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A perfume composition includes groups of perfume components that produce enhanced sensory performance. The composition includes components that have synergistic odor properties.

ABSTRACT

A perfume composition includes groups of perfume components that produce enhanced sensory performance. The composition includes components that have synergistic odor properties.

PERFUME COMPOSITIONS

Field

This invention relates to perfume compositions with enhanced sensory performance, compositions including such perfume compositions, and methods of making and using such compositions. The invention includes perfumes created using materials capable of synergistic blending.

Background

Odor detection is effected through olfactory receptors which are located in neurons in the olfactory epithelium in the nasal cavity. The signals from these neurons pass on to the glomeruli in the olfactory bulb and onto the higher center of the brain for further interpretation. Each receptor neuron expresses a single class of olfactory receptor, and olfactory receptor neurons of such a single type are distributed across the olfactory epithelium. The output fibers from these scattered neurons converge together on a single glomerulus in the olfactory bulb. Thus the signals from olfactory neurons coding for similar molecular properties/moieties carrying the same odor informational content will tend to converge on the same glomeruli in the olfactory bulb. A single odorant molecule will generally excite more than one class of olfactory neuron, and the pattern of excitation will be reproducible and characteristic of that molecule.

In this process the features of the odorant molecule are first fragmented and detected by the odor receptors. Then similar features of different odor molecules reinforce each other at the different odor receptors, and at the olfactory bulb level. The whole is then re-integrated to provide the odor perception, which can be as simple as a single percept. In this way the many odorous molecules emanating from a single flower can excite multiple neurons, whose signals recombine to produce a single olfactory experience which the observer can recognise as typical of the particular flower. A different flower may emit many of the same materials but the differences in levels and composition will be re-integrated to yield a different sensory percept that can be recognised as coming from the different flower.

This combinatorial approach has been proposed previously, but the detailed processes involved are yet far from understood. The complexity of the combinatorial mechanisms has been a recurring feature of olfactory research. Early studies of odor mixtures sought to chart and classify the sensory phenomena when odors were mixed, and

developed terms to describe the observed changes in total intensity that were observed. These studies were limited to binary mixes due to the complexity of the phenomena involved.

Progress has proved equally tricky at a biological level. It has been observed that
 5 single olfactory neurons simultaneously integrated several chemical signals. However
 researchers stress that complex interactions occur between components, and that the
 responses of olfactory neurons are not simply predictable from the responses of their
 components. They found that the events that occurred at the receptor neurons themselves,
 without the contribution of later events at the olfactory bulb, could be linked to changes in
 10 perceived odor, e.g. due to one odorant dominating or even masking the effect of another.
 A natural odor would induce a multi-chemical integration at the olfactory receptor neuron
 which might be equivalent to a shift in their odor coding properties, such that they may
 play a major part in perception process as a whole.

Thus the issues underlying the challenge for researchers trying to understand
 15 odors are becoming clearer while the complexity and non-linearity of the observed
 phenomena is making even reliable classification difficult.

In nature it is common for the odor experience to arise from a complex mixture of
 odor molecules and for this mixture to be perceived as a single percept. This
 circumstance can be observed in animals and insects where olfactory signals can drive
 20 critical behaviours. For example, a moth can identify a flower which emits more than 60
 materials of which 9 are detected by the olfactory system. These have been shown to
 behave as a single percept capable of driving flower-foraging behaviour. The encoding is
 organised through a population of glomerular coding units which are thought to combine
 the different features of the molecular stimulants into the singular percept (via a
 25 mechanism as yet unknown).

In human studies the detailed outcome of such odor mixing has been variable and
 unpredictable though some broad categories of response are regularly observed.

The convergent nature of processes occurring at the higher centres of olfactory
 processing necessarily means that odor mixtures are not always simple combinations of
 30 their components. This being said it is often possible for humans to perceive a complex
 odor mixture as a single whole, while also being able to decompose the experience into
 sensory sub-units. For example, when a malodor and perfume are mixed it is often
 possible to compartmentalise the experience such that the relative contributions of each
 odor type to the overall odor can be judged. So there exists a paradox: that the mix may

be perceived as a single perceptual experience, while that experience may be subdivided on introspection.

The outcome of introspection may not reflect the relative intensities of the component stimuli, or even their odor character. Nevertheless the process can be sufficiently reproducible that it can be used to design new products which deliver useful benefits, e.g. deodorant perfumes.

In such masking scenarios it is usual for one odor to be employed to reduce the perception of a second, less-desirable odor. This is a common practice and routes to optimise the process have been developed. Examples of synergistic interactions between odors are extremely rare by comparison.

In a compilation study based on the results from 520 binary mixtures, the most likely outcome of odor mixing at levels above threshold was that the total intensity of the mix was below the sum of the component intensities, and below that which would be expected from auto-addition following Stevens' Law. Intensity of a single material tends to increase as a logarithmic function of its concentration (Stevens' Law), so the first of these findings is not unexpected, however the second finding is more surprising. It was also found that one of the two components reduced the intensity of the other, more than occurred the other way round. They also found that adding a third, fourth, or fifth iso-intense component did not lead to any increase in overall intensity. This indicated strong compression mechanisms in play.

As noted above, synergistic effects were found to be infrequent. When found, they were thought to be associated with 'synthetic phenomena', where a new different odor quality is created when mixing the two components. Some odor was perceived when mixing sub-threshold levels of odorants but it was not possible to rationalise the observations. It was concluded that any study of these effects would require both intensity and odor character to be measured simultaneously.

Synergy has been described as a higher level of sensory impact than one would expect based on the impacts of the unmixed components. One example is adding a sub-threshold amount of one odorant causing a small but measurable increase in the perceived intensity of another (beverage) odor or in the perceived sweetness of supra-threshold sucrose. It has been thought that the addition of small amounts of one material can occasionally lead to significant increases in the intensity of an aroma or flavour. However, these examples may not be considered definitive examples of synergy unless the sub-threshold stimuli had no odor themselves. Given the statistical nature of a

threshold measure (e.g. the level at which 50% of subjects can detect its presence, and therefore 50% of subjects cannot) the added materials will have been supra-threshold for many of the subjects.

With such issues in mind, the first clear, unambiguous demonstration of synergy in odor detection in humans was shown. The materials were maple lactone mixed with the volatile carboxylic acids, acetic acid and butyric acid. Generally at detection threshold for binary mixtures, the threshold concentration of an individual component tended to be lower than the threshold of the component smelled alone, a phenomenon referred to as Agonism.

Researchers extended their studies to 3-component mixtures, but no universal theme emerged. They concluded that the rules for mixture interactions were such that each mixture must be treated separately and empirically.

In another supra-threshold study, binary mixes of a fruity and a woody odor, using ortho-nasal and retro-nasal stimulation were examined. The fruity intensity could be increased or decreased in mixtures depending on the level of the woody component. Synergy was reported based on eeg measures, where an enlarged N1 peak amplitude was found in some mixes. Other mixes, smelled retro-nasally, showed increased P2 amplitudes during eeg scans. These results may be evidence of both sensory and cognitive processes in play simultaneously during odor perception.

A study of alkyl sulphides and thiols led to the conclusion that the mixing of such materials with similar chemical structure could be characterised by an averaging effect over all components.

Binary mixes of L-carvone (caraway odor) and eugenol (clove odor) were presented at one nostril as a physical mixture versus each odorant presented separately at separate nostrils (dichorhnic mixing). Psychophysical and eeg responses were recorded. The dichorhnic mixtures were perceived as stronger than the physical mixes. The perceived odor character also differed between the two assessment methods. The eeg responses for the dichorhnic mixes showed differences for the P1 & N1 (more sensory) peaks. Taken together all the results show that significant Left-Right hemispheric interactions take place at the higher centers of the brain (or at least, post-glomeruli), and that the peripheral level is a site of significant interaction too.

In a later publication, it was shown that mixture quality (character) is not tied to any particular single component, indicating that one perceives an odor mixture more or

less synthetically as a single percept. In his study the odor and its pleasantness of a mixture was generally intermediate between that of each of the individual components.

WO2002049600, discloses perfume compositions with specific components to promote relaxed mood states.

- 5 The present invention seeks to address at least some of the issues described above. Specifically to identify groups of odor ingredients that can be used to create synergistic odor or perfume compositions and the resulting perfume compositions therefrom.

Summary

- 10 The present invention relates to perfumes created using materials capable of synergistic blending in odor or flavor mixtures. The invention further includes products formed by incorporating such perfumes.

- In one aspect of the invention, there may be a method of preparing a perfume composition by including materials, which when replacing a component of similar odour
15 character in any of the multi-component examples described herein, provide an intensity increase for these new mixtures versus the similar use of a disclosed non-resilient ingredient.

 In another aspect of the invention, there is a method for preparing a composition comprising a candidate active component, comprising the steps of:

- a. selecting a first inactive component in a first mixture, the first inactive component being
20 most similar in odor character to said candidate active component;
- b. selecting a second inactive component in said first mixture, the second inactive component being most dissimilar in odor character to said candidate active component;
- c. preparing a second mixture, wherein said second mixture is the same as the first mixture, except that the first inactive component is replaced with an iso-intense concentration of the
25 candidate active component and the second inactive component is replaced by a known active from the same odor class as the second inactive component;
- d. assess the intensity of the second mixture to determine whether the second mixture is significantly more intense than the first mixture, wherein if the second mixture is significantly more intense than the first mixture, then the candidate active component is considered to have
30 demonstrated resilient activity; and
- e. preparing a perfume composition comprising said candidate active component.

 In another aspect of the invention, there is a method determining the resilient activity level of a candidate active component, comprising the steps of:

- a. selecting a first inactive component in a first mixture, the first inactive component being most similar in odor character to said candidate active component;
- b. selecting a second inactive component in said first mixture, the second inactive component being most dissimilar in odor character to said candidate active component;
- 5 c. preparing a second mixture, wherein said second mixture is the same as the first mixture, except that the first inactive component is replaced with an iso-intense concentration of the candidate active component and the second inactive component is replaced by a known active from the same odor class as the second inactive component; and
- d. assess the intensity of the second mixture to determine whether the second mixture is
- 10 significantly more intense than the first mixture, wherein if the second mixture is significantly more intense than the first mixture, then the candidate active component is considered to have demonstrated resilient activity.

Brief Description of the Drawings

- 15 Figure 1 is a graph showing a threshold value approximation.
- Figure 2 is a bar graph showing the standardized intensity scores of Examples 1-12.
- Figure 3 is a bar graph showing the average intensity scores of Examples A-F.
- Figure 4 is a bar graph showing the average intensity scores of Examples G-O.
- Figure 5 is a bar graph showing odd-numbered odour groups.
- 20 Figure 6 is a bar graph showing even numbered odour groups.
- Figure 7 is a graph showing the average sample intensity of fragrances.

Detailed Description

- 25 The present invention has surprisingly found that specific combinations of ingredients can be used to create synergistic effects where the sensory impact of ingredients in the mix, or of the mix as a whole, is greater than one would expect based on the impacts of the unmixed components. Further, the present invention relates to

compositions that include the synergistic effects, as well as methods of using such compositions to achieve desired responses in users, such as humans.

Those ingredients which are more prominent in the mix than expected are referred to herein as 'resilient' materials and, not to be limited by theory, certain components of perfume compositions have been found to be more resilient than others. The present invention identifies these resilient odor components, including how to identify such resilient odor components and determine threshold levels, and further outlines how they can be combined beneficially with other perfume components. Resilient materials may also combine their odor with other ingredients present to create a new and different odor character in the mixture.

In a first aspect of the invention the perfume composition comprises components from specific groups. The groups, described below, are referred to as Group 1A, Group 1B, and 1C. Perfume compositions of the present invention may include one or more components from one, two or all three of Groups 1A, 1B and 1C.

The first component (Group 1A) is selected from the group consisting of: acetyl cedrene, Camphor powder synthetic, Cedarwood oil, cineole, cinnamic aldehyde (10), cistus labdanum, citral dimethyl acetal, Cosmone, Cyclal C, beta damascone (10), delta damascone (10), Ebanol (10), ethyl vanillin (10), eugenol, Galbanone (10), gamma undecalactone, heliotropin, hexyl cinnamic aldehyde, iso E Super, alpha iso methyl ionone, Mayol, methyl chavicol, methyl cinnamate, methyl ethyl 2 butyrate, Silvanone, Silvial, alpha terpineol, allyl hexanoate, Labienoxime (10), anisic aldehyde(10), Black Pepper Oil, Polysantol(10), Habanolide, dihydroeugenol, Melonal, Violetyne(10), methyl benzoate, Raspberry ketone, and mixtures thereof. Group 1A includes components that are active or resilient components in the perfume compositions of the present invention.

Throughout this specification when an individual component includes "(10)" it signifies a 10% solution of the named material in a solvent, preferably an odourless solvent, including by way of example: dipropyleneglycol.

The second component (Group 1B) is selected from the group consisting of alkyl alcohols, phenyl alkylalcohols, terpene hydrocarbons or mixtures thereof. The components of Group 1B can be added as part of natural oils. Components of Group 1B are described herein as "promoters".

Specific examples of the Group 1B components include: linalol, orange terpenes, phenyl propyl alcohol, phenyl ethyl alcohol, alpha terpineol, Mayol, Mefrosol, citronellol, tetrahydrogeraniol, tetrahydrolinalol, geraniol; and mixtures thereof. The components of

Group 1B have been found to further enhance the synergistic effect of the components of Group 1A.

