

Lipid activation with Seaweed

The present invention relates to a method for accelerating oxidation of a lipid composition for a use in the preparation of food flavoring compositions. Further aspects of the invention are the activated lipid composition as well as food compositions such as concentrated seasoning or flavoring products, condiments, sauces, gravies, ready-to-eat food products, beverage products or noodle products comprising such activated lipid compositions.

Oxidation of lipids is known to generate many natural flavour compounds. There is an interest in the food industry to make good use of those flavour compounds and to have them for example integrated into flavour reaction processes such as Maillard reactions, in order to enhance the generation of certain flavour notes, such as more meaty or fatty flavours.

Healthy eating is presently one of the main trends worldwide, and the food industry has a growing interest in the development of new food and beverage products having less fat, but still excellent organoleptic properties. Oil and Fat are important providers and carriers of taste and aroma, and it is difficult to maintain a similar good taste and aroma profile of a food product having little oil and fat than a same product having lots of oil and fat. For example, fried flavour is often associated with fat and seriously compromised in low fat products. Often, a lack of fried flavour is therefore compensated for by longer frying times of the oil product and at higher temperatures. However, such longer time and higher

temperature treatments of oils and fats may generate undesired, potentially carcinogenic by-products, which are not desired. Furthermore, the stability and shelf life of such highly degraded lipid products is reduced.

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Animal fats, such as beef or chicken fat, are usually treated in controlled thermal oxidation reactions and then used as precursors in a Maillard reaction process. But animal fat is not always easily oxidised and high
10 temperatures and long reaction times are required. Thus, the cost of processing is high and not sustainable for industrial production.

Sun B. et al. in Food Science, 2005, 26(4): 133-136,
15 disclosed a study of determining optimal processing conditions of tallow oxidation. Thereby, temperatures of 140°C and processing times of 3 hours and longer were required for the specific reaction conditions used.

20 Another method of fat activation is enzymatic hydrolysis which breaks down fat into free fatty acids and smaller fatty acid chains. However, this method is less effective in the generation of low molecular weight flavour compounds and hence less efficient than the classical
25 thermal activation of fat.

Furthermore, it is known in the art that certain metal ions such as Co, Cu, Fe, Mn or Ni ions can work as catalysts for accelerating the oxidation reaction of fat.
30 Evidence for this is for example provided by Belitz H.D. et al. in Food Chemistry, third revised Edition, pages 198-200. However, today's consumers clearly prefer food products that are made entirely with natural, authentic

and fresh ingredients. An addition of chemicals for providing metal ions into a food seasoning product is much less appreciated by consumers.

5 However, natural food ingredients rich in metal ions exist and are well known in the art. Garcia-Casal M.N. et al. in Journal of Nutrition, 2007, 137: 2691-2695, for example disclose that certain marine algae, collectively also named as seaweeds, contain high content of iron ions
10 reaching from 157 mg/100g to 196 mg/100g algae. Red mushroom as another alternative natural food ingredient source contains 235.1 mg/100g mushroom material (China Food Composition 2012 version, the 2nd Edition, p57, edited by National Institute of Nutrition and Food Safety,
15 China CDC).

There is still a persisting need in the food industry to find new and better solutions to reduce the fat and/or oil content of a food product and this without compromising or
20 reducing the natural taste and flavour provided for by that fat and/or oil.

There is also a persisting need in the food industry to find new and better solutions to oxidize lipids such as
25 oils and fats more efficiently, at lower temperatures and therefore more cost effective, and for shorter reaction times.

There is also a persisting need of enhancing the natural
30 flavour, e.g. the fried flavour, of a fat or oil composition through oxidation of the oil or fat in a more efficient way and at lower temperatures. Such fat or oil compositions can then be used in food products to reduce

the amount of fat or oil without reducing the organoleptic flavour impact.

