Odor tenacity of perfumery materials

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One of the most important considerations in compounding perfumes or other cosmetic fragrances is that the odors of the compound materials must last as long as possible without losing their odor characteristics. Perfumers must keep this in mind whenever they make fragrances. There are said to be approximately four hundred thousand chemicals which possess odors, and each chemical has its own characteristic odor. Some have very low boiling points and vaporize within a few seconds; others retain their odors over several months. Also, some change odor when they are left in the air. For example, the oils of rose, jasmin and muguet each contain several hundred chemicals. The amounts of these chemicals are well balanced, and thus the essential oils give quite characteristic and harmonious odors. Once these essential oils are applied and left for several hours, however, the odor changes considerably.

We studied the odor tenacity of chemicals and essential oils, then, in order to facilitate fragrance compounding, since it is imperative that perfumes or cosmetics retain their pleasing odors as long as possible.

Method

All chemicals and natural essential oils were obtained commercially. Each material was placed on a piece of bibulous paper (1 mm x 5 mm x 15 cm) withing a 5 mm^2 area. The surface area of the material was maintained constant in all the experiments. After a chemical or essential oil was placed on a piece of paper, this paper was placed in a room in which the temperature and humidity were maintained at 22°C and 45%, respectively. Three trained perfumers smelled the papers after 3 hours, 1 day, 3 days, 1 week, 1 month, and 3 months. When all three perfumers agreed that an odor had dissipated, the time by which this took place was recorded.

Results and discussion

Sturm and Mansfeld reported on odor tenacity and fixing of aromatic chemicals in 1976.[1] They studied the odor tenacity of aromatic chemicals by measuring weight loss over passage of time. In the present experiment, we utilized measurement of olfaction instead of measurement of weight.

Table I shows the results for aliphatic fatty aldehyde. Aliphatic fatty aldehydes have rather longer tenacity than one might expect from their boiling point. This may be due to the change of the aldehyde group to a carboxy group by autoxidation by air.

Table I. Odor tenacity of fatty aldehyde.

Compound	Odor tenacity	Boiling point(C)	Molecular weight
n-Octyl aldehyde	1d - 3d	170	128.22
n-Nonyl aldehyde	3d - 1w	191	142.24
n-Decyl aldehyde	1w - 1m	209	156.27
n-Undecyl aldehyde	1w - 1m	223	170.30
n-Undecylenic aldehyde	1w - 1m	235	168.28
Methyl nonyl acetaldehyde	3m	232	184.32
Dodecyl aldehyde	3m	249	184.31

Table II shows odor tenacity differences according to the chemical nature of materials. n-Octyl aldehyde dimethyl acetal has a somewhat longer odor tenacity than expected judging by its boiling point. This also may be due to the unstable acetal group, which yields an acid group with oxidation.

Table II. Odor tenacity according to chemical nature.

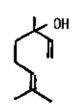
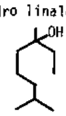
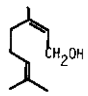
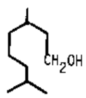
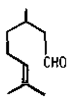
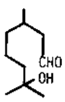
Compound	Odor tenacity	Boiling point(C)	Molecular weight
n-Octyl alcohol	3h - 1d	194	130.22
n-Octyl aldehyde	1d - 3d	170	128.22
n-Octyl aldehyde dimethy acetal	3d - 1w	185	174.29

h: hour, d: day, w: week, m: month.

Table III shows the odor tenacities of monoterpenes. Linalool, citronellal, and geraniol have the same molecular weight and similar structures, but their tenacities are quite different. Geraniol has a much longer odor tenacity than tetrahydrogeraniol. Linalool and tetrahydrolinalool, however, have exactly the same odor tenacity. Similar relations are also apparent in the boiling points of these chemicals. The odor tenacities of other chemicals are listed in Table IV, while Table V shows the odor tenacities of natural essential oils.

Differences in the method of distillation of natural oils may affect their composition. Bergamot oil A (see Table V) is obtained by the cold press method. Its furocoumarin odor persisted after linalool and linalyl acetate odors had disappeared. Bergamot oil B was obtained by the distillation method. This oil does not, therefore, contain furocoumarin, which gives a longer odor tenacity. One can see the same relationship between lemon and orange oils obtained by

Table III. Odor tenacity of monoterpenes

Compound	Odor tenacity	Boiling point(C)	Molecular weight
Linalool	1d - 3d	198	154.25
			
Tetrahydro linalool	1d - 3d	197	158.28
			
Geraniol	1w - 1m	230	154.25
			
Tetrahydro geraniol	1d - 3d	213	158.28
			
Citronellal	3d - 1w	206	154.25
			
Hydroxy citronellal	1w - 1m	241	172.27
			

cold press and distillation methods. Furocoumarin may be a significant factor in the longer odor tenacities of these oils.

It is well known that the odor tenacities of chemicals depend upon their volatility. Galbanum oil, which contains fewer less volatile compounds, has a shorter odor tenacity than galbanum resin. Lavender oils were classified as 1, 2, or 3 according to their fractionation during distillation, as they contained increasing amounts of less volatile materials. Rose absolute 1 and 2 were obtained from different growing areas, which may also be a factor in differing

Table IV. Odor tenacity of other chemicals.

