comprises for instance *Saccharomyces chevalieri; Saccharomyces cerevisiae* and *Acetobacter aceti.*

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. Taste problems may occur such as the presence of (too much) acids, a lack of cocoa taste, and too much off-flavour. Therefore, there remains a need in the art for further controlling fermentation processes of cocoa beans in order to obtain cocoa beans having more consistent or improved characteristics, such as highly flavoured cocoa beans of good and reproducible quality. There also remains a need in the art for a reproducible method of fermenting cocoa materials.

SUMMARY ~~OF THE INVENTION~~

The present disclosure~~invention~~ aims to provide improved microbial compositions for controlling fermentation of cocoa materials.

~~In a first aspect, t~~The present disclosure~~invention~~ relates to the use of a microbial composition for regulating fermentation of plant material essentially consisting of beans and/or pulp derived from fruit pods of the species *Theobroma cacao*, wherein said composition comprises at least three *Lactobacillus* species and at least one *Acetobacter* species. More in particular, the invention relates to the use of a microbial composition comprising:

- *Lactobacillus plantarum, Lactobacillus fermentum,* and *Acetobacter pasteurianus,*
- at least one additional *Lactobacillus* species selected from the group consisting of *Lactobacillus parafarraginis, Lactobacillus farraginis, Lactobacillus diolivorans, Lactobacillus faeni* and *Lactobacillus paracasei,* and
- at least one strain of a yeast species of a genus chosen from the group consisting of *Saccharomyces* and *Candida.*

In a first aspect, there is provided the use of a microbial composition for regulating fermentation of plant material essentially consisting of beans and/or pulp derived from fruit pods of the species *Theobroma cacao*, wherein said composition comprises:

- *Lactobacillus plantarum*, *Lactobacillus fermentum*, and *Acetobacter pasteurianus*,
- at least one additional *Lactobacillus* species selected from the group consisting of *Lactobacillus parafarraginis*, *Lactobacillus farraginis*, *Lactobacillus diolivorans*, *Lactobacillus faeni* and *Lactobacillus paracasei*, and
- at least one strain of a yeast species of a genus chosen from the group consisting of *Saccharomyces* and *Candida*.

In a second aspect, there is provided a method for regulating fermentation of plant material essentially consisting of beans and/or pulp derived from fruit pods of the species *Theobroma cacao*, said method comprising adding to the plant material a microbial composition as defined above.

In a third aspect, there is provided a fermented plant material essentially consisting of beans and/or pulp derived from fruit pods of the species *Theobroma cacao*, and preferably fermented cocoa beans, obtained by carrying out the method as defined above.

In a fourth aspect, there is provided a fermented plant material essentially consisting of beans and/or pulp derived from fruit pods of the species *Theobroma cacao*, and preferably fermented cocoa beans, obtainable by carrying out a method as defined above.

In a fifth aspect, there is provided a cocoa product selected from the group comprising or consisting of cocoa nibs, cocoa powder, cocoa extract, cocoa liquor, cocoa mass, cocoa butter and cocoa cake, prepared with fermented cocoa material as defined above.

In a sixth aspect, there is provided a chocolate or chocolate product prepared with fermented cocoa material as defined above or prepared with the cocoa product as defined above.

In a seventh aspect, there is provided a method for producing a red or purple cocoa-derived material from fermented beans, comprising the steps of:

a) providing cocoa beans that have been fermented with a microbial composition as defined above,

b) preparing a cocoa-derived material from the fermented beans of step a), and

c) treating the cocoa-derived material of step b) with an acid or with an aqueous acidic solution,

wherein said cocoa-derived material is selected from the group comprising cocoa nibs, cocoa flakes, cocoa cake, cocoa powder, cocoa liquor and chocolate, and preferably cocoa nibs or cocoa liquor.

In an eighth aspect, there is provided fermented cocoa beans characterised in that they contain:
(a) less than 3% slaty beans, preferably less than 2% slaty beans, more preferably 1% or less slaty beans, such as between 0 and 1% slaty beans; and
(b) more than 11% purple beans, preferably 15% or more purple beans, more preferably 30% or more purple beans or preferably 40% or more purple beans, wherein said purple beans are fully fermented.