The object of the present invention is to improve the state of the art and to provide an improved solution to overcome at least some of the inconveniences described above. Particularly, the object of the present invention is to provide a new process for lipid oxidation which is industrially feasible and more cost effective than known processes in the art, and where the process still relies on all natural and authentic ingredients.

The object of the present invention is achieved by the subject matter of the independent claims. The dependent claims further develop the idea of the present invention.

Accordingly, the present invention provides in a first aspect a method for accelerating oxidation of lipids comprising the step of holding a lipid composition in the presence of seaweed for a time period from 30 minutes to 6 hours at a temperature from 100°C to 160°C.

In a second aspect, the invention relates to a lipid composition obtainable by the method of the present invention.

A third aspect of the invention relates to a method for improving the flavor of a food composition comprising the step of adding the lipid composition of the present invention to said food composition, and then optionally further processing said food composition in a flavor reaction process, such as for example a Maillard reaction process, to result in a flavor reaction product.

A still further aspect is a food product comprising the lipid composition of the present invention or a flavor reaction product made with using the lipid composition of the present invention.

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The inventors have evaluated the use of iron provided in the form as a chemical and in the form of different natural sources as an ingredient for a use in the process of fat oxidation. Thereby, they have first observed that
10 iron ions when provided in free chemical form accelerate oxidation significantly. Evidence for this is provided below in Example 1, where an addition of 0.14 wt% ferrous gluconate increases the P-AV value from 0.33 (the negative control without iron) to a P-AV value of 2.48 (with the
15 iron). The addition of iron in an equivalent molar amount in the form of a natural source ingredient from e.g. red mushroom into the fat oxidation reaction had very little to no significant catalysis effect. As can be seen in the Example section, the P-AV value after the addition of red
20 mushroom increased only slightly to 0.63 in comparison to the negative control without iron.

However, it was surprisingly found by the inventors that when an equal molar amount of iron was provided to the fat
25 oxidation reaction in the form of a seaweed powder, the rate of fat oxidation increased dramatically. The most significant increases in the oxidation reaction were observed when seaweed powder from the green algae Chlorophyta of the species *Enteromorpha prolifera* and
30 *Enteromorpha clathrata* were used. But also powders from the *Laminaria*, a member of the brown algae *Phaeophyta*, more commonly known as kelp, showed a significant increase in the oxidation reaction over the control powder with red

mushroom. Further, even the powder from a Porphyra, a member of the red algae Rhodophyta, showed an increased oxidation reaction rate if compared to the red mushroom powder; and this although the powder from the Porphyra and
5 Laminaria comprised significantly less iron than the red mushroom powder. Details and further results are provided herein in the Example section below.

Therefore, oxidation of a lipid composition can now be
10 accelerated significantly in a simple and natural authentic way by adding food grade powder of seaweed to an activating heat treatment reaction with fat, oil and/or hydrolyzed fat. Thereby, on one hand the speed of the oxidation reaction will be accelerated and on a second
15 hand flavor and taste compounds and precursors thereof are produced more readily and more efficiently. The resulting activated lipid composition is therefore richer in natural flavor compounds. Furthermore, the activated lipid composition is also richer in natural precursors of still
20 further flavor compounds which can for example be activated by making use of such activated lipid composition as ingredient in further process flavor reactions. Evidence of this can be shown when the activated lipid composition of the present invention is
25 used as an ingredient in a further thermal Maillard reaction process and then incorporated into a food product.

Hence, the present invention is able to reduce the
30 temperature and time used for a thermal activation of fat or oil compositions. This results in more intense and new flavor rich activated lipid compositions. The fact that the lipid activation reaction can now be carried out at

lower temperatures, e.g. at and below temperatures of 160°C, preferably at 145°C and below, the reaction composition has to be heated much less and for less long. This results: i) in a much lesser loss of volatile low-molecular weight flavor compounds from the reaction composition during the thermal processing, and consequently a more flavor rich activated fat composition; and ii) in a reduction of processing costs due to less costs of energy for the heating reaction and saving of time due to the shorter processing reaction. Furthermore, the use of seaweed is very natural and does not be declared as a chemical compound. Seaweeds also have a very positive image with consumers, also in regard as a natural source of providing iron, and a use in food products is therefore very well appreciated.

