METHOD FOR PROCESSING COCOA BEANS

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The invention relates to a method for processing unfermented cocoa beans wherein the cocoa beans are depulped and wherein separated pulp and depulped cocoa beans are separately treated. In particular, the method comprises a fermentation of pulp and at least one treatment of depulped cocoa beans under acidic conditions, followed by preparing a mixture of fermented pulp and acid-treated depulped cocoa beans and the further processing of such mixture. The invention also relates to cocoa beans that are obtained or obtainable by methods of the present invention, to the use thereof for preparing food products, preferably chocolate products, or cocoa products, including cocoa extracts, and to food products and cocoa products, including cocoa extracts thereby obtained.
METHOD FOR PROCESSING COCOA BEANS

TECHNICAL FIELD

[0001] The present invention relates to a method for processing cocoa beans wherein fermented cocoa pulp is used for the processing of cocoa beans. In particular, the present invention relates to a method for processing unfermented cocoa beans wherein the cocoa beans are depulped in order to separate pulp from cocoa beans, and wherein the separated pulp and the depulped cocoa beans are separately treated. After separate treatment, the pulp and depulped cocoa beans are mixed together and further processed. The invention further relates to cocoa beans obtained or obtainable by carrying out a method of the present invention and to uses thereof for preparing cocoa products, including cocoa extracts, and/or food products. The invention further relates to cocoa products, including cocoa extracts, and uses thereof for preparing food products. The invention also relates to food products prepared with cocoa beans and/or cocoa products as defined herein.

BACKGROUND

[0002] Cocoa beans are the principal raw material for chocolate production. These beans are derived from the fruit pods of the tree Theobroma cacao, which is cultivated in plantations in the equatorial zone, e.g., in Ivory Coast, Ghana, and Indonesia. The cocoa beans are embedded in a mucilaginous pulp inside the pods. Raw cocoa beans have an astringent, unpleasant taste and flavour, and have to be microbially fermented, dried, and roasted to obtain the desired characteristic cocoa flavour and taste. Chocolate flavour is influenced by the origin of the cocoa beans, the cocoa cultivars, the on-the-farm fermentation and drying process, and the roasting and further processing performed by the chocolate manufacturer.

[0003] After removal of the beans from the pods, the first step in cocoa processing for example for the cocoa variety forastero is a spontaneous 6 to 10-day fermentation of beans and pulp in heaps, boxes, baskets, or trays. During such process, the beans are freed from adhering pulp. At the end of this period the decomposed pulp is generally washed away by water and the beans dried to produce the cocoa beans of commerce.

[0004] However, the spontaneous cocoa fermentation process is very inhomogeneous and suffers from great variations in both microbial counts and species composition and hence metabolites. The variations seem to depend on many factors including country, farm, pod ripeness, post-harvest pod age and storage, pod diseases, type of cocoa, variations in pulp/bean ratio, the fermentation method, size of the batch, season and weather conditions, the turning frequency or no turning, the fermentation time, etc. which makes reproducibility of fermentation particularly difficult. Because the uncontrolled nature of the usual fermentation process, particularly with respect to the lack of control over the growth and development of microorganisms and metabolic production during the process, the quality of the finished cocoa beans is variable.

[0005] Subsequent drying of fermented beans may for instance comprise artificial drying in a current of hot-air or by spreading out the cocoa beans in the sun to dry. The roasting step involves Maillard reactions between reducing sugars and hydrolysis products of proteins, especially peptides and free amino acids. Unfortunately, also the conditions for drying and roasting are not always adequately controlled. In addition, dried cocoa beans can also be damaged during their transport to the countries specialized in the downstream processing of the beans.

[0006] Attempts have been made in the prior art to control fermentation parameters. For instance, WO 2007/031186 discloses a method to regulate the fermentation of plant material consisting of cocoa beans and/or pulp by adding to said plant material specific bacterial cultures containing at least one lactic acid bacterium and/or at least one acetic acid bacterium at different times during the fermentation process.

[0007] U.S. Pat. No. 5,342,632 discloses a method for treating cocoa beans for improving fermentation comprising removing and separating a portion of the pulp from fresh cocoa beans and fermenting the partly depulped cocoa beans under highly aerobic conditions.

[0008] However, fermentation parameters remain difficult to control in prior art methods and industry must therefore address a wide variability in the composition of a batch of processed cocoa beans.

SUMMARY

[0009] The present invention provides a solution to at least some of the above-mentioned problems.

[0010] The present invention provides an alternative method for controlling cocoa processing. In particular, the invention provides a method for processing cocoa beans into cocoa products having a desired composition, flavour and/or organoleptic properties. The invention provides high-flavoured cocoa beans by means of a simpler, faster, more controllable and reproducible process, resulting in a cocoa product having a controllable and well-defined composition.

[0011] The present invention encompasses the use of fermented cocoa pulp for improving processing of unfermented acid-treated cocoa beans. In the present method pulp that has been fermented is added to unfermented acid-treated cocoa beans, both are mixed together and further processed. The fermented pulp can be obtained in various ways.

[0012] In a first aspect, the invention is directed to a method for processing unfermented cocoa beans comprising the step of preparing a mixture of fermented pulp with acid-treated depulped cocoa beans and further processing said mixture. More in particular, the invention relates to a method for processing unfermented cocoa beans, wherein said unfermented cocoa beans are acid-treated depulped cocoa beans, said method comprising the step of preparing a mixture of fermented pulp with said acid-treated depulped cocoa beans and further processing said mixture.

[0013] In a preferred embodiment, said acid-treated depulped cocoa beans are obtained by depulping unfermented cocoa beans and subjecting said depulped cocoa beans to at least one treatment with an aqueous acidic medium. More in particular, said acid-treated depulped cocoa beans are obtained by the steps of:

[0014] i) providing unfermented cocoa beans,
[0015] ii) depulping the cocoa beans of step i), and
[0016] iii) subjecting said depulped cocoa beans to at least one treatment with an aqueous acidic medium.

[0017] In an optional embodiment the cocoa beans obtained in step i) and/or in step ii) may be further subjected to a mechanical treatment (other than depulping) and/or to a physical treatment. Thus, in an optional embodiment, the cocoa beans may be subjected to another mechanical treat-
ment (other than depulping) and/or to a physical treatment before being treated with an aqueous acidic medium.

[0018] In a particular embodiment step iii) of the present method is performed under aerobic conditions. In other words, the present method is performed under oxygenic atmosphere, i.e. in the presence of oxygen. Unexpectedly, although the first days during a natural fermentation process are normally done under anaerobic conditions, it has now been shown that by applying a method according to the invention, there is no need to remove oxygen and/or to work under anaerobic conditions, and that even under aerobic conditions it is possible to provide in accordance with the present method cocoa beans of a good quality and flavor, and even with high amounts of polyphenols. This is particularly surprising, since it is expected that under normal oxygen conditions oxidation would take place, and this would reduce the amounts of polyphenols.

[0019] In another embodiment, a method is provided comprising the step of releasing polyphenols from said cocoa beans to said medium within two hours of subjecting said cocoa beans to step iii).

[0020] In yet another embodiment, a method is provided comprising inhibiting the generation of at least 80% of said cocoa beans within two hours after having been subjected to depulping or to another mechanical and/or physical treatment.

[0021] In a preferred embodiment said mechanical treatment is selected from the group comprising depulping, scoring, scraping, cracking, crushing, pressing, rubbing, centrifugation, cutting or perforation of the cocoa beans and any combinations thereof.

[0022] In another embodiment said physical treatment is selected from the group comprising a thermal treatment, a microwave treatment, a treatment under water-saturated conditions, an ultrasound treatment, an infra-red treatment, a laser treatment, a pressure treatment and any combinations thereof.

[0023] In an embodiment, a method is provided wherein step iii) comprises the steps of:

- a) immersing the depulped cocoa beans within an aqueous acidic medium until the pH of said cocoa beans reaches a value of between 4.0 and 5.5,
- b) optionally removing the aqueous acidic medium of step a),
- c) incubating the cocoa beans of step a) or of step b) at a temperature of between 25 and 70°C for less than 24 hours, and
- d) optionally washing the cocoa beans of step c).

[0024] In another embodiment, this method further comprises the step of drying the cocoa beans obtained in step c) or step d).

[0025] In another embodiment, the invention provides a method wherein step iii) comprises the steps of:

- a) immersing said depulped cocoa beans within an aqueous acidic medium until the pH of said cocoa beans reaches a value of between 3.6 and 5.5,
- b) optionally removing the aqueous acidic medium of step a),
- c) incubating the cocoa beans of step a) or of step b) at a temperature of between 25 and 70°C for less than 24 hours,
- d) optionally washing the cocoa beans of step c),
- e) immersing the cocoa beans of step c) or of step d) within an aqueous acidic medium or alkali-fying the aqueous acidic medium of step a) until the pH of said cocoa beans reaches a value of between 4.5 and 6.5,
- f) optionally removing the aqueous acidic medium of step e),
- g) incubating the cocoa beans of step e) or of step f) at a temperature of between 25 and 70°C for less than 24 hours,
- h) optionally washing the cocoa beans of step g), and
- i) optionally drying the cocoa beans of step g) or h).

[0029] Preferably, the aqueous acidic medium applied in step a) of the above methods is a solution having a pH lower than 5, and preferably having a pH lower than 4 or lower than 3. In an embodiment the invention provides a method wherein the cocoa beans are immersed in step e) in an aqueous acidic medium of at least 0.1 molar (M) containing acetic acid.