In a ninth aspect, there is provided a chocolate having L value according to Hunter colour system higher than 18, comprising 35% w/w or more dry cocoa solids and not comprising dry milk solids, wherein said dry cocoa solids are of non-Java origin, preferably not from *Theobroma cacao* subsp. *cacao* clones DR2, DRC16, ICRRI01 and ICRRI02, and optionally hybrids thereof.

In a preferred embodiment, the present disclosure~~invention~~ relates to the use of a microbial composition as defined herein wherein said yeast species is *Saccharomyces cerevisiae.*

In another embodiment, the present disclosure~~invention~~ relates to the use of a microbial composition as defined herein, wherein said composition is a starter culture or a high density culture, comprising at least 10^2 CFU (colony forming units) of bacterial strains per g plant material.

~~In another aspect, t~~The present disclosure further~~invention~~ relates to a method for regulating fermentation of plant material essentially consisting of beans and/or pulp derived from fruit pods of the species *Theobroma* cacao, said method comprising adding to the plant material a microbial composition as defined herein.

~~In yet another aspect, t~~The present disclosure~~invention~~ further relates to fermented plant material essentially consisting of beans and/or pulp derived from fruit pods of the species *Theobroma* cacao, and preferably fermented cocoa beans, obtained or obtainable by carrying out the method according to the ~~invention~~present disclosure.

~~In another aspect, t~~The present disclosure also~~invention~~ relates to the use of the disclosed fermented cocoa beans ~~according to the invention~~ for the preparation of cocoa products selected from the group comprising or consisting of cocoa nibs, cocoa powder, cocoa extract, cocoa liquor, cocoa mass, cocoa flakes, cocoa butter, and cocoa cake. The ~~invention~~ present disclosure also relates to a cocoa product selected from the group comprising or consisting of cocoa nibs, cocoa powder, cocoa extract, cocoa liquor, cocoa mass, cocoa butter and cocoa cake, prepared with one or more disclosed fermented cocoa beans ~~according to the invention~~.

Unexpectedly, the beans that were fermented using a microbial composition according to the ~~invention~~ present disclosure showed a light-breaking effect. This means that the fermented beans obtained by carrying out the present fermentation process, have a lighter colour than conventionally fermented cocoa beans (which are browner).

In a preferred embodiment, the present disclosure~~invention~~ therefore provides fermented cocoa beans, and particularly fermented cocoa beans in the form of a powder or cocoa liquor, having an L * value higher than 14, e.g., higher than 15, preferably higher than 16, e.g., higher than 17, more preferably higher than 18, and for instance and very preferably higher than 19 or higher than 20, such as for example having an L * value between 14 and 20, preferably between 16 and 20, more preferably between 17 and 20 or between 18 and 20 such as between 18 and 19.

In another preferred embodiment, the present disclosure~~invention~~ further provides a cocoa product as defined above, and particularly cocoa product in the form of a powder or cocoa liquor, having an L* value higher than 14, e.g., higher than 15, preferably higher than 16, e.g., higher than 17, more preferably higher than 18, and for instance and very preferably higher than 19, or higher than 20, such as for example having an L * value between 14 and 20, preferably between 16 and 20, more preferably between 17 and 20 or between 18 and 20 such as between 18 and 19.

As explained elsewhere in this specification, the microbial compositions, methods and uses described herein allow to obtain beans of a non-Java origin which when fermented have a colour comparable to or approaching the colour of Java origin beans, which are known to have a light colour (e.g., have L* value higher than 20). Consequently, in embodiments the fermented cocoa beans or cocoa products, particularly in the form of a powder or cocoa liquor, having L * values as specified above are of non-Java origin.

The Applicants thus provide a way of regulating a natural, unpredictable fermentation process into a well-controlled process, initiated by the addition of a microbial starter culture as defined herein, leading to faster and improved fermentation. Use of the present microbial compositions not only allows to speed up the fermentation process but also to influence the quality, taste and/or appearance of the obtained fermented beans and cocoa product or chocolate products derived there from. Moreover, faster fermentation processes provide important beneficial effects, as they allow carrying out controlled cocoa fermentation on a much larger scale to obtain higher production capacities, which are necessary to comply with increasing demands for cocoa.