Furthermore, the activated lipid composition is also richer in natural precursors of still further flavor compounds which can for example be activated by making use of such activated lipid composition as ingredient in still further process flavor reactions. Alternatively, the activated lipid composition can be used directly as such in food processing for example to make fried noodle products or oil containing concentrated seasoning products.

Brief Description of the Drawings

Figure 1: Plotted P-AV values of activated corn oil obtained with and without 5 wt% seaweed *Enteromorpha prolifera* at different temperatures for 2 hours.

Figure 2: Plotted P-AV values of activated corn oil with or without 5 wt% seaweed *Enteromorpha prolifera* at 130°C for different time periods.

Figure 3: Plotted P-AV values of activated corn oil with different amounts of seaweed *Enteromorpha prolifera* used during the activation step of the method.

Figure 4: Sensory profiling of the STB (savory thermal base) with activated fat of the present invention and with raw fat (Figure 4A with using beef fat; Figure 4B with using chicken fat).

Figure 5: The volatile flavour compounds of beef STB with 6% raw beef fat as a control are shown in Figure 5A; and the beef STB with 4% activated beef fat according to the present invention are shown in Figure 5B.

Detailed Description of the invention

The present invention pertains to a method for accelerating oxidation of lipids comprising a step of holding a lipid composition in the presence of a seaweed for a time period from 30 minutes to 6 hours at a temperature from 100°C to 160°C.

"The step of holding" refers to keeping, mixing, incubating a mixture of the lipid composition with the seaweed for the specified time period at the specified temperature; and "in the presence of" means herein "mixed with" or "in contact with".

The terms "lipid" or "lipids" are defined herein as a group of naturally occurring hydrophobic molecules including fatty acids, fats, oils, waxes, sterols and fat-soluble vitamins. Particularly, the terms refer herein to eatable fats and eatable oils, and a combination thereof.

"Fat" is herein defined as a triglyceride which is solid at normal room temperature; and "oil" is defined as a triglyceride which is liquid at normal room temperature.

- 5 The term "seaweed" refers herein to macroscopic, multicellular marine algae. Preferably, the term "seaweed" refers herein to red algae (Rhodophyta), brown algae (Phaeophyta) and green algae (Chlorophyta).
- 10 A "lipid composition" is a composition comprising lipids. Preferably, the lipid composition comprises at least 60wt% of dry weight fat, oil or a combination thereof. More preferably, the lipid composition comprises at least 75wt%, or even at least 85wt%, of dry weight fat, oil or a
15 combination thereof.

In a preferred embodiment of the present invention, the seaweed is present in the lipid composition in an amount of 0.1 to 15 wt% or 20 wt%, preferably however in an
20 amount of 0.5 to 10 wt%, more preferably in an amount of 2 to 6 or 7 wt%. The optimal catalytic efficiency, i.e. between costs of adding seaweed and oxidative yield, is between 2 and 6 wt% as exemplified below.

- 25 The temperature range of the present method is from 100°C to 160°C, but preferably from 120°C to 145°C.

The time period according to the present invention of holding the lipid composition in the presence of seaweed
30 at a temperature of at least 100°C is at least 30 minutes, preferably at least 1 hour, more preferably at least 1.5 hours, more preferably at least 2 hours. The shorter the

time period, the less volatile compounds are lost during the heating step and the less the process costs money.

In one embodiment of the present invention, the lipid is a fat, and the fat is an animal fat, preferably selected from beef fat, chicken fat, lamb fat, pork fat or milk fat.