[0040] In another embodiment, the invention relates to a method wherein the aqueous acidic medium applied in step e) is a solution having a pH lower than 6.5, and for instance lower than 6.0. In another embodiment the invention provides a method wherein the cocoa beans are immersed in step e) in an aqueous acidic medium of at least 0.1 molar (M) containing acetic acid. In an example, the aqueous acidic medium applied in step e) is a buffer solution having a pH comprised between 5.5 and 6.5 and containing acetic acid.

[0041] In another embodiment, the invention provides a method wherein step c) comprises incubating the cocoa beans for less than 20 hours, and for instance for less than 18 hours, less than 16 hours, or less than 12 hours. In another embodiment, the invention provides a method wherein step c) comprises incubating the cocoa beans at a temperature which is higher than 40°C, and for instance between 41°C and 45°C.

[0042] In yet another embodiment, the invention provides a method wherein step g) comprises incubating the cocoa beans for less than 16 hours, and for instance for less than 14 hours. Also, in another embodiment the invention provides a method wherein step g) comprises incubating the cocoa beans at a temperature which is lower than 50°C, and for instance lower than 45°C.

[0043] After having been separately treated, the present method involves the preparation of a mixture of fermented pulp with the depulped acid-treated cocoa beans as defined herein and further processing said mixture.

[0044] The present processing method provides an alternative to a natural fermentation. The present method provides for a separate treatment of pulp and depulped beans. The method includes a controlled immersion of the depulped cocoa beans in an aqueous acidic medium, to lower the pH in the cocoa beans to a suitable value, followed by incubation of the acidified cocoa beans under controlled temperature conditions and for a defined period of time. In addition, the invention provides for a separate fermentation of the pulp. After separate treatments, fermented pulp and acid treated depulped beans are combined and incubated together.

[0045] The Applicants have now surprisingly shown that although pulp and the cocoa beans are separately treated, the method allows controlled flavour formation in the cocoa beans and permits to obtain highly-flavoured cocoa products, even if pulp and cocoa beans have been separately treated in at least a part of the present process. By applying a method according to the invention high-flavoured cocoa products having a controllable, reproducible and adjustable composition are obtained. In particular, the present method enables to
provide highly fruity-tasting cocoa with reduced heavy taste and aftertaste intensity; and with improved fruity, flowery and herbaceous notes. In addition, by including co-incubation of fermented pulp with the acid-treated depulped bean, the present method provides cocoa beans having increased levels of endogenous sugars (see also below).

0046 By carrying out a method according to the invention, cocoa beans can be easily and rapidly obtained, e.g. in less than 48 hours, which is considerably faster than when applying a conventional fermentation process. Moreover, the present method has the important advantage of providing cocoa beans that are reproducible. Also, the Applicants have shown that cocoa beans can be obtained that have an acceptable taste and quality without having to subject the cocoa beans to a microbial fermentation. This is rather surprising, since fermentation is generally accepted in the art as being an important factor in flavour development in cocoa beans.

0047 Another particular beneficial aspect of the present method is that it permits to provide cocoa beans having elevated levels of bio-active compounds, i.e. compounds that may provide health effects. In particular, in another embodiment, the invention provides a method wherein the cocoa beans are obtained having an amount of components selected from the group comprising aroma compounds, aroma precursors, ester-precursors, free amino acid precursors, free amino acids, aromatic bioactive molecules, alkaloid compounds, sugars, carbohydrates, and enzymes which is at least 10% higher or at least 10% lower than the amount in the cocoa beans that have been subjected to a conventional fermentation process for at least two days.

0048 The present invention further has the important advantage of normalization of cocoa beans obtained with the present invention, facilitating and speeding up subsequent processing of the cocoa beans, e.g. their application in subsequent food processing. In particularly useful embodiments, the method of the present invention allows for advantageously controlling the characteristies of the cocoa beans and products produced there from, for example, all kind of organoleptic, nutritional, and technological properties and flavour and quality aspects, i.e. taste, flavour, fatty acid composition, polyphenol content, sugar concentration etc., of the processed beans as well as of the resulting cocoa products, such as chocolate.

0049 In a second aspect, the invention relates to cocoa beans that have an amount of components selected from the group comprising aroma compounds, aroma precursor, ester-precursors, free amino acids, aromatic bioactive molecules, alkaloid compounds, sugars, carbohydrates, and enzymes which is at least 10% higher or at least 10% lower than in fermented cocoa beans, i.e. cocoa beans that have been subjected to a conventional fermentation process for at least two days.

0050 In a preferred embodiment, the invention relates to cocoa beans that are obtained or obtainable by a method according to the invention.

0051 The invention also provides in an embodiment, cocoa beans that are no longer able to germinate two hours, and for instance 20, 30, 40, 50, 60, 70, 80, 90, 100 minutes, after having been subjected to depulping or to another mechanical and/or physical treatment.

0052 In another embodiment, the invention provides cocoa beans having one or more of the following features.

0053 In a particular embodiment the cocoa beans provided in accordance with the invention are non-roasted cocoa beans.

0054 In another embodiment, the invention relates to cocoa beans that have an amount of sugars, preferably selected from the group comprising fructose, glucose, and saccharose, which is at least 10% higher than in cocoa beans that have been subjected to a conventional fermentation process, i.e. a fermentation of at least two days but not including the addition during or after this fermentation of separately fermented pulp.

0055 In a particular embodiment, the invention relates to cocoa beans having an amount of fructose which is higher than 1 wt % and preferably higher than 2 wt %.

0056 In an embodiment the invention provides cocoa beans having an amount of theobromine which is higher or lower than a value between 10000 and 16000 mg/kg cocoa beans. Theobromine has diuretic, stimulant and relaxing effects.

0057 In an embodiment, the invention provides cocoa beans having an amount of phenylethylamine (PEA) which is higher or lower than an amount between 0.02-1.4 ppm. In a preferred embodiment, the invention provides cocoa beans having an amount of phenylethylamine which is higher than 5 ppm. Unexpectedly, the present invention permits to provide cocoa beans that have, in unroasted condition, particularly high amounts of phenylethylamine, and in particular higher than the amounts found in unroasted conventionally fermented beans. The elevated amounts of PEA provided in the present cocoa beans further advantageously permit to roast the present beans at lower temperatures and/or during shorter roasting times, since high levels can already be obtained in unroasted beans. Moreover, the PEA concentrations provided in the present cocoa beans are particularly beneficial, since PEA is an important component of cocoa products, that is capable of influencing mood and associated with a feeling of contentment.

0058 In another embodiment, the invention also provides cocoa beans having an amount of Gamma-aminobutyric acid (GABA) which is higher than 500 ppm. The present invention permits to provide cocoa beans that have high amounts of GABA and in particular higher than the amounts found in conventionally fermented beans. The elevated GABA concentrations provided in the present cocoa beans are particularly beneficial, since GABA is also an important component of cocoa materials that is capable of influencing mood, reducing anxiety and stress.

0059 In another embodiment, the invention also provides cocoa beans having amounts of amino acids, which are higher than those found in cocoa beans that have been subjected to a conventional fermentation process for at least two days. In particular, the invention provides cocoa beans having an amount of phenylalanine (PHE) which is higher than 2500 ppm. In yet another embodiment, the invention relates to cocoa beans having an amount of alanine (ALA) which is higher than 1200 ppm. In another embodiment, the invention
provides cocoa beans having an amount of tryptophan (TRP) which is higher than 350 ppm. The present cocoa beans are particularly beneficial, since these amino acids are known to have anti-stress effects and they are believed to be able to influence mood.

[0060] In yet another embodiment, the invention provides cocoa beans having an amount of polyphenols which is higher or lower than an amount between 2.5-4.5 wt %. In a preferred embodiment, cocoa beans having enhanced amounts of flavonoids, including flavanols such as e.g. epicatechin and catechin. The present cocoa beans are particularly beneficial, since flavonoids in general are known to be antioxidants, and to improve heart health.

[0061] In another aspect, the invention also relates to the use of cocoa beans according to the invention for preparing cocoa products such as cocoa powder, cocoa extract, cocoa liquor, cocoa mass, cocoa butter and cocoa cake, and/or for preparing food products, such as chocolate products.

[0062] The invention further relates to a cocoa product selected from the group comprising cocoa powder, cocoa extract, cocoa liquor, cocoa mass, cocoa butter and cocoa cake, prepared with one or more cocoa beans according to the invention, and to uses thereof, e.g. for preparing food products such as chocolate products.

[0063] The invention further provides a food product, preferably a chocolate product, prepared with one or more cocoa beans and/or with one or more cocoa products according to the present invention and to various uses of such food product.

[0064] The invention also further provides a cocoa extract prepared with one or more of cocoa beans according to the present invention and to various uses of such cocoa extract.

[0065] It has been shown that by carrying out a method according to the invention cocoa beans can be obtained having enhanced levels of sugars. In accordance with the invention, by adding fermented pulp to cocoa beans the amount of sugar in the beans can be significantly increased, and in particular the amount of sucrose, fructose and sucrose can be improved, compared to those present in conventionally fermented beans. In addition, by adding fermented pulp to cocoa beans, higher ratios of fructose to sucrose can be obtained compared to cocoa beans that have been conventionally fermented.

