A PROCESS FOR EXTRACTING ANTIOXIDANTS FROM OIL PALM BIOMASS

FIELD OF INVENTION

The present invention relates to a process for extracting compounds with anti-oxidative properties from oil palm biomass such as oil palm leaves, palm pressed fibre and empty fruit bunches.

BACKGROUND OF THE INVENTION

The oil palm produces a vast variety of biomass, i.e. frond, empty fruit bunches, pressed fibre, etc. Each of these types of biomass has applications in different industries such as pulp and paper, wood and bio-energy industries. Before being treated and used for these applications, the oil palm biomass is a potential source of water soluble antioxidants. Concentration of total phenolic compounds, a type of water soluble antioxidants in oil palm leaves, pressed fibre and empty fruit bunches ranges from 5 to 20mg/g of biomass. Therefore there is a need to extract the water soluble antioxidants from the oil palm biomass.

SUMMARY OF THE INVENTION

The present invention relates to a process for extracting and recovering of water soluble compounds with anti-oxidative properties from oil palm biomass such as oil palm leaves, palm pressed fibre and empty palm fruit bunches. There are four different embodiments for extracting water soluble compounds with anti-oxidative properties.

The first embodiment of the process for extracting water soluble compounds with anti-oxidative properties from oil palm biomass includes the steps of:

i) reducing size of the oil palm biomass between 2-10mm length;

ii) loading the oil palm biomass from step (i) into a vessel;

iii) subjecting the oil palm biomass with a stream of carbon dioxide having pressure range of 15-70MPa;

iv) collecting water soluble compounds released from an outlet of the vessel.

The second embodiment of the process for extracting water soluble compounds with anti-oxidative properties from oil palm biomass includes the steps of:

i) reducing size of the oil palm biomass between 2-10mm length;
ii) immersing the oil palm biomass in a solvent;
iii) loading the oil palm biomass from step (ii) into a vessel containing adsorbent;
iv) subjecting the oil palm biomass with a stream of carbon dioxide having pressure range of 15-70MPa ;
v) collecting water soluble compounds released from an outlet of the vessel.

The third embodiment of the process for extracting water soluble compounds with anti-oxidative properties from oil palm biomass includes the steps of:

i) reducing size of the oil palm biomass between 2-10mm length;
ii) immersing the oil palm biomass in a solvent;
iii) loading the oil palm biomass from step (ii) into a vessel containing adsorbent;
iv) subjecting the oil palm biomass with a stream of carbon dioxide having pressure range of 15-70MPa and a stream of solvent simultaneously;
v) collecting water soluble compounds released from an outlet of the vessel.

The fourth embodiment of the process for extracting water soluble compounds with anti-oxidative properties from oil palm biomass includes the steps of:

i) reducing size of the oil palm biomass between 2-10mm length;
ii) loading the oil palm biomass from step (i) into a vessel;
iii) subjecting the oil palm biomass with a stream of carbon dioxide having pressure range of 15-70MPa and a stream of solvent simultaneously;
iv) collecting water soluble compounds released from an outlet of the vessel.

The process for extracting water soluble compounds with anti-oxidative properties from oil palm biomass can be a sub critical water extraction, sub critical carbon dioxide extraction, supercritical water extraction or supercritical carbon dioxide

extraction. The vessel is heated at a temperature range of 30-75°C upon loading of the oil palm biomass in the vessel in all the four embodiments. The adsorbent is silica gel. The solvent is alcohol such as methanol.

DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to a process for extracting and recovering of water soluble compounds with anti-oxidative properties from oil palm biomass such as oil palm leaves, palm pressed fibre and empty palm fruit bunches. There are four different embodiments for extracting water soluble compounds with anti-oxidative properties. The four different embodiments are as follows:

i) a process without solvent and without adsorbent;

ii) a process without solvent but with adsorbent;

iii) a process with solvent and with adsorbent; and

iv) a process with solvent but without adsorbent.

The adsorbent is silica gel and the solvent is alcohol such as methanol.

Hereinafter, this specification will describe the present invention according to the preferred embodiments of the present invention. However, it is to be understood that limiting the description to the preferred embodiments of the invention is merely to facilitate discussion of the present invention and it is envisioned that those skilled in the art may devise various modifications and equivalents without departing from the scope of the appended claims.

