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(71) Applicant: NESTEC S.A. [CH/CH]; Avenue Nestlé 55,  
CH-1800 Vevey (CH).

(72) Inventors; and

(71) Applicants (for US only): KONG, Shuhua [CN/CN]; Flat  
602, No. 84, Lane 1728, South Hong Mei Road, Shanghai,  
200237 (CN). QIN, Lan [CN/CN]; Flat 301, No. 12, Lane  
138, RuShan Road, Shanghai, 200120 (CN).

(74) Agent: ZHONGZI LAW OFFICE; 7F, New Era Build-  
ing, 26 Pinganli Xidajie, Xicheng District, Beijing 100034  
(CN).

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(54) Title: LIPID ACTIVATION WITH SEAWEED

(57) Abstract: A method for accelerating oxidation of a lipid composition for a use in the preparation of food flavoring compositions, wherein the oxidation is accelerated due to the presence of a seaweed in the reaction mixture. The activated lipid composition can be used for food products, condiments, sauces, gravies, ready-to-eat food products, beverage products or noodle products.



## 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.

10

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 temperatures and long reaction times are required. Thus, the cost of processing is high and not sustainable for industrial production.

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Sun B. et al. in Food Science, 2005, 26(4): 133-136, 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

25

chains. However, this method is less effective in the generation of low molecular weight flavour compounds and hence less efficient than the classical thermal activation of fat.

5 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. Evidence for this is for example provided by Belitz H.D. et al. in Food Chemistry, third revised Edition, pages 198-200. However,

10 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.

15 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 reaching from 157 mg/100g to

20 196 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 2<sup>nd</sup> Edition, p57, edited by National Institute of Nutrition and Food Safety, 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 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 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 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  
5 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  
10 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  
15 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  
20 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.

5

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 iron ions  
10 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 iron). The addition of iron  
15 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 mushroom increased only slightly to 0.63  
20 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 oxidation reaction in the form of a seaweed powder, the rate  
25 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 *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 *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 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 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 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 used as an ingredient  
5 in a further thermal Maillard reaction process and then incorporated into a food product.

Hence, the present invention is able to reduce the temperature and time used for a thermal activation of fat or oil  
10 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  
15 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  
20 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  
5 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  
10 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.

15 "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".

20 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  
25 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 combination thereof.

15

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 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.

20

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  
5 the lipid composition in the presence of seaweed 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  
10 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.

15

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,  
20 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  
25 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.

5

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

10 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  
15 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

20 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  
25 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  
5 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.

10 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  
15 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  
20 seaweed presents the most industrially practical and cost effective way of the present invention.

Another aspect of the present invention relates to a lipid 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 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.

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 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.

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 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 are apparent from the figures and following examples.

5

**Example 1:**

Activation of fat: Method and Results

In a first step: Enzymatic hydrolysis of beef fat (tallow) was carried out after the addition of 10 wt% water and 0.5 wt%

10 lipase (Lipozyme TL 100L from Novozymes) to the fat and incubation at 45°C for 2.5 hours in a temperature controlled reaction vessel.

In a second step: Catalysts were added to the hydrolyzed beef fat as specified in Table I. The mixture was then thermally

15 treated under the conditions as specified in Table I.

Thereafter, the mixture, i.e. the activated fat composition, was cooled to room temperature.

The degree of fat oxidation in the activated fat composition

20 was then determined according to the official method provided by the International Organization for Standardization (ISO

6885:2006(E)), i.e. by measuring the presence of secondary oxidation products such as aldehydes and ketones by reacting them with *p*-Anisidine to form products that absorb at 350 nm

25 wavelength of light. P-AV absorption values of the different

mixtures were then determined, whereby the P-AV value is higher the more 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.

10 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<br>prolifera: powder, 5<br>wt% | 125°C | 2.5 hours | 45.66 |

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

For each catalyst used in the present example, the proper

5 content of iron was determined according to standard technique and is as shown in Table II.

