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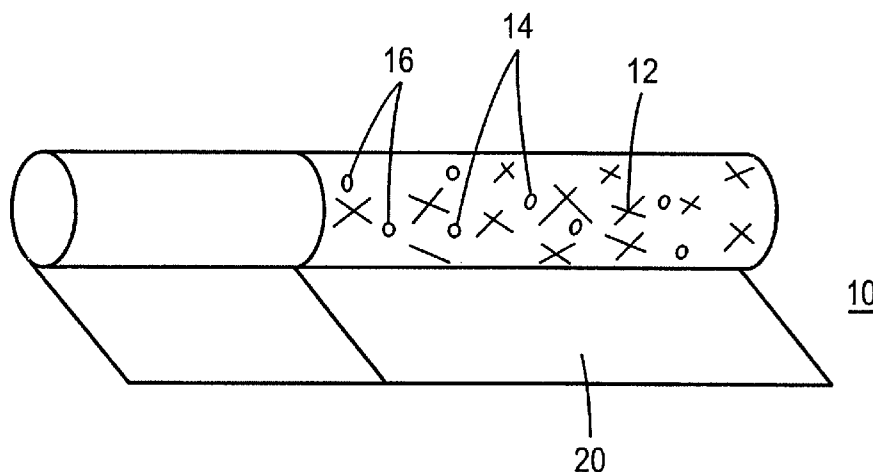


FIG. 1

(57) Abstract: Provided is a smoking article and method for reducing TPM cytotoxicity and targeted constituents in mainstream smoke. The smoking article (10) includes tobacco material (12) including a salt of a lanthanide metal (14). The method includes combining a salt of a lanthanide metal (14), water, and optionally glycerin to produce a solution that is applied to tobacco material (12). Preferably, the salt is an acetate, a sulfate, or a gluconate.



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SMOKING ARTICLES AND METHOD FOR INCORPORATING SALTS OF LANTHANIDE METALS FOR REDUCING TPM CYTOTOXICITY AND TARGETED CONSTITUENTS IN TOBACCO SMOKE

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BACKGROUND

Smoking articles, such as cigarettes, produce both mainstream smoke during a puff and side stream smoke during static burning. Compounds, such as hydroquinone, resorcinol, naphthalene, and catechol are found in the particulate phase of mainstream smoke. Such tobacco smoke constituents have been targeted for reduction.

10

SUMMARY

Provided is a smoking article including tobacco material that is treated with a salt of lanthanide metal and optionally glycerin and a method for reducing TPM cytotoxicity and targeted constituents in tobacco smoke by treating tobacco material with the salts of a lanthanide metal. Preferably, the salts are acetates, sulfates, or gluconates.

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Preferably, the salt of the lanthanide reduces cytotoxicity of tobacco smoke produced by the smoking article by about 1% to about 60%. Preferably, the salt of the lanthanide reduces the mutagenicity of the tobacco smoke by about 1% to about 50%.

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Preferably, the salt of the lanthanide metal reduces the presence of catechol, hydroquinone, resorcinol, and naphthalene by about 1% to about 80%.

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Preferably, the method includes selecting a salt of a lanthanide metal and dissolving the salt in water to form a solution. In an embodiment, the tobacco material is weighed and placed in a tumbling device. Preferably, the solution is added drop wise to or sprayed onto the tobacco material, while the tobacco material is tumbled so that the solution is applied throughout the tobacco material.

In an embodiment, the solution is sprayed onto the tobacco material while in the tumbling device.

In a preferred embodiment, the tobacco material is dried to evaporate the water, and then incorporated into a smoking article.

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In a preferred embodiment, the solution also includes glycerin.

Preferably, the glycerin is included in the smoking article in an amount of about 2% to about 25% by weight of the tobacco material. More preferably the glycerin is included in the smoking article in an amount of about 5% to about 15% by weight of the tobacco material.