Another particular beneficial effect of fermenting the beans using a microbial composition as defined herein is that it permits to yield fermented beans of a relative uniform and reproducible quality.

~~In another aspect, t~~The present disclosure~~invention~~ further provides a method for the downstream processing of cocoa beans that have been fermented with a microbial composition as defined herein.

In an embodiment, the present disclosure~~invention~~ provides a method for producing a red or purple cocoa-derived material from fermented beans, comprising the steps of:

a) providing cocoa beans that have been fermented with a microbial composition as defined herein

b) preparing a cocoa-derived material from the fermented beans of step a), and

c) treating the cocoa-derived material of step b) with an acid or with an aqueous acidic solution

wherein said cocoa-derived material is selected from the group comprising or consisting of cocoa nibs, cocoa flakes, cocoa cake, cocoa powder, cocoa liquor and chocolate. Preferably, said cocoa-derived material is cocoa nibs or cocoa liquor.

The present ~~invention~~ disclosure also relates to red or purple cocoa-derived material obtained from cocoa beans that have been fermented with a microbial composition as defined herein wherein said cocoa-derived material is selected from the group comprising or consisting of cocoa nibs, cocoa flakes, cocoa cake, cocoa powder, cocoa liquor and chocolate, and preferably is cocoa nibs or cocoa liquor. Preferably said red or purple cocoa-derived material is obtained or obtainable by carrying out a method as described herein.

The ~~invention~~ present disclosure further relates to the use of the disclosed fermented cocoa beans ~~according to the invention~~ for the preparation of food products, preferably chocolate products. In another embodiment the ~~invention~~ present disclosure is directed to a food product, preferably a chocolate product, prepared with one or

more disclosed fermented cocoa beans ~~according to the invention~~ and/or with one or more disclosed cocoa products ~~according to the invention~~. It shall be clear that during the downstream processing of fermented cocoa beans to food products such as chocolate products, the fermented beans may be subjected to downstream treatment steps, such as those defined in this application.

With the insight to better show the characteristics of the present disclosure~~invention~~, some preferred embodiments and examples are described hereafter referring to the enclosed drawings.

DESCRIPTION OF FIGURES

FIG. 1 shows the results of a taste panel experiment conducted on samples of cocoa beans that have been subjected to a natural fermentation process as compared to cocoa beans that have been fermented by using a microbial composition according to the invention.

FIG. 2 shows the results of a taste panel experiment conducted on i) chocolate prepared from naturally fermented cocoa beans; ii) chocolate prepared from cocoa beans that have been fermented by using a prior art starter culture; and iii) chocolate prepared from cocoa beans that have been fermented by using a starter culture according to the invention.

FIG. 3 shows the results of a taste panel experiment conducted on samples of cocoa beans that have been fermented by using a microbial composition according to the invention as compared to standard minimum and maximum acceptable taste ranges for cocoa.

FIG. 4 shows the results of a taste panel experiment conducted on samples of cocoa beans that have been fermented by using a microbial composition according to the invention and obtained in three different trials.

FIG. 5 shows the results of a polyphenol and epicatechin levels in cocoa beans that have been subjected to a natural fermentation process as compared to cocoa beans that have been fermented by using a microbial composition according to the invention. On FIG. 5 the polyphenols are expressed in % and the epicatechin is expressed in mg/g.

FIG. 6 shows the results of temperature profiles during the fermentation of cocoa beans that are fermented by using a microbial composition according to the invention in four different trials.

DESCRIPTION OF THE INVENTION

The present invention is directed to microbial starter cultures and uses and methods for regulating the fermentation of cocoa plant material, including cocoa beans and/or cocoa pulp.

The present starter cultures and methods allow for controlling or manipulating the development of desirable characteristics of the fermented cocoa beans and the cocoa products prepared there from. By means of example and not limitation, the present starter cultures method may