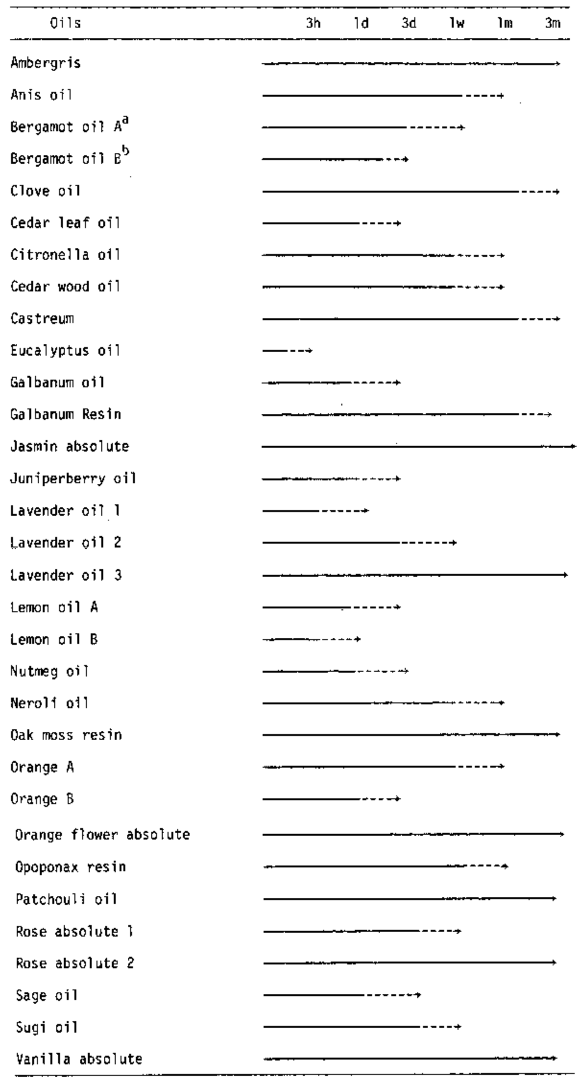
Compound	Odor tenacity	Boiling point(C)	Molecular weight
Allyl caproate	3h - 1d	185	156.22
α-Amyl cinnamic aldehyde	1w - 1m	285	202.30
Acetyl iso-eugenol	3h	80	206.24
Anis aldehyde	3d - 1w	248	136.15
Anisic alcohol	1w - 1m	259	138.17
Benzyl alcohol	3h - 1d	205	108.14
Benzyl acetate	1d - 3d	215	150.17
Cyclamen aldehyde	1w - 1m	270	190.29
Cinnamic aldehyde	3m	252	132.16
1-Carvone	1d - 3d	231	150.22
Citral	1d - 3d	228	152.24
Cyclodecyl acetate	3d - 1w	232	198
Citronellyl formate	3d - 1w	235	184.28
Dimethyl anthranilate	3d - 1w	256	165.20
Dihydro Jasmone	3m	230	166.27
Diacetyl	3m	88	86.09
Ethyl anthranilate	1w - 1m	267	165.20
Eugenol	1m - 3m	253	164.21
Ethyl acetate	3h	77	88.11
Ethyl caprilate	3h - 1d	209	172
Ethyl laurate	1d - 3d	269	228.38
Ethyl undecylenate	3d - 1w	265	212.34
Geranyl formate	1d - 3d	216	182.27
Geranyl iso-valerate	3m	137	238.37
Geranyl ethyl ether	1d - 3d	214	182.31
Hexyl cinnamic aldehyde	3m	305	216.33
Hexyl salicylate	3m	290	222.29
d-Limonene	3h - 1d	177	136.24
Linalyl acetate	3h - 1d	220	196.29
Methyl iso-eugenol	1w - 1m	270	178.23
Methyl heptin carbonate	3d - 1w	217	154.21
γ-Methyl Ionone	3d - 1w	252	206.33
Methyl benzoate	3d - 1w	200	136.15
Methyl n-hexyl ketone	3h	173	128.22
Nerol	3d - 1w	227	154.25
Neryl acetate	1d - 3d	231	196.29
Nerolidol	1w - 1m	276	222.36
Ocimenol	1d - 3d	196	154.25
Phenyl ethyl alcohol	1d - 3d	220	122.17
Phenyl propionic aldehyde	3m	222	134.18
α-Pinene	3h	157	136.24
Rose oxide	3h - 1d	182	154.25
Santalol	3m	302	220.36
α-Terpineol	3d - 1w	219	154.25
γ-Undecalactone	3m	162	184.28

h: Hour

compositions.

Some chemicals, however, may change into other forms before vaporizing completely when they come into contact with air. In this case, the odor or odor tenacity of the chemical changes. These phenomena are not yet well understood.

Table V. Odor tenacity of natural oils.



a: obtained by cold press, b: obtained by distillation

Certain factors are, however, known to influence the odor tenacity of chemicals; among them temperature, humidity, and impurity.

When perfumers try to compound fragrances, they must pay attention to the nature of the chemicals used in order to create well-harmonized fragrances. It will be easier to create fragrances if the constituents of the essential oils going into them, and their chemical and physical natures, are known. In order to create well balanced perfumes one must know not only the odors of the ingredients but also their odor tenacities. Trained perfumers understand these phenomena from experience, but this kind of experimental data may be helpful to young perfumers.

Reference

1. Wolfgang Sturm and Gerd Mansfeld, Tenacity and fixing of aromatic chemicals, Perfumer and Flavorist, 1, 6 (1976).