Claims

1. A method for obtaining a high-yielding oil palm plant that provides a high yield of palm oil comprising:

(i) determining the level of a first metabolite and the level of a second metabolite in mesocarp tissue of a fruit of a parental oil palm plant 11 to 21 weeks after pollination thereof, wherein (a) the first metabolite is selected from the group consisting of malic acid and pyruvic acid; and (b) the second metabolite is 2-oxoglutaric acid;

(ii) determining whether there is a difference between the level of the first metabolite and the level of the second metabolite in the mesocarp tissue of the fruit of the parental oil palm plant and the level of the first metabolite and the level of the second metabolite in mesocarp tissue of a fruit of a reference oil palm plant that is used as a basis for comparison in determining palm oil yield, also 11 to 21 weeks after pollination thereof, wherein the difference is that:

(a) the level of the malic acid in the mesocarp tissue of the fruit of the parental oil palm plant 15 to 17 weeks after pollination thereof is 43% to 100% higher than the level of the malic acid in the mesocarp tissue of the fruit of the reference oil palm plant 15 to 17 weeks after pollination thereof~~the level of the first metabolite in the mesocarp tissue of the fruit of the parental oil palm plant is at least 15% higher than the level of the first metabolite in the mesocarp tissue of the fruit of the reference oil palm plant,~~; or

the level of the pyruvic acid in the mesocarp tissue of the fruit of the parental oil palm plant 11 to 13 weeks after pollination thereof is 33% to 82% higher than the level of the pyruvic acid in the mesocarp tissue of the fruit of the reference oil palm plant 11 to 13 weeks after pollination thereof; and

(b) the level of the 2-oxoglutaric acid in the mesocarp tissue of the fruit of the parental oil palm plant 11 to 15 weeks after pollination thereof is 50% to 69% lower than the level of the 2-oxoglutaric acid in the mesocarp tissue of the fruit of the reference oil palm plant 11 to 15 weeks after pollination thereof~~the level of the second metabolite in the mesocarp tissue of the fruit of the parental oil palm plant is at least 5% lower than the level of the second metabolite in the mesocarp tissue of the fruit of the reference oil palm plant~~; and

(iii) selecting progeny of the parental oil palm plant based on the plant having the 43% to 100% increase in malic acid and the 50% to 69% decrease in 2-oxoglutaric or the plant having the 33% to 82% increase in pyruvic and the 50% to 69% decrease in 2-oxoglutaric, ~~difference~~ to obtain the high-yielding oil palm plant.

~~2. The method of claim 1, wherein the difference is that:~~

~~the level of the malic acid in the mesocarp tissue of the fruit of the parental oil palm plant 15 to 17 weeks after pollination thereof is 43% to 100% higher than the level of the malic acid in the mesocarp tissue of the fruit of the reference oil palm plant 15 to 17 weeks after pollination thereof; and~~

~~the level of the 2-oxoglutaric acid in the mesocarp tissue of the fruit of the parental oil palm plant 11 to 15 weeks after pollination thereof is 50% to 69% lower than the level of the 2-oxoglutaric acid in the mesocarp tissue of the fruit of the reference oil palm plant 11 to 15 weeks after pollination thereof.~~

~~3. The method of claim 1, wherein the difference is that:~~

~~the level of the pyruvic acid in the mesocarp tissue of the fruit of the parental oil palm plant 11 to 13 weeks after pollination thereof is 33% to 82% higher than the level of the pyruvic acid in the mesocarp tissue of the fruit of the reference oil palm plant 11 to 13 weeks after pollination thereof; and~~

~~the level of the 2-oxoglutaric acid in the mesocarp tissue of the fruit of the parental oil palm plant 11 to 15 weeks after pollination thereof is 50% to 69% lower than the level of the 2-oxoglutaric acid in the mesocarp tissue of the fruit of the reference oil palm plant 11 to 15 weeks after pollination thereof.~~

4<u>2</u>. The method ~~of any one of claims 1 to 3~~<u>according to claim 1</u>, wherein the levels of the first and second metabolites in the mesocarp tissue of the fruit of the parental oil palm plant are determined by an analytical technique selected from the group consisting of gas chromatography-mass spectrometry, liquid chromatography-mass spectrometry, capillary electrophoresis-mass spectrometry, a biochemical assay, a chemical assay, a staining assay, and a chromatographic assay.

