

PROCESS FOR REMOVING UNWANTED PROPANOL COMPONENTS FROM UNUSED TRIGLYCERIDE OIL

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TECHNICAL FIELD OF THE INVENTION

The present invention relates to a process for removing unwanted propanol components from unused triglyceride oil, said unwanted propanol components being selected from free chloropropanols, chloropropanol fatty acid esters, free epoxypropanols, epoxypropanol fatty acid esters, and combinations thereof. The present method comprises the steps of contacting a triglyceride oil that is contaminated with the aforementioned unwanted propanol components with an adsorbent, followed by the recovery of a decontaminated triglyceride oil having a reduced concentration of the unwanted propanol components

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BACKGROUND OF THE INVENTION

Free 3-monochloropropane-1,2-diol (3-MCPD) has been identified as a contaminant for a long time in various foods like liquid seasoning or bakery goods heated to high temperatures. This substance is formed when fat- and salt-containing foods are processed at high temperatures. In animal experiments 3-MCPD has led to an increase in the cell count (hyperplasia) in renal tubules and, at higher levels, it triggered benign tumours. No genotoxic effect was observed. It can, therefore, be assumed that the tumours observed in the long-term animal study (mainly benign) only occur above a threshold value. There are no findings from human studies.

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Recent studies have identified 3-MCPD fatty acid esters in refined edible fats and in fat-containing foods. 3-MCPD esters are compounds of 3-MCPD and various fatty acids which are formed at high temperatures under hydration following a reaction between fats and chloride ions. Studies by the food control authorities in Baden-

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Württemberg showed that all refined vegetable oils and fats contain 3-MCPD fatty acid esters. Only oil that had not undergone any heat treatment (e.g. native olive oil) did not contain the substance.

3-MCPD fatty acid esters are formed at high temperatures, probably during the deodorisation of edible fats and oils, the last stage in refinement, during which undesirable odorous and taste-bearing substances are removed. Besides 3-MCPD fatty acid esters also 1,3-dichloropropane-2-ol (1,3-DCPO) fatty acid esters have been
5 identified in heat processed foods.

It has been hypothesized that 2,3-epoxy-1-propanol is an important intermediate in the formation of 3-MCPD and 1,3-DCPO. It is plausible that the same holds for the fatty acid esters of these propanols.

No toxicological data are available on 3-MCPD fatty acid esters, nor for that
10 matter on any of the other above mentioned propanol fatty acid esters. Nonetheless, it would be desirable to have available a simple, mild, but effective process for the removal of these unwanted propanol fatty acid esters.

15 SUMMARY OF THE INVENTION

The inventors have developed a process that enables the effective removal of chloropropanol components from triglyceride oils, said unwanted propanol components being selected from free chloropropanols, chloropropanol fatty acid esters, free
20 epoxypropanols, epoxypropanol fatty acid esters, and combinations thereof, and said process comprising:

- contacting a triglyceride oil that is contaminated with unwanted propanol components with a silicate adsorbent selected from the group consisting of magnesium silicate, calcium silicate, aluminum silicate and combinations of these
25 silicates; and
- recovering a decontaminated triglyceride oil having a reduced concentration of the unwanted propanol components.

The present process is used to treat unused triglyceride oil in order to remove the unwanted propanol components before the oil is used in food preparation.

30 The use of silicate adsorbents for regenerating used frying oils is known and described in the following patent documents: US 4,681,769 (Reagent Chemical & Research Company); US 4,735,815 (Harshaw/Filtrol); US 5,597,600 (The Dallas

Group of America); US 6,187,355 (The University of Georgia Research Foundation, Inc.); US 2007/0154602 (Michael C. Withiam).

The oil refining process of the present invention offers the advantage that it enables the selective removal of the unwanted propanol components. Free fatty acid levels, for instance, are not greatly affected by the present process. The present process can be carried out using standard equipment that is readily available in oil processing factories. Furthermore, the present process can be carried out under mild conditions, e.g. at relatively low temperatures. Finally, the present process offers the advantage that it does not adversely effect the stability of the triglyceride oil

The present invention also encompasses the use of the aforementioned silicate adsorbent for reducing the concentration of unwanted propanol components in triglyceride oils, said unwanted propanol components being selected from free chloropropanols, chloropropanol fatty acid esters, free epoxypropanols, epoxypropanol fatty acid esters, and combinations thereof.

