

Preface

The present work is the result of many years of private study to which has been added three years of evening and off-duty work, mainly at the University Extension Division of *Rutgers* — The State University of New Jersey.

Notes were collected and compiled from many lengthy travels to faraway producing areas. Samples were submitted to the author from other areas, and first-hand information was received from research stations, universities, distilleries, growers and exporters all over the world.

By August 1958, the author found himself in possession of an almost complete collection of perfume and flavor materials of natural origin. These materials were all available or could be made available upon request at due notice. Dozens of varieties and different qualities of each individual raw material were closely studied for appearance, odor, flavor and possible adulterations. Suggestions have been made in this book for the use of these materials in perfumes and flavors, based partly upon the author's previous work, partly upon entirely new experiments which were carried out at the University Extension Division of *Rutgers*, The State University of New Jersey.

During three years of lecturing at the University Extension Division, the author became aware of the fact that the perfumery and flavor literature does not include any work that describes the odor *and flavor* of the raw materials from nature in everyday words. There is no recent or up-to-date handbook of raw materials suggesting the use of the materials, the replacement of one material for another, the proportional strength of flavor materials, etc. Furthermore, there was no up-to-date work which gave any practical indication of availability and present world production of these materials. Export figures are obviously not always indicative of the true production.

In order to present the compiled material in the handiest and most up-to-date form, the author decided to publish a one-volume dictionary form of practical handbook. The two-column set-up is a suggestion for which the author gives his printers all the credit and praise. The photographs are, with a few exceptions, taken by the author. Two-thirds of the photographs were taken during May-July 1960, and not a single photograph is more than five years old when this book appears. It was the author's express wish that this work should include full-color reproductions of some of the flower photographs.

A work of this type is strongly subjective by its very nature. All odor and flavor experiments were carried out by the author personally, and were repeated as recently as possible in order to make the information most true to the facts. When literature sources are not given, it is because information was never taken for granted if it was at all possible for the author to check and re-check the information personally. This principle has been carried out throughout the book, and the author is convinced that this policy should be of definite advantage to the reader who seeks actual and practical information. No information or statement has been

entered in the book without being checked during the five-year period 1956—1960, and the greater part of all information has been re-checked during 1959—1960.

The perfume and flavor trade has been veiled and concealed for decades, if not for centuries. It is true that perfumery and flavor creation is an art and a science, and we all realize that the art cannot be taught or developed by research through generations. But it is the author's firm belief that science is a necessary part of perfumery and flavor creation. Consequently, we should not conceal what is already known or what can be concluded from the facts. In science, we all stand on the shoulders of our predecessors; our present knowledge is greater because they gave us a flying start. The same applies to that part of perfumery and flavor creation which is dependent upon science. It is the author's hope that the present work may contribute to the wider and further expanded knowledge of perfume and flavor materials from nature.

Elizabeth, New Jersey (U.S.A.)

August, 1960.

STEFFEN ARCTANDER

Acknowledgements

Although this work is an entirely personal undertaking, the author wishes to express his gratitude to a large number of individuals: friends in the industry, growers and distillers, scientists and artists, laymen and specialists in the perfume and flavor fields. Without the correct and highly up-to-date information graciously supplied by these people and institutions, this work would not have been possible.

The University Extension Division, *Rutgers*, The State University of New Jersey (U.S.A.) has been most helpful to the author in his making contact with authoritative sources of information on certain subjects.

The perfume and flavor industry has lent great support to the author in the areas of verifying information, procuring samples of certain rare materials, welcoming his personal visits to various installations, etc.

Planters and distillers all over the world have been most cooperative with respect to furnishing samples and information of production, future aspects, local use, etc. of many of the materials in the book.

Fellow perfumers and students at the University Extension Division have contributed greatly to the completion of this work by their direct and indirect encouragement to the author.

Through their correspondence with the author since long before the book was conceived, agricultural institutes, research stations, laboratories, etc. all over the world have been most helpful and co-operative in exchanging information, samples, etc. with the author.

Certain periodicals, technical monthly reviews, etc. have encouraged the author to a great measure, and have connected him with important sources of information, etc.

The printers in Copenhagen, Denmark, cannot be praised highly enough. Without their immediate readiness, this work would have lost years in achieving actuality. The entire outlining of the shape, set-up, binding and two-column printing, etc. was the prompt routine work of the printers. Proofreading was reduced through their outstanding accuracy. The reproduction of the author's photographs in black/white and in color has the unreserved admiration of the author.

The author's thanks also go to Natalie Fine for her efforts in correcting linguistic and grammatical errors committed by the author in his rough manuscript, and for her expert advice with respect to phraseology, etc. The author wishes to add that he takes full responsibility for omissions in this important part of the work of writing; changes and additions inevitably had to be made right up to the eleventh hour of the book's production.

The author wishes finally to state his affectionate appreciation of the patience and co-operation offered by his wife. The long hours of collecting and collating information, taking care of lengthy and prolific correspondence, and the never-ending checking and re-checking of flavor and odor experiments were only made possible through her loyal and patient encouragement.

Elizabeth, New Jersey (U.S.A.) August, 1960.

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The materials are listed alphabetically, using the most common commercial names in English. Reference is made to synonyms and foreign names on the widest possible scale. In many cases, however, it has been necessary to use the botanical Latin name where no commercial name exists, or where the English name does not describe the material unambiguously. Condensed French, German and Spanish indices are included at the end of the book.

Bold type is used in the text to indicate reference from the index and to emphasize the location of the topic name, etc., thus saving time for the reader who wants a brief information on a certain specific subject.

