CLAIMS

1. A mutant, non-naturally occurring or transgenic plant cell comprising:

(i) a polynucleotide comprising, consisting or consisting essentially of a sequence encoding a neoxanthin synthase and having at least 60% sequence identity to SEQ ID NO:1 or SEQ ID No. 6;

(ii) a polypeptide encoded by the polynucleotide set forth in (i);

(iii) a polypeptide having at least 67% sequence identity to SEQ ID NO:2 or at least 68% sequence identity to SEQ ID No. 7; or

(iv) a construct, vector or expression vector comprising the isolated polynucleotide set forth in (i),

and in which the expression or activity of the neoxanthin synthase is modulated as compared to a control or wild type plant.

2. A mutant, non-naturally occurring or transgenic plant comprising the plant cell according to Claim 1.

3. A method for modulating the carotenoid content of a plant, comprising the steps of:

(a) modulating the expression or activity of neoxanthin synthase in the plant, preferably, in which the neoxanthin synthase comprises:

(i) a polynucleotide comprising, consisting or consisting essentially of a sequence encoding a neoxanthin synthase and having at least 60% sequence identity to SEQ ID NO:1 or SEQ ID No. 6;

(ii) a polypeptide encoded by the polynucleotide set forth in (i); or

(iii) a polypeptide having at least 67% sequence identity to SEQ ID NO:2 or at least 68% sequence identity to SEQ ID No. 7;

(b) measuring the carotenoid content in at least a part of the mutant, non-naturally occurring or transgenic plant obtained in step (a); and

(c) identifying a mutant, non-naturally occurring or transgenic plant in which the carotenoid content therein has changed in comparison to a control plant in which the expression or activity of neoxanthin synthase has not been modulated.

4. A method according to Claim 3, in which the expression or activity of lycopene beta cyclase or 9-cis-epoxycarotenoid dioxygenase or a combination thereof is also modulated in the plant.

5. A method according to Claim 4, in which the lycopene beta cyclase comprises the polynucleotide sequence set forth in SEQ ID NO:8 or has at least 60% sequence identity thereto or the polypeptide sequence comprises the set forth in SEQ ID NO:9 or has at least 60% sequence identity thereto and in which the 9-cis-epoxycarotenoid dioxygenase comprises the polynucleotide sequence set forth in SEQ ID NO:13 or has at least 60% sequence identity thereto.

6. A method for modulating the beta-damascenone content in a plant, comprising the steps of:

(a) modulating the expression or activity of neoxanthin synthase in the plant, preferably, in which the neoxanthin synthase comprises:

(i) a polynucleotide comprising, consisting or consisting essentially of a sequence encoding a neoxanthin synthase and having at least 60% sequence identity to SEQ ID NO:1 or SEQ ID No. 6;

(ii) a polypeptide encoded by the polynucleotide set forth in (i); or

(iii) a polypeptide having at least 66% sequence identity to SEQ ID NO:2 or at least 60% sequence identity to SEQ ID No. 7;

(b) measuring the beta-damascenone content in at least a part of the mutant, non-naturally occurring or transgenic plant obtained in step (a) or an aerosol thereof; and

(c) identifying a mutant, non-naturally occurring or transgenic plant in which the beta- damascenone content has changed in comparison to a control plant in which the expression or activity of neoxanthin synthase has not been modulated.

7. A mutant, non-naturally occurring or transgenic plant or plant material derived or derivable therefrom that is obtained or obtainable by a method according to Claim 6.

8. A mutant, non-naturally occurring or transgenic plant, in which expression of neoxanthin synthase or the activity of the protein encoded thereby has been increased; in which the green leaf lutein content or the beta-carotene content or the combined lutein and beta-carotene content of the plant is higher than a control plant in which the expression or the activity of neoxanthin synthase has not been increased; and in which the beta-damascenone content in aerosol of cured plant material is at least 10% higher than the aerosol from the control plant, preferably, in which: (i) the green leaf lutein content of the plant is at least about 18 mg/100g; (ii) in which the beta-carotene content of the plant is at least about 12 mg/100g; and (iii) in which the beta-damascenone content in aerosol upon heating is at least about 1 ng/mg.

9. Plant material including biomass, seed or leaves from a plant according to any of Claims 2, 7 or 8.

10. A tobacco product comprising a plant cell according to Claim 1, at least a part of a plant of any of Claims 2, 7 or 8 or plant material according to Claim 9.

11. A method for producing beta-damascenone comprising the steps of:

(a) providing at least part of a plant according to any of Claims 2, 7 or 8, plant material according to Claim 9, or a tobacco product according to Claim 10; and

(b) providing heat thereto to produce an aerosol comprising beta-damascenone.

12. An isolated polynucleotide comprising, consisting or consisting essentially of a sequence encoding a neoxanthin synthase and having at least 99% sequence identity to SEQ ID No. 6.

13. An isolated polypeptide encoded by the polynucleotide set forth in Claim 12.

14. An isolated polypeptide having at least 67% sequence identity to SEQ ID NO:2 or at least 68% sequence identity to SEQ ID No. 7.