DETAILED DESCRIPTION OF THE INVENTION

Accordingly, one aspect of the present invention relates to process for removing unwanted propanol components from unused triglyceride oil, said unwanted propanol components being selected from free chloropropanols, chloropropanol fatty acid esters, free epoxypropanols, epoxypropanol fatty acid esters, and combinations thereof, and said process comprising:

- contacting a triglyceride oil that is contaminated with unwanted propanol components with a silicate adsorbent selected from the group consisting of magnesium silicate, calcium silicate, aluminum silicate and combinations of these silicates; and
- recovering a decontaminated triglyceride oil having a reduced concentration of the unwanted propanol components

The term "oil" whenever used herein encompasses both oils that are liquid at ambient temperature and oils that are solid at ambient temperature (fats).

The term “unused” as used herein in relation to triglyceride oil refers to a triglyceride oil that has not been used in the preparation of food, e.g. as a frying medium.

In the present process the contacting of the contaminated triglyceride oil with the silicate adsorbent may be realized by mixing liquid or liquefied triglyceride oil with a particulate silicate adsorbent. Alternatively, the contacting (and subsequent recovery) may be achieved by passing the contaminated triglyceride oil through a porous bed of silicate adsorbent.

The present process advantageously employ a highly porous silicate adsorbent. Preferably, the silicate adsorbent has a surface area (B.E.T.) of at least 100 m²/g, more preferably the silicate adsorbent has a surface area (B.E.T.) of 200-800 m²/g.

According to another preferred embodiment the silicate employed is a particulate material. Typically, the silicate adsorbent is a powder having a mass weighted average diameter in the range of 3-200 µm. Even more preferably the powder has a mass weighted average diameter in the range 20-150 µm, most preferably in the range of 50-100 µm.

Particularly good results can be obtained with the present process when a neutral or basic silicate adsorbent is employed. Thus, in accordance with a preferred embodiment of the invention the silicate adsorbent has a pH of 7-10.8, more preferably a pH of 7.8-10.0, said pH being measured in a 10% (w/w) suspension of the silicate adsorbent in water.

The present process can use different types of silicate adsorbents, of which magnesium silicate is most preferred. In accordance with a particularly preferred embodiment, the magnesium silicate is an amorphous synthetic magnesium silicate, preferably an amorphous synthetic hydrous magnesium silicate.

The magnesium silicate employed in accordance with the present invention preferably contains at least 8 wt.% MgO and at least 40 wt.% SiO₂ on an ignited basis. Even more preferably, the magnesium silicate contains 12% MgO and at least 50% SiO₂ on an ignited basis. Typically, MgO and SiO₂ together represent at least 60 wt.% of the magnesium silicate.

In accordance with another preferred embodiment, the magnesium silicate contains MgO and SiO₂ in a mole ratio of 1:1.3 to 1:5, more preferably in a mole ratio of 1:1.8 to 1:4.

The magnesium silicate used in accordance with the invention typically exhibits a loss on drying at 105 °C of not more than 20 wt.%, more preferably of not more than 15%.

The magnesium silicate suitably exhibits a loss on ignition at 900 °C (dry basis)
5 of not more than 20 wt.%, more preferably of not more than 20%.

The benefits of the present process are particularly evident in case the contaminated triglyceride oil contains substantial levels of unwanted chloropropanol components. Thus, in a particularly advantageous embodiment of the invention the contaminated oil contains the unwanted chloropropanol components in a concentration
10 that is equivalent to at least 100 µg/kg, more preferably at least 200 µg/kg, and most preferably at least 300 µg/kg of non-esterified chloropropanol components. A suitable analytical method for determining the latter concentration is described in R. Weisshaar, *“Determination of total 3-chloropropane-1,2-diol (3-MCPD) in edible oils by cleavage of MCPD esters with sodium methoxide”*, Eur. J. Lipid Sci. Technol. (2008) 110, 183-
15 186. Improved analytical methods for the quantitative determination of 3-MCPD in triglyceride oils are currently being developed and validated.

In the present process the concentration of unwanted chloropropanol components is advantageously reduced to a level that is below the equivalent of 300 µg/kg of non-esterified chloropropanol components. More preferably, the present
20 process yields a decontaminated triglyceride oil containing chloropropanol components in a concentration that is below the equivalent of 200 µg/kg, even more preferably below the equivalent of 100 µg/kg, and most preferably below the equivalent of 50 µg/kg of non-esterified chloropropanol components.