[0066] Also, addition of the fermented pulp to the beans has a beneficial effect on the taste of the cocoa beans and the chocolate products prepared therefrom. In particular it permits to reduce the bitterness of the obtained cocoa beans and of the chocolate products prepared therefrom. The present invention is thus particularly beneficial as it permits to reduce the amounts of (exogenous) sugars that are added for preparing chocolate from cocoa beans according to the invention. Thus, using the present cocoa beans, fewer sugars need to be added when preparing chocolate from the present cocoa beans to obtain good tasting chocolate.

[0067] In addition, while in the prior art chocolate containing high amounts of cocoa solids, e.g. chocolate containing more than 30 wt % of dry fat free cocoa solids based on the theobromine level, usually has a bitter taste. On the contrary using the present cocoa beans to prepare this type of chocolate now permits to obtain chocolate containing relatively high amounts of cocoa solids with a surprisingly reduced bitter taste.

[0068] It is unexpected that the above-indicated effects can be achieved by adding fermented pulp to the beans especially since there is no indication in the prior art that fermented pulp, which during a spontaneous fermentation will decompose and drain away, may be re-used for processing cocoa beans, and even for processing cocoa beans that are not fermented but chemically treated, and may induce beneficial effects as herein disclosed. Also, it is highly surprisingly that herein disclosed improvements can be achieved in view of the limited time period during which the cocoa beans and the fermented pulp are co-incubated.

[0069] With the insight to better show the characteristics of the invention, some preferred embodiments and examples are described hereafter.

DETAILED DESCRIPTION OF THE INVENTION

[0070] In a first aspect, the present invention is directed to a method for processing unfermented cocoa beans.

[0071] While the present invention primarily relates to the processing of the cocoa beans of the major cocoa plant species, Theobroma cacao, the invention is not limited solely to this species and further includes the subspecies T. cacao cacao and T. cacao sahaeocarpum. For example, many cocoa varieties are hybrids between different species; an example of such a hybrid is the trinitario variety. In accordance with the present invention cocoa beans obtained from various varieties such as Criollo, Forastero or Trinitario may therefore be used in a method of the present invention.

[0072] The term “cocoa beans” as used herein is intended to refer to cocoa beans or cocoa seeds as such as well as parts thereof and includes cocoa nibs. Cocoa beans basically consist of two parts: an outer part comprising the testa or seed coat surrounding the bean, and an inner part comprising two cotyledons and the embryo or germ contained within the testa. In the present specification, the terms “testa” or “shell” or “seed coat” are used as synonyms. The term “pulp” in accordance with the present invention relates to the mucilaginous plant material in which cocoa beans are embedded inside the cocoa pods.

[0073] According to the invention, unfermented cocoa beans from preferably freshly harvested pods are used as a primary material. The term “unfermented” cocoa beans used herein is intended to refer to cocoa beans that have been liberated from cocoa pods and that have not yet germinated.

[0074] The term “fermented cocoa beans” is intended to refer to cocoa beans that have been fermented for at least two days, thus, that have undergone a conventional fermentation process, i.e. while surrounded by their pulp according to techniques known in the prior art.

[0075] As used herein the term “non-depulped” cocoa beans refers to cocoa beans that have not been liberated from their pulp. The term “depulped” cocoa beans refers to cocoa beans that have been essentially liberated from their pulp. Preferably “essentially liberated” refers to the removal from the cocoa beans of more than 60%, preferably more than 65, 70, 75, 80, 85, 90, 95, 97, or 99% by weight of pulp based upon the original total combined weight of beans and pulp.

[0076] The term “bioconverted” or “bioconverting” as used herein refers to the treatment of cocoa beans as an alternative to a natural fermentation of cocoa beans. Bioconversion involves controlled immersion(s) of cocoa beans in at least one aqueous acidic medium, to alter the pH in the cocoa beans, preferably under controlled temperature conditions.

[0077] The term “acid-treated cocoa beans” or “bioconverted cocoa beans” as used herein refers to beans that have undergone a bioconversion process, i.e. to beans that have been immersed in at least one aqueous acidic medium (as
defined herein), to alter the pH in the cocoa beans, preferably under controlled temperature conditions.

[0078] The term aqueous acidic medium in this context is intended to refer to an aqueous medium that has a pH lower than 7, lower than 5, lower than 4, lower than 3, and for instance a pH of 2.6; 3.0; 4.0; 4.5; 5.0; 5.5; 6.0; or 6.5.

[0079] Method

[0080] The present method encompasses the processing of unfermented cocoa beans comprising the step of preparing a mixture of fermentable pulp with acid-treated depulped cocoa beans and further processing said mixture.

[0081] In a preferred embodiment, the invention relates to a method for processing unfermented cocoa beans comprising the steps of:

[0082] (I) depulping unfermented cocoa beans thereby obtaining pulp and depulped cocoa beans,

[0083] (II) Subjecting said pulp to a fermentation process thereby obtaining fermented pulp,

[0084] (III) Subjecting said depulped cocoa beans to at least one treatment with an aqueous acidic medium, and

[0085] (IV) Preparing a mixture of the fermented pulp obtained in step (II) with the depulped cocoa beans obtained in step (III) and further processing said mixture.

[0086] In an optional embodiment, the cocoa beans may be subjected to mechanical treatment different from depulping and/or to a physical treatment before being treated with an aqueous acidic medium. Suitable embodiments of mechanical and physical treatments are presented below.

[0087] One step in this preferred embodiment consists of depulping said cocoa beans, and separately recovering pulp and depulped cocoa beans. In other words, cocoa beans which quickly after harvest have been liberated from the pulp surrounding them are used, with the result that the microbial processes which usually begin upon storage or fermentation of cocoa beans are absent as far as possible. This is achieved for example by removing the cocoa beans of healthy pods as quickly as possible preferably within fewer than 10, particularly 5 days after harvest. The cocoa beans are then immediately liberated of preferably essentially all of the pulp that surrounds them. This can be done for example by mechanical means, assisted by washing.

[0088] In a preferred embodiment, this preferred method comprises the step of removing essentially all of the pulp surrounding the cocoa beans and preferably “essentially all” refers to more than 60%, preferably more than 65, 70, 75, 80, 85, 90, 95, 97, or 99% by weight of pulp based upon the original total combined weight of beans and pulp.

[0089] The pulp and depulped cocoa beans are separately treated in accordance with the present invention.

[0090] Cocoa Pulp

[0091] According to the invention fermented pulp is put into practice. Fermented cocoa pulp is obtained in various ways.

[0092] In a first embodiment, the invention provides a method wherein said fermented pulp is obtained by subjecting cocoa beans with adhering pulp to a fermentation process, and collecting the pulp within the first three days of said fermentation process, and for instance within one, two or three days of the fermentation process. Thus, this embodiment of the method comprises the collection of pulp that drains away during a conventional fermentation process of cocoa beans and the use thereof as fermented pulp in the present method.

[0093] In a second embodiment, the invention provides a method wherein fermented pulp is obtained by depulping unfermented cocoa beans, collecting said pulp, and subjecting said pulp to a fermentation process.

[0094] In this second embodiment, cocoa pulp is obtained, preferably from cocoa beans which have been liberated from their surrounding pulp quickly after pod harvest, with the result that the microbial processes which usually begin upon storage or fermentation of cocoa beans have not yet started as far as possible. This is achieved for example by removing the cocoa beans of healthy pods as quickly as possible preferably within fewer than 10, particularly 5 days after harvest. The cocoa beans are then immediately liberated of pulp that surrounds them. Various ways are known in the art for depulping cocoa beans, including example mechanical means, assisted by washing. The pulp is recuperated.

[0095] In a further step, fermented pulp is prepared by subjecting the recuperated cocoa pulp to a fermentation process. In general, the pulp is microbiologically sterile when healthy, undamaged pods are opened aseptically. Microbial fermentation starts when the pulp is inoculated with microorganisms, either accidentally at the manual opening of the pods or via controlled addition.

[0096] Preferably fermentation of said pulp comprises a fermentation in the presence of yeasts, lactic acid bacteria (LAB), and acetic acid bacteria (AAB) for less than 52 hours, and for instance for less than 50, 45, 40, 35, 30, 24 hours, according to procedures known in the art. For instance the pulp can be fermented in boxes or vessels, preferably with a mixing unit. Fermentation can be done under anaerobic and aerobic conditions at a temperature of for instance between 20 and 25°C, and for instance between 24°C and 27°C, and for instance between 20 and 52°C.

[0097] In another preferred embodiment, fermentation of said pulp can be done by adding specific microbial starter cultures to the pulp that has been separated from cocoa beans. Suitable examples of starter cultures are for instance described in WO 2007/031186, which is incorporated herein by reference. In an example, pulp is fermented with a microbial starter culture, e.g. for less than 24 hours at a temperature of between 25°C and 40°C.

[0098] In a third embodiment, the invention provides a method wherein pulp is collected according to the method of the above-mentioned first embodiment and is added as inoculum during the pulp fermentation process according to the above-mentioned second embodiment. In other words, the invention provides for the use of fermented pulp as inoculum during the fermentation process of freshly harvested pulp material.

[0099] During fermentation, the pulp, containing about 80% water, 18% sugars, 1.5% citric acid, pectin and minor quantities of amino acids and mineral salts, becomes host to a wide range of microbial activities: e.g., yeasts transform sugars into alcohol, acetic acid bacteria will metabolize alcohol into acetic acid, and lactic acid bacteria will change sugars into lactic acid. With the help of pectinolytic enzymes, the pulp loses its mucilaginous nature.