All the four embodiments require grinding of the palm biomass into smaller mass or sizes prior to the process for extracting and recovering of water soluble compounds. This allows for higher extraction efficiency. Once the oil palm biomass is grinded into smaller sizes, they are ready for extraction.

The first embodiment relates to a process for extracting water soluble compounds with anti-oxidative properties without solvent and without adsorbent. In this case, the oil palm biomass is loaded into an empty vessel. Then, the vessel is sealed. The vessel comprises a vent for gas to pass through at top of the vessel and another vent or outlet at

the other end. Gas which is pressurized and heated to certain pressure and temperature (termed as super or sub critical state) is pumped into the vessel. The gas which is passing through the oil palm biomass, dissolves and carries the anti-oxidative compounds along as it is being released from the outlet of the vessel. The gas released from the outlet is then collected. Once the gas is released from the vessel, it depressurized spontaneously, leaving behind the anti-oxidative compounds.

The second embodiment is similar to the first embodiment with the exception that the oil palm biomass is first immersed in a solvent and the solvent is then concentrated to a minimal volume. The solvent is then loaded into a vessel pre-packed with an adsorbent. Pressurized gas is then pumped into the vessel and the anti-oxidative compounds are being carried through the adsorbent to an outlet of the vessel upon which, they are collected. This embodiment gives an advantage of being able to concentrate the anti-oxidative compounds in the oil palm biomass prior to extraction, thus is more efficient and gives higher throughput.

The third embodiment is similar to the second whereby prior to extraction, the oil palm biomass is pre concentrated in a solvent and the solvent is loaded into a vessel pre packed with adsorbent. In this embodiment however, a solvent is pumped and pre mixed with pressurized gas before they are pumped into the vessel. The pressurized gas, solvent and anti-oxidative compounds from the oil palm biomass are then collected at an outlet of the vessel. This embodiment involves a solvent and therefore yields higher extraction efficiency than the embodiment without the presence of a solvent.

The fourth embodiment is similar to the first embodiment whereby the oil palm biomass is loaded straight into an empty vessel without the need for pre concentration in a solvent. A solvent is pumped and pre mixed with pressurized gas before they are pumped into the vessel. The pressurized gas, solvent and anti-oxidative compounds from the oil palm biomass are then collected at an outlet of the vessel. This embodiment involves a solvent and therefore yields higher efficiency than the embodiment without the presence of solvent.

In all the four embodiments, the pressurized gas is carbon dioxide having pressure range of 15-70MPa. The vessel is heated at a temperature range of 30-75°C upon loading of the oil palm biomass in the vessel in all the four embodiments. The adsorbent is silica gel. The solvent is alcohol such as methanol.

The invention will be further understood from the following non-limited examples.

EXAMPLE 1

Empty fruit bunch that is obtained upon pressing of oil palm fruit bunches for its oil is ground into powder form of 2 – 10mm length. 30g of the grounded empty fruit bunch are loaded into an empty, 30mL extraction vessel. The extraction vessel is then heated to 40^0C. Pressurized carbon dioxide (15 Mpa, - 4^0C) is pumped into the vessel for 3 hours. The extract containing the anti-oxidative compounds that come out from an outlet of the extraction vessel is collected.

EXAMPLE 2

Empty fruit bunch that is obtained upon pressing of oil palm fruit bunches for its oil is ground into powder form of 2 – 10mm length. 5g of the grounded empty fruit bunch is immersed in 30mL methanol and mixed vigorously. Thereafter, the mixture is filtered and the methanol in the filtrate is removed till only about 5mL remained. 1mL of the filtrate is loaded into 250mm length x 200mm internal diameter vessel which is pre-packed with silica gel. The extraction vessel is then heated to 40^0C. Pressurized carbon dioxide (15 Mpa, - 4^0C) is pumped into the vessel for 1hour. The extract containing the anti-oxidative compounds that come out from an outlet of the extraction vessel is collected.