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Preferably, the glycerin enhances the reductions in cytotoxicity, mutagenicity and reduces the relative amount of targeted constituents of mainstream smoke when compared to the use of the salt of a lanthanide metal alone. While glycerin alone can also reduce cytotoxicity

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and mutagenicity, the combination of glycerin and the salt of the lanthanide metal is also enhanced when compared to use of glycerin alone.

Preferably, the salt of the lanthanide and glycerin reduces the cytotoxicity and mutagenicity of tobacco smoke produced by the smoking article by about 20% to about 70%.

5 The smoking article may further include (a) humectants; (b) sweeteners; and/or (c) flavorants.

BRIEF DESCRIPTION OF THE DRAWINGS

10 Figure 1 is an illustration of an embodiment of a smoking article with reduced cytotoxicity and mutagenicity.

DETAILED DESCRIPTION

As described herein and shown in Figure 1, a smoking article 10 with reduced TPM toxicity and targeted constituents is provided.

15 Preferably, the smoking article 10 contains tobacco material 12 contacted with a salt of a lanthanide metal 14 that aids in reducing the content of compounds, such as hydroquinone, resorcinol, naphthalene, and catechol, in the particulate phase of mainstream smoke. Preferably, the cytotoxicity and mutagenicity is also reduced by the inclusion of the salt of a lanthanide metal 14.

20 In a preferred embodiment, the salt 14 is an acetate, a sulfate, or a gluconate. Most preferably, the salt 14 is an acetate salt of a lanthanide metal.

The term "smoking article" includes cigarettes, pipes, cigars, and cigarillos. Non-traditional cigarettes such as cigarettes for electrical smoking systems are also included in the definition of smoking articles or cigarettes generally.

25 Preferably, the smoking article 10 is a cigarette, which contains tobacco material 12. In a preferred embodiment, the cigarette includes a filter. In an embodiment, the cigarette may also contain at least one sorbent.

30 A traditional cigarette typically contains two sections, a tobacco-containing portion sometimes referred to as the tobacco or cigarette rod, and a filter portion which may be referred to as a filtration zone. Tipping paper typically surrounds the filter, which forms the buccal end of the cigarette. The tipping paper overlaps with the tobacco rod in order to hold the filter and tobacco rod together. The tobacco rod, or tobacco containing element of the cigarette includes the paper wrapper in which the tobacco is wrapped and the adhesive holding the seams of the paper wrapper together. The tobacco rod has a first end which is integrally attached to the filter
35 and a second end which is lit or heated for smoking the tobacco. When the tobacco rod is lit or

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heated for smoking, the smoke travels from the lit end downstream to the filter end of the tobacco rod and further downstream through the filter.

The "upstream" and "downstream" relative positions between filter segments and other features are described in relation to the direction of mainstream smoke as it is drawn from a tobacco rod and through a multi-component filter during a puff.

In a preferred embodiment, the filter of the smoking article includes a sorbent. A "sorbent" is a substance that can condense or hold molecules of other substances on its surface, and/or can take up other substances, i.e., through penetration of the other substances into its inner structure, or into its pores. Accordingly, the term "sorbent" as used herein refers to either an adsorbent, an absorbent, or a substance that can function as both an adsorbent and an absorbent. Preferred sorbents include various forms of activated carbon, molecular sieves, such as zeolites, and mixtures thereof.

Examples of suitable types of tobacco materials that may be used include, but are not limited to, flue-cured tobacco, Burley tobacco, Maryland tobacco, Oriental tobacco, rare tobacco, specialty tobacco, blends thereof and the like. The tobacco material may be provided in any suitable form, including, but not limited to, tobacco lamina, processed tobacco materials, such as volume expanded or puffed tobacco, processed tobacco stems, such as cut-rolled or cut-puffed stems, reconstituted tobacco materials, blends thereof, and the like. Tobacco substitutes may also be used.

Humectants, flavorants, and sweeteners may also be blended with the tobacco material.