Table II

Amounts of iron provided by the catalysts used in the samples

10 in the fat activation process:

| Sample | Added catalyst                              | Amount of iron<br>provided with the<br>catalyst in wt% of<br>sample |
|--------|---------------------------------------------|---------------------------------------------------------------------|
| 1      | -none -                                     | 0 wt%                                                               |
| 2      | Enteromorpha<br>prolifera: powder, 5<br>wt% | 0.014 wt%                                                           |
| 3      | Porphyra marginata:<br>powder, 5 wt%        | 0.0027 wt%                                                          |
| 4      | Laminaria japonica:<br>powder, 5 wt%        | 0.00023 wt%                                                         |
| 5      | Enteromorpha<br>clathrata: powder, 5<br>wt% | 0.014 wt%                                                           |
| 6      | Ferrous gluconate:                          | 0.017 wt%                                                           |

|   |                                             |           |
|---|---------------------------------------------|-----------|
|   | 0.14 %                                      |           |
| 7 | Red mushroom powder:<br>5wt%                | 0.012 wt% |
|   |                                             |           |
| 8 | -none -                                     | 0 wt%     |
| 9 | Enteromorpha<br>prolifera: powder, 5<br>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.

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.

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 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  
5 clearly 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 catalyst in the  
10 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.

15 These results are further confirmed at a reaction 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 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. The mixtures were  
25 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.

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

5 described in Example 1. The results are 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      |

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

It is evident from the above result that seaweed performs well as a catalyst in the plant oil activation process. Comparing  
 15 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 accelerated the oxidation of sunflower oil as shown in sample 4.

### 20 **Example 3:**

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

The effect of the reaction temperature as to the acceleration of the oxidation reaction with and without the presence of  
 25 seaweed (*Enteromorpha prolifera*) was determined. The same

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 temperature of the activation reaction was varied between 110°C and 140°C.

5 The P-AV value of the different reaction end-products were then determined as described above. The results are shown in Figure 1.

10 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 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  
15 oil was significantly increased.

#### **Example 4:**

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

20 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 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,  
25 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 then determined as described above. The results are shown in Figure 2.

30 It can be concluded from those results that quasi no oxidation reaction takes place for up to ca. 0.5 hours. 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:**

5    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.

10   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.

15

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.

25

**Example 6:**

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

30   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  
5 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  
10 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  
15 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  
20 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<br>flavor | 1                    | 9        |
| More crispy              | 4                    | 6        |

25

**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

5 reaction, an activated beef fat composition, i.e. Sample 2 of Example 1, as well as a chicken fat 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

10 activated fat compositions per total reaction mixture was integrated 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  
15 results, with and without added activated fat compositions, were then evaluated by a professional sensory panel and by GC-MS analysis. The results are shown in Figures 4 and 5, respectively.

20 As can be seen from Figure 4A, the beef flavor reaction 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  
25 chicken flavor reaction product 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.

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**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.

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The volatiles compounds were sampled with an SPME-fibre (75µm, 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 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 (30 m × 0.25 mm × 0.25µm; 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

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230°C at 12°C/min and maintained at 230°C for 10min. Helium (99.999%) was used 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.

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 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.

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 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 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  
5 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  
5 a seaweed for a time period from 30 minutes to 6 hours at  
a temperature from 100°C to 160°C.
2. The method according to claim 1, wherein the lipid  
composition comprises at least 60wt% of dry weight fat,  
10 oil or a combination thereof.
3. The method according to claim 1 or 2, 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  
15 preferably in an amount of 2 to 7 wt%.
4. The method according to one of the claims 1-3, wherein  
the temperature ranges from 120°C to 145°C.
- 20 5. The method according to one of the claims 2-4, wherein  
the fat is an animal fat, preferably selected from beef  
fat, chicken fat, lamb fat, pork fat or milk fat.
- 25 6. 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.

7. The method according to one of the claims 1-6, comprising  
5 a step of hydrolyzing the lipid composition.

8. The method according to one of the claims 1-7, wherein  
the seaweed is a green algae (Chlorophyta), preferably  
selected from the genus *Ulvaria* or *Enteromorpha*.

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9. The method according to one of the claims 1-8, wherein  
the seaweed is *Enteromorpha prolifera*.

10. The method according to one of the claims 1-9, wherein  
15 the seaweed is in a powdered form.

11. A lipid composition obtainable by the method according to  
one of the claims 1-10.

20 12. A method for improving the flavor of a food composition  
comprising the step of adding the lipid composition of  
claim 11 to said food composition.

13. The method according to claim 12, wherein the food  
25 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.

14. A food product comprising the lipid composition of claim  
5 11 or the flavor reaction product of claim 13.

15. The food product according to claim 14, which is a  
concentrated seasoning or flavoring product, a condiment,  
a sauce, a gravy, a ready-to-eat food product, a beverage  
10 product or a noodle product.