EXAMPLE 3

Empty fruit bunch that is obtained upon pressing of oil palm fruit bunches for its oil is ground into powder form of 2 – 10mm length. 5g of the grounded empty fruit bunch is

immersed in 30mL methanol and mixed vigorously. Thereafter, the mixture is filtered and the methanol in the filtrate is removed till only about 5mL remained. 1mL of the filtrate is loaded into 250mm length x 200mm internal diameter vessel which is pre-packed with silica gel. The extraction vessel is then heated to 40^0C. Pressurized carbon dioxide (15 Mpa, - 4^0C) and 0.5mL methanol are pumped into the vessel simultaneously for 1 hour. The extract containing the anti-oxidative compounds that come out from an outlet of the extraction vessel is collected.

EXAMPLE 4

Empty fruit bunch that is obtained upon pressing of oil palm fruit bunches for its oil is ground into powder form of 2 – 10mm length. 30g of the grounded empty fruit bunch was loaded into an empty, 30mL extraction vessel. The extraction vessel is then heated to 40^0C. Pressurized carbon dioxide (15 Mpa, - 4^0C) and 0.2mL methanol are pumped into the vessel simultaneously for 3 hours. The extract containing the anti-oxidative compounds that come out from an outlet of the extraction vessel is collected.

EXAMPLE 5

Fresh oil palm leaves are grounded into powder form of 2 – 7mm length. 30g of the grounded oil palm leaves is loaded into an empty, 30mL extraction vessel. The extraction vessel is then heated to 40^0C. Pressurized carbon dioxide (15 Mpa, - 4^0C) is pumped into the vessel for 3 hours. The extract containing the anti-oxidative compounds that come out from an outlet of the extraction vessel is collected.

EXAMPLE 6

Fresh oil palm leaves are grounded into powder form of 2 – 10mm length. 5g of the grounded oil palm leaves is immersed in 30mL methanol and mixed vigorously. Thereafter, the mixture is filtered and the methanol in the filtrate is removed till only about 5mL remained. 1mL of the filtrate is loaded into 250mm length x 200mm internal

diameter vessel which is pre-packed with silica gel. The extraction vessel is then heated to 40^0C. Pressurized carbon dioxide (15 Mpa, - 4^0C) is pumped into the vessel for 1hour. The extract containing the anti-oxidative compounds that come out from an outlet of the extraction vessel is collected.

EXAMPLE 7

Fresh oil palm leaves are grounded into powder form of 2 – 10mm length. 5g of the grounded empty fruit bunch is immersed in 30mL methanol and mixed vigorously. Thereafter, the mixture is filtered and the methanol in the filtrate is removed till only about 5mL remained. 1mL of the filtrate is loaded into 250mm length x 200mm internal diameter vessel which is pre-packed with silica gel. The extraction vessel is then heated to 40^0C. Pressurized carbon dioxide (15 Mpa, - 4^0C) and 0.5mL methanol are pumped into the vessel simultaneously for 1 hour. The extract containing the anti-oxidative compounds that come out from an outlet of the extraction vessel is collected.

EXAMPLE 8

Fresh oil palm leaves are grounded into powder form of 2 – 10mm length. 30g of the grounded oil palm leaves is loaded into an empty, 30mL extraction vessel. The extraction vessel is then heated to 40^0C. Pressurized carbon dioxide (15 Mpa, - 4^0C) and 0.2mL methanol are pumped into the vessel simultaneously for 3 hours. The extract containing the anti-oxidative compounds that come out from an outlet of the extraction vessel is collected.

CLAIMS

1. A process for extracting water soluble compounds with anti-oxidative properties from oil palm biomass, the process includes the steps of:

i) reducing size of the oil palm biomass between 2-10mm length;

ii) immersing the oil palm biomass in a solvent;

iii) loading the oil palm biomass from step (ii) into a vessel containing adsorbent;

iv) subjecting the oil palm biomass with a stream of carbon dioxide having pressure range of 15-70MPa ;

v) collecting the water soluble compounds released from an outlet of the vessel.

wherein the vessel is heated at a temperature range of 30-75°C upon loading of the oil palm biomass in the vessel; and

wherein the oil palm biomass is such as palm leaves, pressed fibre and empty fruit bunches.

2. The process for extracting water soluble compounds with anti-oxidative properties as claimed in claim 1 wherein the adsorbent is silica gel.

3. The process for extracting water soluble compounds with anti-oxidative properties as claimed in claim 1 wherein the solvent is alcohol.