The third component (Group 1C) may be selected from the group consisting of aldehyde C12 (10), anethole, Ambermax (10), isobornyl acetate, Calone 1951 (10),
 5 coumarin, cuminic aldehyde (10), Ginger oil, Oakmoss synthetic, Patchouli oil, undecavertol, Vetiver oil; and mixtures thereof. The materials from Group 1C can also be added as part of natural oils. Materials from Group 1C are optional in the composition.

As noted above, one or more components of one, two or three Groups may be used in the present invention. One or more components from Group 1A is present in the
 10 composition in amounts from about 20% to about 80% by weight of the composition, or from about 30% to about 80% by weight of the composition, or from about 40% to about 80% by weight of the composition, or from about 50% to about 80% by weight of the composition, or from about 30% to about 60% or from about 50% to about 60% by weight of the composition. The number of individual components from Group 1A can be
 15 one, two, three, four or more than four. When present, one or more components from Group 1B is present in the composition in amount from about 5% to about 50% by weight of the composition, or from about 15% to about 50% by weight of the composition, or from about 25% to about 50% of the composition or from about 15 % to about 25%, or from about 10% to about 20% by weight of the composition. The number of individual
 20 components from Group 1B, when included in the composition, can be one, two, three, four or more than four. A component from Group 1C, when present, is present in the composition in amounts up to about 35% of the composition or from about 18% or less by weight of the composition. The number of individual components from Group 1C, when included in the composition, can be one, two, three, four or more than four.

25 Thus, one aspect of the present invention includes a combination of the aforementioned Groups 1A, 1B, and 1C.

A second aspect of the present invention includes materials that are limited in their use in the composition, or materials that are excluded. There are two groups of these materials in the present invention: Group 2A and Group 2B.

30 Group 2A includes allyl cyclohexyl propionate, Bangalol, Bourgeonal, Cassis bases, ethyl methyl phenyl glycidate, ethylene brassylate, Florosa, Herboxane, cis 3 hexenyl methyl carbonate, Jasmatone, Lemonile, Lilial, methyl anthranilate, Methyl Laitone, phenyl ethyl phenylacetate, Rose oxide, styrallyl acetate, Traseolide, Ultravani, Ylang oil and mixtures thereof.

Group 2B includes isononyl acetate, linalyl acetate, and mixtures thereof.

When present, the materials in Group 2A or Group 2B are independently present in the composition at no more than about 1.0% by weight of the composition, and more preferably no more than about 0.6% by weight of the composition (other than as a component of a natural oil). Thus, the materials of Group 2A, when used independently from being present in a natural oil, may be present in an amount of from zero percent to about 1.0% or up to about 0.6% by weight of the perfume composition. Similarly, the materials of Group 2B, when used independently from being present in a natural oil, may be present in an amount of from zero percent to about 1.0% or up to about 0.6% by weight of the perfume composition.

The total concentration of non-essential oil additions of materials from Groups 2A and 2B comprises less than 2% by weight of the total perfume composition, and more desirably less than about 1% by weight of the total perfume composition. In some embodiments, the perfume compositions of the present invention are free of any materials from group 2A, and in some embodiments, the perfume compositions of the present invention are free of any materials from group 2B.

All percentages are based on total weight of materials in the perfume composition (other than that added as part of a natural essential oil), the total percentage of an essential oil or analogue (where it is a named ingredient), and 10 times the actual concentration of the pure material where it is noted as followed by (10), such as for aldehyde C12 (10). Where a material appears in two or more groups then its contribution should be considered as split between the groups (e.g. Mayol, alpha terpineol); e.g. 50:50 between two groups.

The present invention has surprisingly found that specific combinations of ingredients can be used to create synergistic odor or perfume compositions. Not to be limited by theory, certain components of the perfume composition have been found to be more resilient than others. A resilient odor component is one that provides a character to the entire composition greater than would be expected to otherwise provide based on the odor properties of the single material. The present invention identifies resilient odor components which are more easily identified in mixes and their odor character becomes a clear component of the odor character of the mixture as a whole. Another benefit of the present invention is that the presence of resilient materials leads can lead to a new and different odor character being created in the mixture. The present invention is quite useful in that it achieves providing a stronger, or more complex, or unique perfume while

avoiding the need for adding more ingredients in the composition. For example, a resilient component may give a higher perceived intensity while using less of that resilient component in the perfume composition.

When odor mixtures are created from equal proportions of iso-intense ingredients, the mixtures containing significant proportions of 'resilient materials' are often associated with higher perceived intensity than mixtures where they are absent.

The odor character contribution of a second group of materials, 'non-resilient materials', is reduced on mixing with more resilient materials. In certain compositions, these non-resilient materials may be masked altogether. Therefore the amounts of the non-resilient materials, such as those listed in Groups 2A and 2B, in the compositions should be limited in the levels described above, if used at all. Resilient components, such as those in Group 1A, should be present in a significantly higher amount than components in Group 2A and/or in Group 2B.

Thus, the aforementioned aspect of the invention includes perfume compositions including one or more component selected from at least one of Groups 1A, 1B and 1C in combination with a component from one or more of Groups 2A and 2B.

A third group of materials tend to be present when resilient materials and/or mixes containing them are enhanced, but do not generally demonstrate such a prominent olfactory contribution themselves. These are the Group 1B promoters. Many of the Group 1B promoters are alcohols, which are general blending materials. This invention has surprisingly found that the Group 1B materials promote the contribution of the resilient material in the perfume composition. The Group 1B promoters increase the intensity of the resilient component(s). Group 1B promoters will increase the intensity of the Group 1A material(s) without the odor of the Group 1B promoter coming through prominently. The Group 1B promoters are optionally included in the perfumes of the present invention.

A threshold concentration of an odor component is the minimum concentration at which the odor is perceived. These behaviours can be demonstrated in mixes where all the components are present as iso-intense stimuli in equal parts at threshold concentrations. Threshold concentration can be considered as a standard level for creating iso-intense concentrations, which can be identified relatively unambiguously for all materials. If no interactions were to take place between the iso-intense components of a mixture, then each material would be perceived equally. If some materials became more olfactorily prominent, and/or intense, then it is judged that their odor has been

enhanced by the presence of the other materials. Thus forming mixtures with iso-intense materials gives a useful approach to identify when and how enhancement may take place within a mixture or for the mixture as a whole. At threshold levels of perception of the odor component such enhancement is more easily identified.

5 A useful solvent for making liquid phase samples at threshold concentration is dipropylene glycol (dpg). The concentration of perfumery material is generally so small in such compositions that physical effects between materials at threshold will be very small, and the main effects will be sensory.

10 The present invention includes perfume compositions that include components that are consistently perceived at intensities above threshold in mixtures, while their concentration remains at threshold concentration level. Thus, the intensity of the odor of one or more components is increased through the present invention, even though the actual amount of the one or more components is at the threshold concentration level.

15 It is noted that it is possible to increase the intensity of a particular facet of odor character by using trivial additions, but the present invention goes beyond the mere use of trivial additions described herein. Trivial additions include adding materials of the same odor facet to achieve a greater odor. For example, it is possible to combine materials at or below threshold concentration such that in combination they produce an odor above threshold perception level. This can be achieved by combining only materials which each
20 act partially or totally at the same receptor(s). Such groups of materials will usually be identifiable in that they have similar odors or shared odor facets. For example, combining sub-threshold amounts of different rose-smelling materials may produce a suprathreshold mixture with a rose odor. However, this alone is not the mechanism of the present invention. The resilient odor components in the compositions of the present invention
25 produce enhanced effects and odor intensity benefits. This can be achieved without the simultaneous presence of other materials with shared odor characteristics. Of course, the present invention does not exclude their use with such materials. The approach of blending materials only having similar odor characteristics is described above by way of example to differentiate the alternative approach to 'apparent enhancement', which is
30 based on trivial additive effects.

 In addition to the resilient odor components used in the present invention, a second component may be added. Added second component materials may not play such a prominent olfactory role themselves in the overall odor profile of the mixture. They may not be perceived as among the most intense components, however neither do they

strongly dilute or detract from the intensity performance of mixtures containing resilient materials. It has been surprisingly found that the combination of resilient odor components with a second component produces mixtures with useful, enhanced performance (e.g., higher perceived intensity of the mix with the resilient odor component).

The perfume or fragrance compositions according to the present invention can be used in a variety of products. As used herein, the term "product" shall refer to products including perfume compositions described above, and includes consumer products, medicinal products, and the like. Such products can take a variety of forms including powders, bars, sticks, tablets, creams, mousses, gels, lotions, liquids, sprays, and sheets. The amount of perfume composition in such products may lie in a range from 0.05% (as for example in low odor skin creams) to 30% (as for example in fine fragrances) by weight thereof. The incorporation of perfume composition into products of these types is known, and existing techniques may be used for incorporating perfumes for this invention. Among various methods to incorporate perfume compositions into a product include mixing the perfume composition directly into or onto a product, but another possibility is to absorb the perfume composition on a carrier material and then admix the perfume-plus-carrier mixture into the product.

To provide a more concise description, some of the quantitative expressions given herein are not qualified with the term "about". It is understood that whether the term "about" is used explicitly or not, every quantity given herein is meant to refer to the actual given value, and it is also meant to refer to the approximation to such given value that would reasonably be inferred based on the ordinary skill in the art, including approximations due to the experimental and/or measurement conditions for such given value.

The present invention includes perfume compositions and products including such perfume compositions, as well as methods of using such perfume compositions and products. The methods of use include providing a perfume composition or product as described herein to a human and allowing the human to smell the resulting odor to achieve a desired effect. The desired effect may include, for example, providing to a user (such as a human) emotional benefits, cognitive benefits, and/or improved interactions with perceptions in other modalities.

The present invention also includes a method to evaluate certain perfumes/odors and determining the threshold concentration for a perfume or flavour that can be used to

identify the benefits of the invention. The evaluation may then be used to produce a perfume composition (or product including the perfume composition) with the desired threshold amount of the fragrance desired. Thus, there is provided a method of determining a threshold amount of a fragrance, and preparing a perfume composition using the results of the evaluation. The

5 method may further include forming a product with the perfume composition.

In the examples and description below, the method includes use of a solvent. The solvent in the examples is dipropylene glycol, sometimes referred to here as dpg, though other low odor or odourless solvents may be used.

10 In these examples the threshold in dpg of each ingredient was first determined and then each ingredient was incorporated into the perfume at that level. Perfumes were also created with all the ingredients present at approximately 0.3 times threshold, and another set with all ingredients present at 0.1 times threshold concentration. For illustration the experiments below were carried out using a 10ml aliquot of perfume in 125ml brown glass jars.

15 **Threshold Measurement**

One suitable method for ascertaining the detection and/or recognition threshold of each odor ingredient from a liquid solution is derived from the Method of Limits (which is described in the ASTM 'Manual on Sensory Testing Methods', STP 434 (1968), American Soc for Testing Materials, Philadelphia, Pa. 19103, USA). An initial experiment was conducted to determine the
20 approximate threshold level. A concentration series of samples was made and diluted until no perfume odor was discernible. Then an ascending series of concentrations of a perfume ingredient in dipropylene glycol starting below threshold level, was presented to each assessor who then judged the presence or absence of the designated odor quality in each sample. The series continued until the judgement changed (from 'not present' to 'present'). Data from more
25 than 15 assessments was pooled and analysed to interpolate the concentration in a series at which the target odor would have been detected (and/or recognised) in 50% of assessments.

The relationship between detection rates and $\log_{10}$ concentrations was hypothesised to be sigmoid; therefore to predict the 50% detection rate for each ingredient, a fit line was derived conforming to the function:

$$y = \frac{100\%}{1 + 10^{k(\text{threshold} - x)}}$$

Where y is the percentage detection rate, x is the $\log_{10}$ of the percentage concentration of the ingredient in dipropylene glycol, k is the constant determining the gradient of the sigmoid function, and *threshold* is the concentration value at the inflection point of the sigmoid curve (and also therefore, the concentration at the 50% detection rate).

Values for k and *threshold* were approximated, then fitted using the solver add-in module of Microsoft XL 2007 such that root mean squared error (RMSE) between the observed and predicted points was minimised. The resultant RMSEs for all fit lines were below 10% and deemed acceptable. Fig. 1 shows a threshold value approximate for one sample perfume ingredient.

Assessment of Odor Intensity Measurement

A team of male and female assessors are used in the evaluation of sample intensity. In this work, the assessors were between the age of 25 and 65 years old. They were selected for evaluations on the basis of their ability to correctly rank the odour intensities of a series of dilutions (in dpg) of perfume ingredients. The standard perfume ingredient used in odour assessment sessions was benzyl acetate, prepared in a series of dilutions listed in the table below. Each dilution was associated with an odour intensity score. Other materials could be used in a similar fashion.

Intensity Score	Benzyl Acetate in DPG	Odour description
0	0%	No Odour
1	0.005%	Slight
2	0.016%	Weak
3	0.05%	Definite
4	0.10%	Moderate
5	0.23%	Moderately Strong
6	0.67%	Strong
7	2.3%	Intense
8	5.1%	Very intense

Standard dilutions as above were present during evaluations and provided for reference to assist assessors in the evaluations.