[0100] Fermented pulp obtained in accordance with the present invention can be diluted with water, e.g. at a dilution rate with water of between 1:1 and 1:10 and of for instance 1:1, 1:2, 1:4 or 1:10.

[0101] Acid-Treated Cocoa Beans

[0102] In accordance with the present invention, acid-treated depulped cocoa beans are put into practice. In a pre-
ferred embodiment, acid-treated cocoa beans are obtained by depulping unfermented cocoa beans and subjecting said depulped cocoa beans to at least one treatment with an aqueous acidic medium. In an optional embodiment, before being treated with an aqueous acidic medium, and before or after being depulped, the unfermented cocoa beans may be subjected to another mechanical treatment (other than depulping) and/or a physical treatment.

Pre-treatments of the unfermented cocoa beans, such as depulping optionally in combination with other mechanical or physical pre-treatments, has the effect of initiating the opening of the testa of the cocoa beans. With the term “pre-treatment” of cocoa beans as used herein it is intended to refer to a depulping of the cocoa beans, optionally in combination with other mechanical or physical pre-treatments.

The term “testa opening” as used herein refers either to the damaging of the testa of cocoa beans, e.g. to obtain testa showing cracks or bursts, but also to a partial or complete removal of the testa from the cocoa beans. In some cases it may be desirable to fully remove the testa of the cocoa beans. However, there is also evidence of flavor improvement if the testa is simply bursted or damaged to provide an exposed surface of the cocoa nib. “Initiation” of testa opening is intended to coincide with the start of the pre-treatment applied on the cocoa beans to obtain testa opening.

In another preferred embodiment, the present invention therefore provides a method wherein the pre-treatment involves opening the testa of at least 50% and preferably of at least 60, 70, 80 or 90% of the pre-treated cocoa beans.

Opening of the testa can be measured in different ways. One way consists of measuring a change in pH in the cocoa beans. This can be done by collecting cocoa beans, producing cocoa nibs, bringing said nibs in water and boiling the water containing the beans for 3 minutes, preferably for 5 minutes at 100° C. The water containing the nibs is then filtered and the pH of the filtrate is measured.

Another way consists of carrying out diffusion measurements. For instance the amount (wt % or ppm) of components such as e.g. polyphenols that have been leaked out of the cocoa beans during a certain period of time can be measured. This can be done by placing X number of pre-treated cocoa beans for Y minutes in Z liters of water or another solvent at a certain temperature T (° C.). The Applicants indicate that when polyphenols can be detected in the medium surrounding the beans, testa opening has been initiated.

In another embodiment, the pre-treatment of cocoa beans according to the present invention has the effect of inhibiting germination of the cocoa beans. As is well known in the art, germination is the growth of an embryonic plant contained within a seed, it results in the formation of the seedling. The term “germination of cocoa beans (cocoa seeds)” as used herein refers to the sprouting of a cocoa seedling from a cocoa seed. “Inhibition” of germination as used in the present application is intended to refer to the effect of avoiding that germination of the cocoa seeds starts but also to the effect of ending (interrupting) germination of the cocoa seeds if germination already started. “Initiation” of the inhibition of germination in this context is intended to coincide with the start of the pre-treatment applied on the cocoa beans.

In another preferred embodiment, the present invention therefore provides a method wherein the pre-treatment involves the inhibition of at least 80% of said cocoa beans, and preferably of at least 85, 90, 95% or even up to 100% of the cocoa beans within two hours of subjecting said cocoa beans to the pre-treatment, and thus within two hours of initiating the pre-treatment.

Inhibition of germination can be measured by determining a germination rate by means of a germination assay. The germination rate is the number of cocoa seeds that germinate under proper conditions, and in particular, that germinate when growing the cocoa seeds on earth or cotton for 7 days at 25-31° C. under humidity saturated conditions. The germination rate is expressed as a percentage, e.g. an 15% germination rate indicates that about 15 out of 100 seeds germinate.

Pre-Treatments

Various pre-treatments and combinations thereof may be applied in accordance with the present invention.

In a preferred embodiment, said mechanical treatment is selected from the group comprising depulping, scoring, scraping, cracking, crushing, pressing, rubbing, centrifugation, cutting or perforation of the cocoa beans and any combinations thereof.

In another preferred embodiment, said physical treatment is selected from the group comprising a thermal treatment, a microwave treatment, a treatment under water-saturated conditions, an ultrasound treatment, an infra-red treatment, a laser treatment, a pressure treatment and any combinations thereof.

In one example said physical treatment comprises subjecting said cocoa beans for at least 1 minute to a temperature lower than 15° C. or lower than 10° C. or lower than 0° C.

In another example said physical treatment comprises subjecting said cocoa beans to a temperature of more than 100° C. for at least 1 minute.

In another example said physical treatment comprises subjecting said cocoa beans to a microwave radiation of 300 MHz to 300 GHz substantially homogeneous field for at least 1 minute.

In yet another example said physical treatment comprises exposing said cocoa beans to infra-red radiation of a wavelength of between 750 nm and 1 mm for at least 1 minute.

The Applicants have shown that by subjecting cocoa beans to a pre-treatment the uptake by the cocoa beans of the aqueous acidic medium is greatly facilitated, e.g. diffusion of acids in the cocoa beans is accelerated, and as a consequence, the conversion of metabolites in the beans is improved and accelerated. In addition, the acid concentration used to treat the cocoa beans can be reduced, and/or washing of the cocoa beans after acid treatment—if done—is greatly facilitated, e.g. less washing is required or in case of washing less water needs to be percolated through the bioconverted cocoa beans.

Further, the present method allows to normalize (regulate, control) the starting time for the bioconversion process, and thus to regulate the bioconversion process, and to steer and influence taste development in the beans. Taste regulation becomes possible, i.e. the development of certain flavours can be influenced or selected (e.g. fruitiness), which results in a more homogeneous taste. This facilitates and improves (rapidity) the subsequent processing of the cocoa beans, for instance by reducing conching time and lowering the need for cocoa blending.

In another embodiment the invention provides a method comprising the step of releasing polyphenols from
said cocoa beans to said medium within two hours of subjecting said cocoa to a treatment with an aqueous acidic medium.

In particular, the present method permits to release a detectable amount of polyphenols from said cocoa beans to said medium within two hours of subjecting said cocoa to the aqueous acidic medium. The term “detectable amount” in this context is used to refer to that amount that can significantly be detected when using appropriate detection equipment, such as e.g. equipment for carrying out HPLC or RHIPLC analyses. Such detectable amount can be determined and measured by a person skilled in the art. In one example for instance, the method permits to release at least 0.01 mg/g (at least 10 ppm) of polyphenols from said cocoa beans within two hours of subjecting said cocoa to an aqueous acidic medium.

Controlled pre-treatment followed by controlled bioconversion further results in beneficial effects on cocoa flavour development. The above-given pre-treatments have the beneficial effect of opening the testa of a predominant amount of treated cocoa beans, but surprisingly do not have a negative effect on the subsequent bioconversion, and on flavour production and development in the pre-treated cocoa beans. The present method thus also allows excellent flavour formation in the cocoa beans and permits to obtain highly-flavoured cocoa products having excellent organoleptic properties.

The invention also provides cocoa beans having an amount of polyphenols two hours after having been subjected to at least one treatment with an aqueous acidic medium followed by incubation of the cocoa beans at a temperature of between 25 and 70°C, which is significantly lower than the total amount of polyphenols before being subjected to said treatment. The term “significantly lower” used in this context, intends to refer to that amount that significantly differs from the amount detected for cocoa beans before being subjected to the at least one treatment with an aqueous acidic medium. Such detectable amount can be determined and measured by a person skilled in the art when using appropriate detection equipment, such as e.g. equipment for carrying out HPLC or RHIPLC analyses.

In another embodiment the invention provides a method comprising inhibiting the germination of at least 80%, and preferably at least 85%, 90%, 95%, and even up to 100% of said cocoa beans within two hours of subjecting said cocoa beans to a pre-treatment as defined herein.

The present invention thus provides methods involving controlled pre-treatment of unfermented cocoa beans followed by controlled processing by bioconversion, of said pre-treated cocoa beans. The pre-treatment has the important advantage of normalisation of the starting material. In addition, the Applicants have also surprisingly shown that pre-treatment of cocoa beans facilitates and speeds up subsequent bioconversion of the pre-treated cocoa beans.

The Applicants also showed that by subjecting cocoa beans to a pre-treatment as described herein a predominant part of the treated cocoa beans lose the capacity to germinate. However, surprisingly, this loss of germination capacity has no significant effect on the capacity of the cocoa beans to undergo enzymatic activities and/or to undergo a conversion of aroma and other metabolites on the beans. Thus, surprisingly, the Applicants showed that a loss of germination capacity did not significantly affect the development of good flavour characteristics in the cocoa beans. On the contrary, the Applicants demonstrated that a controlled pre-treatment followed by controlled bioconversion results in beneficial effects on cocoa flavour development. Pre-treatment of the cocoa beans as defined herein significantly improves conversion of metabolites and precursors in the cocoa beans, improves the formation of aroma compounds, e.g. ester compounds and ester-precursors, free amino acids, aromatic bioactive molecules, etc. The present method thus also allows excellent flavour formation in the cocoa beans and permits to obtain highly-flavoured cocoa products having excellent organoleptic properties. Unexpectedly, inhibition of germination of the cocoa beans permits to halter internal energy source consumption and to maintain the cocoa beans at a specific stage until the start of a subsequent bioconversion process.