~~5~~3. The method of any one of claims 1 to 4<u>2</u>, wherein:

the parental oil palm plant<u>, the progeny plant and the high-yielding oil palm plant are dura breeding stock plants</u> ~~is a dura breeding stock plant;~~

~~the progeny comprises an oil palm plant selected from the group consisting of a dual breeding stock plant and a tenera agricultural production plant; and~~

~~the high-yielding oil palm plant is selected from the group consisting of a dura~~

~~breeding stock plant and a tenera agricultural production plant~~.

4. The method of any one of claims 1 to 2, wherein:

the parental oil palm plant is a cross of a dura breeding stock plant and a pisifera breeding stock plant;

the progeny plant is a tenera agricultural production plant; and

the high-yielding oil palm plant is a tenera agricultural production plant.

5. The method of any one of claims 1 to 2, wherein:

the parental oil palm plant, the progeny plant and the high-yielding oil palm plant are tenera breeding stock plants.

6. The method of any one of claims 1 to 42, wherein:

the parental oil palm plant is a cross of tenera breeding stock plant and a pisifera breeding stock plant;

the progeny comprises an oil palm plant selected from the group consisting of a tenera breeding stock plant, a pisifera breeding stock plant, and a tenera agricultural production plant; and

the high-yielding oil palm plant is selected from the group consisting of a tenera breeding stock plant and a tenera agricultural production plant.

~~7. The method of any one of the claims 1 to 6, wherein the difference is that (a) the mean level of the first metabolite in the mesocarp tissue of a plurality of the fruits of a plurality of the parental oil palm plants is at least 15% higher than the mean level of the first metabolite in the mesocarp tissue of a plurality of the fruits of a plurality of the reference oil palm plants, and (b) the mean level of the second metabolite in the mesocarp tissue of a plurality of the fruits of a plurality of the parental oil palm plants is at least 5% lower than the mean level of the second metabolite in the mesocarp tissue of a plurality of the fruits of a plurality of the reference oil palm plants.~~

~~8~~7. A method for obtaining palm oil from a high-yielding oil palm plant that provides a high yield of palm oil comprising:

(i) obtaining the high-yielding oil palm plant by the method of any one of claims 1 to ~~7~~6; and

(ii) isolating palm oil from a fruit of the high-yielding oil palm plant.

~~9~~8. A method for predicting oil yield of a test oil palm plant comprising:

(i) determining the level of a first metabolite and the level of a second metabolite in mesocarp tissue of a fruit of a test oil palm plant 11 to 21 weeks after pollination thereof, wherein (a) the first metabolite is selected front the group consisting of malic acid and pyruvic acid; and (b) the second metabolite is 2-oxoglutaric acid;

(ii) determining whether there is a difference between the level of the first metabolite and the level of the second metabolite in the mesocarp tissue of the fruit of the test oil palm plant and the level of the first metabolite and the level of the second metabolite in mesocarp tissue of a fruit of a reference oil palm plant that is used as a basis for comparison in determining palm oil yield, also 11 to 21 weeks after pollination thereof, wherein the difference is that:

(a) the level of the malic acid in the mesocarp tissue of the fruit of the parental oil palm plant 15 to 17 weeks after pollination thereof is 43% to 100% higher than the level of the malic acid in the mesocarp tissue of the fruit of the reference oil palm plant 15 to 17 weeks after pollination thereof, or

the level of the pyruvic acid in the mesocarp tissue of the fruit of the parental oil palm plant 11 to 13 weeks after pollination thereof is 33% to 82% higher than the level of the pyruvic acid in the mesocarp tissue of the fruit of the reference oil palm plant 11 to 13 weeks after pollination thereof;~~the level of the first metabolite in the mesocarp tissue of the fruit of the test oil palm plant is at least 15% higher than the level of the first metabolite in the mesocarp tissue of the fruit of the reference oil palm plant,~~ and

(b) the level of the 2-oxoglutaric acid in the mesocarp tissue of the fruit of the parental oil palm plant 11 to 15 weeks after pollination thereof is 50% to 69% lower than the level of the 2-oxoglutaric acid in the mesocarp tissue of the fruit of the reference oil palm plant 11 to 15 weeks after pollination thereof~~the level of the second metabolite in the mesocarp tissue of the fruit of the test oil palm plant is at least 5% lower than the level of the second metabolite in the mesocarp tissue of the fruit of the reference oil palm plant~~; and

(iii) predicting the oil yield of the test oil palm plant based on the plant having the 43% to 100% increase in malic acid and the 50% to 69% decrease in 2-oxoglutaric or the plant having the 33% to 82% increase in pyruvic and the 50% to 69% decrease in 2-oxoglutaric~~difference~~.

