven or conventional oven

without degrading the container indicating stability at low temperatures (-20°C) and high temperatures (160-180°C).

Example 7.

A dough similar to the dough of example 6 was produced by mixing 60 g (19 wt%) of potato starch and 120 g (38 wt%) of pea starch, 10 g (3 wt%) of hemp fibre, and 12 g (4 wt%) of bees wax with 120 g of water. After mixing the dry ingredients in an automated mixer for about 10 to 15 minutes the water was added followed by an additional mixing for at least about 30 minutes. Like in example 6, fibers and wax were cut beforehand to smaller pieces (smaller than about 2 cm) so that everything mixed more homogeneously and fitted better in the mixer. Upon completion of the mixing procedure a damp (slightly wet) powdery composition was obtained. Larger clumps (balls), if any, were broken before inserting the composition (dough) in the mold for cooking. Depending on the desired shape and dimensions of the appliance, the necessary amount of mixture was weighed. For example, for a bowl, 33 gr of the mixture was weighed.

Like in example 6, a pre-determined amount of mixture was inserted in a mold that was pre-heated at a temperature between 180°C and 200°C.

With the mold at temperature, the mixture was spread in the cavities of the mold. The mold was closed and pressurized to spread the mixture. Cooking was ready once steam ceased to escape from openings in the mold. The cooking time for 16 bowls for example was 1 to 2 minutes.

After 2 minutes a baked product in the shape of the mold could be released upon opening of the mould. The baked product had an expanded honeycomb like texture and showed a crunchy, crispy bite, showed a excellent rigidity and hardness. Compared to the appliance of example 6 provision of additional fibers up to 3 wt.% was found to improve rigidity and hardness allowing rougher handling of cooked product, including dropping the formed item from a height of 50 cm without breaking. Further increase of fiber content, e.g. up to 4 wt.% was found to further improve rigidity and hardness.

Inventors found that appliances, e.g. bowls with about 4% fiber quantity, were able to resist hot food and hot liquid preparations with a temperature to 80 °C or more, e.g. 90°C for at least 1 hour without essentially losing functionality.

Containers, e.g. bowls, prepared using this recipe were successfully used to store food preparations in the refrigerator and/or freezer. Said food preparations were re-heated in the same container using a microwave oven or conventional oven without degrading the container indicating stability at low temperatures (-20°C) and high temperatures (160-180°C).

Example 8.

In yet a further example a mixture was prepared by mixing 120 g of pea starch (33 wt.%), 60 g of potato starch (17 wt. %), 36 g of pea fiber (10 wt. %), 15 g (4 wt. %) of distillers grains (a cereal byproduct of a brewers/ distillation process), 12 g (3 wt. %) of bees wax and 120 g (33 wt.% of water). The total fraction of fibers (pea+cereal) amounting to about 14 wt. %.

Like the other examples according to the invention products formed from this composition were found suitable for manufacturing of a broad variety of appliances including but not limited to cups, trays, bowls, and plates.

Like the other examples according to the invention products formed from this composition were found to be suitable for human consumption. Products are edible and have a pleasant taste and crispness. Products with distillers grains may be preferred for their characteristic taste. Products with hemp and/or pea fiber may be preferred for a more neutral taste.

Like the other examples according to the invention products formed from this composition were found suitable to hold cold and warm solid food preparations. Preparations with sauce are also accepted.

Like the other examples according to the invention products formed from this composition were found suitable for passage in an oven, microwave oven, fridge, and freezer.

Like the other examples according to the invention products formed from this composition were found to be biodegradable and were found to degrade within a period of 10 days under ambient composting conditions, e.g. a home compost heap.

Like the other examples according to the invention composted products formed from this composition were found to not negatively affect soils. Since the

compositions according to the invention do not comprise plastics (e.g. synthetic polymers) or other unnatural synthetic ingredients no harmful residues were left after 10 days of composting, e.g. no micro particles of plastic which are commonly found for products formed with PLA (poly lactic acid). Containers, e.g. bowls, prepared using this recipe were successfully used to store food preparations in the refrigerator and/or freezer. Said food preparations were re-heated in the same container using a microwave oven or conventional oven without degrading the container indicating stability at low temperatures (-20°C) and high temperatures (160-180°C).

Claims

1. A method for producing a biodegradable appliance for containing food, which method comprises the steps of producing a water-based dough and cooking and shaping the dough in a heated mold to produce the appliances in a predetermined shape, characterised in that the dough is produced by mixing

- 30.0-70.0 wt. %, preferably 40.0-60.0 wt. %, of vegetable starch,
- 20.0-50.0 wt. %, preferably 25.0-45. 0 wt. % of a water based liquid, preferably water,
- 1.0-50.0 wt. %, preferably 1.0-25.0 wt. % of fibers,
- the remainder up to 100.0 wt. % being made up by one or more additives,

wherein the vegetable starch comprises between 5.0 - 40.0 wt. %, preferably between 10.0 - 30.0 wt. %, more preferably between 10.0 – 25.0 wt. % of potato starch, and 25.0 – 60.0 wt. %, preferably 30.0 - 50.0 wt. %, more preferably 30.0 – 40.0 wt. % of a vegetable starch different from potato starch, the wt% being expressed on the basis of the total dough composition.