In another embodiment of the present invention, the lipid is an oil. Preferably, the oil is from plant origin, and preferably selected from the group consisting of corn oil, olive oil, soybean oil, sunflower oil, peanut oil, walnut oil, palm oil, rattan pepper oil, rapeseed oil, and sesame oil, or a combination thereof. Those oils are advantageously used in the present invention for the preparation of culinary food products where they provide an enhanced organoleptic experience of fried and fatty flavors. Most preferably, the oil is sunflower oil. Frying typically leads to the formation of (E,E)-2,4-decadienal which is one of the key compound contributing to fried aroma. And (E,E)-2,4-decadienal is typically formed via lipid oxidation of linoleic fatty acid, which is the dominant fatty acid in sunflower oil.

In one embodiment, the method of the present invention comprises a step of hydrolyzing the lipid composition. Preferably, the lipid composition is hydrolyzed before the step of holding said composition at a temperature from 100°C to 160°C in the presence of a seaweed. The hydrolysis of the fat and/or oil before the oxidation step at a higher temperature has the advantage that the triglycerides and long fatty acid chains are at least partially degraded and provide a better source and access

to the following oxidation reaction with seaweed as a catalyst.

Preferably, the hydrolysis of the lipid composition is an enzymatic hydrolysis, preferably with making use of a lipase enzyme. Thereby, the enzymatic hydrolysis may be at a temperature from 40°C to 60°C, preferably from 45°C to 55°C. The advantage of using enzymatic hydrolysis over e.g. chemical or other physical hydrolysis methods is that a substantially complete hydrolysis of the lipid material can be obtained and this without the use of any harsh chemicals or other dangerous interventions. Furthermore, the hydrolysis reaction can be kept at relatively low temperatures to minimize the loss of any volatile low molecular weight flavor compounds present in the reaction and limiting the costs of heating such reaction volumes. The lipase enzyme for this enzymatic hydrolysis step may be for example Lipase S or Lipozyme TL from Novozymes, Validase lipase AN or Validase lipase MJ from DSM. The enzymes are typically added to the hydrolysis reaction in an amount from 100 to 1500 mg per 100 g of fat.

In a preferred embodiment of the present invention, the seaweed is selected from the group consisting of red algae (Rhodophyta), brown algae (Phaeophyta) and green algae (Chlorophyta), or a combination therefrom. More preferably, the seaweed is a green algae (Chlorophyta) selected from the genus *Ulvaria* or *Enteromorpha*. Most preferably, the seaweed is the green algae *Enteromorpha prolifera*.

In one embodiment, the seaweed is used in the present invention in a powdered form. This form of application of

the seaweed presents the most industrially practical and cost effective way of the present invention.

Another aspect of the present invention relates to a lipid
5 composition obtainable by the method as described above.

A still further aspect of the present invention pertains to a method for improving the flavor of a food composition comprising the step of adding the lipid composition of the
10 present invention to said food composition. Preferably, the food composition comprising the added lipid composition is further processed in a flavor reaction process, preferably in a Maillard reaction process, to result in a flavor reaction product.

15

The present invention also pertains to a food product comprising the lipid composition or the flavor reaction product of the present invention as described above. The food product can be a concentrated seasoning or flavoring
20 product, a condiment, a sauce, a gravy, a ready-to-eat food product, a beverage product or a noodle product. Preferably, the beverage product is a concentrated or ready-to-drink milk or coffee beverage.

25 Those skilled in the art will understand that they can freely combine all features of the present invention disclosed herein. In particular, features described for the method for accelerating oxidation of lipids of the present invention can be combined with the method for
30 improving the flavor of a food composition and with the product claims of a lipid composition and the food product of the present invention; and vice versa. Further,

features described for different embodiments of the present invention may be combined.

Further advantages and features of the present invention
5 are apparent from the figures and following examples.

Example 1:

Activation of fat: Method and Results

In a first step: Enzymatic hydrolysis of beef fat (tallow)
10 was carried out after the addition of 10 wt% water and 0.5 wt% lipase (Lipozyme TL 100L from Novozymes) to the fat and incubation at 45°C for 2.5 hours in a temperature controlled reaction vessel.