Suitable humectants that can be used with the tobacco material include, without limitation, glycerol, glycerin, triethylene glycol and propylene glycol.

In a preferred embodiment, the tobacco material 12 is treated with a solution including a salt of a lanthanide metal 14. Preferably, the lanthanide metal is lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, or lutetium.

Also provided is a method for treating tobacco materials with a solution including a salt of a lanthanide metal. The method includes forming a solution of water and the salt of a lanthanide metal. Water is used to dissolve the salt of a lanthanide metal, and is therefore only needed in an amount suitable to dissolve the salt.

The salt of the lanthanide metal is added to the tobacco material in an amount of about from 0.25% to about 25% by weight of the tobacco material. More preferably, the salt of a lanthanide metal is added to the tobacco material in an amount of about 0.1% to about 10% by weight of the tobacco material.

In an embodiment, glycerin 16 is added to the tobacco material 12 in an amount of about 2% to about 25% by weight of the tobacco material 12. More preferably, glycerin 16 is added to

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the tobacco material 12 in an amount of about 5% to about 15% by weight of the tobacco material 12. This portion of glycerin 16 is in addition to the use, if any, of glycerin 16 as a humectant.

If too much glycerin 16 is added, the wrapping paper 20 of the smoking article 10 may become too moist.

Preferably, the glycerin 16 enhances the reduction of cytotoxicity and mutagenicity when used in conjunction with the salt of a lanthanide metal 14. As shown in Tables 1 and 2 below, neither glycerin 16 nor the salt of the lanthanide metal 14 reduces the cytotoxicity or mutagenicity as much as the combination of glycerin 16 and the salt 14, though both glycerin 16 and the salt 14 can be independently effective in reducing cytotoxicity and mutagenicity.

In an embodiment, after the solution is formed, the tobacco material 12 is placed in a tumbling device and drops of the solution are added through a nozzle as the tobacco tumbles so that the solution is spread throughout the tobacco material. In another embodiment, the solution is sprayed onto the tobacco material while in the tumbling device.

The tobacco material is then dried to evaporate the water, and processed for inclusion in a smoking article.

Example 1

About 3.2 g of solid $\text{La}(\text{OAc})_3 \cdot x\text{H}_2\text{O}$ is dissolved in about 20 g of deionized water in a vial. About 40 g of tobacco material is placed in a tumbling device. The solution is sprayed through a nozzle onto the tobacco material as the tobacco material is tumbled. The treated tobacco is dried to evaporate the water and equilibrated in a conditioned room.

Table 1

Compounds	8% $\text{La}(\text{OAc})_3 \cdot x\text{H}_2\text{O}$ ($x \leq 2$)	7.4% $\text{Ce}(\text{OAc})_3 \cdot \text{H}_2\text{O}$	8% $\text{Eu}(\text{OAc})_3 \cdot \text{H}_2\text{O}$	8.2% $\text{Lu}(\text{OAc})_3 \cdot \text{H}_2\text{O}$
catechol	-41%	-54%	-48%	-33%
HQ	-60%	-23%	-39%	-49%
resorcinol	-56%	-	-33%	-39%
Naphthalene	-51%	-47%	-54%	-33%
Cytotoxicity	-25%	-	-	-
Mutagenicity	-46%	-	-21%	-

*-: No significant change (absolute change <20%)

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Table 1 shows the results of FTC tests of the tobacco treated with acetate salts of a lanthanide metal incorporated into a smoking article and smoked. Under FTC conditions, the 3rd and 4th puffs of the mainstream TPM are collected. The relative phenolic and PAH contents are obtained by GC/MS methods. The TPM cytotoxicity data is obtained using the Neutral Red Uptake, while mutagenicity data is obtained using Ames assays.

In all cases, the cytotoxicity is reduced. The mutagenicity of the mainstream smoke is only reduced when the tobacco was treated with 8%La(OAc)₃·xH₂O, 8%Eu(OAc)₃·H₂O, or 8.2%Lu(OAc)₃·H₂O.