4. The process for extracting water soluble compounds with anti-oxidative properties as claimed in claim 3 wherein the alcohol is methanol.

5. A process for extracting water soluble compounds with anti-oxidative properties from oil palm biomass, the process includes the steps of:

i) reducing size of the oil palm biomass between 2-10mm length;

ii) immersing the oil palm biomass in a solvent;

iii) loading the oil palm biomass from step (ii) into a vessel containing adsorbent;

iv) subjecting the oil palm biomass with a stream of carbon dioxide having pressure range of 15-70MPa and a stream of solvent simultaneously;

v) collecting the water soluble compounds released from an outlet of the vessel.

wherein the vessel is heated at a temperature range of 30-75°C upon loading of the oil palm biomass in the vessel; and

wherein the oil palm biomass is such as palm leaves, pressed fibre and empty fruit bunches.

6. The process for extracting water soluble compounds with anti-oxidative properties as claimed in claim 5 wherein the adsorbent is silica gel.

7. The process for extracting water soluble compounds with anti-oxidative properties as claimed in claim 5 wherein the solvent is alcohol.

8. The process for extracting water soluble compounds with anti-oxidative properties as claimed in claim 5 wherein the alcohol is methanol.

9. A process for extracting water soluble compounds with anti-oxidative properties from oil palm biomass, the process includes the steps of:

i) reducing size of the oil palm biomass between 2-10mm length;

ii) loading the oil palm biomass from step (i) into a vessel;

iii) subjecting the oil palm biomass with a stream of carbon dioxide having pressure range of 15-70MPa and a stream of solvent simultaneously;

iv) collecting the water soluble compounds released from an outlet of the vessel.

wherein the vessel is heated at a temperature range of 30-75°C upon loading of the oil palm biomass in the vessel; and

wherein the oil palm biomass is such as palm leaves, pressed fibre and empty fruit bunches.

10. The process for extracting water soluble compounds with anti-oxidative properties as claimed in claim 11 wherein the solvent is alcohol.

11. The process for extracting water soluble compounds with anti-oxidative properties as claimed in claim 5 wherein the alcohol is methanol.

A PROCESS FOR EXTRACTING ANTIOXIDANTS FROM OIL PALM BIOMASS

FIELD OF INVENTION

The present invention relates to a process for extracting compounds with anti-oxidative properties from oil palm biomass such as oil palm leaves, palm pressed fibre and empty fruit bunches.

BACKGROUND OF THE INVENTION

The oil palm produces a vast variety of biomass, i.e. frond, empty fruit bunches, pressed fibre, etc. Each of these types of biomass has applications in different industries such as pulp and paper, wood and bio-energy industries. Before being treated and used for these applications, the oil palm biomass is a potential source of water soluble antioxidants. Concentration of total phenolic compounds, a type of water soluble antioxidants in oil palm leaves, pressed fibre and empty fruit bunches ranges from 5 to 20mg/g of biomass. Therefore there is a need to extract the water soluble antioxidants from the oil palm biomass.

SUMMARY OF THE INVENTION

The present invention relates to a process for extracting and recovering of water soluble compounds with anti-oxidative properties from oil palm biomass such as oil palm leaves, palm pressed fibre and empty palm fruit bunches. There are four different embodiments for extracting water soluble compounds with anti-oxidative properties.

The first embodiment of the process for extracting water soluble compounds with anti-oxidative properties from oil palm biomass includes the steps of:

i) reducing size of the oil palm biomass between 2-10mm length;

ii) loading the oil palm biomass from step (i) into a vessel;

iii) subjecting the oil palm biomass with a stream of carbon dioxide having pressure range of 15-70 MPa at a temperature of -4°C;

iv) collecting water soluble compounds released from an outlet of the vessel.

The second embodiment of the process for extracting water soluble compounds with anti-oxidative properties from oil palm biomass includes the steps of:

i) reducing size of the oil palm biomass between 2-10mm length;

ii) immersing the oil palm biomass in a solvent;

iii) loading the oil palm biomass from step (ii) into a vessel containing adsorbent;

iv) subjecting the oil palm biomass with a stream of carbon dioxide having pressure range of 15-70 MPa at a temperature of -4°C;

v) collecting water soluble compounds released from an outlet of the vessel.