15 In a second step: Catalysts were added to the hydrolyzed beef fat as specified in Table I. The mixture was then thermally treated under the conditions as specified in Table I. Thereafter, the mixture, i.e. the activated fat composition, was cooled to room temperature.

20

The degree of fat oxidation in the activated fat composition was then determined according to the official method provided by the International Organization for Standardization (ISO 6885:2006(E)), i.e. by measuring the
25 presence of secondary oxidation products such as aldehydes and ketones by reacting them with *p*-Anisidine to form products that absorb at 350 nm wavelength of light. P-AV absorption values of the different mixtures were then determined, whereby the P-AV value is higher the more
30 secondary oxidation products have been built in the fat composition. A P-AV value close to 0 (zero) indicates an absence of secondary oxidation products and hence very little to no fat oxidation. A high P-AV value is

indicative to the amount of secondary oxidation products present in the fat mixtures and hence the degree of fat activation. The P-AV value results are indicated in Table I.

5

Table I

Results of fat activation are as follows:

Sample	Added catalyst	Reaction temperature	Reaction time	P-AV value
1	-none -	115°C	2.5 hours	0.33
2	Enteromorpha prolifera: powder, 5 wt%	115°C	2.5 hours	23.40
3	Porphyra marginata: powder, 5 wt%	115°C	2.5 hours	0.78
4	Laminaria japonica: powder, 5 wt%	115°C	2.5 hours	1.33
5	Enteromorpha clathrata: powder, 5 wt%	115°C	2.5 hours	15.96
6	Ferrous gluconate: 0.14 %	115°C	2.5 hours	2.48
7	Red mushroom powder: 5wt%	115°C	2.5 hours	0.63
8	-none -	125°C	2.5 hours	28.47
9	Enteromorpha prolifera: powder, 5 wt%	125°C	2.5 hours	45.66

All samples were reacted under air pumping of 2.5 L/min per 100g fat.

10

For each catalyst used in the present example, the proper content of iron was determined according to standard technique and is as shown in Table II.

5 Table II

Amounts of iron provided by the catalysts used in the samples in the fat activation process:

Sample	Added catalyst	Amount of iron provided with the catalyst in wt% of sample
1	-none -	0 wt%
2	Enteromorpha prolifera: powder, 5 wt%	0.014 wt%
3	Porphyra marginata: powder, 5 wt%	0.0027 wt%
4	Laminaria japonica: powder, 5 wt%	0.00023 wt%
5	Enteromorpha clathrata: powder, 5 wt%	0.014 wt%
6	Ferrous gluconate: 0.14 %	0.017 wt%
7	Red mushroom powder: 5wt%	0.012 wt%
8	-none -	0 wt%
9	Enteromorpha prolifera: powder, 5 wt%	0.014 wt%

Hence, samples 2, 5, 6, 7 and 9 all comprise about equimolar amounts of iron in the fat activation reaction. However, samples 3 and 4 comprise significantly less total amounts of iron.

5

The results indicate that free iron ions can act as a fat oxidation catalyst: P-AV value of sample 6, which comprises ferrous gluconate, is clearly elevated in comparison to the negative control sample 1, which does not comprise added iron. Red mushroom powder (sample 7), although comprising about the same amount of iron as sample 6 does not substantially act as a catalyst in this reaction.

15 It is evident from the above results, that powders from the different seaweeds as indicated in Table I (i.e. Samples 2-5) and comprising similar or even lower amounts of iron as samples 6 and 7, act as catalyst in the fat activation process. Particularly, it is evident from
20 samples 2 and 5, that seaweed powder from *Enteromorpha*, i.e. *Enteromorpha prolifera* and *Enteromorpha clathrata*, perform very well as catalyst and are the most preferred solutions of the present invention. Seaweed powder from the brown algae *Laminaria* (sample 4) performs also clearly
25 above the negative and the red mushroom powder control samples 1 and 7, as well as the powder from *Porphyra* (a red algae type); and this despite the fact that those seaweed powders comprise much lesser amounts of iron. Hence, all tested seaweed powders perform better as a
30 catalyst in the presented method for accelerating oxidation of a fat, than the use of another biological material, red mushroom powder, which has about the same

equimolar amount of iron as those powders from the green algae seaweeds.