The examples tested were prepared as described herein. The examples consisted of dilutions in dpg of mixtures of materials, at or above their individual threshold concentrations. In general approximately 10g of each solution was placed in a capped 125ml jar and allowed to equilibrate for a minimum of 2 hours at room temperature. Assessments were made by assessors removing the cap and smelling the contents. Jars were assessed in random order. Assessors assigned a score between 0 and 8 to each sample, with 0 corresponding to no odour and 8 representing very intense odour. After that, at least 15 assessments were obtained for each sample.

Where assessments for a sample are carried out over several sessions and/or with different subjects, it is possible to facilitate comparisons between samples by normalising the results for each sample across sessions and assessors. This may occur, for example, when too many samples are available for the assessor to be reliably assessed in one session. The data for Examples 1 to 12 was analysed in this fashion, as described below.

Assessors were presented with a segment of the samples in a series of sessions, in order to reduce the fatigue and inconsistency of assessment associated with a large number of samples. Each assessor's scores were standardised as follows: for each assessor, the mean of all the individual's scores within the session was calculated ($\bar{x}_{(\text{assessor, session})}$), and the sample standard deviation of the same score set was calculated

($s_{(assessor,session)}$). Using these statistics, each of the assessor's data points was converted to a standardised score, that is, the i^{th} score for each assessor (x_i) was recalculated into ($x_{std,i}$) as follows:

$$x_{std,i} = \frac{x_i - \bar{x}_{(assessor,session)}}{s_{(assessor,session)}}$$

- 5 The data was further analysed using analysis of variance. The mean of all standardised scores, for all assessors ($\bar{x}_{std}$) was then calculated for each sample.

The Examples were made using a variety of fragrance ingredients listed in Table A. All example mixes were made volumetrically on the principle of adding a small known quantity of each stock solution (in dpg) to a vial and diluting to the required
10 amount with additional clean dpg. Ideal stock solutions were such that 20 μ L of each ingredient stock solution, when diluted further in a solution totalling 20mL would deliver a solution of all ingredients at the estimated threshold concentration of each ingredient. Stock solutions were prepared gravimetrically in serial dilution steps: e.g. to make a 0.0005% solution of an ingredient, 0.50g were added to 9.50g dpg resulting in a 5%
15 solution totalling 10.00g; 0.15g of this solution would then be diluted in 14.85g dpg, resulting in a 0.05% solution totalling 15g; this second solution would then be diluted by the same dilution factor by adding 0.15g of 0.05% solution to 14.85g dpg, resulting in 15g of 0.0005% solution.

Mixture stocks were stored in a refrigerator, in containers with very little residual
20 headspace above the solution (minimising loss of volatiles).

Each Example was prepared by adding the target quantity of each stock solution to a vial and making up to a total of 20.0g. Each mixture was then agitated and left to equilibrate. Each was used as-is, and was further diluted by a factor of 3/10 and 1/10, to produce the sub-threshold mixes. In this way, each mixture was prepared at 3
25 concentrations: (1) with each component at threshold concentration, (2) with each component at 0.3*threshold concentration and, (3) with each component at 0.1*threshold concentration.

TABLE A

Perfumery Name	Chemical Name & other specialty names
9 DECENOL-1-OL	9-decen-1-ol
ACETYL CEDRENE	1-[(3R,3aR,7R,8aS)-2,3,4,7,8,8a-hexahydro-3,6,8,8a-tetramethyl-1H-3a,7-methanoazulen-5-yl]-ethanone
ALDEHYDE C12	dodecanal
ALLYL CYCLOHEXYL PROPIONATE	prop-2-enyl-3-cyclohexylpropanoate
ALLYL HEXANOATE	prop-2-en-1-yl hexanoate
AMBERMAX	2H-2,44a-Methanonaphthalene-8-ethanol
AMBROX DL	dodecahydro-3a,6,6,9a-tetramethylnaphtho-(2,1-b)-furan
ANETHOLE	(E)-4- methoxy-1-propenyl benzene
ANISIC ALDEHYDE	4-methoxy benzaldehyde
AURANTION	methyl 2-[(7-hydroxy-3,7-dimethyloctylidene)amino]benzoate, = Aurantil Pure
BANGALOL	2-ethyl-4-(2,2,3-trimethyl-1-cyclopent-3-enyl)but-2-en-1-ol, (Z)- & (E)- isomers
BENZALDEHYDE	benzaldehyde
BENZYL ACETATE	benzyl acetate
BOURGEONAL	p-tert-Butyldihydrocinnamaldehyde
CALONE 1951	3-(1,3-benzodioxol-5-yl)-2-methylpropanal
CAMPBOR POWDER SYNTHETIC	1,7,7-trimethyl bicyclo(2.2.1)heptan-2-one
CASHMERAN	1,1,2,3,3-pentamethyl-2,5,6,7-tetrahydroinden-4-one
CEDARWOOD OIL	
CINEOLE	1,3,3- trimethyl-2-oxabicyclo(2.2.2)octane
CINNAMIC ALDEHYDE	3-phenylprop-2-enal
CIS 3 HEXENOL	(Z)-hex-3-en-1-ol
CIS 3 HEXENYL METHYL CARBONATE	carbonic acid, 3-hexenyl methyl ester, (Z)-

Perfumery Name	Chemical Name & other specialty names
CISTUS LABDANUM OIL	
CITRAL DIMETHYL ACETAL	1,1- dimethoxy-3,7-dimethyl-2,6-octadiene
CITRONELLOL	3,7-dimethyl-6-octen-1-ol
CITRONELLYL ACETATE	3,7- dimethyl-6-octen-1-yl acetate
COSMONE	(5Z)-3-methylcyclotetradec-5-en-1-one
COUMARIN	2H-1- benzopyran-2-one
CUMINIC ALDEHYDE	4-propan-2-ylbenzaldehyde
CYCLAL C	2,4- dimethyl-3-cyclohexene-1-carbaldehyde
CYCLAMEN ALDEHYDE	2-methyl-3-isopropylphenyl- propionaldehyde
DAMASCONE BETA	(E)-1-(2,6,6-trimethyl-1-cyclohexenyl)but-2- en-1-one
DAMASCONE DELTA	1-(2,6,6-trimethyl-1-cyclohex-3-enyl)but-2- en-1-one
DECALACTONE GAMMA	5-hexyl-furan-2(3H)-one
DIHYDRO EUGENOL	2-methoxy-4-propyl-phenol
DIHYDROMYRCENOL	2,6- dimethyl-7-octen-2-ol
DIMETHYL BENZYL CARBINYL ACETATE	(2-methyl-1-phenylpropan-2-yl) acetate, [or... benzeneethanol, a,a-dimethyl-, acetate]
EBANOL	(E)-3-methyl-5-(2,2,3-trimethyl-1-cyclopent- 3-enyl)pent-4-en-2-ol
ETHYL 2 METHYL BUTYRATE	ethyl 2-methylbutanoate
ETHYL METHYL PHENYL GLYCIDATE	ethyl methyl phenyl glycidate, = EMPG
ETHYL SAFRANATE	ethyl 2,6,6-trimethylcyclohexa-1,3-diene-1- carboxylate
ETHYL VANILLIN	2-ethoxy-4-formyl phenol
EUGENOL	1-hydroxy-2-methoxy-4-(2-propylenyl)- benzene
FLOROSA	tetrahydro-4-methyl-2-(2-methylpropyl)-2H- pyran-4-ol

Perfumery Name	Chemical Name & other specialty names
GALBANONE	1-(5,5-dimethyl-1-cyclohexenyl)pent-4-en-1-one
GERANIOL	(2E)-3,7- dimethyl-2,6-octadien-1-ol
GERANIUM OIL	
GINGER OIL	
HABANOLIDE	(12E)-oxa cyclohexadec-12-en-2-one,
HELIOTROPIN	1,3-benzodioxole-5-carbaldehyde
HERBOXANE	2-butyl-4,4,6-trimethyl-1,3-dioxane
HEXYL CINNAMIC ALDEHYDE	2-(phenyl methylene) octanal
INDOLE	1H-indole, = Indole Pure
IONONE BETA	4-(2,6,6-trimethyl-1-cyclohexen-1-yl)- 3-buten-2-one
IRONE ALPHA	4-(2,5,6,6-tetramethyl-2-cyclohexen-1-yl)- 3-buten-2-one
ISO BORNYL ACETATE	(1,7,7-trimethyl-6-bicyclo[2.2.1]heptanyl) acetate
ISO BUTYL QUINOLINE	2-(2-methylpropyl)quinoline
ISO E SUPER	1-(2,3,8,8-tetramethyl-1,3,4,5,6,7-hexahydronaphthalen-2-yl)ethanone
ISO NONYL ACETATE	3,5,5-trimethylhexyl acetate
JASMATONE	2-hexylcyclopentan-1-one
LABIENOXIME	2,4,4,7- tetramethyl-6,8-nonadiene-3-one oxime
LEMONILE	3,7-dimethyl-2,6-nonadienenitrile
LILIAL	3-(4-tert-butylphenyl)butanal
LINALOL	3,7- dimethyl octa-1,6-dien-3-ol
LINALYL ACETATE	3,7- dimethyl-1,6-octadien-3-yl acetate
MANDARIN ALDEHYDE	(E)-dodec-2-enal
MANZANATE	ethyl 2-methylpentanoate
MAYOL	4-(1-methylethyl)-cyclohexanemethanol
MEFROSOL	3-methyl-5-phenylpentan-1-ol
MELONAL	2,6-Dimethyl-5-heptenal

Perfumery Name	Chemical Name & other specialty names
METHYL ANTHRANILATE	methyl 2-aminobenzoate
METHYL BENZOATE	methyl benzoate
METHYL CHAVICOL	p-allyl anisole
METHYL CINNAMATE	methyl 3-phenylprop-2-enoate
METHYL DIANTILIS	2-ethoxy-4-(methoxymethyl)phenol
METHYL DIHYDROJASMONATE, = Hedione	cyclopentaneacetic acid, 3-oxo-2-pentyl-, methyl ester
METHYL IONONE ALPHA ISO	3-buten-2-one, 3-methyl-4-(2,6,6-trimethyl-2-cyclohexen-1-yl)
METHYL LAITONE	8-methyl-1-oxaspiro(4.5)decan-2-one
METHYL NAPHTHYL KETONE	1-(2-naphthalenyl)-ethanone
METHYL PAMPLEMOUSSE	1,1-dimethoxy-2,2,5-trimethyl-4-hexene
METHYL TUBERATE	4-methyl-5-pentyloxolan-2-one
NONALACTONE GAMMA	dihydro-5-pentyl-2(3H)-furanone
NUTMEG OIL	
OAKMOSS SYNTHETIC	
ORANGE TERPENES (Orange Oil Terpenes)	
ORTHOLATE	2-Tert-butylcyclohexyl acetate, = OTBCHA
PARA CRESYL METHYL ETHER	1-methoxy-4-methyl benzene
PATCHOULI OIL	
PEPPER OIL BLACK	
PETITGRAIN PARAGUAY	
PHENYL ACETIC ACID	2-phenyl acetic acid
PHENYL ETHYL ACETATE	1-phenylethyl acetate, = styrallyl acetate
PHENYL ETHYL ALCOHOL	benzeneethanol
PHENYL ETHYL PHENYL ACETATE	2-phenylethyl 2-phenylacetate
PHENYL PROPYL ALCOHOL	3-phenylpropan-1-ol
POLYSANTOL	(E)-3,3-dimethyl-5-(2,2,3-trimethyl-3-cyclopenten-1-yl)-4-penten-2-ol
PTBCHA	p-tert-butyl cyclohexyl acetate

Perfumery Name	Chemical Name & other specialty names
RASPBERRY KETONE	4-(4-hydroxyphenyl)butan-2-one
ROSE OXIDE	4-methyl-2-(2-methylprop-1-enyl)oxane
SAFRALEINE	2,3,3-trimethyl-2H-inden-1-one
SILVANONE SUPRA	Cyclohexadecanolide + cyclopentadecanone
SILVIAL	2-methyl-3-[4-(2-methylpropyl)phenyl]propanal
TERPINEOL ALPHA	alpha,alpha,4- trimethyl-3-cyclohexene-1-methanol
TETRAHYDRO GERANIOL	3,7-dimethyl octan-1-ol
TETRAHYDRO LINALOL	3,7-dimethyl-octan-3-ol
TRASEOLIDE	
	1-(1,1,2,6-tetramethyl-3-propan-2-yl-2,3-dihydroinden-5-yl)ethanone
ULTRAVANIL	2-ethoxy-4-methylphenol
UNDECALACTONE GAMMA	5- heptyl-dihydro-2(3H)-furanone
UNDECAVERTOL	4-methyl-3-decen-5-ol
VETYVER OIL	
VIOLETTYNE	1,3- undecadien-5-yne
YLANG YLANG OIL	

Examples 1-6. Fragrances blended.