Figure 1:

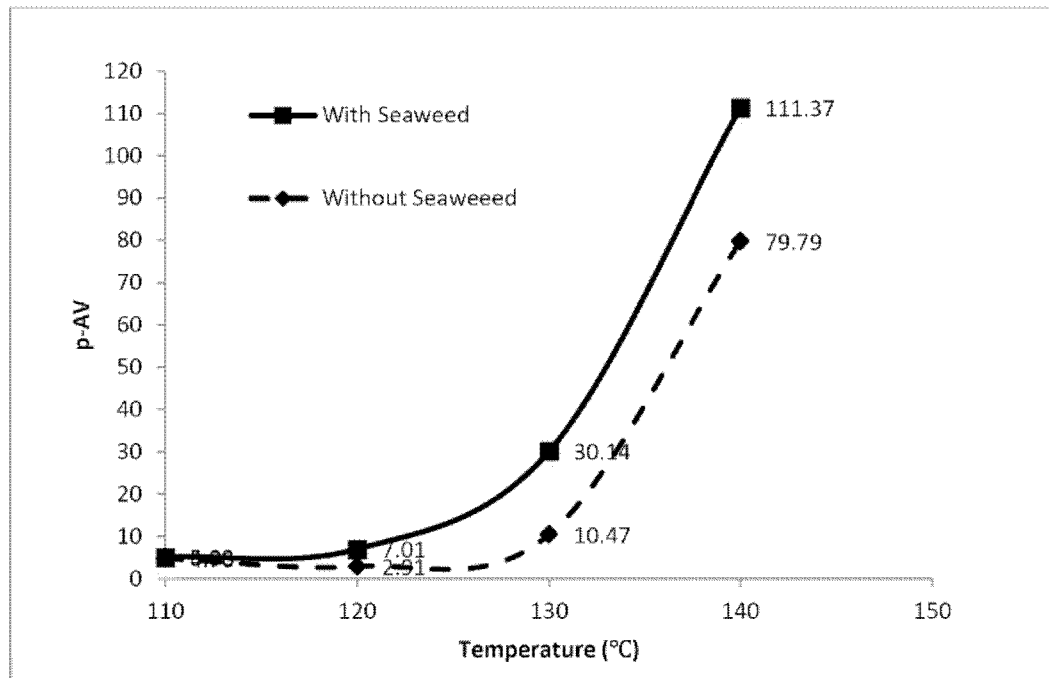


Figure 2:

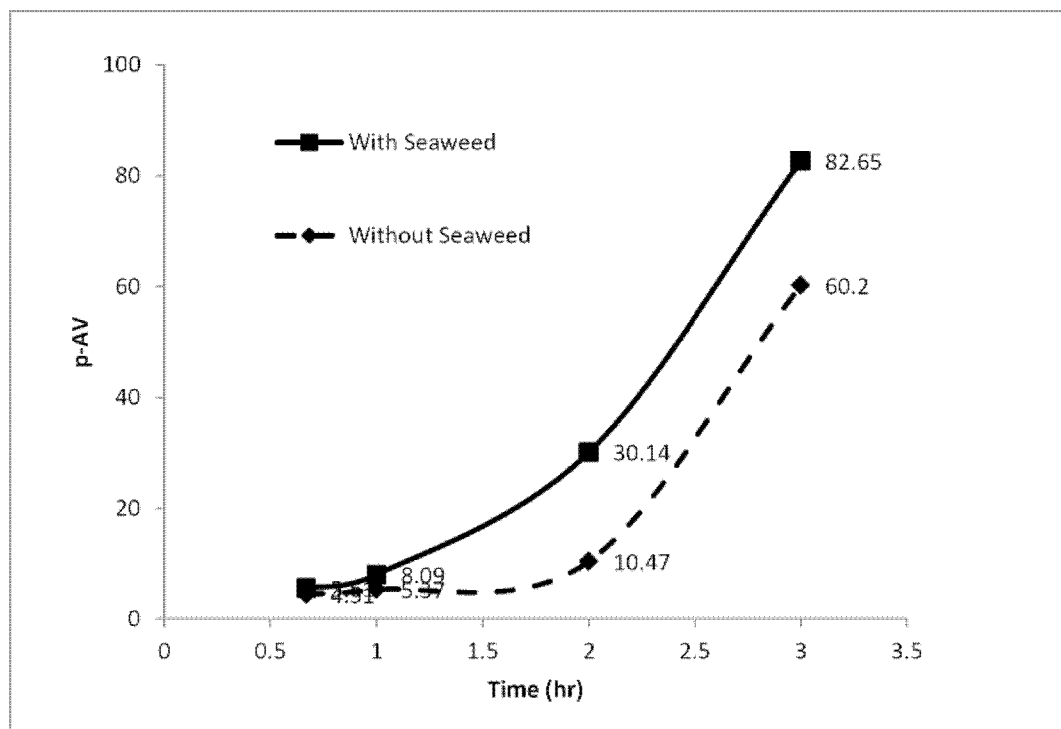


Figure 3:

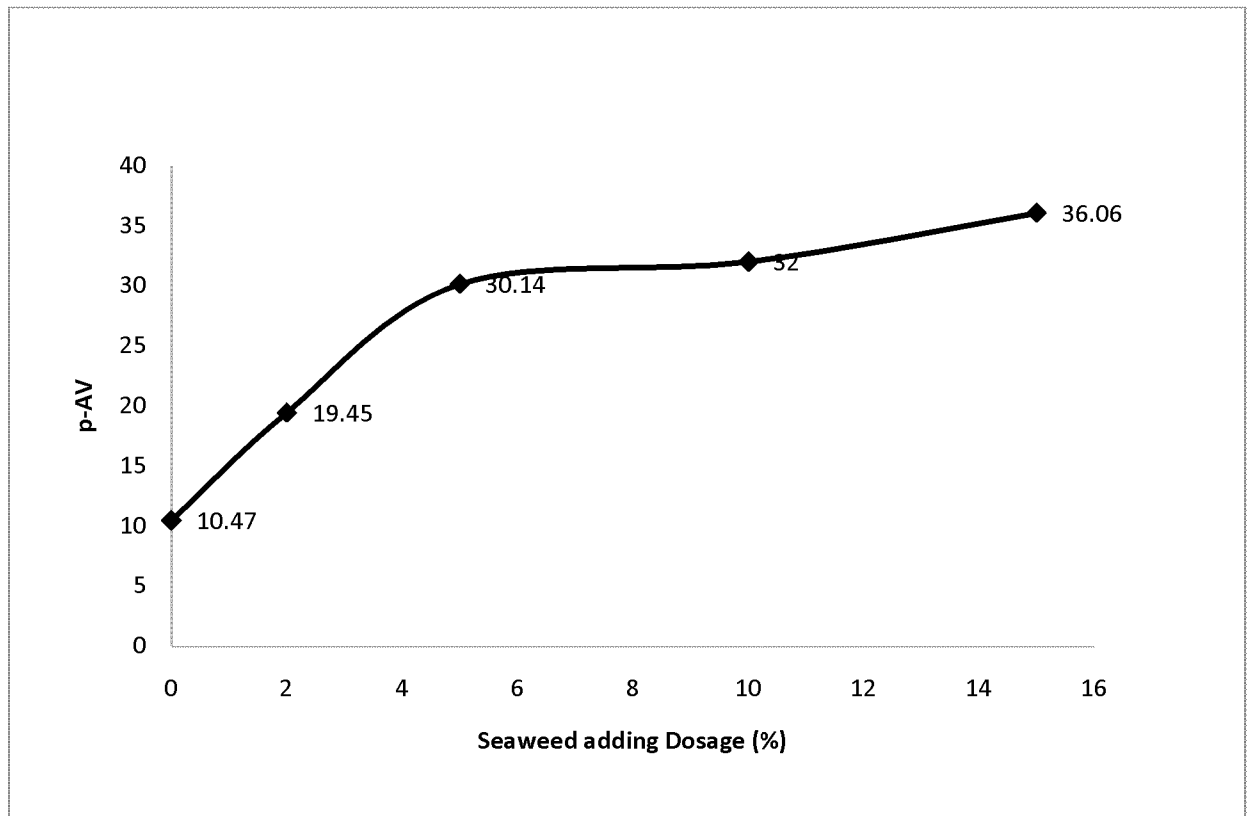
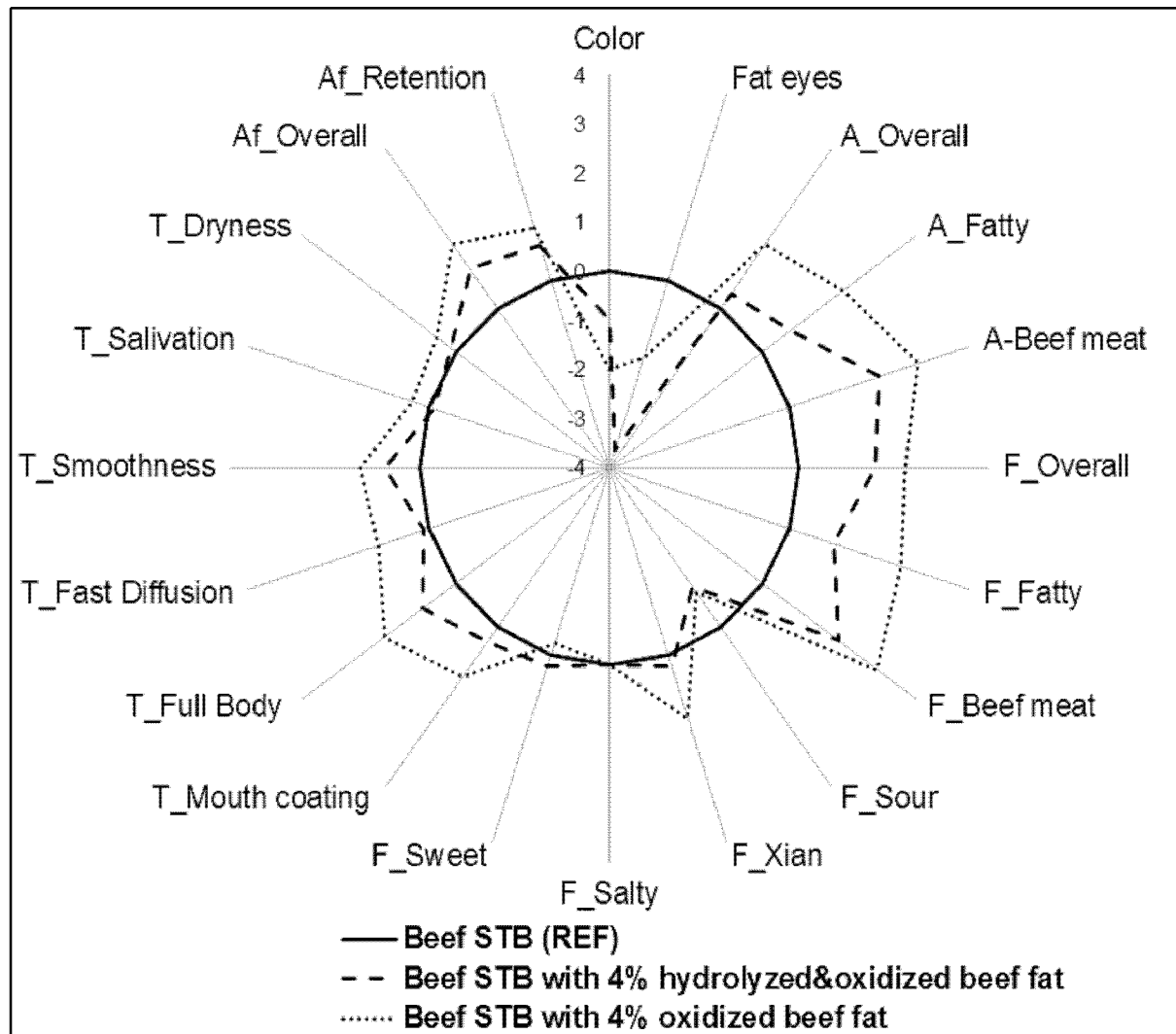