2. Method according to claim 1 involving the steps of (a) producing the dough by mixing the ingredients, (b) introducing the dough into a cavity of a heated mould in the shape of the appliance to be produced, (c) cooking by heating the dough in the mold to a temperature of between 150.0 and 260.0 °C while subjecting the dough to an elevated pressure, and removing the thus produced appliance from the mold.

3. Method according to claim 1 or 2, wherein the dough further contains 2.0 – 5.0 wt. % of an edible wax.

4. Method according to any one of the preceding claims, wherein the biodegradable appliance is suitable for human consumption.

5. Method according to any one of the preceding claims, wherein the dough comprises between 1 and 2 wt.% of hemp fiber.

6. Method according to any one of the preceding claims wherein the mixture is comprised solely of natural ingredients.

7. Method according to any one of the preceding claims wherein the water based liquid, preferably water, is added after pre-mixing the vegetable starch, the fibers, and the one or more additives.

8. Method according to any of the preceding claims, wherein the dough is cooked at a temperature of at least 155 °C, preferably at least 165 °C, and of maximum 250°C, preferably maximum 225°C, most preferably between 180 °C and 200 °C.

9. Method according to any one of the preceding claims wherein the mold is pre-heated to the cooking temperature before the dough is introduced into the mold.

10.Method according to any one of the preceding claims wherein the mold is provided with at least one vent such that steam generated during cooking may escape.

11. Method according to claim 10 wherein the mold is provided with a plurality of vents dimensioned such as to contain the mixture within the mold.

12.Method according to any one of the preceding claims, wherein the vegetable starch different from potato starch is selected from one or more of a cereal starch, a root vegetable starch or a bean starch.

13.Method according to any one of the preceding claims, wherein the vegetable starch different from potato starch is selected from one or more of rice, wheat, maize, cassava, acorns, arrowroot, arracacha, banana, barley, breadfruit, buckwheat, canna, colacasia, katakuri, kudzu, malanga, millet, oats, oca, polynesian arrowroot, sago, sorghum, sweet potatoes, rye, taro, chestnuts, water chestnuts and yams, favas, lentils, mung beans, peas, and chickpeas, preferably pea starch.

14.Method according to any one of the preceding claims, wherein the dough contains 30.0 - 40.0 wt. % of water.

15.Method according to any one of the preceding claims, wherein the fibers are one or more selected from the group of pea fibers, hemp fibers, and residues of cereals used in the brewing of beer, preferably hops.

16. Method according to claim 3, wherein the edible wax is a natural wax, preferably an animal wax, more preferably a bees wax.

17. Method according to any one of the preceding claims, wherein the biodegradable appliance is one or more selected from the group of a packaging for holding food in particular a container, a tray, a platter, a bowl, a pan, a cup, a beaker, a jar, a pot, and a dish.

18. Method according to any one of the preceding claims, wherein the biodegradable appliance forms a biodegradable part of a composite appliance comprising a biodegradable portion and a non-biodegradable portion, such as cutlery item, in particular a knife, a spoon, a fork.

19.A biodegradable appliance obtainable by the method as defined in any one of the preceding claims.

20.Biodegradable appliance according to claim 19 having a wall thickness of at least 0.5 mm, preferably at least 1.0 mm, and maximum 5.0 mm, preferably maximum 2.5 mm.

21.A packaging comprising a biodegradable appliance as defined in claim 19 or 20, wherein the appliance is a container comprising a circumferential wall enclosing an inner volume containing one or more food products containing water and/or fat, wherein the circumferential wall comprises an upper circumferential edge with a sealing surface sealed to a plastic film covering the inner volume of the packaging.

22. A composition for producing an biodegradable appliance, comprising

- 30.0-70.0 wt. %, preferably 40.0-60.0 wt. %, of vegetable starch,
- 20.0-50.0 wt. %, preferably 25.0-45. 0 wt. % of a water based liquid, preferably water,
- 1.0-50.0 wt. %, preferably 1.0-25.0 wt. % of fibers,
- the remainder up to 100.0 wt. % being made up by one or more additives,

wherein the vegetable starch comprises between 5.0 - 40.0 wt. %, preferably between 10.0 - 30.0 wt. %, more preferably between 10.0 – 25.0 wt. % of potato starch, and 25.0 – 60.0 wt. %, preferably 30.0 - 50.0 wt. %, more preferably 30.0 – 40.0 wt. % of a vegetable starch different form potato starch, the wt% being expressed on the basis of the total dough composition.