Bioconversion

In accordance with the present invention, after pre-treatment, depulped cocoa beans are subjected to at least one treatment with an aqueous acidic medium, i.e. are bioconverted. In an optional embodiment the depulped cocoa beans are first washed after the pre-treatment before being subjected to at least one treatment with an aqueous acidic medium.

Basically three different embodiments of methods for obtaining acid-treated depulped cocoa beans are provided in accordance with the present invention; in particular:

a method comprising one step of immersing depulped cocoa beans in an aqueous acidic medium;

a method comprising two steps of immersing cocoa beans in an aqueous acidic medium, and

a method comprising a step of immersing depulped cocoa beans in an aqueous acidic medium and a step of alkalinising the aqueous acidic medium used in a previous step.

These embodiments will be elaborated hereafter.

In a first embodiment a method is provided for preparing acid-treated depulped cocoa comprising the steps of:

- immersing the depulped cocoa beans within an aqueous acidic medium until the pH of said cocoa beans reaches a value of between 4.0 and 5.5,
- optionally removing the aqueous acidic medium of step a),
- incubating the cocoa beans of step a) or of step b) at a temperature of between 25 and 70°C for less than 24 hours,
- optionally washing the cocoa beans of step c).

The above embodiment of the method may further comprise the step of drying the cocoa beans obtained in step c) or step d).

In the immersion step of the bioconversion process immersion of the cocoa beans is executed until the pH of said cocoa beans reaches a value of between 4.0 and 5.5, and for instance a pH value of between 4.8 and 5.5 or between 5.0 and 5.5.

In a second embodiment a method is provided for preparing acid-treated depulped cocoa comprising the steps of:

- immersing said depulped cocoa beans within an aqueous acidic medium until the pH of said cocoa beans reaches a value of between 3.6 and 5.5,
- optionally removing the aqueous acidic medium of step a),
- incubating the cocoa beans of step b) at a temperature of between 25 and 70°C for less than 24 hours,
- optionally washing the cocoa beans of step c),
immersing the cocoa beans of step d) within an aqueous acidic medium until the pH of said cocoa beans reaches a value of between 4.5 and 6.5.

(f) optionally removing the aqueous acidic medium of step e).

g) incubating the cocoa beans of step f) at a temperature of between 25 and 70°C for less than 24 hours,

(h) optionally washing the cocoa beans of step g), and

(i) optionally drying the cocoa beans of step h).

In a first immersion step of this method (step a), immersion of the cocoa beans is executed until the pH of said cocoa beans reaches a value of between 3.6 and 5.5. In a preferred embodiment, said step comprises immersing the cocoa beans within an aqueous acidic medium until the pH of said cocoa beans reaches a pH value lower than 5.5 and for instance a pH of between 3.8 and 5.0 or between 4.0 and 4.8.

In a second immersion step of this method (step e) immersion of the cocoa beans is executed until the pH of said cocoa beans reaches a value of between 4.5 and 6.5. In a preferred embodiment, the present step comprises immersing the cocoa beans within an aqueous acidic medium until the pH of said cocoa beans reaches a pH value lower than 6.0 and for instance a pH of between 4.8 and 5.8 or between 5.0 and 5.5.

Optionally, after the first incubation the cocoa beans are not washed with water but directly immersed within said second aqueous acidic medium until the pH of the beans reaches a value of between 4.5 and 6.5. This will effect at least partial removal of acid from the beans.

In yet a third embodiment, a method is provided for preparing acid-treated depulped cocoa comprising the steps of:

(a) immersing said depulped cocoa beans within an aqueous acidic medium until the pH of said cocoa beans reaches a value of between 3.6 and 5.5,

(b) optionally removing the aqueous acidic medium of step a),

c) incubating the cocoa beans of step b) at a temperature of between 25 and 70°C for less than 24 hours,

(d) optionally washing the cocoa beans of step c),

(e) alkaliifying the aqueous acidic medium of step a) until the pH of said cocoa beans reaches a value of between 4.5 and 6.5,

(f) optionally removing the aqueous acidic medium of step e),

(g) incubating the cocoa beans of step f) at a temperature of between 25 and 70°C for less than 24 hours,

(h) optionally washing the cocoa beans of step g), and

(i) optionally drying the cocoa beans of step h).

Thus in this third embodiment of the present method for processing cocoa beans step e) involves the step of alkaliifying the aqueous acidic medium of step a) until the pH of the cocoa beans reaches a value of between 4.5 and 6.5. Alkaliifying the aqueous acidic medium in step e) can be done for instance by adding a base or a basic solution to the acidic medium of step a), e.g. a NaOH solution. This is further illustrated in example 3.

The following characteristics apply for any of the above disclosed bioconversion methods.

In accordance with any of the methods for bioconversion explained above, the cocoa beans applied in step a) of the above methods can be used just as they occur after the pre-treatment or they can first be dried.

If dried cocoa beans are used, such beans can be treated with water before further treatment. For this, the dried cocoa beans are incubated in water at a temperature of not more than 70°C, preferably 55°C or less, particularly 45°C or less, e.g. 40°C, until the original water content, e.g. approximately 30 to 35 wt %, has been essentially restored.

Alternatively, if dried cocoa beans are used they can immediately be immersed within an aqueous acidic medium until the pH of said cocoa beans reaches a suitable value, as indicated above in step a) of the above methods.

The different bioconversion methods explained above comprise immersing the cocoa beans in step a) of the methods and in step e) of the second method within an aqueous acidic medium at a temperature higher than 30°C and preferably higher than 35°C and for instance between 40 and 65°C.

The duration of step a) of the different methods and of step e) of the second or third method should be sufficiently long to bring about complete acid penetration of the cocoa beans. In another embodiment the method therefore comprises immersing the cocoa beans within an aqueous acidic medium for a time period of less than 40 hours, and for instance less than 35, 30, 25, 20, 15 hours.

An aqueous acidic medium used in the present method is a medium having a pH lower than 7, preferably lower than 5, more preferably lower than 3. Such aqueous acidic medium may comprise either inorganic or organic acids with preference for amphiphilic acids. When selecting the acids, it should be borne in mind that they should not impair the flavour of the cocoa beans but readily penetrate into the cocoa beans. Short-chain aliphatic monocarboxylic acids have proved especially suitable. Acid or acid buffer systems that can be used include acetic acid, ascorbic acid, citric acid, hydrochloric acid, phosphoric acid. Particularly good results were achieved using for instance acetic acid. It is assumed that acetic acid is especially suitable as it, due to its hydrophobic properties, can penetrate the high fatty components in the cocoa beans and pervade biological membranes when the concentration is sufficient.

In order to quickly change the pH in the cocoa beans by immersion in said acid solution, both the acid concentration in the medium and the quantitative ratio of acid in the medium to cocoa beans are important. The acid concentration in the medium should not drop critically during absorption of the acid into the cocoa beans, and the individual cocoa beans should be in free contact with the medium. For this purpose, an at least 0.1 molar (M) acid solution is preferably used as a medium, and use of a 0.2 to 0.6 M acid solution is particularly suitable. The quantitative ratio of cocoa beans (g dry matter) to the volume of medium (ml) should advantageously be comprised between 10:1 and 1:10, or between 1:5 and 5:1 and for instance be 1:4, 1:3, 1:2, 1:1, 2:1, 3:1, 4:1. Optionally, the cocoa beans’ absorption of acid can be promoted by slight pre-drying of individual beans, or by mixing the cocoa beans and/or the medium.

Preferably, the aqueous acidic medium applied in step a) of the above methods is a solution having a pH lower than 5, and preferably having a pH lower than 4 or lower than 3. In a preferred embodiment, a method is provided wherein said aqueous acidic medium applied in step a) of the present methods is an acetic acid solution. Thus, a method is provided wherein said aqueous acidic medium applied in step a) is or
contains an acetic acid solution. During natural fermentation processes, usually first a break down of citric acid will be seen in the cocoa pulp, after which production of organic acids, including acetic acid, is usually observed. Despite this teaching, the Applicants have now unexpectedly shown that even when using acetic acid, which in fact reflects the later stage of a natural fermentation process, during a first stage of the present method, cocoa beans can be obtained with a good quality and flavor. Thus, surprisingly, and contrary to prior art teachings, the application of the acetic acid during the (first) immersion step of the present method is adequate to obtain cocoa beans with a good quality and flavor.

In another embodiment, the aqueous acidic medium applied in step e) is a solution having a pH lower than 6.5, and for instance lower than 6.0. In a preferred embodiment the aqueous acidic medium applied in step e) is a buffer solution having a pH comprised between 5.5 and 6.5 and containing acetic acid.

After immersion of the cocoa beans within an aqueous acidic medium until the pH of said cocoa beans reaches a suitable value in step a) of the three methods and/or in step e) of the second or third method, the beans having the internal pH value as indicated are incubated at a temperature of between 25 and 70°C, and for instance between 30 and 65°C, or between 40 and 55°C, and preferably for less than 24 hours, and for instance for 5, 8, 10, 12, 15, 18, 20, 22 hours. During these incubation steps, enzymatic conversions take place within the beans whereby the formation of flavour precursors or flavour compounds are effectively stimulated.