These results are further confirmed at a reaction

- 5 temperature of 125°C, where sample 9 is still providing a better fat oxidation result than sample 8.

Example 2:

Method and Results of thermal processed activated plant 10 oils

Dried seaweed (*Enteromorpha prolifera*) was purchased from a local shop in Shanghai China, and milled to a fine powder. 5g seaweed powder was then added to 100g corn oil and sunflower oil respectively, as specified in Table III.

- 15 The mixtures were then thermally treated under the conditions as specified in Table III. Thereafter, the mixtures, i.e. the activated oil compositions, were cooled to room temperature.

- 20 The degree of oil oxidation in the activated oil compositions was then determined as P-AV values according to the official method provided by the International Organization for Standardization (ISO 6885:2006(E)) in the same way as described in Example 1. The results are
25 indicated in Table III.

Table III

Results of oil activation are as follows:

Sample	Added catalyst	Reaction temperature	P-AV value
1	Corn oil - no catalyst	130°C, 2h	10.47

2	Corn oil with seaweed		30.14
3	Sunflower oil - no catalyst	130°C, 40min	10.91
4	Sunflower oil with seaweed		25.98

All samples were reacted under air pumping of 1.5 L/min per 100g oil.

- 5 It is evident from the above result that seaweed performs well as a catalyst in the plant oil activation process. Comparing with sample 1, seaweed performed well as a catalyst for accelerating the oxidation of corn oil as shown in sample 2; and comparing with sample 3, seaweed
 10 accelerated the oxidation of sunflower oil as shown in sample 4.

Example 3:

Effect of seaweed as a catalyst to reaction temperature in the corn oil oxidation reaction
 15

The effect of the reaction temperature as to the acceleration of the oxidation reaction with and without the presence of seaweed (*Enteromorpha prolifera*) was determined. The same experimental process as described in
 20 Example 2 was used. The experiment was repeated in the same way as for sample 1 and sample 2 in Example 2, with the exception that the temperature of the activation reaction was varied between 110°C and 140°C. The P-AV value of the different reaction end-products were then
 25 determined as described above. The results are shown in Figure 1.

It can be concluded from those results that there is no difference between with and without seaweed at lower temperatures where no oxidation reaction took place. With the increase of temperature, however, it became evident
5 that seaweed acts as a catalyst for the oxidation reaction as the P-AV values of the sample with the presence of seaweed in the oil was significantly increased.

Example 4:

10 Effect of seaweed as a catalyst to reaction time for the corn oil oxidation reaction

The effect of the reaction time period as to the acceleration of the oxidation reaction with and without the presence of seaweed was determined. The same
15 experimental process as described in Example 2 was used. The experiment was repeated in the same way as for sample 1 and sample 2 in Example 2, with the exception that the reaction time period was varied from 40min to 3 hours. The P-AV value of the different reaction end-products were
20 then determined as described above. The results are shown in Figure 2.

It can be concluded from those results that quasi no oxidation reaction takes place for up to ca. 0.5 hours.
25 Thereafter, the oil oxidation of the sample with the presence of seaweed is significantly accelerated in comparison to the sample without the presence of seaweed.

Example 5:

30 Effect of dosage of seaweed to the acceleration of the corn oil oxidation reaction

The effect of different amounts of seaweed added to the corn oil activation reaction was determined. The same experimental process as described in Example 2 was used. The experiment was repeated in the same way as for sample 2 in Example 2, with the exception that the amount of added seaweed was varied between 2 and 15 wt%. The P-AV value of the different reaction end-products were then determined as described above. The results are shown in Figure 3.