~~10. A method for obtaining a high-yielding oil palm plant that provides a high yield of~~

palm oil comprising:

(i) determining the level of a first metabolite and the level of a second metabolite in mesocarp tissue of a fruit of a parental oil palm plant 11 to 21 weeks after pollination thereof, wherein (a) the first metabolite is selected from the group consisting of fructose-1,6-diphosphate, glucose-1-phosphate, glycerol-3-phosphate, pyruvic acid, and ribose-5-phosphate; and (b) the second metabolite is 3- phosphoglyceric acid;

(ii) determining whether there is a difference between the level of the first metabolite and the level of the second metabolite in the mesocarp tissue of the fruit of the parental oil palm plant and the level of the first metabolite and the level of the second metabolite in mesocarp tissue of a fruit of a reference oil palm plant that is used as a basis for comparison in determining palm oil yield, also 11 to 21 weeks after pollination thereof, wherein the difference is that (a) the level of the first metabolite in the mesocarp tissue of the fruit of the parental oil palm plant is at least 15% higher than the level of the first metabolite in the mesocarp tissue of the fruit of the reference oil palm plant, and (b) the level of the second metabolite in the mesocarp tissue of the fruit of the parental oil palm plant is at least 5% lower than the level of the second metabolite in the mesocarp tissue of the fruit of the reference oil palm plant; and

(iii) selecting progeny of the parental oil palm plant based on the difference to obtain the high-yielding oil palm plant.

11. The method of claim 10, wherein the difference is that:

the level of the fructose-1,6-diphosphate in the mesocarp tissue of the fruit of the parental oil palm plant 19 to 21 weeks after pollination thereof is 33% to 82% higher than the level of the fructose-1,6-diphosphate in the mesocarp tissue of the fruit of the reference oil palm plant 19 to 21 weeks after pollination thereof; and

the level of the 3-phosphoglyceric acid in the mesocarp tissue of the fruit of the parental oil palm plant 13 to 17 weeks after pollination thereof is 17% to 31% lower than the level of the 3-phosphoglyceric acid in the mesocarp tissue of the fruit of the reference oil palm plant 13 to 17 weeks after pollination thereof.

12. The method of claim 10, wherein the difference is that:

the level of the glucose-1-phosphate in the mesocarp tissue of the fruit of the parental oil palm plant 19 to 21 weeks after pollination thereof is 30% to 75% higher than the level of the glucose-1-phosphate in the mesocarp tissue of the fruit of the reference oil palm plant 19 to 21 weeks after pollination thereof; and

~~the level of the 3-phosphoglyceric acid in the mesocarp tissue of the fruit of the parental oil palm plant 13 to 17 weeks after pollination thereof is 17% to 31% lower than the level of the 3-phosphoglyceric acid in the mesocarp tissue of the fruit of the reference oil palm plant 13 to 17 weeks after pollination thereof.~~

~~13. The method of claim 10, wherein the difference is that:~~

~~the level of the glycerol-3-phosphate in the mesocarp tissue of the fruit of the parental oil palm plant 11 to 19 weeks after pollination thereof is 22% to 190% higher than the level of the glycerol-3-phosphate in the mesocarp tissue of the fruit of the reference oil palm plant 11 to 19 weeks after pollination thereof; and~~

~~the level of the 3-phosphoglyceric acid in the mesocarp tissue of the fruit of the parental oil palm plant 13 to 17 weeks after pollination thereof is 17% to 31% lower than the level of the 3-phosphoglyceric acid in the mesocarp tissue of the fruit of the reference oil palm plant 13 to 17 weeks after pollination thereof.~~

~~14. The method of claim 10, wherein the difference is that:~~

~~the level of the pyruvic acid in the mesocarp tissue of the fruit of the parental oil palm plant 11 to 13 weeks after pollination thereof is 33% to 82% higher than the level of the pyruvic acid in the mesocarp tissue of the fruit of the reference oil palm plant 11 to 13 weeks after pollination thereof; and~~