For instance, in an example, the invention provides a method wherein step c) comprises incubating the cocoa beans for less than 20 hours, and for instance for less than 18 hours, less than 16 hours, or less than 12 hours. In another embodiment, the invention provides a method wherein step c) comprises incubating the cocoa beans at a temperature which is higher than 40°C, and for instance between 41°C and 45°C.

In yet another embodiment, the invention provides a method wherein step g) comprises incubating the cocoa beans for less than 16 hours, and for instance for less than 14 hours.

Also, in another embodiment the invention provides a method wherein step g) comprises incubating the cocoa beans at a temperature which is lower than 50°C, and for instance lower than 45°C.

Optionally, in a further embodiment, the aqueous acidic medium used in the immersion step is removed prior to the subsequent incubation of said cocoa beans under the above-indicated conditions.

In another optional embodiment, the cocoa beans are incubated during their immersion within the indicated media, than the media are moved and thereafter, the cocoa beans can be further incubated under the above-indicated conditions. In an example, beans are incubated in the immersion media at a temperature of between 25 and 50°C and for less than 10 hours, and for instance at a temperature of between 30 and 45°C for 2 to 4 hours. Thereafter the media are removed and the beans can be further incubated under the above-indicated conditions.

In yet another embodiment, after having been incubated the acid diffused into the cocoa beans and the acid concentration may be reduced. The acid can then be removed from the cocoa beans in various ways. For instance, for this purpose, the cocoa beans can be washed with water after incubation. This can be done by immersing the cocoa beans in water into which the acid diffuses from the cocoa beans. The water is changed many times to keep the acid concentration low. Alternatively, pure water is percolated through the batch of cocoa beans.

Alternatively, after the first incubation the cocoa beans are not washed with water but directly immersed within said second aqueous acidic medium until the pH of the beans reaches a value of between 4.5 and 6.5. This will also effect at least partial removal of acid from the beans.

After the first and second incubation steps, acid can be removed from the cocoa beans within preferably less than 24 hours.

According to another embodiment, cocoa beans that have been bioconverted according to methods as disclosed above can be dried or not. If they are dried, preferably, said drying is performed by means of conventional drying techniques such as e.g. sun, microwave hot air, commonly known in the art. Preferably, in such case the cocoa beans are dried until a moisture content of the mixture of less than 10%, especially until a moisture content of 9, 8, 7, 6, or 5%, is reached.

Mixture

In a further embodiment of the present method a mixture is prepared of fermented pulp with acid-treated cocoa beans as defined herein. In a preferred embodiment, cocoa beans are dried before mixing fermented pulp therewith.

The invention further provides a method wherein the fermented pulp may be diluted before or during mixing with the cocoa beans. In other words, a method is provided wherein fermented pulp is diluted prior to or during admixing of said pulp to said cocoa beans. In an embodiment, said fermented pulp is provided in a liquid form.

In another embodiment, a method is provided wherein said acid-treated cocoa beans are dried before mixing fermented pulp therewith. In other words, the invention provides the step of mixing fermented pulp to dried unfermented and acid-treated cocoa beans. The term “mixing” used in this context is used as synonym of adding, feeding, or admixing fermented pulp to the cocoa beans. In the present context, this step includes the addition of pulp that has been fermented separately from the cocoa beans that are to be treated or mixed therewith.

Preferably fermented pulp is mixed with acid-treated cocoa beans at a quantitative ratio of fermented pulp (g dry matter) to acid-treated cocoa beans (g dry matter) of between 1:1 and 1:100, and for instance of at least 1:1, 1:2, 1:3, and for instance at least 1:10 or at least 1:20 or 1:50. Fermented pulp may be diluted with water, as explained above.

Subsequently, the mixture is further processed by incubation of the mixture at a temperature of between 4°C and 70°C, for between 10 min and 24 hours, and for instance at a temperature of between 4°C and 70°C, for between 30 min and 24 hours or at a temperature of between 4°C and 55°C for between 30 min and 12 hours, or at a temperature of between 20°C and 45°C for between 30 min and 10 hours.

Optionally, if the acid-treated cocoa beans have been dried, the dried cocoa beans can be rehydrated and mixed with fermented pulp. Rehydration of the dried cocoa beans can for instance be obtained by mixing said cocoa beans with fermented pulp, wherein the pulp is optionally blended with water.
Cocoa Products

In yet another aspect, the invention relates to cocoa beans that are obtained or obtainable by a method according to the invention.

Cocoa beans according to the invention have a well-defined and controllable composition, flavour and/or organoleptic properties, and that in particular are high-flavoured cocoa products. Cocoa flavour may be classified according to the following categories: cocoa flavour; acid/sharp, astringent, bitter, raw/green, fragrant/floral, brown fruit, late sour and thick mouth feel. Scores for cocoa beans according to the invention may be assessed on a point system and a high score in a category indicates a strong intensity for a particular flavour.

In addition, the invention relates to cocoa beans that have an amount of one or more components selected from the group comprising:

- aroma compounds, such as sugar alcohols and esters;
- aroma precursors, such as reduced sugars, pyrazines, amino acids, peptides;
- compounds such as gamma-aminobutyric acid (GABA) or phenylethylamine (PEA);
- free amino acids, such as phenylalanine, tyrosine, alanine, tryptophan;
- aromatic bioactive molecules such as polyphenols, linalol, anandamide, cycloartenol;
- alkaloid compounds such as theobromine, caffeine;
- polyphenols such as epiicatechin or catechin;
- sugars such as sucrose, fructose, saccharose;
- enzymes such as proteases;
- sugar converting enzymes, such as invertase; and
- carbohydrate converting enzymes, such as amylase;

which amount is in particular higher or lower than in fermented cocoa beans, and preferably at least 10, 15, 20, 25% higher or at least 10, 15, 20, 25% lower than in fermented cocoa beans.

“Fermented cocoa beans” in this context refers to cocoa beans that have not been separately treated or separately fermented from their pulp, but refers to cocoa beans that have undergone a conventional fermentation process, i.e. while surrounded by their pulp. The term “conventional fermentation process” refers to a fermentation process according to techniques known in the prior art and for a duration of at least two days.

In particular, the invention relates to cocoa beans that have an amount of one or more components selected from the group defined above which amount is in particular higher or lower, and preferably at least 10, 15, 20, 25% higher or at least 10, 15, 20, 25% lower than in cocoa beans that have not been processed with fermented pulp in accordance with the present method.

In another embodiment, the invention provides a method as disclosed herein, wherein the cocoa beans obtained or obtainable by a method according to the invention have an amount of components selected from the group comprising aroma compounds, aroma precursors, ester-precursors, free amino acids, aromatic bioactive molecules, alkaloid compounds, sugars, carbohydrates, and enzymes as defined above which is at least 10% higher or at least 10% lower than the amount in said unfermented cocoa beans after having been subjected to a fermentation process for at least two days.

In addition, the invention relates to cocoa beans that have an adjustable amount of components such as those enumerated above. The term “adjustable amount” as used herein is intended to refer to the possibility, when carrying out the present method, to obtain a well-defined amount, i.e. concentration or quantity, of components in said cocoa beans.

The invention provides cocoa beans, in particular non-roasted cocoa beans, having one or more of the following features.

In an embodiment, the invention relates to cocoa beans that have an amount of sugars, and preferably sugars selected from the group comprising saccharose, fructose and glucose which is at least 10% higher than in cocoa beans that have been subjected to a fermentation process of at least two days and that have not been processed with fermented pulp as defined herein.

In a preferred embodiment, the invention relates to cocoa beans having an amount of fructose, which is higher than 1 wt % (i.e. % by weight of the beans) and preferably higher than 2 wt %, and for instance higher than 2.5 wt %.

In another preferred embodiment, the invention relates to cocoa beans having an amount of glucose, which is higher than 0.5 wt % (i.e. % by weight of the beans), and for instance higher than 0.8 wt %.

In another preferred embodiment, the invention relates to cocoa beans having an amount of saccharose, which is higher than 1 wt % (i.e. % by weight of the beans), and for instance higher than 1.5 wt %.

In a preferred embodiment, the invention provides cocoa beans having an amount of fructose, which is at least 5 times, preferably at least 10 times higher than in beans that have been subjected to a fermentation process of at least two days and that have not been processed with fermented pulp as defined herein.

In another preferred embodiment, the invention provides cocoa beans having an amount of glucose which is at least 2 times, preferably at least 4 times higher than in beans that have been subjected to a fermentation process of at least two days and that have not been processed with fermented pulp as defined herein.

In yet another preferred embodiment, the invention provides cocoa beans having an amount of saccharose which is at least 1.5 times, preferably at least 2 times higher than in beans that have been subjected to a fermentation process of at least two days and that have not been processed with fermented pulp as defined herein.

In another embodiment, the invention relates to cocoa beans having a ratio of fructose to glucose which is higher than 1, and for instance higher than 2, or higher than 3.

In yet another embodiment, the invention provides cocoa beans having a total amount of sugars, selected from the group consisting of glucose, saccharose and fructose, which is at least 5 times, and for instance at least 7 times or at least 9 times higher than in beans that have been subjected to a fermentation process of at least two days, and that have not been processed with fermented pulp as defined herein.