In accordance with a particularly beneficial embodiment of the invention, the
25 unwanted propanol components that are removed by the present process are selected from the group consisting of 3-monochloropropane-1,2-diol (3-MCPD), 2-monochloropropane-1,3-diol (2-MCPD), 1,3-dichloropropane-2-ol (1,3-DCPO) and 1,2-dichloropropane-3-ol (1,2-DCPO), 3-MCPD fatty acid esters, 2-MCPD fatty acid esters, 1,3-DCPO fatty acid esters, 1,2-DCPO fatty acid esters and combinations
30 thereof. Even more preferably, the unwanted propanol components are selected from 2-MCPD fatty acid esters, 3-MCPD fatty acid esters, 1,3 DCPO fatty acid esters and 1,2-DCPO fatty acid esters and combinations thereof. Most preferably, the unwanted propanol components are 3-MCPD fatty acid esters.

In the present process the total MCPD fatty acid ester content of the triglyceride oil is usually reduced by at least 30%, most preferably it is reduced by at least 50%; said reduction corresponding to the decrease in MCPD fatty acid ester content that is achieved in the decontaminated triglyceride oil relative to the contaminated triglyceride oil starting material. Here “the total MCPD fatty acid ester content” refers to the cumulative concentration of 3-MCPD fatty acid esters and 2-MCPD fatty acid esters. According to a particularly preferred embodiment of the present process, the 3-MCPD content of the triglyceride oil is reduced by at least 50%.

The total DCPO fatty acid ester content of the triglyceride oil is typically reduced by at least 30%, and most preferably by at least 50%. Here “the total DCPO fatty acid ester content” refers to the cumulative concentration of 1,3-DCPO fatty acid esters and 1,2-DCPO fatty acid esters.

The present method enables the effective removal of epoxypropanol components, e.g. epoxypropanol components selected from the group consisting of 2,3-epoxy-1-propanol, 2,3-epoxy-1-propanol fatty acid esters and combinations thereof. The latter epoxypropanol components are believed to be important intermediates in the formation of chloropropanols. It has been shown that in the presence of water and chloride ions, 2,3-epoxy-1-propanol is rapidly converted in 3-MCPD. Thus, removal of the epoxypropanol components from triglyceride oil can prevent the formation of chloropropanol components.

As explained herein before, the present process offers the advantage that it enables the selective removal of unwanted propanol components. Thus, unexpectedly the levels of free fatty acids are not greatly affected by the present process. Accordingly, in the present process the free fatty acid content of the decontaminated triglyceride oil is preferably not more than 0.5 wt.% lower than the free fatty acid content of the contaminated triglyceride oil. Likewise, in the present process the free fatty acid content of the triglyceride oil is preferably reduced by not more than 60%, more preferably by not more than 50% and most preferably by not more than 40%.

The triglyceride oil that is treated in accordance with the present process typically contains at least 80 wt.%, more preferably at least 90 wt.% of triglycerides.

The present process is suitably carried out in an oil processing plant, e.g. as one of the final stages of oil refining. Most preferably the present process is used as a

deodorized contaminated triglyceride oils as a starting material as the levels of unwanted propanol components is especially high in deodorized triglyceride oils.

As explained herein before, the present process is used to remove unwanted propanol components from contaminated triglyceride oil, before the triglyceride oil is used in the preparation of foods. Thus, the contaminated triglyceride oil that is used a starting material in the process is not a used cooking oil.

The contaminated triglyceride oil that is employed in the present process further exhibits at least one, preferably at least two, and most preferably all three of the following features:

- a free fatty acid content of less than 1.5 %, more preferably a free fatty acid content of less than 0.5%;
- less than 0.5 wt.% of polymeric material;
- a Food Oil Sensor reading of less than 0.2.

Methods for determining the above mentioned analytical parameters have been described, for instance, by Lin et al., "*The Recovery of Used Frying Oils with Various Adsorbents*", J. of Food Lipids 5 (1998), 1016.

The present process can suitably be used to remove unwanted propanol components from animal oils, marine oils, algae oils and vegetable oils. Preferably, the triglyceride oil employed is vegetable oil. Even more preferably, the triglyceride oil is a vegetable oil selected from palm oil, palm kernel oil, coconut oil, sunflower oil, soybean oil, rapeseed oil and combinations thereof. Most preferably, the triglyceride oil is palm oil.

The contact time between triglyceride oil and the silicate adsorbent in the present process typically lies in the range 5-200 minutes, more preferably in the range of 10-60 minutes.