TABLE 1

Material	Group	Resilient /Active	Estimated Threshold	Example 1	Example 2	Example 3
Benzyl Acetate			0.0066%		0.0066%	
Cashmeran			0.0026%			
Cedarwood	1a	☐	0.0127%	0.0127%		
Cincolc	1a	☐	0.00002%			
Cis 3 Hexenol			0.0007%	0.0007%		
Cistus Labdnum Oil	1a	☐	0.0038%			
Citral Dimethyl Acetal	1a	☐	0.0307%			
Citronellol	1b		0.0031%	0.0031%		0.0307%
Cyclal C	1a	☐	0.0003%			
Damascone Delta (10%)	1a	☐	-0.0025%			
Dihydromyrcenol			0.0010%			
Ebanol (10%)	1a	☐	0.0074%		0.0074%	
Ethyl 2 Methyl Butyrate			0.00002%			
Ethyl Safranate			0.0022%	0.0022%		
Eugenol	1a	☐	0.0010%			
Geranium oil			0.0003%			
Linalol	1b		0.0032%		0.0032%	
Manzanate			0.000003%			0.000003%
Methyl Chavicol	1a	☐	0.0022%			0.0022%
Methyl Cinnamate	1a	☐	0.0069%		0.0069%	
Methyl Diantilis			0.0030%	0.0030%		
Nutmeg Oil			0.0016%			0.0016%
Phenyl Ethyl Alcohol	1b		0.0022%			
Terpinol Alpha	1a	☐	0.0205%			
total 1a: count (% in fragrance oil)				1 (58.32%)	2 (52.64%)	2 (95.41%)
total 1b: count (% in fragrance oil)				1 (14.14%)	2 (23.08%)	0
total 1c: count (% in fragrance oil)						
total 2a: count (% in fragrance oil)						
total 2b: count (% in fragrance oil)						
total others: count (% in fragrance oil)				3 (27.53%)	1 (24.28%)	2 (4.59%)

Examples 1-6. Fragrances blended according to the invention.

TABLE 1 (continued)

Material	Group	Resilient /Active	Estimated Threshold	Example 4	Example 5	Example 6
Benzyl Acetate			0.0066%			
Cashimran			0.0026%		0.0026%	
Cedarwood	1a	☐	0.0127%			
Cincole	1a	☐	0.00002%		0.00002%	
Cis 3 Hexenol			0.0007%			
Cistus Labdnum Oil	1a	☐	0.0038%			0.0038%
Citral Dimethyl Acetal	1a	☐	0.0307%			
Citronellol	1b	☐	0.0031%			
Cyclal C	1a	☐	0.0003%			0.0003%
Damascone Delta (10%)	1a	☐	0.0025%		0.0025%	
Dihydronyrcenol			0.0010%	0.0010%		
Ebanol (10%)	1a	☐	0.0074%			
Ethyl 2 Methyl Butyrate			0.00002%	0.00002%		
Ethyl Safranate			0.0022%			
Eugenol	1a	☐	0.0010%	0.0010%		
Geranium oil			0.0003%			0.0003%
Linalol	1b		0.0032%		0.0032%	
Marzanate			0.000003%			0.000003%
Methyl Chavicol	1a	☐	0.0022%			
Methyl Cinnamate	1a	☐	0.0069%			0.0069%
Methyl Dianilis			0.0030%			
Nutmeg Oil			0.0016%			
Phenyl Ethyl Alcohol	1b		0.0022%	0.0016%		
Terpinol Alpha	1a	☐	0.0205%	0.0205%		
total 1a: count (% in fragrance oil)				2 (45.34%)	2 (30.54%)	3 (97.17%)
total 1b: count (% in fragrance oil)					1 (38.63%)	
total 1c: count (% in fragrance oil)						
total 2a: count (% in fragrance oil)						
total 2b: count (% in fragrance oil)						
total others: count (% in fragrance oil)				2 (4.29%)	1 (30.83%)	2 (2.83%)

EXAMPLE 1: 141.5 μ L of a cis-3-hexenol solution at 0.10% in dpg, 50.7 μ L of a cedarwood oil solution at 5.00% in dpg, 6.1 μ L of a Methyl Diantilis solution at 9.93% in dpg, 44.6 μ L of an Ethyl Safranate solution at 1.00% in dpg, and 18.4 μ L of a citronellol solution at 3.34% in dpg, were added to 19.74mL of dpg and mixed.

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EXAMPLE 2: 18.4 μ L of a linalol solution at 3.50% in dpg, 15.1 μ L of an Ebanol solution at 0.98% in dpg, 18.9 μ L of a methyl cinnamate solution at 7.32% in dpg, 18.9 μ L of a benzyl acetate solution at 7.01% in dpg, and 18.4 μ L of a citronellol solution at 3.34% in dpg, were added to 19.91mL of dpg and mixed.

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EXAMPLE 3: 189.3 μ L of a citral dimethyl acetal solution at 3.25% in dpg, 8.9 μ L of a methyl chavicol solution at 5.00% in dpg, 20 μ L of a nutmeg oil solution at 1.50% in dpg, and 6.9 μ L of a Manzanate solution at 0.01% in dpg, were added to 19.77mL of dpg and mixed.

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EXAMPLE 4: 195.5 μ L of a terpineol alpha solution at 2.10% in dpg, 18.2 μ L of a dihydromyrcenol solution at 1.15% in dpg, 19.5 μ L of a eugenol solution at 1.00% in dpg, 6.9 μ L of a ethyl methyl-2-butyrate solution at 0.05% in dpg, and 88.7 μ L of a phenyl ethyl alcohol solution at 0.50% in dpg, were added to 19.67mL of dpg and mixed.

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EXAMPLE 5: 18.4 μ L of a linalol solution at 3.50% in dpg, 8.9 μ L of a cineole solution at 0.04% in dpg, 9.9 μ L of a Cashmeran solution at 5.21% in dpg, and 9.2 μ L of a damascone delta solution at 0.55% in dpg, were added to 19.95mL of dpg and mixed.

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EXAMPLE 6: 5 μ L of a Cyclal C solution at 1.01% in dpg, 15.1 μ L of a cistus labdnam oil solution at 4.99% in dpg, 13.8 μ L of a methyl cinnamate solution at 10.00% in dpg, 6.9 μ L of a Manzanate solution at 0.01% in dpg, and 126.2 μ L of a geranium oil solution at 0.05% in dpg, were added to 19.83mL of dpg and mixed.

Examples 7-12. Fragrances not conforming to the selection rules for the invention.

TABLE 2

Material	Group	Resilient /Active	Estimated Threshold	Example 7	Example 8	Example 9
Allyl Cyclohexyl Propionate	2a		0.0087%		0.0087%	
Camphor	1a	□	0.0016%			0.0001%
Cis 3 Hexenyl Methyl Carbonate	2a		0.00010%			
Coumarin	1c		0.00039%		0.00039%	
Cyclamen Aldehyde			0.00010%		0.0001%	
Ethyl Methyl Phenyl Glycidate	2a		0.0011%	0.0011%		
Ethyl Vanillin (10%)	1a	□	0.0248%			
Florosa	2a		0.00012%			0.0001%
Geranium oil			0.00032%			
Indole			0.00017%	0.0002%		
Iso Bornyl Acetate	1c		0.0055%			
Iso Nonyl Acetate	2b		0.0126%	0.0126%		
Linalyl Acetate	2b		0.0109%			
Mcfrosol	1b		0.0051%		0.0051%	
Methyl Dihydrojasmonate			0.0020%			
Methyl Laitone	2a		0.00003%	0.00003%		
ParaCresyl Methyl Ether			0.00012%	0.00012%		
Patchouli			0.00053%			0.00053%
Phenyl Ethyl Phenyl Acetate	2a		0.0075%			0.0075%
total 1a: count (% in fragrance oil)					1 (19.08%)	
total 1b: count (% in fragrance oil)					1 (1.44%)	
total 1c: count (% in fragrance oil)					1 (32.28%)	
total 2a: count (% in fragrance oil)				2 (7.96%)		3 (93.53%)
total 2b: count (% in fragrance oil)				1 (90.01%)		
total others: count (% in fragrance oil)				2 (2.03%)	1 (0.38%)	1 (6.47%)

Examples 7-12. Fragrances not conforming to the selection rules for the invention.

TABLE 2 (continued)

Material	Group	Resilient /Active	Estimated Threshold	Example 10	Example 11	Example 12
Allyl Cyclohexyl Propionate	2a		0.0087%			
Camphor	1a	□	0.0016%		0.0087%	
Cis 3 Hexenyl Methyl Carbonate	2a		0.00010%			
Coumarin	1c		0.00039%			
Cyclamen Aldehyde	2a		0.00010%			
Ethyl Methyl Phenyl Glycidate	1a	□	0.0011%			
Ethyl Vanillin (10%)	2a		0.0248%		0.0248%	0.0248%
Florosa			0.00012%			0.0001%
Geranium oil			0.00032%		0.00032%	
Indole			0.00017%			
Iso Bornyl Acetate	1c		0.0055%			0.0055%
Iso Nonyl Acetate	2b		0.0126%		0.0126%	
Linalyl Acetate	2b		0.0109%		0.01085%	
Mefrosol	1b		0.0051%			
Methyl Dihydrojasmonate			0.0020%			
Methyl Laitone	2a		0.00003%	0.0020%		
ParaCresyl Methyl Ether			0.00012%	0.00003%		
Patchouli			0.00053%			
Phenyl Ethyl Phenyl Acetate	2a		0.0075%	0.0075%		0.0075%
total 1a: count (% in fragrance oil)				1 (14.23%)	1 (43.31%)	1 (65.43%)
total 1b: count (% in fragrance oil)						
total 1c: count (% in fragrance oil)						
total 2a: count (% in fragrance oil)				2 (67.51%)	1 (15.17%)	1 (14.52%)
total 2b: count (% in fragrance oil)					2 (40.97%)	2 (20.05%)
total others: count (% in fragrance oil)				1 (18.26%)	1 (0.55%)	

EXAMPLE 7: 10 μ L of a para-cresyl methyl ether solution at 0.02% in dpg, 19.2 μ L of an isononyl acetate solution at 13.11% in dpg, 20 μ L of a Methyl Laitone solution at 0.0010% in dpg, 18.2 μ L of an ethyl methyl phenyl glycidate solution at 1.20% in dpg, and 66.3 μ L of an indole solution at 0.05% in dpg, were added to 19.87mL of dpg and mixed.

EXAMPLE 8: 17 μ L of a Cyclamen Aldehyde solution at 0.12% in dpg, 19.2 μ L of an isononyl acetate solution at 13.11% in dpg, 18.2 μ L of a Coumarin solution at 0.42% in dpg, 18.3 μ L of an allyl cyclohexyl propionate solution at 9.49% in dpg, and 103 μ L of a Mefrosol solution at 1.00% in dpg, were added to 19.82mL of dpg and mixed.

EXAMPLE 9: 17.8 μ L of a Florosa solution at 0.00012% in dpg, 141.5 μ L of a cis-3-hexenyl methyl carbonate solution at 0.00071% in dpg, 19.4 μ L of a patchouli oil solution at 0.00053% in dpg, and 186.9 μ L of a phenyl ethyl phenyl acetate solution at 0.0075% in dpg, were added to 19.63mL of dpg and mixed.

EXAMPLE 10: 17.1 μ L of a Galbanone solution at 1.02% in dpg, 17.1 μ L of a vetyver oil solution at 2.48% in dpg, 19.5 μ L of a eugenol solution at 1.00% in dpg, and 17.7 μ L of a Methyl Anthranilate solution at 1.21% in dpg, were added to 19.93mL of dpg and mixed.

EXAMPLE 11: 183.3 μ L of a linalyl acetate solution at 0.011% in dpg, 19.2 μ L of an isononyl acetate solution at 0.013% in dpg, 18.5 μ L of an ethyl vanillin solution at 0.0025% in dpg, 18.3 μ L of an allyl cyclohexyl propionate solution at 0.0087% in dpg, and 126.2 μ L of a geranium oil solution at 0.00032% in dpg, were added to 19.63mL of dpg and mixed.

EXAMPLE 12: 17.8 μ L of a Florosa solution at 0.14% in dpg, 22 μ L of an Isobornyl Acetate solution at 5.00% in dpg, 18.5 μ L of an ethyl vanillin solution at 2.68% in dpg, 29.7 μ L of a phenyl ethyl phenyl acetate solution at 5.04% in dpg, were added to 19.91mL of dpg and mixed.

The range of odors available under the invention is extremely wide, and not limited to any particular segment. Odor descriptions of the perfume compositions in Table 3 below

show non-limiting examples of the breadth of odor types available according to the invention. The intensity results are shown in Table 4.

TABLE 3

Example	Odor Description
1	Citrus, spicy, green
2	Balsamic, floral
3	Spicy, sweet, fruity
4	Fruity sweet
5	Thick, fruity
6	Fruity, green
7	Floral, fruity
8	Oriental, sweet
9	Floral, fatty
10	Spicy, fruity
11	Floral
12	Floral (lilac)

TABLE 4

Example	Concentration of ingredients	Mean of Standard Intensity	Std Dev of Standard Intensity
Ex 1	Threshold	2.20	0.31
	Threshold 0.3	0.95	0.43
	Threshold * .01	-0.59	0.38
Ex 2	Threshold	1.45	0.71
	Threshold * 0.3	0.23	0.23
	Threshold * 0.1	-0.53	0.42
Ex 3	Threshold	1.81	0.59
	Threshold * 0.3	0.08	0.22
	Threshold * 0.1	-0.54	0.16

Example	Concentration of ingredients	Mean of Standard Intensity	Std Dev of Standard Intensity
Ex 4	Threshold	1.29	0.91
	Threshold * 0.3	0.51	1.00
	Threshold *0.1	-0.52	0.61
Ex 5	Threshold	1.85	1.34
	Threshold * 0.3	0.68	1.10
	Threshold *0.1	-0.40	0.51
Ex 6	Threshold	1.92	0.38
	Threshold * 0.3	0.39	0.30
	Threshold *0.1	-0.59	0.42
Ex 7	Threshold	0.32	0.60
	Threshold * 0.3	-0.57	0.50
	Threshold *0.1	-1.11	0.47
Ex 8	Threshold	0.09	0.55
	Threshold * 0.3	-0.54	0.16
	Threshold *0.1	-1.02	0.20
Ex 9	Threshold	0.51	0.30
	Threshold * 0.3	-0.59	0.47
	Threshold *0.1	-0.88	0.19
Ex 10	Threshold	0.27	0.52
	Threshold * 0.3	-0.35	0.45
	Threshold *0.1	-0.98	0.37
Ex 11	Threshold	0.08	0.71
	Threshold * 0.3	-0.97	0.29
	Threshold *0.1	-1.37	0.38
Ex 12	Threshold	0.19	1.21
	Threshold * 0.3	-0.57	0.61
	Threshold *0.1	-1.00	0.48

A two-way ANOVA was performed on the data set: the two qualitative predictive factors selected were named "Example", corresponding to the samples assessed, and

“Concentration”, corresponding to the three sample strengths; threshold, $0.3 \times \text{threshold}$ and $0.1 \times \text{threshold}$.