It can be concluded from those results that the samples with an amount of 2 wt% seaweed or more are generating secondary oxidation products under 130°C for 2 hours. It further can be seen that in this specific experimental set-up a saturation of the catalytic effect is reached with the addition of about 5 wt%, or slightly above, of added seaweed to the reaction mixture. An optimal amount of seaweed can be determined for this reaction to be between ca. 2 wt% and 5 wt% of added seaweed.

Example 6:

Sensory evaluation of fried noodles with activated corn oil containing seaweed versus activated corn oil not containing seaweed

To verify the influence of the activated oil, the activated corn oil with or without seaweed was added as an ingredient into the fried noodles. The activated oil compositions were prepared in the same way as sample 1 and sample 2 of Example 2.

The preparation method of fried noodles is described as below: add 43g water and 10g activated corn oil (according to sample 1 or sample 2 of Example 2) into 100g wheat

powder to make a dough and then roll out the dough and slice it into noodles. Thereafter, the noodles are fried in palm oil at 180°C for ca. 2 min. The results are shown in Table IV: Sample A are the fried noodles containing the activated corn oil from sample 1 (without seaweed catalyst), and Sample B the fried noodles containing the activated corn oil from sample 2 (with seaweed catalyst).

Sample A and B were then evaluated and tasted by 10 panelists on 3 sensory attributes including fried aroma smell by the nose, fried flavor and crispy taste in the mouth. The evaluation was based on a direct comparison between Sample A and B by the panelists, and indicated as to their individual chosen preferences. It is evident from these results that Sample B, which comprises the seaweed activated oil, has a stronger fried aroma and flavor profile as Sample A which comprised the activated oil without seaweed catalyst.

Table IV

Sensory result of fried noodle:

Sensory Attributes	Number of Preference	
	Sample A	Sample B
Stronger fried aroma	2	8
Stronger fried flavor	1	9
More crispy	4	6

Example 7:

Sensory profiling of process flavors with activated versus non activated fat

To verify the influence of the activated fat composition when further used as an ingredient into a Maillard process flavor reaction, an activated beef fat composition, i.e. Sample 2 of Example 1, as well as a chicken fat

5 composition, prepared in the same way as Sample 2 but with chicken fat instead of beef fat, was added to the reaction mixture of a Maillard flavor reaction and further processed. For this, 4 wt% of the activated fat compositions per total reaction mixture was integrated
10 into a beef or chicken flavor seasoning reaction mixture as disclosed in document WO2012/080175A1, Example 1 and 2 respectively, and further processed as described in said document to obtain a savory thermal base (STB). Comparative results, with and without added activated fat
15 compositions, were then evaluated by a professional sensory panel and by GC-MS analysis. The results are shown in Figures 4 and 5, respectively.

As can be seen from Figure 4A, the beef flavor reaction
20 product with the corresponding activated beef fat expresses a significantly stronger and more pronounced meaty and fatty note than the corresponding reaction product without the addition of the activated beef fat. The same is true for the chicken flavor reaction product
25 as can be seen in Figure 4B. Therein, the activated chicken fat contributed significantly to the stronger chicken flavor note, full body and mouth coating, and meaty note than the corresponding reaction product without the addition of the activated chicken fat.

30

Example 8:

GC-MS analysis of process flavors with activated versus non activated fat

The samples as prepared for Example 7 were further analyzed for volatile compounds using GC-MS technology.