The third embodiment of the process for extracting water soluble compounds with anti-oxidative properties from oil palm biomass includes the steps of:

i) reducing size of the oil palm biomass between 2-10mm length;

ii) immersing the oil palm biomass in a solvent;

iii) loading the oil palm biomass from step (ii) into a vessel containing adsorbent;

iv) subjecting the oil palm biomass with a stream of carbon dioxide having pressure range of 15-70 MPa at a temperature of -4°C and a stream of solvent simultaneously;

v) collecting water soluble compounds released from an outlet of the vessel.

The fourth embodiment of the process for extracting water soluble compounds with anti-oxidative properties from oil palm biomass includes the steps of:

i) reducing size of the oil palm biomass between 2-10mm length;

ii) loading the oil palm biomass from step (i) into a vessel;

iii) subjecting the oil palm biomass with a stream of carbon dioxide having pressure range of 15-70 MPa at a temperature of -4°C and a stream of solvent simultaneously;

iv) collecting water soluble compounds released from an outlet of the vessel.

The process for extracting water soluble compounds with anti-oxidative properties from oil palm biomass can be a sub critical water extraction, sub critical carbon dioxide extraction, supercritical water extraction or supercritical carbon dioxide extraction. The vessel is heated at a temperature range of 30-75°C upon loading of the oil palm biomass in the vessel in all the four embodiments. The adsorbent is silica gel. The solvent is alcohol such as methanol.

DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to a process for extracting and recovering of water soluble compounds with anti-oxidative properties from oil palm biomass such as oil palm leaves, palm pressed fibre and empty palm fruit bunches. There are four different embodiments for extracting water soluble compounds with anti-oxidative properties. The four different embodiments are as follows:

i) a process without solvent and without adsorbent;
ii) a process without solvent but with adsorbent;
iii) a process with solvent and with adsorbent; and
iv) a process with solvent but without adsorbent.

The adsorbent is silica gel and the solvent is alcohol such as methanol.

Hereinafter, this specification will describe the present invention according to the preferred embodiments of the present invention. However, it is to be understood that limiting the description to the preferred embodiments of the invention is merely to facilitate discussion of the present invention and it is envisioned that those skilled in the art may devise various modifications and equivalents without departing from the scope of the appended claims.

All the four embodiments require grinding of the palm biomass into smaller mass or sizes prior to the process for extracting and recovering of water soluble compounds. This allows for higher extraction efficiency. Once the oil palm biomass is grinded into smaller sizes, they are ready for extraction.

The first embodiment relates to a process for extracting water soluble compounds with anti-oxidative properties without solvent and without adsorbent. In this case, the oil palm biomass is loaded into an empty vessel. Then, the vessel is sealed. The vessel comprises a vent for gas to pass through at top of the vessel and another vent or outlet at the other end. Gas which is pressurized and heated to certain pressure and temperature (termed as super or sub critical state) is pumped into the vessel. The gas which is passing through the oil palm biomass, dissolves and carries the anti-oxidative compounds along as it is being released from the outlet of the vessel. The gas released from the outlet is then collected. Once the gas is released from the vessel, it depressurized spontaneously, leaving behind the anti-oxidative compounds.

The second embodiment is similar to the first embodiment with the exception that the oil palm biomass is first immersed in a solvent and the solvent is then concentrated to a minimal volume. The solvent is then loaded into a vessel pre-packed with an adsorbent. Pressurized gas is then pumped into the vessel and the anti-oxidative compounds are being carried through the adsorbent to an outlet of the vessel upon which, they are collected. This embodiment gives an advantage of being able to concentrate the anti-oxidative compounds in the oil palm biomass prior to extraction, thus is more efficient and gives higher throughput.

The third embodiment is similar to the second whereby prior to extraction, the oil palm biomass is pre concentrated in a solvent and the solvent is loaded into a vessel pre packed with adsorbent. In this embodiment however, a solvent is pumped and pre mixed with pressurized gas before they are pumped into the vessel. The pressurized gas, solvent and anti-oxidative compounds from the oil palm biomass are then collected at an outlet of the vessel. This embodiment involves a solvent and therefore yields higher extraction efficiency than the embodiment without the presence of a solvent.