- The ANOVA determined that the two-factor model was a significant fit for the data ($F=23.440$, $d.f.=13$, $p<0.05$, $R^2=0.706$) at the 95% confidence level. Type 1 Sum of Squares analysis demonstrated significant contributions to the data variability by both Example ($F=9.703$, $d.f.=11$, $p<0.05$) and Concentration ($F=98.993$, $d.f.=2$, $p<0.05$) factors, as such significant differences were demonstrable between the samples at near-threshold concentrations. Model fit statistics are shown in Tables 5 and 6.

TABLE 5

Analysis of variance:					
Source	DF	Sum of squares	Mean squares	F	Pr > F
Model	13	120.089	9.238	23.440	< 0.0001
Error	130	51.233	0.394		
Corrected Total	143	171.321			
Computed against model $Y = \text{Mean}(Y)$					

TABLE 6

Type I Sum of Squares analysis:					
Source	DF	Sum of squares	Mean squares	F	Pr > F
Example	11	42.063	3.824	9.703	< 0.0001
Concentration	2	78.025	39.013	98.993	< 0.0001

- Fig. 2 shows the means and 95% confidence intervals for the standardised scores of the examples; note that examples 1-6 are shown to confidently score >0 whereas examples 7-12 have negative means.

- Post-hoc Duncan analysis of the samples demonstrates significant differences between Examples according to the present invention (Examples 1-6) and comparative Examples 7-12. In Table 7, there is no mean difference between members of a group with the same letter, whereas significant differences exist between the means of samples in different groups (critical $p=0.05$). No sample was found to belong in both groups A

and B. Therefore, Examples 1-6 can be said to significantly outperform Comparative Examples 7-12.

TABLE 7

Example	LS means (Std Intensity)	Standard error	Groups
1	0.851	0.181	A
2	0.381	0.181	A
3	0.452	0.181	A
4	0.424	0.181	A
5	0.709	0.181	A
6	0.573	0.181	A
7	-0.454	0.181	B
8	-0.492	0.181	B
9	-0.320	0.181	B
10	-0.351	0.181	B
11	-0.751	0.181	B
12	-0.458	0.181	B

5 Examples A to O

In a series of further examples, A to O, the intensity of each mixture was assessed by subjects in a separate experiment using a unipolar rating scale (a description of rating scales and their use may be found in the ASTM 'Manual on Sensory Testing Methods', STP 434 (1968), see in particular pp 19-22, American Soc for Testing Materials, Philadelphia, Pa. 19103, USA). In this scale 'no intensity' was rated 0 and other intensities were rated as described earlier. Perfume compositions were prepared following the general procedures described above for Examples 1 through 12. The weight percent of each ingredient in the compositions is shown in Tables 8-13. 10 ml of each perfume solution was placed in a 125 ml brown glass jar and allowed to equilibrate. Subjects assessed the jar contents and rated the perceived intensity of odour. The procedure was repeated over 3 sessions until 15 assessments were made.

The examples A to O, illustrate the benefits of the present invention: that a mixture according to the present invention will smell stronger when presented at threshold concentration than a similar mixture using materials that are with less-active or not active according to the present invention. In the examples the components that are less active or not active are labelled "Inactive". The components that are part of the present invention are labelled "Resilient or Active". Further, the combination of group 1a materials and group 1b materials (or similar alkyl alcohols), all present at threshold concentration, can deliver a sensory boost in its intensity. The average or mean scores of Examples A-O are shown in Figures 3 and 4. The black bars indicate a 95% confidence interval.

TABLE 8

Material	Group	Resilient/ Active	Estimated Threshold	Mix A	Mix B
Methyl Benzoate	1a	☐	0.006 07%	0.00597%	0.00599%
Tetrahydro Linalol	1b		0.000 20%	0.00020%	0.00020%
Violettyne	1a	☐	0.001 93%	0.00192%	0.00192%
Polysantol	1a	☐	0.000 92%	0.00092%	0.00091%
Ionone Beta			0.000 90%	0.00089%	0.00089%
Dihydro Eugenol	1a	☐	0.000 96%	0.00096%	0.00097%
Decalactone Gamma			0.000 36%	0.00036%	0.00036%
Allyl Hexanoate	1a	☐	0.002 35%	0.00236%	0.00234%
Tetrahydro Geraniol	1b		0.010 87%		0.01075%
Phenyl Ethyl Alcohol	1b		0.002 22%		0.00221%
total 1a: count (% in fragrance oil)				5 (89.33%)	5 (45.72%)
total 1b: count (% in fragrance oil)				1 (1.47%)	3 (49.59%)
total 1c: count (% in fragrance oil)					
total 2a: count (% in fragrance oil)					
total 2b: count (% in fragrance oil)					
total others: count (% in fragrance oil)				2 (9.19%)	2 (4.69%)

TABLE 9

Material	Group	Resilient/ Active	Estimated Threshold	Mix C	Mix D
Methyl Benzoate	1a	☐	0.006 07%	0.00605%	0.00594%
Violettyne	1a	☐	0.001 93%	0.00193%	0.00189%
Iso Butyl Quinoline			0.000 65%	0.00065%	0.00064%
Ambrox DL			0.001 56%	0.00156%	0.00155%
Irone Alpha			0.000 82%	0.00082%	0.00082%
Dihydro Eugenol	1a	☐	0.000 96%	0.00096%	0.00094%
Aurantiol			0.000 09%	0.00009%	0.00009%
Labienoxime	1a	☐	0.000 25%	0.00025%	0.00025%
Tetrahydro Geraniol	1b		0.010 87%		0.01064%
Linalol	1b		0.003 22%		0.00321%
total 1a: count (% in fragrance oil)				4 (74.60%)	4 (34.74%)
total 1b: count (% in fragrance oil)					2 (53.32%)
total 1c: count (% in fragrance oil)					
total 2a: count (% in fragrance oil)					
total 2b: count (% in fragrance oil)					
total others: count (% in fragrance oil)				4 (25.40%)	4 (11.94%)

TABLE 10

Material	Group	Resilient/ Active	Estimated Threshold	Mix E	Mix F
Florosa	2a		0.000 12%	0.00012%	0.00012%
Calone 1951	1c		0.000 48%	0.00047%	0.00048%
Petitgrain			0.001 06%	0.00107%	0.00106%
Pepper Oil Black	1a	☐	0.000 82%	0.00086%	0.00081%
Dihydro Eugenol	1a	☐	0.000 96%	0.00096%	0.00095%
Allyl Hexanoate	1a	☐	0.002 35%	0.00235%	0.00240%
Labienoxime	1a	☐	0.000 25%	0.00025%	0.00025%
Phenyl Ethyl Alcohol	1b		0.002 22%		0.00221%
Geraniol	1b		0.000 51%		0.00051%
total 1a: count (% in fragrance oil)				4 (72.60%)	4 (50.20%)
total 1b: count (% in fragrance oil)					2 (30.91%)
total 1c: count (% in fragrance oil)				1 (7.78%)	1 (5.41%)
total 2a: count (% in fragrance oil)				1 (2.05%)	1 (1.40%)
total 2b: count (% in fragrance oil)					
total others: count (% in fragrance oil)				1 (17.57%)	1 (12.08%)

TABLE 11

Material	Group	Resilient /Active	Estimated Threshold	Mix G	Mix H	Mix I
Mandarin Aldehyde			0.011 72%	0.11696%		
Methyl Benzoate	1a	☐	0.006 07%		0.06071%	0.06055%
Tetrahydro Linalol	1b		0.000 20%	0.00200%	0.00201%	0.00202%
Iso Butyl Quinoline			0.000 65%	0.00662%		
Anisic Aldehyde	1a	☐	0.000 10%		0.00096%	0.00097%
Ambrox DL			0.001 56%	0.01557%	0.01559%	0.01561%
Cosmone	1a	☐	0.000 75%	0.00767%		
Habanolide	1a	☐	0.004 07%		0.04067%	0.04114%
Phenyl Acetic Acid			0.005 43%	0.05419%	0.05424%	0.05424%
Decalactone						
Gamma			0.000 36%	0.00361%	0.00365%	0.00359%
9-Decen-1-ol	1b		0.004 32%	0.04321%		
Labienoxime	1a	☐	0.000 25%		0.00247%	0.00247%
Tetrahydro Geraniol	1b		0.010 87%			0.10849%
Citronellol	1b		0.003 07%			0.03070%
total 1a: count (% in fragrance oil)				1 (3.07%)	3 (58.13%)	3 (32.88%)
total 1b: count (% in fragrance oil)				1 (18.10%)	0 (1.12%)	2 (44.16%)
total 1c: count (% in fragrance oil)						
total 2a: count (% in fragrance oil)						
total 2b: count (% in fragrance oil)						
total others: count (% in fragrance oil)				3 (78.83%)	3 (40.75%)	3 (22.97%)

TABLE 12

Material	Group	Resilient/ Active	Estimated Threshold	Mix J	Mix K	Mix L
Benzaldehyde		☐	0.000 64%	0.00064%		
Methyl Benzoate	1a	☐	0.006 07%		0.00607%	0.00607%
Tetrahydro Linalol	1b	☐	0.000 20%	0.00020%	0.00020%	0.00020%
Silvial	1a	☐	0.003 59%	0.00359%	0.00359%	0.00359%
PTBCHA		☐	0.003 03%	0.00303%		
Pepper Oil Black	1a	☐	0.000 82%		0.00082%	0.00082%
Ionone Beta		☐	0.000 90%	0.00090%		
Habanolide	1a	☐	0.004 07%		0.00407%	0.00407%
Aurantiol		☐	0.000 09%	0.00009%	0.00009%	0.00009%
Allyl Hexanoate	1a	☐	0.002 35%	0.00235%	0.00235%	0.00235%
Citronellyl Acetate		☐	0.002 89%	0.00289%		
Tetrahydro Geraniol	1b	☐	0.010 87%		0.01087%	0.01087%
Phenyl Ethyl Alcohol	1b	☐	0.002 22%			0.00222%
Citronellol	1b	☐	0.003 07%			0.00307%
total 1a: count (% in fragrance oil)				1 (43.39%)	3 (60.22%)	3 (50.67%)
total 1b: count (% in fragrance oil)				0 (1.47%)	1 (39.45%)	3 (49.05%)
total 1c: count (% in fragrance oil)						
total 2a: count (% in fragrance oil)						
total 2b: count (% in fragrance oil)						
total others: count (% in fragrance oil)				4 (55.14%)	1 (0.33%)	1 (0.28%)

TABLE 13

Material	Group	Resilient/ Active	Estimated Threshold	Mix M	Mix N	Mix O
Florosa	2a	☐	0.000 12%	0.00012%		
Citral Dimethyl						
Acetal	1a	☐	0.030 75%		0.03055%	0.03054%
Calone 1951	1c	☐	0.000 48%	0.00048%	0.00048%	0.00048%
Iso Bornyl Acetate	1c	☐	0.005 50%	0.00552%		
Cineole	1a	☐	0.000 02%		0.00002%	0.00002%
Ambermax	1c	☐	0.000 26%	0.00026%	0.00026%	0.00026%
Coumarin	1c	☐	0.000 39%	0.00039%	0.00039%	0.00039%
Nutmeg Oil		☐	0.001 58%	0.00160%	0.00158%	0.00159%
Allyl Cyclohexyl						
Propionate	2a	☐	0.008 68%	0.00870%		
Damascone Delta	1a	☐	0.000 25%		0.00025%	0.00025%
Mefrosol	1b	☐	0.005 13%	0.00512%		
Hexyl Cinnamic						
Aldehyde	1a	☐	0.016 50%		0.01637%	0.01643%
Citronellol	1b	☐	0.003 07%			0.00306%
Terpineol Alpha	1a&1b	☐	0.020 51%			0.02050%
total 1a: count (% in fragrance oil)					3 (0.00%)	3 (78.21%)
total 1b: count (% in fragrance oil)				1 (23.08%)		1 (8.34%)
total 1c: count (% in fragrance oil)				2 (29.96%)	2 (2.26%)	2 (1.52%)
total 2a: count (% in fragrance oil)				1 (39.76%)		
total 2b: count (% in fragrance oil)						
total others: count (% in fragrance oil)				1 (7.20%)	1 (97.74%)	2 (11.93%)

Perfumes created according to the present invention displayed higher odor intensities, and in some aspects significantly higher odor intensities, than comparative perfumes using the test method described above. For demonstration purposes, care was

taken that the perfumes did not contain materials whose main odor character was shared with other materials in the perfume. This effectively minimised (or excluded) additive effects caused by two similar odors at or around threshold exciting the same receptors and thus resulting in an above-threshold activity level at that receptor. Thus the perfumes of the invention are shown to have a higher intensity, which arises from a synergistic interplay between the ingredients. It has been traditionally understood that such phenomena are rare. The present invention allows for the formulation of perfumes with internal synergy in a reliable, repeatable fashion. The present invention provides a method for formulating such perfumes, and further, the perfumes themselves cover a wide odor range and offer benefits. Perfume is often one of the more expensive components of consumer products, so any such broadly-applicable increase in intensity is valuable to the formulator.