Example 2

About 4.0 g of glycerin is dissolved in about 20 g of deionized water. About 3.2 g of solid La(OAc)₃·xH₂O is added to form a solution. About 40 g of tobacco material is placed in a tumbling device. The solution is sprayed into the tumbling device through a spraying nozzle as the tobacco material is tumbled. The treated tobacco is dried and equilibrated in a conditioned room.

Table 2

Compounds	8% La(OAc) ₃ ·xH ₂ O 10% glycerin	7.4% Ce(OAc) ₃ ·H ₂ O 10% glycerin	7.7% Eu(OAc) ₃ ·H ₂ O 10% glycerin	8.2% Lu(OAc) ₃ ·H ₂ O 10% glycerin	10% glycerin
phenol	-74%	-65%	-73%	-74%	-69%
o-cresol	-58%	-53%	-62%	-63%	-66%
m/p-cresol	-66%	-52%	-61%	-62%	-63%
catechol	-45%	-39%	-40%	-37%	-41%
HQ	-56%	-48%	-50%	-62%	-27%
resorcinol	-53%	-80%	-71%	-65%	-
Naphthalene	-61%	-	-29%	-51%	-63%
Fluorene	-31%	-	-21%	-21%	-41%
Phenanthrene	-37%	-	-	-	-26%
Cytotoxicity	-40%	-36%	-47%	-44%	-22%
Mutagenicity	-40%	-41%	-56%	-45%	-

*-: No significant change (absolute change <20%)

Table 2 shows the results of an FTC test of the tobacco material treated with glycerin and the salt of a lanthanide metal is incorporated into a smoking article and smoked. Under FTC conditions, the 3rd and 4th puffs of the mainstream TPM are collected. The relative

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phenolic and PAH contents are obtained by GC/MS methods. The TPM cytotoxicity and mutagenicity data are obtained using Neutral Red Uptake and Ames assays, respectively.

As seen in Table 2, the cytotoxicity and mutagenicity for all samples treated with glycerin and a salt of a lanthanide metal is greatly reduced compared to tobacco treated with glycerin alone.

As compared to Table 1, the addition of glycerin to the solution improves the smoke chemistry of the cigarettes, resulting in enhanced reduction in TPM cytotoxicity and mutagenicity, as compared to the cigarettes containing tobacco treated with only an acetate salt of a lanthanide metal.

Test results indicate that the combination of glycerin and a salt of a lanthanide metal is most effective for reducing cytotoxicity and mutagenicity, whereas the salt or glycerin alone shows only minor reductions.

While the foregoing has been described in detail with reference to specific embodiments thereof, it will be apparent to one skilled in the art that various changes and modifications may be made, and equivalents thereof employed, without departing from the scope of the claims.

CLAIMS:

1. A smoking article comprising:
a portion of tobacco material including a salt of a lanthanide metal,
5 wherein the salt is an acetate, a sulfate, or a gluconate.
2. A smoking article according to claim 1, wherein the portion of tobacco material further includes glycerin.
- 10 3. A smoking article according to claim 2, wherein glycerin is included in the smoking article in an amount of about 2% to about 25% by weight of the tobacco material.
4. A smoking article according to claim 1, wherein the acetate salt of a lanthanide is selected from the group consisting of $\text{La}(\text{OAc})_3 \cdot x\text{H}_2\text{O}$, $\text{Ce}(\text{OAc})_3 \cdot \text{H}_2\text{O}$, $\text{Eu}(\text{OAc})_3 \cdot \text{H}_2\text{O}$,
15 $\text{Lu}(\text{OAc})_3 \cdot \text{H}_2\text{O}$, and combinations thereof.
5. A smoking article according to claim 1, wherein the smoking article includes the salt of a lanthanide metal in an amount of about 0.25% to about 25% by weight of the tobacco material.
- 20 6. A method of making a smoking article for reducing TPM cytotoxicity and mutagenicity in smoke comprising:
contacting a portion of tobacco material with a solution containing a salt of a lanthanide metal to form a treated portion of tobacco material; and
incorporating the treated portion of tobacco material into a smoking article,
25 wherein the salt of a lanthanide metal is an acetate, a sulfate, or a gluconate.
7. A method according to claim 6, wherein the solution further includes glycerin.
8. A method according to claim 7, wherein the glycerin is included in the solution in an
30 amount of about 2% to about 25% by weight of the tobacco material.
9. A method according to claim 7, wherein the glycerin is included in the solution in an amount of about 5% to about 15% by weight of the tobacco material.
- 35 10. A method according to claim 6, further including drying the treated portion of tobacco material.