In an embodiment, the invention relates to cocoa beans that have an amount of free amino acids (FAA) selected from the group comprising alanine, phenylalanine, tryptophan, leucine, and valine, and preferably selected from the group comprising alanine, phenylalanine and tryptophan, which is at least 10% higher than in cocoa beans that have been subjected to a fermentation process of at least two days.
The term “free” in this context refers to amino acids that are not covalently bound to another moiety.

[0224] In particular, the invention provides cocoa beans having an amount of phenylalanine which is higher than 2500 ppm, and for instance higher than 3000 ppm or higher than 3500 ppm. In yet another embodiment, the invention relates to cocoa beans having an amount of alanine which is higher than 1200 ppm or higher than 2200 ppm, and for instance higher than 2400 ppm or higher than 3000 ppm. In another embodiment, the invention provides cocoa beans having an amount of tryptophan which is higher than 350 ppm, and preferably higher than 500 ppm or higher than 900 ppm.

[0225] In another embodiment, the invention relates to cocoa beans that have an amount of decarboxylated amino acids such as phenethylamine (PEA) (i.e. decarboxylated phenylalanine) and/or gamma-aminobutyric acid (GABA) (i.e. decarboxylated glutamic acid), which is at least 10% higher than in cocoa beans that have been subjected to a fermentation process of at least two days.

[0226] The invention relates to cocoa beans having an amount of phenethylamine which is higher or lower, and preferably higher, than an amount comprised 0.02-1.4 ppm. In an embodiment, the invention provides non cocoa beans having an amount of phenethylamine which is higher than 5 ppm, and for instance higher than 10, 15, 20, 25, or 30 ppm.

[0227] In another embodiment, the invention also provides cocoa beans having an amount of gamma-aminobutyric acid which is higher than 500 ppm, and for instance higher than 1000, or higher than 1500 ppm.

[0228] In another preferred embodiment, the invention relates to cocoa beans having elevated amounts of alkaloids. In a preferred embodiment, the invention relates to cocoa beans, having an amount of theobromine which is higher or lower than a value between 10000 and 16000 μg/g cocoa beans and preferably which is higher or lower than a value between 10404 and 15606 μg/g cocoa beans and for instance which is higher or lower than a value between 10000 and 16850 μg/g cocoa beans.

[0229] In another preferred embodiment, the invention relates to cocoa beans having an amount of polyphenols which is higher or lower than an amount between 2.5-4.5 wt%. Preferably, said polyphenols include epicatechin and catechin.

[0230] The invention in particular relates to cocoa beans that are obtainable or obtained by a method according to the present invention.

[0231] In another aspect, the invention also relates to cocoa products prepared with one or more cocoa beans as defined herein. “Cocoa products” according to the present invention are defined as products that can be prepared using cocoa beans, and may be selected from the group comprising cocoa powder, cocoa extract, cocoa liquor, cocoa mass, cocoa cake, and cocoa butter. Cocoa products can be in a liquid form or in a dry or lyophilized form, such as in the form of granules, pellets, or a powder.

[0232] Cocoa products according to the invention can be prepared in a form to be directly administered to an individual, and are preferably formulated for oral consumption. By way of example, a cocoa product according to the invention can be prepared in the form of tablets, chewable tablets, capsules, and liquid syrup.

[0233] Cocoa products according to the invention can also be introduced in food products. The high-flavoured cocoa beans according to the invention are particularly suitable for the production of high-flavoured food products.

[0234] Advantageously, the present invention permits to provide highly-flavoured cocoa beans and highly-flavoured cocoa products derived therefrom such as e.g. cocoa liquor, cocoa mass, cocoa cake, cocoa powder, cocoa extract, cocoa butter.

[0235] Food Products and Extracts

[0236] In yet another aspect, the invention relates to the use of cocoa beans as defined herein and/or of cocoa products as defined herein for the preparation of food products, preferably chocolate products.

[0237] The invention also relates to a food product prepared with one or more cocoa beans as defined herein and/or with one or more cocoa products as defined herein.

[0238] The invention thus relates to the use of cocoa beans according to the invention for the preparation of food products, e.g. preferably chocolate products, and to food products thereby obtained. For this, cocoa beans according to the invention can be conventionally processed into cocoa products such as cocoa butter, cocoa powder, cocoa liquor, cocoa mass, and further introduced in food products. The high-flavoured cocoa beans according to the invention are particularly suitable for the production of high-flavoured food products.

[0239] The term “food product” is used herein in a broad sense, and covers food for humans as well as food for animals (i.e. a feed). In a preferred aspect, the food is for human consumption. The food may be in the form of a solution or as a solid, depending on the use and/or the mode of application and/or the mode of administration. Non-limitative examples of food products which may be obtained using cocoa beans according to the present invention include for instance chocolate products, chocolate drinks, nutritional beverages, beverage powders, milk-based products, ice cream, confectionery, bakery products such as cakes and cake mixes, fillings, cake glaze, chocolate bakery filling, doughnuts, and dairy products.

[0240] Food products, e.g. chocolate products, comprising cocoa beans or cocoa products derived thereof as defined herein have improved characteristics, including for instance improved storage stability, improved organoleptic properties such as for instance a better flavour profile, better flavour release, prolonged flavor retention and improved appearance, than equivalent products made from cocoa beans that have not been pre-treated in accordance with the present invention.

[0241] The invention provides in a particular embodiment, as mentioned above, the cocoa beans according to the invention are particularly suitable for preparing chocolate having a high content of cocoa solids (e.g. containing more than 30 wt % of cocoa solids) but which is nevertheless surprisingly sweet-tasting and fruity-tasting.

[0242] In another embodiment, the invention encompasses the use of cocoa beans according to the invention for the preparation of cocoa extracts, and to cocoa extracts thereby obtained. For this, cocoa beans according to the invention can be conventionally processed into cocoa extracts according to techniques known in the art.

[0243] The present invention will be described in greater detail below with the aid of the examples which follows. It goes without saying, however, that these examples are given
EXAMPLES

Example 1

This example illustrates an embodiment of the present method for processing unfermented cocoa beans. Freshly harvested ripe pods are opened and the cocoa beans are removed. The recovered fresh cocoa beans are first weighed and then passed through a depulper having an inlet for beans at one end and a pulp outlet underneath. The recovered fresh cocoa beans and the amount of pulp removed from the fresh cocoa beans in the depulper is at least 50 wt %, based on the original combined weight of the beans and pulp.

Subsequently the separated pulp is placed into usual fermentation boxes for up to 52 hours of fermentation at a temperature of between 25° C. and 70° C. The depulped beans are separately treated by placing the depulped cocoa beans in a vessel. The beans are treated with 600 mM acetic acid (pH 2.6) and the temperature can be raised to 41° C. The pH 1 range can be monitored and controlled until the internal bean pH value reached approximately 4.4 (duration approximately 3 h). During a first incubation period the pH is kept at approximately 4.4. After 23 hours the aqueous solution is removed. During a second incubation period the beans are treated with 600 mM acetic acid (pH 5.5) for approximately 2 hours. The internal bean pH is kept at approximately pH 5.5. pH measurements can be conducted as follows: at regular intervals during the method 10 g of beans are collected. A 5 g bean mix is brought in 20 ml of water and boiled for 3 minutes at 100° C. The water is filtrated and the pH is measured.

The beans are then dried by evaporation of the water under vacuum during gentle heating, at a temperature below 60° C., until the moisture content is less than 10%.

Subsequently, 10 Kg of dried beans are placed in a vessel. 5 Kg of fermented pulp is added into the vessel. Fermented pulp is added to the vessel. Beans and fermented pulp are stirred. The beans and the fermented pulp are incubated at a temperature of 25° C. for at least 1 hour. After this incubation, the beans are removed from vessel and dried.

The obtained dried beans are roasted in an oven at 120° C. for 30 min or 140° C. for 30 min. The flavours generated by the roasting can then be evaluated by a panel of individuals used to evaluating such flavours. Scores are assessed on a point system. A high score in a category indicated a strong intensity of a particular flavour. Each sample can be evaluated for the following sensations “cocoa flavour” (derived from Ghana beans), “acidity” (qualifies the basic taste generated by dilute aqueous solutions of most acids), “bitterness” (qualifies the basic taste generated by dilute solutions of various substances such as quinine, perceived on the top of the tongue and at the back of the palate), “astringency” (the term has been broadened to the entire actions of polyphenols which result in sensations of a physical nature, from the suppression of unctuousness to the astringency in the medical sense which covers constriction and/or crissipation of the tissues), “fruity” (taste note belonging to the bouquet and which evokes a fruit which has reached maturity: apple, banana, pear and the like), “flowery” (corresponds to an olfactory sensation evoking flowers in general: rose, jasmine, lily, lilac and the like), “smoky” (taste and odor of smoked ham; defect resulting in general from drying the cocoa beans after fermentation by means of a wood fire), “musty”, and “raw” (feature of insufficiently roasted cocoas where the flavour has not developed; linked to astringency and acidity; “earthy” (corresponds to an olfactory sensation that evokes raw groundnuts).

Example 2

This example illustrates another embodiment of the present method for processing unfermented cocoa beans. Freshly harvested ripe pods are opened and the cocoa beans are removed. The recovered cocoa beans are depulped in a similar way as described in example 1.

Fermented pulp is obtained by subjecting cocoa beans with adhering pulp to a conventional fermentation process and by collecting the pulp after 24 h.