Quick Test for Resilience

In another aspect of the present invention, there is a method for identifying whether a new material exhibits resilience, the method being simple and relatively quick to perform. In other methods, there are included multiple evaluations of many mixtures of components in a balanced experimental design, however, it may be preferable if a test could be devised where a new material could be added to a standard mixture, where there would be a high probability that the resilient property of the test material would become evident. This is the objective of this alternative, quick test method for determining resilience. As used below, this method will be referred to as the "Quick Test".

The approach that is taken is to create two mixtures where all the ingredients are non-resilient and present at threshold concentration. There is also minimal odour character overlap between ingredients in each. These ingredients can then be substituted with test materials. Resilient materials are partially defined by a tendency to increase the intensity of the mixtures containing them. New ingredients can be classified by measuring the perceived intensity changes that occur when known, non-resilient materials are replaced.

If the intensity of the mixture was increased significantly by the substitution of an inactive component with the new test material, then a synergistic interaction would have been introduced, and the test material is demonstrating 'resilient' activity as that term is used herein.

Composition of Test Mixtures

The mixtures of inactives were devised using the same odour classes as discussed above. The odour spectrum has been subdivided into ten broad odour classes. These are: Floral, Aldehydic, Citrus/fresh, Green/watery, Herbal, Woody/amber, Powdery/musk, Spicy, Fruity-light, Fruity-heavy. These descriptors are used regularly in the perfumery art and are well understood by those practicing the art. They have been assigned to two mixtures such that one mix contains odour groups, Aldehydic, Green/watery, Woody/amber, Spicy, and Fruity-heavy; the other mix comprises Citrus/fresh, Herbal, Powdery/musk, Fruity-light, and Floral. The new test material should replace one of the non-active materials in the appropriate test mixture, preferably replacing the non-active most similar in odour character to the test material.

The present inventors have found that the Quick Test works most effectively when two actives are present in the mixture. This approach regularly achieves a significant increase in intensity compared to the mix with no actives present.

Summary of Quick Test Procedure

The preferred quick test procedure is summarised below.

It has proved preferable to use a test mixture where one of the inactive materials has already been replaced by an active. Therefore two 'standard' actives have been nominated for use with each of the mixtures of non-actives. The standard active is a material which will be incorporated into the test mix along with the test material, both at threshold concentration. Together the two substitutions should result in a mixture with significantly higher intensity than the original mix with no actives present. The two 'standard' actives have different odours and fall into different odour classes. They are listed below in the Experimental Section.

The present invention includes a method for identifying and selecting new actives whereby the candidate material delivers enhanced intensity (greater or equal to one unit on the standard scale described herein) when it is substituted for an inactive material in one of the two test mixtures described for this purpose, with or without a second inactive material being substituted with a known active. Preferred actives and inactives are described in the specification. The invention includes preparing a perfume composition using the substituted inactive material, or inactive materials.

The first stage of the test is to identify into which class the test material falls and select the mix of inactives with a class most similar to this. The unknown will be substituted for the non-resilient material from the same odour group. This mixture will be used as the basis of the further investigation. Next, the non-resilient material judged to be most different in odour from the unknown should be selected. This non-resilient material will be substituted with a resilient from the same odour class. Examples of resilient materials for each odour class are given in the text above

With consideration of the desired result of determining the benefit of the substitution and with an ultimate goal of preparing a composition with a suitable resilient component, the invention includes the quick test method. The method may be used for identifying and selecting new actives whereby the candidate material delivers enhanced intensity (e.g., greater or equal to one unit on the standard scale described herein) when it is substituted for an inactive material in one of the two test mixtures described for this purpose. This may be performed with or without a second inactive material being substituted with a known active. Preferred actives and inactives are described above.

A method may include the following process. First, the user identifies and considers each of the inactive components in two test mixtures. In step 1, an inactive component is selected which is most similar in odour character to the candidate material. This identified component is known as the "most similar" inactive. This is will identify which of the two test mixtures will be used in the following steps. The next step (step 2) is to identify which inactive material in the test mixture selected from step 1 is most different from the candidate material. Identification of the most different inactive material is optional, however, it is preferred to identify this component so as to maximise the difference. The identified "most different" material will be replaced by a known active from the same odour class.

The third step is to reformulate the selected test mixture by replacing at least one, and desirably both of the two inactives (the most similar inactive and the most different inactive) identified in steps 1 & 2 above. For example, the most similar inactive (identified from step 1) may be removed and replaced with iso-intense concentrations of the candidate material and the most dissimilar material may be removed and replaced with an iso-intense concentration of the known active from step 2. Examples of suitable

concentrations for actives are described above. The threshold concentration of the candidate material can be found using the method described above.

In step four, the intensity of the new mixture from step 3 may be assessed using the preferred method described in the paragraph below. If the new mixture is significantly more intense than the original test mixture of inactives (e.g. the intensity is one unit or more greater), then the candidate material is considered to have demonstrated resilient activity. This conclusion may be used to develop a perfume composition including the candidate material. Therefore, it may be useful to use the present method to develop a modified perfume composition whereby at least one component has been substituted, for example, an active component substituted for an inactive component or vice versa.

Assessment of 'Resilient' Activity: The intensity of the new mix, with the new test material and a standard active incorporated, should be assessed versus the intensity of the related mixture of five inactive materials. It is preferred to use the intensity scale employed in the experimental section below. This is a sensory scale where sensory scores are illustrated by standard concentrations of benzyl acetate in dipropylene glycol. If the new mixture is significantly more intense than the blend of inactives (e.g. by more than 1 unit using this scale) then the new test material may be considered to be demonstrating 'resilient' activity. A composition including the resilient material can then be prepared.

Formulations of the two test mixtures, and the two standard actives to be used with each, are given in the Experimental section.

Experimental Section 1: Quick Test for Resilient ingredients

Sample Preparation

All samples and reference solutions consisted of dilutions, in dpG. 10g of each solution was placed in a capped 100ml jar and allowed to equilibrate for a minimum of 2 hours at room temperature. Assessments were made by removing the cap and smelling the contents and replacing the cap.

Assessors were presented with a segment of the samples in a series of sessions, in order to reduce the fatigue and inconsistency of assessment associated with a large

number of samples. Order of sample presentation was from presumed weakest intensity to presumed strongest intensity, to minimise carry-over from intense samples. Baseline mixtures were presented first, and all other test mixtures were randomised thereafter.

Assessment Procedure

- 5 A team of male and female assessors between 25 and 65 years of age were used in the evaluation of sample intensity. They were selected for evaluations on the basis of their ability to correctly rank the odour intensities of a series of dilutions (in dipropylene glycol, dpg) of perfume ingredients.

- 10 The intensity measurements were benchmarked against standard concentrations of benzyl acetate. Prior to assessment sessions, panellists were presented with benzyl acetate, prepared in a series of dilutions in dpg, as listed in the table below. Each dilution is associated with an odour intensity score.

i: Standardised dilutions of benzyl acetate in dpg, with corresponding scores:

Intensity Score	Benzyl Acetate in dpg	Odour description
0	0%	No Odour
1	0.005%	Slight
2	0.016%	Weak
3	0.05%	Definite
4	0.10%	Moderate
5	0.23%	Moderately Strong
6	0.67%	Strong
7	2.3%	Intense
8	5.1%	Very intense

- 15 Standard dilutions as above were present during evaluations and provided for reference to assist assessors in the evaluations.

Experimental Samples:

Two sets of experimental mixtures were prepared and assessed: Set 1; 1a, 1b, 1c, 1d, and 1e; and Set 2; 2a, 2b, 2c, 2d and 2e.

- 20 In development of these samples, one inactive ingredient was selected for each of the odour groups: 1, Aldehydic; 2, Citrus/Fresh; 3, Green Watery 4, Herbal; 5, Woody

Amber; 6, Powdery Musk; 7, Spicy; 8, Fruity Heavy; 9, Fruity Light; 10, Floral. These materials were then used to prepare two 5-component mixtures, which formed the baseline sample in each set.

- 5 The Set 1 samples were made from odd-numbered odour groups only; Set 2 samples were made from even-numbered odour groups only. This precaution ensured that all samples were made from ingredients selected from non-adjacent odour groups and thus minimised any overlap in odour character between the inactive components in each mix. All ingredients were incorporated at their estimated threshold concentration in dpG, using the method described above.
- 10 Each set consisted of 5 samples:
- (a) A baseline mixture made solely of 5 known-inactive ingredients, each selected from different, non-adjacent odour groups.
 - (b) A version of the baseline mixture made with one inactive ingredient substituted with a known-active ingredient from the same odour group, resulting in a mix of 4 inactive ingredients and 1 active material (eg mix 1b contains an active material from group 7, 7act, in the table overleaf).
 - (c) This second, "b" mixture formed the basis of a third mix (c), where a second inactive ingredient was substituted with a known-active ingredient, resulting in a mix of 3 inactive and 2 active ingredients (eg mix 1c contains an active material from groups 7 & 9, 7act and 9act, in the table overleaf).
 - (d) & (e) Two subsequent mixtures (d) and (e) were prepared, each containing 3 inactive and 2 active ingredients, using mixture "c" as their starting point. In these mixtures, one of the two active ingredients from "c" was replaced by an alternative known-active ingredient from within the same odour group.
- 25 The new actives used in the (d) and (e) mixes provide dummy test materials to demonstrate the usefulness (or not) of the test methodology.

The resulting 10 samples are described in the table below.

ii: Formulation of Set 1 and Set 2 samples

	Set 1: Odd Numbered Odour Group at Threshold				Set 2: Even Numbered Odour Group at Threshold		
Sample Format	Test number	Odor Group	Ingredient		Test Number	Odor Group	Ingredient
Mix type A; baseline mix; no actives	1A	1	Aldehyde c12		2A	2	Linalyl acetate
		3	Calone			4	Isononyl acetate
		5	Ebanol			6	Methyl laitone
		7	Methyl diantilis			8	Nonalactone gamma
		9	Phenoxy ethyl iso butyrate			10	Jasmatone
Mix type B; 4 inactives; 1 active	1B	1	Aldehyde c12		2B	2	Linalyl acetate
		3	Calone			4	Iso nonyl acetate
		5	Ebanol			6	Methyl laitone
		7act	Dihydro eugenol			8act	Damascone delta
		9	Phenoxy ethyl iso butyrate			10	Jasmatone
Mix type C; 3 inactives; 2 actives	1C	1	Aldehyde c12		2C	2act	Citral dimethyl acetal
		3	Calone			4	Iso nonyl acetate
		5	Ebanol			6	Methyl laitone
		7act	Dihydro eugenol			8act	Damascone delta
		9act	Ethyl safranate			10	Jasmatone

	Set 1: Odd Numbered Odour Group at Threshold				Set 2: Even Numbered Odour Group at Threshold		
Sample Format	Test number	Odor Group	Ingredient		Test Number	Odor Group	Ingredient
Mix type D; 2 actives; first substitution	1D		2D				
		1	Aldehyde c12		2act'		Petitgrain
		3	Calone		4		Iso nonyl acetate
		5	Ebanol		6		Methyl laitone
		7act'	Eugenol		8act		Damascone delta
		9act	Ethyl safranate		10		Jasmatone
Mix type E; 2 actives; second substitution	1E		2E				
		1	Aldehyde c12		2act		Citral dimethyl acetal
		3	Calone		4		Iso nonyl acetate
		5	Ebanol		6		Methyl laitone
		7act	Dihydro eugenol		8act'		Raspberry ketone
		9act'	Labienoxime		10		Jasmatone

Sensory Analysis

- All of the mixes above were assessed for perceived intensity with reference to the benzyl acetate-anchored intensity scale. The mean intensities were recorded and
- 5 compared to assess whether inclusion of the test material and known actives had resulted in significant increases in perceived intensity, in comparison to the corresponding 5-component mix of inactives.

Data analysis

Mean intensity scores, n=15:

iii: Means table: Set 1 (odd-numbered odour groups)

Sample	1a	1b	1c	1d	1e
Description	odd, no actives	odd, 1 active: Dihydro Eugenol	odd, 2 actives: Dihydro Eugenol & Ethyl Safranate	odd, 2 actives, 1 sub, Eugenol	odd, 2 actives, 1 sub, Labienoxime
Mean intensity	0.83	1.40	1.83	3.07	3.30
Std Dev.	0.52	0.60	0.70	0.86	1.11

iv: Means table: Set 1 (odd-numbered odour groups)

Sample	2a	2b	2c	2d	2e
Description	even, no actives	even, 1 active: citral dimethyl acetal	even, 2 actives, citral dimethyl acetal & δ - Damascone	even, 2 actives, 1 sub, petitgrain oil	even, 2 actives, 1 sub, Raspberry Ketone
Mean intensity	1.37	2.47	3.37	3.23	3.90
Std Dev.	0.77	0.92	0.83	0.94	0.76

5 The intensity scores for each sample set were entered as the dependent variable of two-way analyses of variance (ANOVA). Each analysis had the same two factors: 1) “observation”, with 15 levels, corresponding to each set of panellist ratings and 2) “sample”, with 5 levels, corresponding to samples a-c in the corresponding set of sample mixtures.