CLAIMS

1. A mutant or transgenic tobacco plant cell comprising:

(i) a polynucleotide comprisingor consisting of a sequence encoding a neoxanthin synthase and having at least 60% sequence identity to SEQ ID NO:1 or SEQ ID No. 6;

(ii) a polypeptide encoded by the polynucleotide set forth in (i);

(iii) a polypeptide having at least 67% sequence identity to SEQ ID NO:2 or at least 68% sequence identity to SEQ ID No. 7; or

(iv) a construct, vector or expression vector comprising the isolated polynucleotide set forth in (i),

and in which the expression or activity of the neoxanthin synthase is increased or decreased as compared to a control or wild type tobacco plant.

2. A mutant or transgenic tobacco plant comprising a tobacco plant cell according to Claim 1.

3. A method for producing a tobacco plant with increased or decreased carotenoid content, comprising the steps of:

(a) increasing or decreasing the expression or activity of neoxanthin synthase in the tobacco plant, in which the neoxanthin synthase comprises:

(i) a polynucleotide comprising, consisting or consisting essentially of a sequence encoding a neoxanthin synthase and having at least 60% sequence identity to SEQ ID NO:1 or SEQ ID No. 6;

(ii) a polypeptide encoded by the polynucleotide set forth in (i); or

(iii) a polypeptide having at least 67% sequence identity to SEQ ID NO:2 or at least 68% sequence identity to SEQ ID No. 7;

(b) measuring the carotenoid content in at least a part of the mutant or transgenic tobacco plant obtained in step (a); and

(c) identifying a mutant or transgenic tobacco plant in which the carotenoid content therein has increased or decreased in comparison to a control tobacco plant in which the expression or activity of neoxanthin synthase has not beenincreased or decreased;

in which increasing the expression or activity of neoxanthin synthase increases the carotenoid content in the tobacco plant.

4. A method according to Claim 3, in which the expression or activity of lycopene beta cyclase or 9-cis-epoxycarotenoid dioxygenase or a combination thereof is also increased or decreased in the tobacco plant, in which increasing the expression or activity of lycopene beta cyclase increases the carotenoid content and decreasing the expression or activity of 9-cis-epoxycarotenoid dioxygenase increases the carotenoid content in the tobacco plant.

5. A method according to Claim 4, in which the lycopene beta cyclase comprises the polynucleotide sequence set forth in SEQ ID NO:8 or has at least 60% sequence identity thereto or the polypeptide sequence comprises the set forth in SEQ ID NO:9 or has at least 60% sequence identity thereto and in which the 9-cis-epoxycarotenoid dioxygenase comprises the polynucleotide sequence set forth in SEQ ID NO:13 or has at least 60% sequence identity thereto.

6. A method for producing a tobacco plant with increased or decreased beta-damascenone content, comprising the steps of:

(a) increasing or decreasing the expression or activity of neoxanthin synthase in the tobacco plant, in which the neoxanthin synthase comprises:

(i) a polynucleotide comprising, consisting or consisting essentially of a sequence encoding a neoxanthin synthase and having at least 60% sequence identity to SEQ ID NO:1 or SEQ ID No. 6;

(ii) a polypeptide encoded by the polynucleotide set forth in (i); or

(iii) a polypeptide having at least 66% sequence identity to SEQ ID NO:2 or at least 60% sequence identity to SEQ ID No. 7;

(b) measuring the beta-damascenone content in at least a part of the mutant or transgenic tobacco plant obtained in step (a) or an aerosol produced by heating thereof; and

(c) identifying a mutant or transgenic tobacco plant in which the beta- damascenone content has increased or decreased in comparison to a control tobacco plant in which the expression or activity of neoxanthin synthase has not been increased or decreased;

in which increasing the expression or activity of neoxanthin synthase increases the beta-damascenone content in the tobacco plant.

7. A mutant or transgenic tobacco plant or plant material derived or derivable therefrom that is obtained or obtainable by a method according to Claim 6.

8. A mutant or transgenic tobacco plant according to Claim 2 or Claim 7, in which expression of neoxanthin synthase or the activity of the protein encoded thereby has been increased; in which the green leaf lutein content or the beta-carotene content or the combined lutein and beta-carotene content of the tobacco plant is higher than a control tobacco plant in which the expression or the activity of neoxanthin synthase has not been increased; and in which the beta-damascenone content in aerosol of cured plant material is at least 10% higher than the aerosol from the control tobacco plant, preferably, in which: (i) the green leaf lutein content of the tobacco plant is at least 18 mg/100g; (ii) in which the beta-carotene content of the tobacco plant is at least 12 mg/100g; and (iii) in which the beta-damascenone content in aerosol upon heating is at least 1 ng/mg.

9. Plant material including biomass, seed or leaves from a tobacco plant according to any of Claims 2, 7 or 8.

10. A tobacco product comprising a tobacco plant cell according to Claim 1, at least a part of a plant of any of Claims 2, 7 or 8 or plant material according to Claim 9.

11. A method for producing beta-damascenone comprising the steps of:

(a) providing at least part of a tobacco plant according to any of Claims 2, 7 or 8, plant material according to Claim 9, or a tobacco product according to Claim 10; and

(b) providing heat thereto to produce an aerosol comprising beta-damascenone.