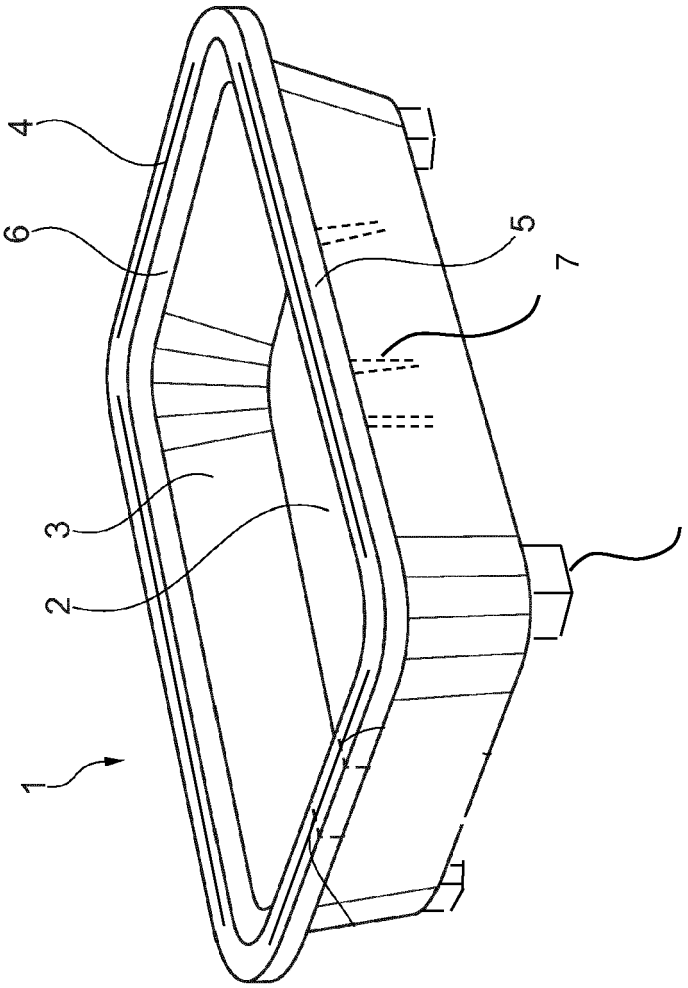

Fig. 1

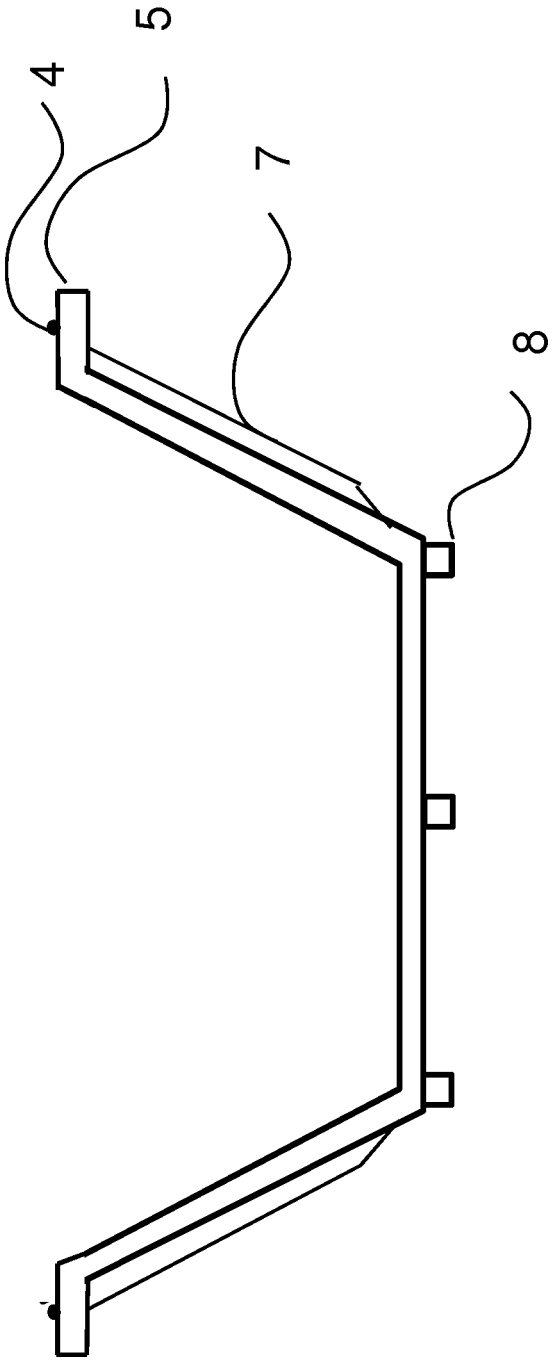

Fig. 2

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2019/071622

A. CLASSIFICATION OF SUBJECT MATTER
INV. A21D13/48 B65D65/46 C08L3/02
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A21D B65D C08L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data, BIOSIS, FSTA

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 711 908 A (TIEFENBACHER KARL [AT] ET AL) 27 January 1998 (1998-01-27) claims 1-12 examples 1,6-9,11 column 1, line 50 - column 3, line 67 -----	1-22
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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 September 2019	26/09/2019

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2019/071622

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Information on patent family members

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