Best results are obtained in the present process if the triglyceride oil is contacted with the silicate adsorbent at elevated temperatures. Preferably, the contaminated triglyceride oil has a temperature of 80-260 °C when it is contacted with the silicate adsorbent.

The amount of silicate adsorbent employed in the present process typically exceed 0.1% by weight of the contaminated triglyceride oil. Preferably, the amount of silicate adsorbent lies within the range of, 0.3-10%, most preferably in the range of 0.5-5% by weight of the contaminated triglyceride oil.

Another aspect of the invention relates to the use a silicate adsorbent as defined herein before for reducing the concentration of unwanted propanol components in triglyceride oils, said unwanted propanol components being selected from free chloropropanols, chloropropanol fatty acid esters, free epoxypropanols, epoxypropanol fatty acid esters, and combinations thereof.

A further aspect of the inventions relates to a deodorized triglyceride oil selected from palm oil, a palm oil fraction or a combination thereof, said deodorized triglyceride oil being characterized by a 3-MCPD content that is less than the equivalent of 300 µg/kg of non-esterified 3-MCPD. Even more preferably the 3-MCPD of the deodorized triglyceride oil is less than the equivalent of 200 µg/kg of non-esterified 3-MCPD, even more preferably less than the equivalent of 100 µg/kg of non-esterified 3-MCPD. Most preferably, the 3-MCPD of the deodorized triglyceride oil is even less than the equivalent of 50 µg/kg of non-esterified 3-MCPD.

As explained herein, before, deodorisation of triglyceride oils, such as palm oil and palm oil fractions, is believed to trigger the formation of chloropropanols. The present invention enables the production of deodorized palm oils and deodorized palm oil fractions that contain very low concentrations of 3-MCPD. The term “palm oil fraction” as referred to herein refers to e.g. olein or stearin fractions that can be isolated from palm oil (or fractions of palm oil) by means of fractionation (e.g. solvent fractionation or dry fractionation).

Yet another aspect of the invention relates to an infant food comprising from 0.3-80 wt.%, preferably 0.5-40 wt.%, most preferably 1-15 wt.% of a deodorized triglyceride oil as defined above. The infant food according to the present invention is typically designed for consumption by infants that are no older than 12 months, especially no older than 6 months.

According to a particularly preferred embodiment, the infant food is an infant formula. Infant formula is an artificial substitute for human breast milk, intended for infant consumption. The infant formula of the present invention may be provided in liquid or instant form.

The invention is further illustrated by means of the following non-limiting examples.

EXAMPLES

Example 1

Deodorised, dry palm oil super olein (IV=64) containing more than 300 µg/kg
5 of 3-MCPD was treated with Dalsorb® F50, a synthetic, amorphous magnesium
silicate that is marketed by the Dallas Group of America, Whitehouse, NJ, USA.

The oil (464.3 g) was heated to 95 °C in a stirred vessel, following which the
magnesium silicate adsorbent (9.3 g) was added under stirring (850 rpm). Pressure was
reduced to 100 mbar, the temperature of the oil maintained at 95 °C and stirring was
10 continued for 30 minutes (850 rpm), following which the adsorbent was removed by
filtration.

It was found that the amount of 3-MCPD in the oil had been reduced by more
than 50% as a result of the treatment with the magnesium silicate adsorbent. Results
further indicate that this methodology enables the reduction of 3-MCPD levels to less
15 than 50 µg/kg.

Example 2

Deodorised, dry palm oil super olein (IV=64) containing more than 300 µg/kg
of 3-MCPD was treated with D-sol D60 a Magnesol® product, a synthetic, amorphous
20 magnesium silicate that is marketed by the Dallas Group of America, Whitehouse, NJ,
USA.

The oil (410.1 g) was heated to 95 °C in a stirred vessel, following which the
magnesium silicate adsorbent (8.2 g) was added under stirring (850 rpm). Pressure was
reduced to 100 mbar, the temperature of the oil maintained at 95 °C and stirring was
25 continued for 30 minutes (850 rpm), following which the adsorbent was removed by
filtration.

It was found that the amount of 3-MCPD in the oil had been reduced by more
than 50% as a result of the treatment with the magnesium silicate adsorbent. Results
further indicate that this methodology enables the reduction of 3-MCPD levels to less
30 than 50 µg/kg.

Example 3

Deodorised, dry palm oil super olein (IV=64) containing more than 300 µg/kg of 3-MCPD was treated with 3000 M a Magnesol® product, a synthetic, amorphous magnesium silicate that is marketed by the Dallas Group of America, Whitehouse, NJ, USA.