The depulped beans are separately treated by placing of fresh cocoa beans in a vessel. The beans are treated with 600 mM acetic acid (pH 2.6) and the temperature can be raised to 41° C. The change in pH in the cocoa beans is monitored by regular sampling and measuring as described in Example 1 until the internal bean pH value reached approximately 4.4 (duration approximately 3 h). The aqueous solution is removed. In a first incubation period the pH is kept at about 4.4 at 41° C. under water saturated conditions. After 23 hours the buffer is changed. A second incubation period is induced using 600 mM acetic acid (pH 5.5) for approximately 2 hours. The internal bean pH is kept at approximately pH 5.5 under water saturated conditions.

The beans are not dried but subsequently mixed with the fermented pulp. 10 Kg of beans are placed in a vessel. 5 Kg of fermented pulp is added into the vessel. Beans and pulp are stirred. The beans and pulp are incubated at a temperature of 30° C. for 24 hours. After this incubation, the beans are removed from vessel and dried.

The obtained dried beans can be roasted in an oven at 120° C. for 30 min or at 140° C. for 30 min. The flavours generated by the roasting can then be evaluated by a panel of individuals used to evaluating such flavours, as described for example 1.

Example 3

This example illustrates another embodiment of the present method for processing unfermented cocoa beans.

Freshly harvested ripe pods were opened and the cocoa beans were removed. The recovered fresh cocoa beans were passed through a depulper and the depulped beans were separately recovered.

The depulped beans were separately treated by placing the depulped cocoa beans in a vessel. The beans were treated with 600 mM acetic acid (pH 2.6) at a temperature of 41° C. The pH range was monitored and controlled until the internal bean pH value reached approximately 4.4 (duration approximately 3 h). During a first incubation period the pH was kept at approximately 4.4. After 23 hours the aqueous solution is removed. During a second incubation period the beans were treated with 600 mM acetic acid (pH 5.5) for approximately 2 hours. The internal bean pH is kept at approximately pH 5.5. pH measurements can be conducted as described in example 1. The obtained acid-treated beans were dried in the sun.
Fermented pulp was prepared by subjecting another batch of cocoa beans with adhering pulp to a conventional fermentation process and by collecting the pulp after 8 h.

This fermented pulp was then added to the sun-dried acid-treated beans and rehydrated the beans. The mixture of the fermented pulp and dried beans was incubated at 25 °C for 6 hours. Then the cocoa beans were recovered and dried.

1. Method for processing unfermented cocoa beans, wherein said unfermented cocoa beans are acid-treated depulped cocoa beans, said method comprising the step of preparing a mixture of fermented pulp with said acid-treated depulped cocoa beans and further processing said mixture.

2. Method according to claim 1, wherein said fermented pulp is obtained by
   subjecting cocoa beans with adhering pulp to a fermentation process, and
   collecting the pulp within the first three days of said fermentation process.

3. Method according to claim 1, wherein said fermented pulp is obtained by depulping unfermented cocoa beans, collecting said pulp, and subjecting said pulp to a fermentation process.

4. Method according to claim 3, wherein said pulp is subjected to a fermentation process in the presence of yeasts, lactic acid bacteria (LAB), and acetic acid bacteria (AAB) for less than 52 hours.

5. Method according to claim 3 or 4, wherein pulp that is collected according to the method of claim 2 is added as inoculum during the fermentation process of claim 3 or 4.

6. Method according to any of claims 1 to 5, wherein said cocoa beans are dried before mixing fermented pulp there-with.

7. Method according to any of claims 1 to 6, wherein fermented pulp is diluted prior to or during mixing with said cocoa beans.

8. Method according to any of claims 1 to 7, wherein said pulp is provided in a liquid form.

9. Method according to any of claims 1 to 8, wherein fermented pulp is mixed with acid-treated cocoa beans at a quantitative ratio of fermented pulp (g dry matter) to acid-treated cocoa beans (g dry matter) of between 1:1 and 1:100.

10. Method according to any of claims 1 to 9, wherein further processing of said mixture comprises incubation of the mixture at a temperature between 25 °C and 70 °C for between 10 min and 24 hours.

11. Method according to any of claims 1 to 10, wherein said acid-treated depulped cocoa beans are obtained by the steps of:
   i) providing unfermented cocoa beans,
   ii) depulping the cocoa beans of step i), and
   iii) subjecting said depulped cocoa beans to at least one treatment with an aqueous acidic medium.

12. Method according to claim 12, wherein step iii) is performed under aerobic conditions.

13. Method according to claim 11 or 12, wherein step iii) comprises the steps of:
   a) immersing the depulped cocoa beans within an aqueous acidic medium until the pH of said cocoa beans reaches a value of between 4.0 and 5.5,
   b) optionally removing the aqueous acidic medium of step a),
   c) incubating the cocoa beans of step a) or of step b) at a temperature of between 25 and 70 °C for less than 24 hours, and
   d) optionally washing the cocoa beans of step c).

14. Method according to any of claims 11 to 12, wherein step iii) comprises the steps of:
   a) immersing said depulped cocoa beans within an aqueous acidic medium until the pH of said cocoa beans reaches a value of between 3.6 and 5.5,
   b) optionally removing the aqueous acidic medium of step a),
   c) incubating the cocoa beans of step a) or of step b) at a temperature of between 25 and 70 °C for less than 24 hours,
   d) optionally washing the cocoa beans of step c),
   e) immersing the cocoa beans of step c) or of step d) within an aqueous acidic medium or alkali-fying the aqueous acidic medium of step a) until the pH of said cocoa beans reaches a value of between 4.5 and 6.5,
   f) optionally removing the aqueous acidic medium of step e),
   g) incubating the cocoa beans of step e) or of step f) at a temperature of between 25 and 70 °C for less than 24 hours,
   h) optionally washing the cocoa beans of step g), and
   i) optionally drying the cocoa beans of step g) or h).

15. Method according to any of claims 13 to 15 wherein said aqueous acidic medium applied in step a) is a solution having a pH lower than 5.

16. Method according to any of claims 13 to 16, wherein the cocoa beans are immersed in step a) in an aqueous acidic medium of at least 0.1 molar (M) containing acetic acid.

17. Method according to any of claims 15 to 17 wherein said aqueous acidic medium applied in step c) is a solution having a pH lower than 6.5.

18. Method according to any of claims 15 to 18, wherein the cocoa beans are immersed in step c) in an aqueous acidic medium of at least 0.1 molar (M) containing acetic acid.

19. Method according to any of claims 13 to 19, wherein the quantitative ratio of cocoa beans (g dry matter) to the volume of medium (ml) in steps a) and/or c) is between 1:10 and 1:10:1.

20. Method according to any of claims 1 to 20, wherein the cocoa beans obtained or obtainable by a method according to any of claims 1 to 20 have an amount of components selected from the group comprising aroma compounds, aroma precursors, ester-precursors, free amino acids, aromatic bioactive molecules, alkaloid compounds, sugars, carbohydrates, and enzymes which is at least 10% higher or at least 10% lower than the amount in said unfermented cocoa beans after having been subjected to a fermentation process for at least two days.

21. Cocoa beans having an amount of components selected from the group comprising aroma compounds, aroma precipor, ester-precursors, free amino acids, aromatic bioactive molecules, alkaloid compounds, sugars, carbohydrates, and enzymes which is at least 10% higher or at least 10% lower than in fermented cocoa beans.

22. Cocoa beans according to claim 21, having an amount of theobromine which is higher or lower than a value between 10000 and 10000 μg/g cocoa beans.
24. Cocoa beans according to claim 22 or 23, having an amount of phenylethylamine (PEA) which is higher than 5 ppm.

25. Cocoa beans according to any of claims 22 to 24, having an amount of Gamma-aminobutyric acid (GABA) which is higher than 500 ppm.

26. Cocoa beans according to any of claims 22 to 25 having an amount of phenylalanine (PHE) which is higher than 2500 ppm.

27. Cocoa beans according to any of claims 22 to 26, having an amount of alanine (ALA) which is higher than 1200 ppm.

28. Cocoa beans according to any of claims 22 to 27, having an amount of tryptophan (TRP) which is higher than 350 ppm.

29. Cocoa beans according to claims 22 to 28, having an amount of fructose, which is higher than 1 wt %.

30. Cocoa beans according to claims 22 to 29, having an amount of glucose, which is higher than 0.5 wt %.

31. Cocoa beans according to any of claims 22 to 30, having a ratio of fructose to glucose which is higher than 1.

32. Cocoa beans according to any of claims 22 to 31, having an amount of saccharose, which is higher than 1 wt %.

33. Cocoa beans according to any of claims 22 to 32 which are obtainable by a method according to any of claims 1 to 21.

34. Use of cocoa beans according to any of claims 22 to 33 for the preparation of cocoa products selected from the group comprising cocoa powder, cocoa extract, cocoa liquor, cocoa mass, cocoa butter and cocoa cake.

35. Use of cocoa beans according to any of claims 22 to 33 for the preparation of food products, preferably chocolate products.

36. Cocoa product selected from the group comprising cocoa powder, cocoa extract, cocoa liquor, cocoa mass, cocoa butter and cocoa cake, prepared with one or more cocoa beans according to any of claims 22 to 33.

37. Food product, preferably a chocolate product, prepared with one or more cocoa beans according to any of claims 22 to 33 and/or with one or more cocoa products according to claim 36.

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