~~the level or the 3-phosphoglyceric acid in the mesocarp tissue of the fruit of the parental oil palm plant 13 to 17 weeks after pollination thereof is 17% to 31% lower than the level of the 3-phosphoglyceric acid in the mesocarp tissue of the fruit of the reference oil palm plant 13 to 17 weeks after pollination thereof.~~

~~15. The method of claim 10, wherein the difference is that:~~

~~the level of the ribose-5-phosphate in the mesocarp tissue of the fruit of the parental oil palm plant 11 to 15 weeks after pollination thereof is 47% to 75% higher than the level of the ribose-5-phosphate in the mesocarp tissue of the fruit of the reference oil palm plant 11 to 15 weeks after pollination thereof; and~~

~~the level of the 3-phosphoglyceric acid in the mesocarp tissue of the fruit of the parental oil palm plant 13 to 17 weeks after pollination thereof is 17% to 31% lower than the level of the 3-phosphoglyceric acid in the mesocarp tissue of the fruit of the reference oil palm plant 13 to 17 weeks after pollination thereof.~~

~~16. The method of any one of claims 10 to 15, wherein the levels of the first and second metabolites in the mesocarp tissue of the fruit of the parental oil palm plant are determined by an analytical technique selected from the group consisting of gas chromatography-mass spectrometry, liquid chromatography-mass spectrometry, capillary electrophoresis-mass spectrometry, a biochemical assay, a chemical assay, a staining assay, and a chromatographic assay.~~

~~17. The method of any one of claims 10 to 16, wherein:~~

~~the parental oil palm plant is a dura breeding stock plant;~~

~~the progeny comprises an oil palm plant selected from the group consisting of a dura breeding stock plant and a tenera agricultural production plant; and~~

~~the high-yielding oil palm plant is selected from the group consisting of a dura breeding stock plant and a tenera agricultural production plant.~~

~~18. The method of any one of claims 10 to 16, wherein:~~

~~the parental oil palm plant is a tenera breeding stock plant;~~

~~the progeny comprises an oil palm plant selected from the group consisting of a tenera breeding stock plant, a pisifera breeding stock plant, and a tenera agricultural production plant; and~~

~~the high-yielding oil palm plant is selected from the group consisting of a tenera breeding stock plant and a tenera agricultural production plant.~~

~~19. The method of any one of the claims 10 to 18, wherein the difference is that (a) the mean level of the first metabolite in the mesocarp tissue of a plurality of the fruits of a plurality of the parental oil palm plants is at least 15% higher than the mean level of the first metabolite in the mesocarp tissue of a plurality of the fruits of a plurality of the reference oil palm plants, and (b) the mean level of the second metabolite in the mesocarp tissue of a plurality of the fruits of a plurality of the parental oil palm plants is at least 5% lower than the mean level of the second metabolite in the mesocarp tissue of a plurality of the fruits of a plurality of the reference oil palm plants.~~

~~20. A method for obtaining palm oil from a high-yielding oil palm plant that provides a high yield of palm oil comprising:~~

~~(i) obtaining the high-yielding oil palm plant by the method of any one of claims 10 to 19; and~~

(ii) isolating palm oil from a fruit of the high-yielding oil palm plant.

21. A method for predicting oil yield of a test oil palm plant comprising:

(i) determining the level of a first metabolite and the level of a second metabolite in mesocarp tissue of a fruit of a test oil palm plant 11 to 21 weeks after pollination thereof, wherein (a) the first metabolite is selected from the group consisting of fructose-1,6-diphosphate, glucose-1-phosphate, glycerol-3-phosphate, pyruvic acid, and ribose-5-phosphate; and (b) the second metabolite is 3- phosphoglyceric acid;

(ii) determining whether there is a difference between the level of the first metabolite and the level of the second metabolite in the mesocarp tissue of the fruit of the test oil palm plant and the level of the first metabolite and the level of the second metabolite in mesocarp tissue of a fruit of a reference oil palm plant that is used as a basis for comparison in determining palm oil yield, also 11 to 21 weeks after pollination thereof, wherein the difference is that (a) the level of the first metabolite in the mesocarp tissue of the fruit of the test oil palm plant is at least 15% higher than the level of the first metabolite in the mesocarp tissue of the fruit of the reference oil palm plant, and (b) the level of the second metabolite in the mesocarp tissue of the fruit of the test oil palm plant is at least 5% lower than the level of the second metabolite in the mesocarp tissue of the fruit of the reference oil palm plant; and

(iii) predicting the oil yield of the test oil palm plant based on the difference.