10 Figure 5 shows a means plot of intensities for mixes in Set 1. In this Figure, bars labelled with differing letters (e.g., A, B or AB vs. C, but not A vs. AB) are significantly different. The ANOVA model was found to significantly predict the variation in the data set ($F=13.4$, $df(\text{model})=18$, $p<0.01$). Type I SS analysis reveals significant main effects for observation and sample factors, revealing pertinent but consistent differences between
15 samples as well as the individual panellist’s use-of-scale.

v: Type I Sums-of-Squares analysis (Set 1)

Source	DF	Sum of squares	Mean squares	F	Pr > F
Observation	4	68.087	17.022	45.362	< 0.0001
Sample	14	22.587	1.613	4.299	< 0.0001

Post-hoc multiple comparisons revealed significant differences between the samples at three levels (samples which do not share the same group in the far-right-hand column are significantly different, $p < 0.05$):

5

vi: Post-hoc Duncan Analysis (Set 1)

Category	LS means	Standard error	Lower bound (95%)	Upper bound (95%)	Groups
1e: 2 actives, 1 sub, Labienoxime	3.300	0.158	2.983	3.617	A
1d: 2 actives, 1 sub, Eugenol	3.067	0.158	2.750	3.384	A
1c: 2 actives	1.833	0.158	1.516	2.150	B
1b: 1 active	1.400	0.158	1.083	1.717	B
1a: no actives	0.833	0.158	0.516	1.150	C

Conclusion ANOVA (Set1) : Labienoxime and Eugenol are active, ie Resilient, within the definition set forth above.

ANOVA, Set 2 (even-numbered groups):

- 10 Figure 6 shows a means plot of intensities for mixes in set 2. In this Figure, bars labelled with differing letters (e.g., A, B or AB vs. C, but not A vs. AB) are significantly different. The ANOVA model was found to significantly predict the variation in the data set ($F=13.4$, $df(\text{model})=18$, $p < 0.01$). Type I SS analysis (overleaf) reveals significant main effects for observation and sample factors, revealing pertinent but consistent
- 15 differences between observers and samples.

vii: Type I Sums-of-Squares analysis (Set 2)

Source	DF	Sum of squares	Mean squares	F	Pr > F
Observation	4	68.087	17.022	45.362	< 0.0001
Sample	14	22.587	1.613	4.299	< 0.0001

- Post-hoc multiple comparisons (Duncan method) revealed significant differences between the samples at four levels (samples which do not share the same group in the far-right-hand column are significantly different, $p < 0.05$):
- 20

viii: Post-hoc Duncan Analysis (Set 2)

Category	LS means	Standard error	Lower bound (95%)	Upper bound (95%)	Groups	
2e: 2 actives, 1 sub, Raspberry Ketone	3.900	0.196	3.508	4.292	A	
2c: 2 actives	3.367	0.196	2.975	3.759	A	B
2d: 2 actives, 1 sub, petitgrain oil	3.233	0.196	2.841	3.625		B
2b: 1 active	2.467	0.196	2.075	2.859		C
2a: no actives	1.367	0.196	0.975	1.759		D

Conclusion (ANOVA Set2) : Both Raspberry Ketone and Petitgrain Oil are active, ie

5 Resilient within the definition set forth above.

Based on the results of both ANOVAs, the principle is demonstrated that where two active ingredients are present, the resulting mixture is significantly stronger than the baseline mixture. It is demonstrated that two-active-mixes are consistently significantly more intense than the baseline mixes.

10 Through the present invention, an unknown material can be tested for Resilient character by substitution along with a known active in a mix with other non-resilient materials of different odour character, all materials present at threshold concentration. If the substitutions result in a significant increase in odour intensity of greater than one unit on the standard benzyl acetate scale relative to a mix of 5 non-active materials then the

15 unknown material can be assigned as a Resilient material by the definition set forth above.

Perfume Formulations

The method described above may be used to test not only ingredients but perfumes. By a "perfume" it is meant a balanced blend of materials that demonstrates a

20 homogenous, if multi-faceted, odour character. There are several odorant mixes which are used as single ingredients, for example the natural oils; these have a combined odour character theme despite being composed of individual ingredients which cover a range of different odour characters. Commercial perfumes also frequently have a clear odour

theme, to the extent that they can be placed into 'genealogies of perfume' and discussed relative to the history and practices from which they evolved. It would not be unusual to discuss a perfume in terms such as: sweet, floral fruity; or fresh, spicy, musk, and so on. The smells are more complex and the odours have more body but the odour characters
 5 tend to be built with a level of uniformity too. If a perfume has too many odour facets of equal prominence it would lose that directness that consumer value in a perfume. So the inquiry is what would happen if a perfume was treated as a perfume ingredient.

Commercially-relevant perfumes tend to show reasonable uniformity between the odour character just above threshold and that at higher concentrations. As a result, it is
 10 possible to treat them as though they were an ingredient such as an essential oil, and to see whether they might act as a resilient material, or not.

The perfume is perceived not as a complex combination of tens of ingredients but as a single odour with a variety of facets. A brief exposure is sufficient to allow enough information to be received about the odour character for the subject to be able to make
 15 useful comparisons between perfumes some time after first perceived. The initial exposure can be augmented by a deeper examination and introspection of the perceived character to decompose the overall event into potential sensory components. This process is akin to perceiving purple colour, then assessing the relative levels of red and blue from which it is composed. The ability to dissect the colour analytically in no way detracts
 20 from the ability to perceive the blend as a single percept.

Perfume Behaviour: Measuring the Resilience of a Perfume

Resilient materials can be identified using the procedures outlined above. That procedure is useful in that it uses materials incorporated in mixes at their threshold concentration. The resulting perfumes themselves may be assessed using their threshold
 25 concentration, as would be done for an essential oil ingredient. The perfumes can therefore be incorporated into the test mixtures at threshold concentration.

Any issues associated with detecting minor components at a lower concentration than that of the main olfactory note of the perfume may be minimised by using a descending concentration series to measure the threshold. For example, the test subject
 30 starts at a concentration above threshold and assesses successive dilutions until the perfume character is no longer detected. The last concentration at which the target odour

- character was perceived is recorded as the threshold for that assessment. The subject should take care to avoid becoming adapted to the odour by using short sniffs, 2 seconds should be enough, and frequent rests. The subject can confirm the threshold by repeating the process for a few samples close to the threshold. The consensus threshold is then
- 5 calculated as that concentration where a 50% detection rate would be achieved. Perfumes diluted to the consensus threshold were then used in the Test for New Actives as for other perfume ingredients.

The method was then analogous to that used above for testing new ingredients.

Experimental Section 2

10 Assessment Procedure

The panel was equivalent to that in Experimental Section 1, and assessed the samples for intensity only, based on the same 8-point scale and using the standard dilutions of Benzyl Acetate for reference.

Sample Preparation

- 15 Samples consisted of 10mL of mixture solution, presented in 100mL amber powder jars, lidded and equilibrated for 2+ hours, as described in Experimental Section 1.

Experimental Samples

Four experimental samples were made; t, u, v and w, which consisted of the following:

- 20 (t) A baseline mixture (t) made solely of 5 known-inactive ingredients, each selected from different, non-adjacent odour groups.
- (u) A version (u) of the baseline mixture was made with one inactive ingredient substituted with a known-active ingredient (delta damascone) from the same odour group, resulting in a mix of 4 inactive ingredients and 1 active.
- 25 (v) & (w) Mixture u formed the basis of a third (v) and fourth (w), where a second inactive ingredient was substituted with one of two model perfumes: model 5, an aesthetically-pleasing accord with a predominantly powdery-sweet character, reinforced

by green notes and model R1, developed from model 5, and adapted to fit the formulation rules for Synergistic Scents as described above.

The resulting 4 samples are described in table ix, below.

5

ix: Formulations of mixtures t, u, v & w.

Sample Mixture	Odour Group	ingredient	Concentration
t	2	linalyl acetate	0.01086%
	4	iso nonyl acetate	0.01259%
	6	Methyl Laitone	0.00003%
	8	nonalactone gamma	0.00056%
	10	Jasmatone	0.00116%
u	2	linalyl acetate	0.01085%
	4	iso nonyl acetate	0.01261%
	6	Methyl Laitone	0.00003%
	8act	Damascone delta	0.00025%
	10	Jasmatone	0.00116%
v	2	linalyl acetate	0.01084%
	4	iso nonyl acetate	0.01260%
	6-M5	Model 5	0.01001%
	8act	Damascone delta	0.00025%
	10	Jasmatone	0.00119%
w	2	linalyl acetate	0.01080%
	4	iso nonyl acetate	0.01258%
	6 -MR	Model r1	0.00875%
	8act	Damascone delta	0.00026%
	10	Jasmatone	0.00115%

Sensory results

A one-way, within-subjects ANOVA was performed on the data. Figure 7 shows a means plot of intensities for mixes t, u, v and x, with error bars representing the 95% confidence interval of the mean. A significant main effect ($F=23.95$, $df = 3$, $p<0.05$) showed that the variation between the sample means was significantly different. Post-hoc

mean comparisons by Duncan method showed that all sample intensity means were significantly different from each other ($p < 0.05$). Mixture w (made with model R1) was the best-performing sample, and significantly stronger than v (made from model 5, a variant of the same perfume).

5

x: Post-hoc Duncan analysis

Sample	LS means	Standard error	Lower bound (95%)	Upper bound (95%)	Groups	
w	3.100	0.182	2.736	3.464	A	
v	2.567	0.182	2.203	2.930		B
u	1.933	0.182	1.570	2.297		C
t	1.033	0.182	0.670	1.397		D

Discussion and conclusion

This experiment shows that the mixture w is significantly more intense than all other mixes, and more than 1 unit more intense than mix u and 2 units more intense than mix t. This is despite the fact that the concentration of Model R1 perfume incorporated in the mix is significantly lower than the concentration of Model 5 (in mixture v). The two Model perfumes share similar odours and ingredient skeletons; however Model R1 has been adjusted to fall within the rules of the Resilient Perfume description above. The sensory results are consistent with Model R1 behaving as a resilient ingredient. Thus the perfume falling within the description above has been shown to be a Resilient perfume within the above definition.

Perfumes incorporated into this test as though they were single ingredients have shown different levels of resilience, leading to significant increases in overall intensity. Had these perfumes been essential oils, they would have been identified as resilient and non-resilient ingredients. As perfumes, it may be considered that they share similar properties to resilient ingredients and that, on the basis of their performance in this test, the existence of resilient and non-resilient perfumes has been identified. This is useful in forming perfumes that will be acceptable and suitable for intended purposes.

While the invention has been described above with reference to specific embodiments thereof, it is apparent that many changes, modifications, and variations can

be made without departing from the inventive concept disclosed herein. Accordingly, it is intended to embrace all such changes, modifications, and variations that fall within the spirit and broad scope of the appended claims.

CLAIMS:

1. A method for preparing a composition comprising a candidate active component, comprising the steps of:
 - a. selecting a first inactive component in a first mixture, the first inactive component being most similar in odor character to said candidate active component;
 - b. selecting a second inactive component in said first mixture, the second inactive component being most dissimilar in odor character to said candidate active component;
 - c. preparing a second mixture, wherein said second mixture is the same as the first mixture, except that the first inactive component is replaced with an iso-intense concentration of the candidate active component and the second inactive component is replaced by a known active from the same odor class as the second inactive component;
 - d. assess the intensity of the second mixture to determine whether the second mixture is significantly more intense than the first mixture, wherein if the second mixture is significantly more intense than the first mixture, then the candidate active component is considered to have demonstrated resilient activity; and
 - e. preparing a perfume composition comprising said candidate active component.
2. The method of claim 1, wherein said second mixture has an intensity that is at least one intensity score unit greater than the first mixture.
3. A method determining the resilient activity level of a candidate active component, comprising the steps of:
 - a. selecting a first inactive component in a first mixture, the first inactive component being most similar in odor character to said candidate active component;
 - b. selecting a second inactive component in said first mixture, the second inactive component being most dissimilar in odor character to said candidate active component;
 - c. preparing a second mixture, wherein said second mixture is the same as the first mixture, except that the first inactive component is replaced with an iso-intense concentration of the candidate active component and the second inactive

component is replaced by a known active from the same odor class as the second inactive component; and

- 5 d. assess the intensity of the second mixture to determine whether the second mixture is significantly more intense than the first mixture, wherein if the second mixture is significantly more intense than the first mixture, then the candidate active component is considered to have demonstrated resilient activity.
4. The method of claim 3, wherein said second mixture has an intensity that is at least one intensity score unit greater than the first mixture.