The volatiles compounds were sampled with an SPME-fibre
5 (75 μ m, carboxen/polydimethylsiloxane) and separated with a
gas chromatograph-mass spectrometer (Finnigan trace GC/MS,
Finnigan, USA). First, the beef STB was dissolved with
water at the dosage of 1.2g/100ml hot water. 3g solution
was weighted and placed in a 15ml vial. The vial was
10 sealed with PTFE/BYTL septum and equilibrated at 55°C for
30min, with the presence of SPME- fibre in the headspace.
After the equilibration time, the injection was conducted
in a split less mode for 3min at 250°C. The volatile
compounds were separated with a capillary column DB-WAX
15 (30 m $\times$ 0.25 mm $\times$ 0.25 μ m; J&W Scientific, Folsom, CA,
USA). The separation was performed as follows: the oven
temperature was held at 40°C for 3min, ramped to 100°C at
the rate of 5°C/min and then to 230°C at 12°C/min and
maintained at 230°C for 10min. Helium (99.999%) was used
20 as carrier gas at a linear velocity of 1.8ml/min. The
compounds were analysed by MS. Mass spectra was obtained
in the electron impact mode with an energy voltage of 70ev
and emission current of 35Ua. The detector was set at a
scanning range of 35-450m/z at a rate of 4.45scans/s.
25 Identification of the volatile compounds was carried out
by comparison of their mass spectra with the Wiley, NIST
and Replib libraries and also by comparing their Kovats
indices (KIs) with those of standard compounds and data
from the literature. Linear KIs of the compounds were
30 calculated, using a series of n-alkanes injected under the
same chromatographic conditions and compared with
available literature data.

The identified volatile compounds were quantified by GC/MS. The areas of the peaks were measured by calculating the total ion current.

- 5 These findings are confirmed in the GC-MS results as presented in Figures 5A and 5B. The volatile flavour compounds of beef STB with 6% raw beef fat as a control are shown in Figure 5A, while the beef STB with 4% activated beef fat according to the present invention are
10 shown in Figure 5B.

- The results showed that more volatile flavor compounds with stronger flavor intensity are released from the beef reaction product with the added activated beef fat
15 composition (Figure 5B), than where not activated beef fat was added (Figure 5A). Particularly, it could be observed that more aldehyde and furan compounds which contribute to a fatty and meaty flavor were released from the reaction product with the activated fat.

Claims

1. A method for accelerating oxidation of lipids comprising a step of holding a lipid composition in the presence of a seaweed for a time period from 30 minutes to 6 hours at a temperature from 100°C to 160°C, wherein the lipid composition comprises at least 60wt% of dry weight fat, oil or a combination thereof.
2. The method according to claim 1, wherein the seaweed is present in the lipid composition in an amount of 0.1 to 20 wt%, preferably in an amount of 0.5 to 10 wt%, more preferably in an amount of 2 to 7 wt%.
3. The method according to one of the claims 1-2, wherein the temperature ranges from 120°C to 145°C.
4. The method according to one of the claims 2-3, wherein the fat is an animal fat, preferably selected from beef fat, chicken fat, lamb fat, pork fat or milk fat.
5. The method according to one of the claims 2-4, wherein the oil is selected from corn oil, olive oil, soybean oil, sunflower oil, peanut oil, walnut oil, rattan pepper oil, rapeseed oil, sesame oil, or a combination thereof.
6. The method according to one of the claims 1-5, wherein the seaweed is a green algae (Chlorophyta), preferably selected from the genus Ulvaria or Enteromorpha.

7. The method according to one of the claims 1-6,
wherein the seaweed is *Enteromorpha prolifera*.
- 5 8. The method according to one of the claims 1-7,
wherein the seaweed is in a powdered form.
9. A lipid composition obtainable by the method
according to one of the claims 1-8.
- 10 10. A method for improving the flavor of a food
composition comprising the step of adding the lipid
composition of claim 9 to said food composition.
- 15 11. The method according to claim 10, wherein the food
composition comprising the added lipid composition is
further processed in a flavor reaction process,
preferably in a Maillard reaction process, to result
in a flavor reaction product.
- 20 12. A food product comprising the lipid composition of
claim 9 or the flavor reaction product of claim 11.
- 25 13. The food product according to claim 12, which is a
concentrated seasoning or flavoring product, a
condiment, a sauce, a gravy, a ready-to-eat food
product, a beverage product or a noodle product.