The fourth embodiment is similar to the first embodiment whereby the oil palm biomass is loaded straight into an empty vessel without the need for pre concentration in a solvent. A solvent is pumped and pre mixed with pressurized gas before they are

pumped into the vessel. The pressurized gas, solvent and anti-oxidative compounds from the oil palm biomass are then collected at an outlet of the vessel. This embodiment involves a solvent and therefore yields higher efficiency than the embodiment without the presence of solvent.

In all the four embodiments, the pressurized gas is carbon dioxide having pressure range of 15-70 MPa at a temperature of -4°C. The vessel is heated at a temperature range of 30-75°C upon loading of the oil palm biomass in the vessel in all the four embodiments. The adsorbent is silica gel. The solvent is alcohol such as methanol.

The invention will be further understood from the following non-limited examples.

EXAMPLE 1

Empty fruit bunch that is obtained upon pressing of oil palm fruit bunches for its oil is ground into powder form of 2 – 10mm length. 30g of the grounded empty fruit bunch are loaded into an empty, 30mL extraction vessel. The extraction vessel is then heated to 40^0C. Pressurized carbon dioxide (15 MPa, - 4^0C) is pumped into the vessel for 3 hours. The extract containing the anti-oxidative compounds that come out from an outlet of the extraction vessel is collected.

EXAMPLE 2

Empty fruit bunch that is obtained upon pressing of oil palm fruit bunches for its oil is ground into powder form of 2 – 10mm length. 5g of the grounded empty fruit bunch is immersed in 30mL methanol and mixed vigorously. Thereafter, the mixture is filtered and the methanol in the filtrate is removed till only about 5mL remained. 1mL of the filtrate is loaded into 250mm length x 200mm internal diameter vessel which is pre-packed with silica gel. The extraction vessel is then heated to 40^0C. Pressurized carbon dioxide (15 MPa, - 4^0C) is pumped into the vessel for 1hour. The extract containing the

anti-oxidative compounds that come out from an outlet of the extraction vessel is collected.

EXAMPLE 3

Empty fruit bunch that is obtained upon pressing of oil palm fruit bunches for its oil is ground into powder form of 2 – 10mm length. 5g of the grounded empty fruit bunch is immersed in 30mL methanol and mixed vigorously. Thereafter, the mixture is filtered and the methanol in the filtrate is removed till only about 5mL remained. 1mL of the filtrate is loaded into 250mm length x 200mm internal diameter vessel which is pre-packed with silica gel. The extraction vessel is then heated to 40^0C. Pressurized carbon dioxide (15 MPa, - 4^0C) and 0.5mL methanol are pumped into the vessel simultaneously for 1 hour. The extract containing the anti-oxidative compounds that come out from an outlet of the extraction vessel is collected.

EXAMPLE 4

Empty fruit bunch that is obtained upon pressing of oil palm fruit bunches for its oil is ground into powder form of 2 – 10mm length. 30g of the grounded empty fruit bunch was loaded into an empty, 30mL extraction vessel. The extraction vessel is then heated to 40^0C. Pressurized carbon dioxide (15 MPa, - 4^0C) and 0.2mL methanol are pumped into the vessel simultaneously for 3 hours. The extract containing the anti-oxidative compounds that come out from an outlet of the extraction vessel is collected.

EXAMPLE 5

Fresh oil palm leaves are grounded into powder form of 2 – 7mm length. 30g of the grounded oil palm leaves is loaded into an empty, 30mL extraction vessel. The extraction vessel is then heated to 40^0C. Pressurized carbon dioxide (15 MPa, - 4^0C) is pumped into the vessel for 3 hours. The extract containing the anti-oxidative compounds that come out from an outlet of the extraction vessel is collected.

EXAMPLE 6

Fresh oil palm leaves are grounded into powder form of 2 – 10mm length. 5g of the grounded oil palm leaves is immersed in 30mL methanol and mixed vigorously. Thereafter, the mixture is filtered and the methanol in the filtrate is removed till only about 5mL remained. 1mL of the filtrate is loaded into 250mm length x 200mm internal diameter vessel which is pre-packed with silica gel. The extraction vessel is then heated to 40^0C. Pressurized carbon dioxide (15 MPa, - 4^0C) is pumped into the vessel for 1hour. The extract containing the anti-oxidative compounds that come out from an outlet of the extraction vessel is collected.