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FIG. 1

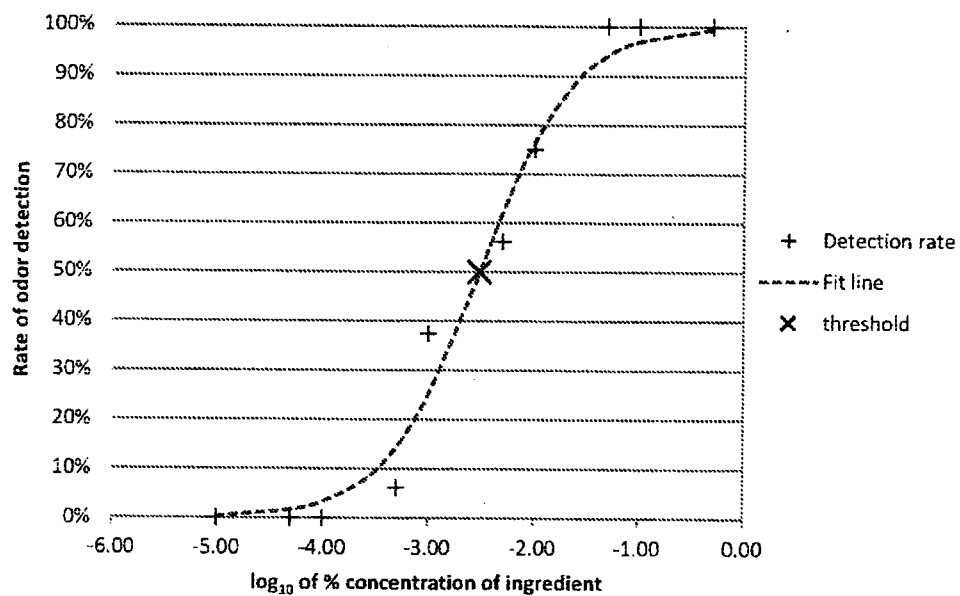


FIG. 2

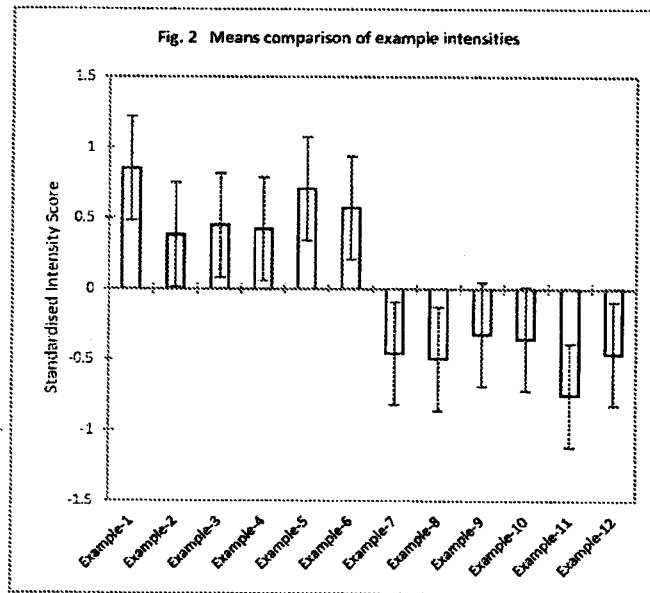


FIG. 3

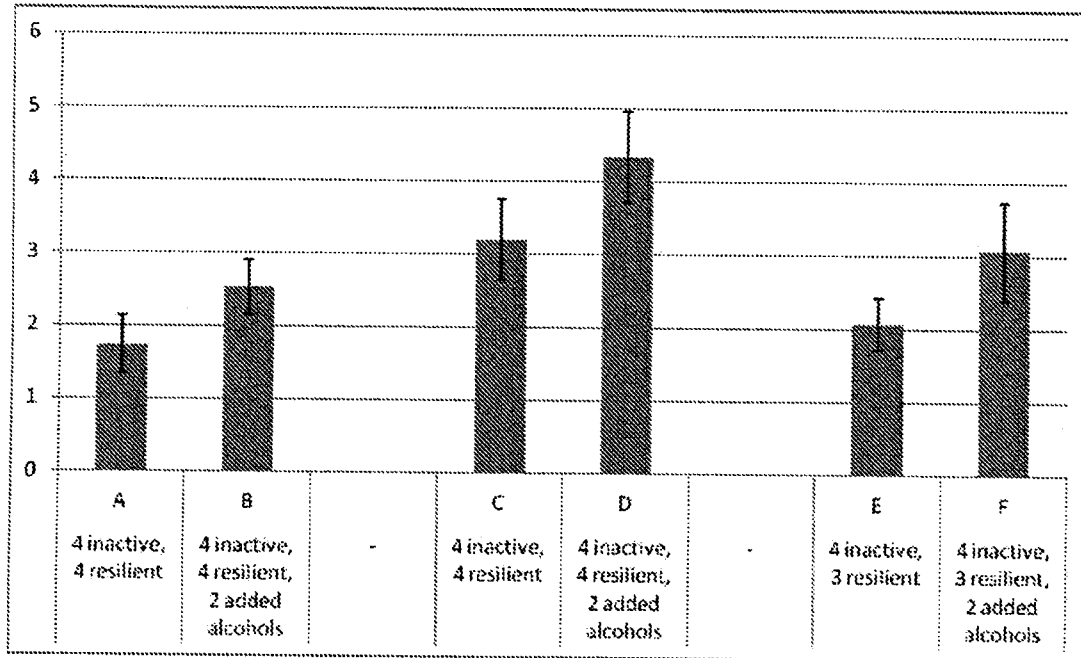
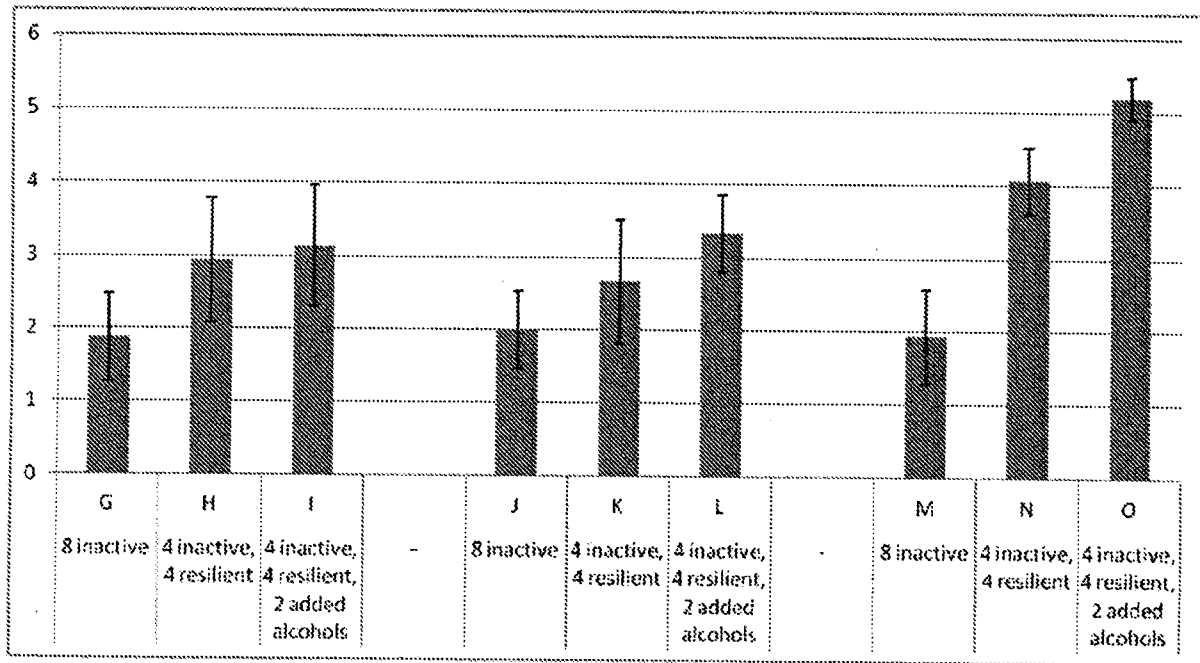


FIG. 4



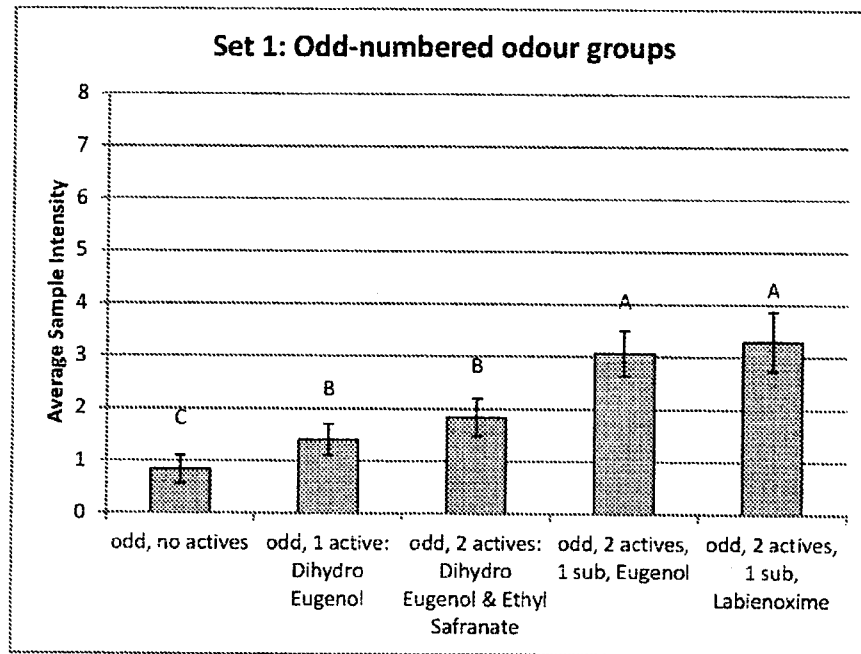


Figure 5

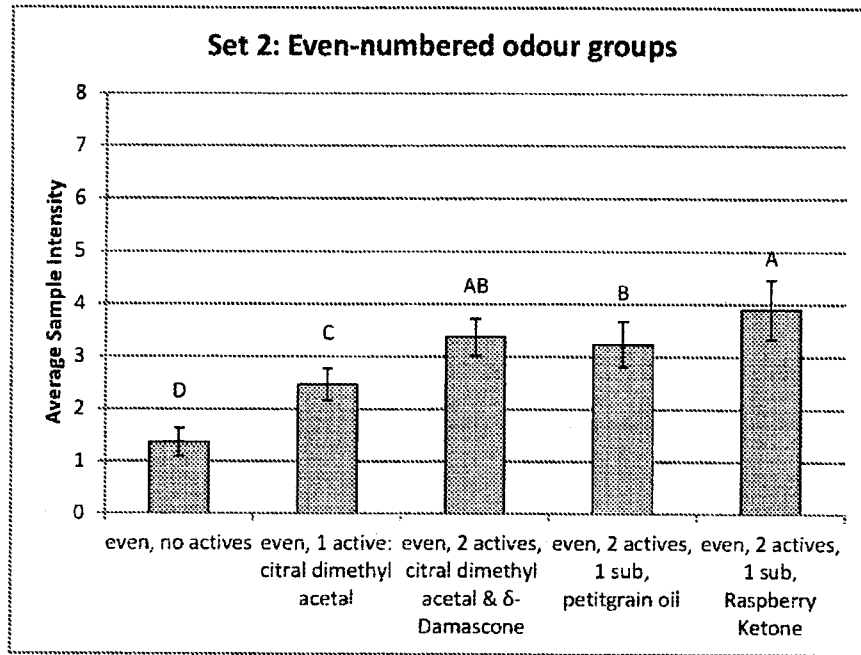


Figure 6

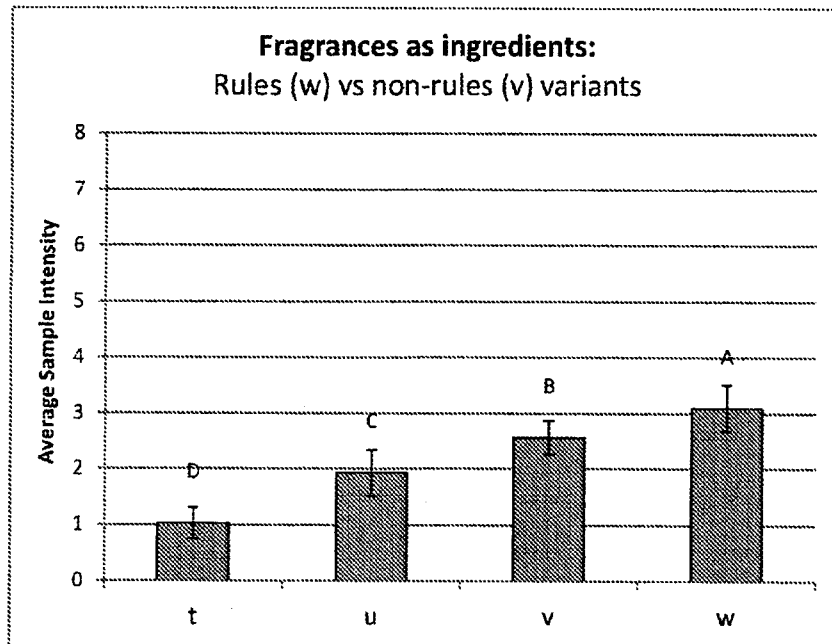


Figure 7