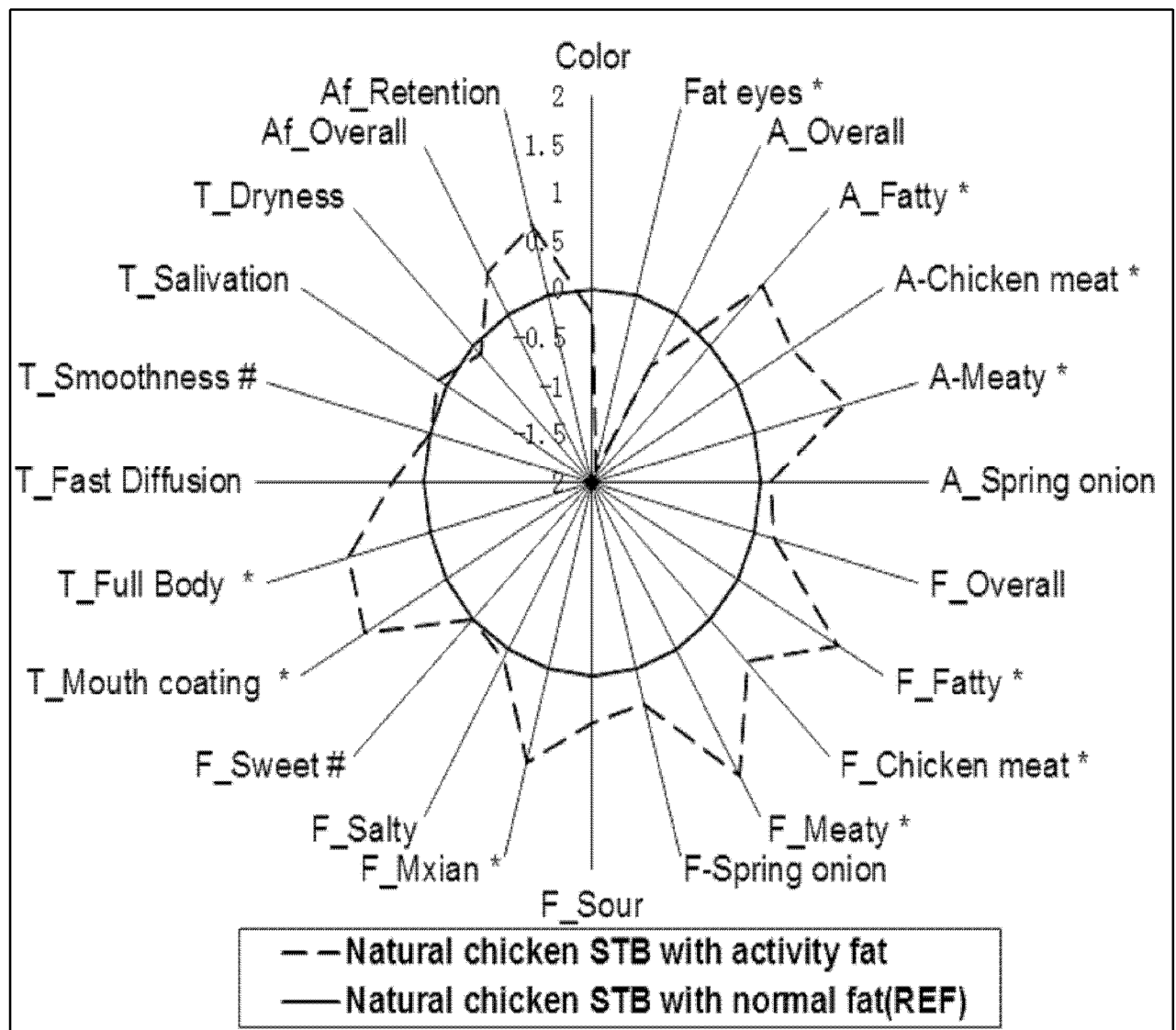