The oil (445.4 g) was heated to 95 °C in a stirred vessel, following which the magnesium silicate adsorbent (8.9 g) was added under stirring (850 rpm). Pressure was reduced to 100 mbar, the temperature of the oil maintained at 95 °C and stirring was continued for 30 minutes (850 rpm), following which the adsorbent was removed by filtration.

It was found that the amount of 3-MCPD in the oil had been reduced by more than 50% as a result of the treatment with the magnesium silicate adsorbent. Results further indicate that this methodology enables the reduction of 3-MCPD levels to less than 50 µg/kg.

CLAIMS

1. A process for removing unwanted propanol components from unused triglyceride oil, said unwanted propanol components being selected from free chloropropanols,
5 chloropropanol fatty acid esters, free epoxypropanols, epoxypropanol fatty acid esters, and combinations thereof, and said process comprising:
 - contacting a triglyceride oil that is contaminated with unwanted propanol components with a silicate adsorbent selected from the group consisting of magnesium silicate, calcium silicate, aluminum silicate and combinations of
10 these silicates; and
 - recovering a decontaminated triglyceride oil having a reduced concentration of the unwanted propanol components.
2. Process according to claim 1, wherein the silicate adsorbent has a surface area
15 (B.E.T.) of at least 100 m²/g, preferably of 200-800 m²/g.
3. Process according to claim 1 or 2, wherein the silicate adsorbent is a powder having a mass weighted average diameter in the range of 3-200 µm, preferably in the range 20-150 µm, more preferably in the range of 50-100 µm.
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4. Process according to any one of the preceding claims, wherein the silicate adsorbent has a pH of 7-10.8, preferably of 7.8-10.0 (suspension of 10% (w/w) in water).
5. Process according to any one of the preceding claims, wherein the silicate adsorbent
25 is magnesium silicate.
6. Process according to claim 5, wherein the magnesium silicate contains at least 12% MgO and at least 50% SiO₂ on an ignited basis.
- 30 7. Process according to claim 5 or 6, wherein the magnesium silicate contains MgO and SiO₂ in a mole ratio of 1:1.3 to 1:5, preferably in a mole ratio of 1:1.8 to 1:4.

8. Process according to any one of the preceding claims, wherein the unwanted propanol components are selected from the group consisting of 3-monochloropropane-1,2-diol (3-MCPD), 2-monochloropropane-1,3-diol (2-MCPD), 1,3-dichloropropane-2-ol (1,3-DCPO) and 1,2-dichloropropane-3-ol (1,2-DCPO), 3-MCPD fatty acid esters, 2-MCPD fatty acid esters, 1,3-DCPO fatty acid esters, 1,2-DCPO fatty acid esters and combinations thereof.
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9. Process according to any one of the preceding claims, wherein the total MCPD fatty acid ester content of the triglyceride oil is reduced by at least 30%, preferably by at least 50%.
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10. Process according to any one of the preceding claims, wherein the free fatty acid content of the decontaminated triglyceride oil is not more than 0.5 wt.% lower than the free fatty acid content of the contaminated triglyceride oil.
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11. Process according to any one of the preceding claims, wherein the contaminated triglyceride oil is not a used cooking oil.
12. Process according to any one of the preceding claims, wherein the contaminated triglyceride oil has a free fatty acid content of less than 1.5 %.
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13. Process according to any one of the preceding claims, wherein the contaminated triglyceride oil contains less than 0.5 wt.% of polymeric material.
- 25 14. Use of a silicate adsorbent as defined in any one of claims 1-7 for reducing the concentration of unwanted propanol components in triglyceride oils, said unwanted propanol components being selected from free chloropropanols, chloropropanol fatty acid esters, free epoxypropanols, epoxypropanol fatty acid esters, and combinations thereof.
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15. A deodorized triglyceride oil selected from palm oil, a palm oil fraction or a combination thereof, said deodorized triglyceride oil being characterized by a 3-MCPD content that is equivalent to less than 300 µg/kg of non-esterified 3-MCPD,

preferably equivalent to less than 200 µg/kg of non-esterified 3-MCPD and even more preferably is equivalent to less than 100 µg/kg of non-esterified 3-MCPD..

16. An infant food comprising from 0.3-80 wt.% of a deodorized triglyceride oil
5 according to claim 15.

17. Infant food according to claim 16, wherein the infant food is an infant formula.