11. A method according to claim 6, wherein the salt of a lanthanide metal is at least one of:
(i) sprayed onto the portion of tobacco material; and (ii) added drop wise to the portion of tobacco material.

5

12. A method according to claim 6, wherein the portion of tobacco material is placed in a tumbling device prior to contacting the portion of tobacco material with the solution.

13. A method according to claim 6, wherein the treated portion of tobacco material includes
10 the salt of a lanthanide metal in an amount of about 0.25% to about 25% by weight of the tobacco material.

14. A method according to claim 6, wherein the lanthanide metal is selected from the group
consisting of lanthanum, cerium, praseodymium, neodymium, promethium, samarium,
15 europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, lutetium, and combinations thereof.

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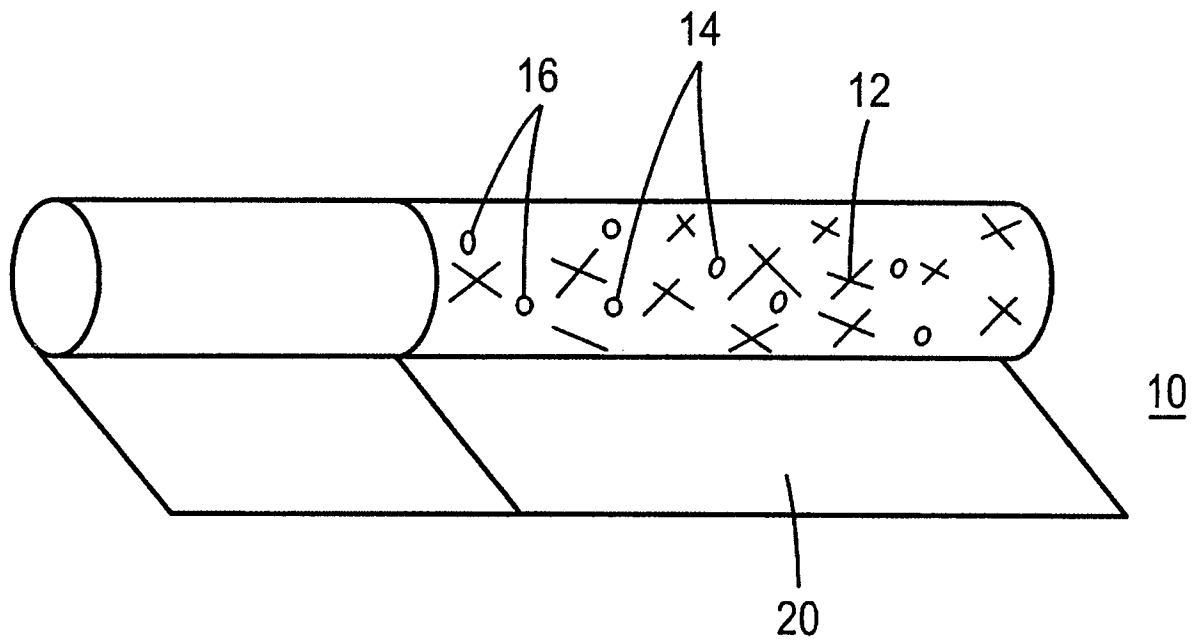


FIG. 1