EXAMPLE 7

Fresh oil palm leaves are grounded into powder form of 2 – 10mm length. 5g of the grounded empty fruit bunch is immersed in 30mL methanol and mixed vigorously. Thereafter, the mixture is filtered and the methanol in the filtrate is removed till only about 5mL remained. 1mL of the filtrate is loaded into 250mm length x 200mm internal diameter vessel which is pre-packed with silica gel. The extraction vessel is then heated to 40^0C. Pressurized carbon dioxide (15 MPa, - 4^0C) and 0.5mL methanol are pumped into the vessel simultaneously for 1 hour. The extract containing the anti-oxidative compounds that come out from an outlet of the extraction vessel is collected.

EXAMPLE 8

Fresh oil palm leaves are grounded into powder form of 2 – 10mm length. 30g of the grounded oil palm leaves is loaded into an empty, 30mL extraction vessel. The extraction vessel is then heated to 40^0C. Pressurized carbon dioxide (15 MPa, - 4^0C) and 0.2mL methanol are pumped into the vessel simultaneously for 3 hours. The extract containing the anti-oxidative compounds that come out from an outlet of the extraction vessel is collected.

CLAIMS

1. A process for extracting water soluble compounds with anti-oxidative properties from oil palm biomass, the process includes the steps of:

i) reducing size of the oil palm biomass between 2-10mm length;

ii) immersing the oil palm biomass in a solvent;

iii) loading the oil palm biomass from step (ii) into a vessel containing adsorbent;

iv) subjecting the oil palm biomass with a stream of carbon dioxide having pressure range of 30-70 MPa;

v) collecting the water soluble compounds released from an outlet of the vessel.

wherein the vessel is heated at a temperature range of 30-75°C upon loading of the oil palm biomass in the vessel; and

wherein the oil palm biomass is such as palm leaves, pressed fibre and empty fruit bunches.

2. The process for extracting water soluble compounds with anti-oxidative properties as claimed in claim 1 wherein the adsorbent is silica gel.

3. The process for extracting water soluble compounds with anti-oxidative properties as claimed in claim 1 wherein the solvent is alcohol.

4. The process for extracting water soluble compounds with anti-oxidative properties as claimed in claim 3 wherein the alcohol is methanol.

5. A process for extracting water soluble compounds with anti-oxidative properties from oil palm biomass, the process includes the steps of:

i) reducing size of the oil palm biomass between 2-10mm length;

ii) immersing the oil palm biomass in a solvent;

iii) loading the oil palm biomass from step (ii) into a vessel containing adsorbent;

iv) subjecting the oil palm biomass with a stream of carbon dioxide having pressure range of 30-70 MPa and a stream of solvent simultaneously;

v) collecting the water soluble compounds released from an outlet of the vessel.

wherein the vessel is heated at a temperature range of 30-75°C upon loading of the oil palm biomass in the vessel; and

wherein the oil palm biomass is such as palm leaves, pressed fibre and empty fruit bunches.

6. The process for extracting water soluble compounds with anti-oxidative properties as claimed in claim 5 wherein the adsorbent is silica gel.

7. The process for extracting water soluble compounds with anti-oxidative properties as claimed in claim 5 wherein the solvent is alcohol.

8. The process for extracting water soluble compounds with anti-oxidative properties as claimed in claim 5 wherein the alcohol is methanol.

9. A process for extracting water soluble compounds with anti-oxidative properties from oil palm biomass, the process includes the steps of:

i) reducing size of the oil palm biomass between 2-10mm length;

ii) loading the oil palm biomass from step (i) into a vessel;

iii) subjecting the oil palm biomass with a stream of carbon dioxide having pressure range of 30-70 MPa and a stream of solvent simultaneously;

iv) collecting the water soluble compounds released from an outlet of the vessel.

wherein the vessel is heated at a temperature range of 30-75°C upon loading of the oil palm biomass in the vessel; and

wherein the oil palm biomass is such as palm leaves, pressed fibre and empty fruit bunches.

10. The process for extracting water soluble compounds with anti-oxidative properties as claimed in claim 11 wherein the solvent is alcohol.

11. The process for extracting water soluble compounds with anti-oxidative properties as claimed in claim 5 wherein the alcohol is methanol.