Figure 4A:



STB means: Savory thermal base

Figure 4B:



STB means: Savory thermal base

Figure 5A:

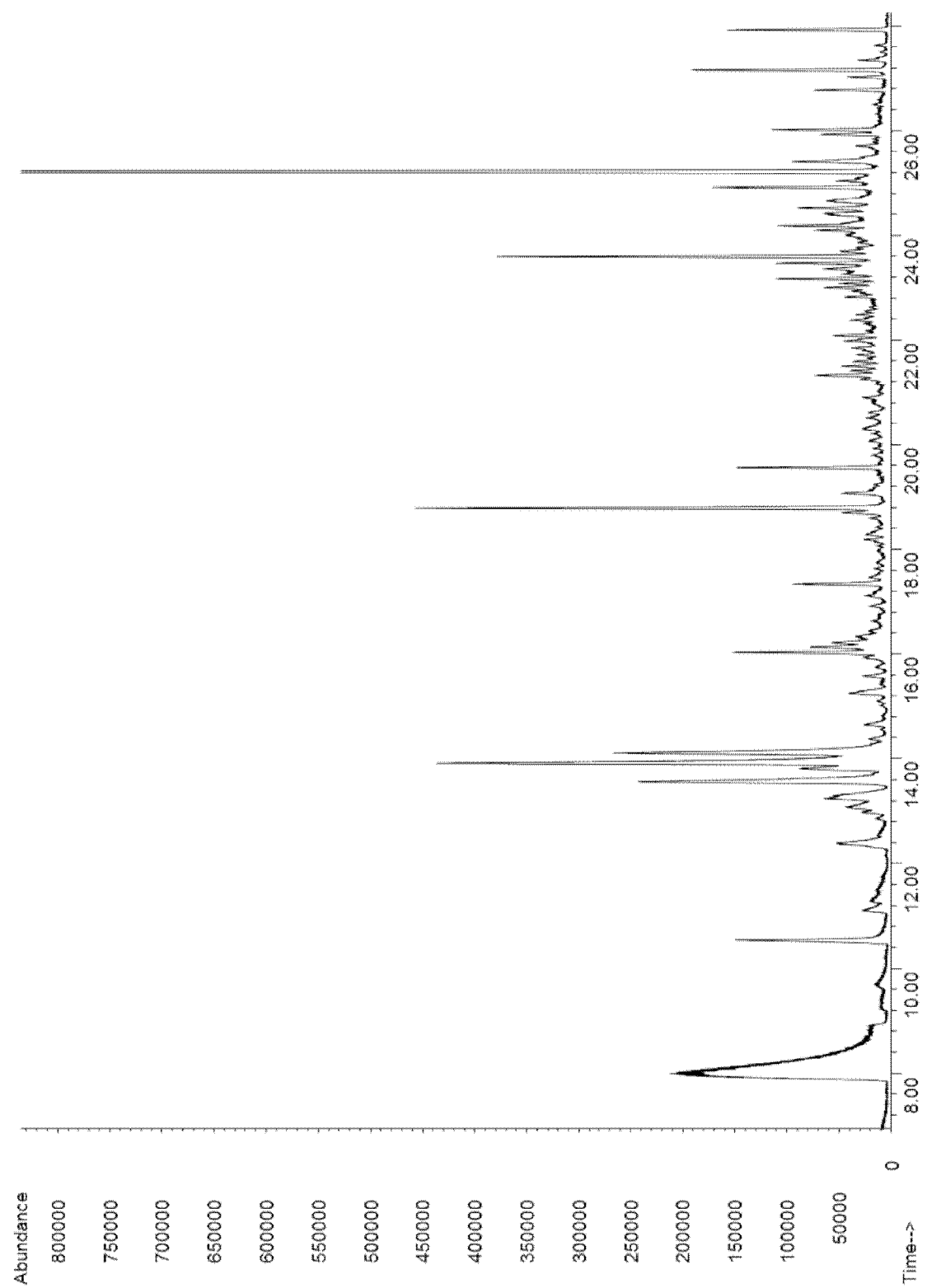
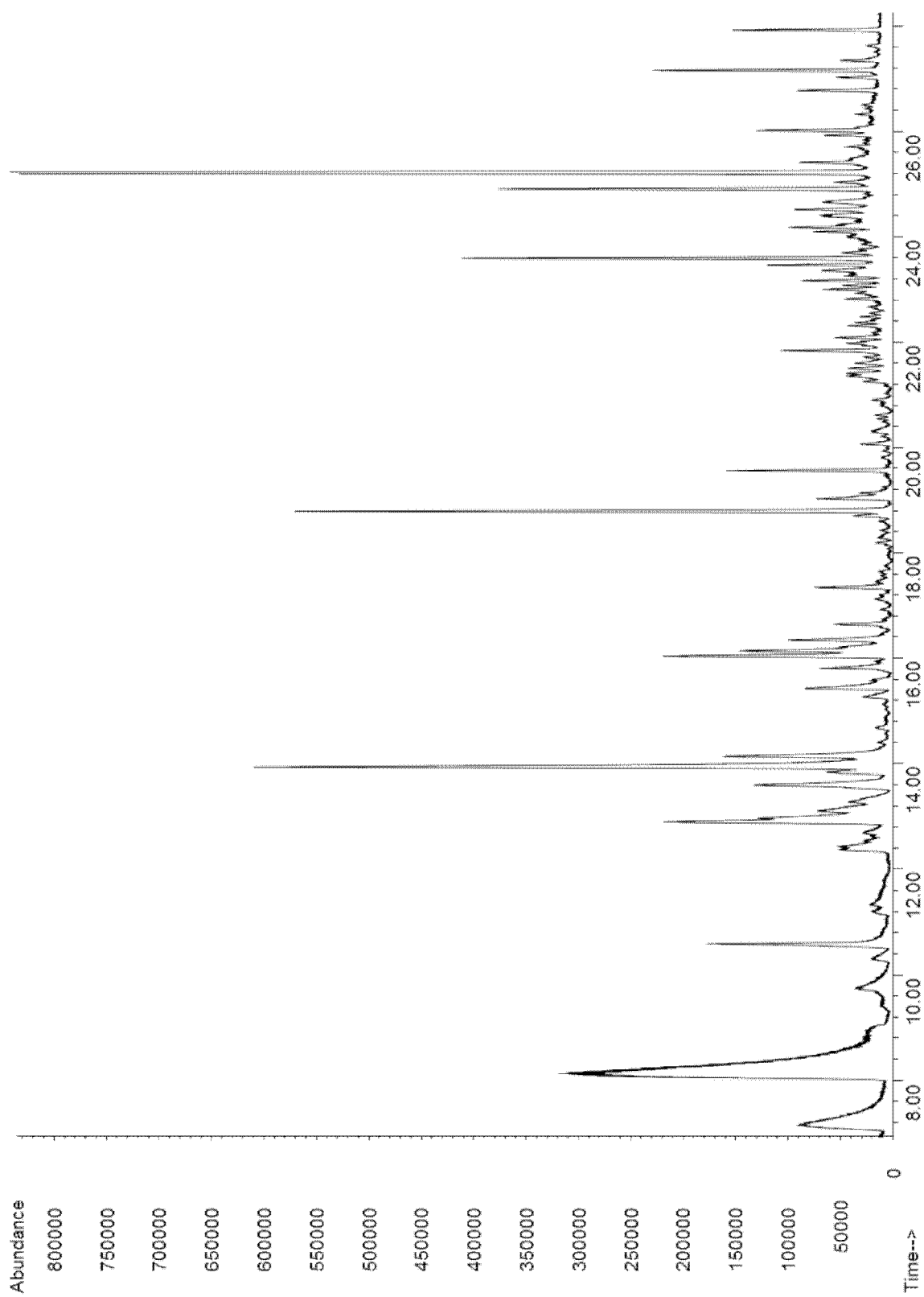


Figure 5B:



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2015/072845

**A. CLASSIFICATION OF SUBJECT MATTER**

A23L 1/29(2006.01)i; A23D 7/04(2006.01)i; C11B 5/00(2006.01)i

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

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

A23L A23D C11B

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNABS, CPRSABS, CNKI, DWPI, SIPOABS, GOOGLE SCHOLAR: lipid, fat, oil, oxidiz+, oxidat+, oxidaz+, accelerat+, increas+, improv+, seaweed, algae, rhodophyta, phaeophyta, chlorophyta, enteromorpha prolifera, porphyra marginata, laminaria japonica, enteromorpha clathrata, catalyst, ferrous, iron, mailard, essence, flavor, flavour, spice

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                                     | Relevant to claim No. |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| E         | WO 2015058330 A1 (NESTEC SAET AL.) 30 April 2015 (2015-04-30)<br>claims 1-15. description, page 7, line 15 to line 18, and page 8, line 27 to line 28. | 1-15                  |
| A         | CN 104872726 A (FUJIAN ANJING FOOD CO LTD ETC) 02 September 2015 (2015-09-02)<br>see the whole text                                                    | 1-15                  |
| A         | US 2014295047 A1 (KEMIN IND INC) 02 October 2014 (2014-10-02)<br>see the whole text                                                                    | 1-15                  |
| A         | JP 2004305020 A (NIKONIKO NORI KK) 04 November 2004 (2004-11-04)<br>see the whole text                                                                 | 1-15                  |

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

\* Special categories of cited documents:

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

“E” earlier application or patent but published on or after the international filing date

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

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

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

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

“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

“&” document member of the same patent family

Date of the actual completion of the international search

30 October 2015

Date of mailing of the international search report

10 November 2015

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P.R.CHINA  
6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing  
100088, China

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Authorized officer

LIU, Yang

Telephone No. (86-10)62411057

**INTERNATIONAL SEARCH REPORT**  
**Information on patent family members**

International application No.

**PCT/CN2015/072845**

| Patent document<br>cited in search report |            |    | Publication date<br>(day/month/year) | Patent family member(s) |            |    | Publication date<br>(day/month/year) |
|-------------------------------------------|------------|----|--------------------------------------|-------------------------|------------|----|--------------------------------------|
| WO                                        | 2015058330 | A1 | 30 April 2015                        | None                    |            |    |                                      |
| CN                                        | 104872726  | A  | 02 September 2015                    | None                    |            |    |                                      |
| US                                        | 2014295047 | A1 | 02 October 2014                      | US                      | 2012183654 | A1 | 19 July 2012                         |
|                                           |            |    |                                      | WO                      | 2012099958 | A1 | 26 July 2012                         |
|                                           |            |    |                                      | CA                      | 2824990    | A1 | 26 July 2012                         |
| JP                                        | 2004305020 | A  | 04 November 2004                     | None                    |            |    |                                      |