The *strict alphabetical order* suffers from certain drawbacks:

Lemongrass Oil is placed between **Lemon Aroma** and **Lemon Oil**. **Gingergrass Oil** is between **Ginger Absolute** and **Ginger Oil**. **Ho Leaf Oil** and **Ho Wood Oil** are separated by the entries of Hop and Horseradish, etc.

Abbreviations

°C. =	degrees centigrade.
cms. =	centimeters.
milligrams per 100 grams =	thousandth of one percent. One mg% equals ten parts per million (10 ppm.).
ml. =	millilitres.
mm. Hg. =	millimeters of mercury pressure, an indication of low pressure in connection with vacuum distillation.
sp. =	species (of plants).
tons =	metric tons (one ton = 1000 kilos or 2200 lbs.).
var. =	variety of (Latin: <i>varietas</i>) a botanical species.

Part One

Definitions and Methods of Processing

A

Absolute.

An **Absolute** is a prepared perfume material. Absolutes are highly concentrated, entirely alcohol soluble and usually liquid perfume materials. They are obtained by alcohol-extraction of concrètes (see this monograph) or other hydrocarbon types of extracts or from fat-extracts of plant material (see below). Waxes, terpenes, sesquiterpenes and most of the odorless matters are eliminated from the concrètes during the preparation of absolutes. The concrète is usually extracted at room temperature or under gentle heat. Several extractions may be required in order to completely exhaust the odorous matter from the concrète. The mixed alcoholic extracts are then chilled under stirring for a considerable length of time (up to several weeks). Waxes, sesquiterpenes etc. are precipitated in the cold and by subsequent cold filtration of the alcoholic extract, or by centrifuging, the alcoholic solution of the absolute is obtained. The alcohol is recovered by evaporation, which requires a gentle vacuum towards the end of the distillation. Most absolutes will contain traces of ethylalcohol (i. e. 2% or less). If the ethylalcohol has been denatured with a nonvolatile or high-boiling material, this denaturant will be present in the absolute in significant amounts, since the extraction of an absolute requires many times the quantity of alcohol.

Absolutes can in exceptional cases be solid or semi-solid (e. g. sage clary absolute, beeswax absolute, bruyère absolute, etc.). Under **Hyacinth Absolute** (see this monograph in Part Two of this book) is described briefly an adsorption method for the production of absolutes.

Occasionally the alcohol-soluble fraction of a **Resinoid** is called an **Absolute**. The resulting product is not identical to the so-called alcohol resinoid, also commercially known as **Resin Absolute**. The latter is prepared by direct alcohol extraction of the natural raw material (gum resin, oleoresin, etc.). See monograph on **Resin Absolute** in Part One of this book.

If a natural raw material is first extracted with petroleum ether to produce a **Resinoid** (see this) and the resinoid in turn is extracted with alcohol, this process will yield a highly refined and pale colored "**Absolute**". Under **Labdanum Absolute from Resinoid** in Part Two of this book is described one such material. Petroleum ether extraction of natural gum resins, oleoresins etc. often yield very light colored resinoids, very suitable for further processing to **Absolutes** of attractive appearance and odor.

Butaflor is a registered name (P. Robertet & Cie.) given to a series of highly concentrated perfume materials produced by extraction with butane at subnormal temperature. The solvent is recovered by evaporation at room temperature (boiling point of butane is $-0^{\circ}.50C.$). The

low extraction temperature and the selective solvent result in a pale-colored, almost waxfree and terpeneless product. The method is particularly useful and advantageous when applied to very delicate or heat-sensitive botanical materials, e. g. lilac flowers, lily of the valley (muguet), orange flowers, jasmin, rose, etc. Certain staple materials are also treated by this method, e.g. ginger rhizomes. It should be kept in mind that not all Butaflores are completely alcohol-soluble.

Absolute from Châssis.

See also **Pommade**. When the flowers are removed in the daily batches from the greased trays (“châssis”), some fat will adhere to these exhaust flowers. The fat contains perfume oil. Extraction of the flowers with a hydrocarbon type of solvent will isolate the perfumed fat as a “concrète de châssis” from which an **Absolute from Châssis** is in turn produced by alcohol extraction, chilling, filtration and evaporation.

Absolute from distillation water.

During the steam – or water distillation of geranium oil, lavandin, lavender, neroli, petitgrain, rose etc. the distillation waters contain significant amounts of dissolved or dispersed odorous matter which will not readily separate. Such distillation waters are often extracted with petroleum ether or benzene. After solvent recovery the residual “distillation water concrète” is extracted with alcohol, or it may be used as it comes from the first extraction. **Lavender Water-Absolute, Rose Water Absolute**, etc. are prepared this way. These absolutes are practically terpeneless and consist mainly of water-soluble components of the essential oil in the plant material. In certain cases, they are “the missing links” between absolutes and essential oils from same plant material. Water absolutes present highly interesting perfume notes which are often missing or wanted in essential oils or perfume bases. Various **Water-Absolutes** are described under the monographs of the respective plant materials in Part Two of this book.

Absolute from Pommade.

These materials are by some authors considered as essential oils in the sense, that they are “volatile oils”. This reasoning is also justified by the definitions given in the present book. Pommade absolutes are prepared in the same way as described under **Absolute (from Concrète)**, but the starting material in this case is a **Pommade** (see this monograph). Under certain circumstances, the pommade-absolutes are prepared from a **Concrète from Pommade** (see this). **Absolute from Pommade** is also known as: **Pommade Concentrate**.

Absolute Oil.

This term usually refers to the steam distillable part of an Absolute. Very few, if any, absolute oils are commercially available. They are, however, frequently prepared in analytical laboratories in order to establish data of the constituents of an absolute as compared to the corresponding essential oil. **Absolute Oils** constitute only a fraction of the quantity of the parent absolute, but they often display the most refined notes of its fragrance.

Anhydrols are a form of diluted **Absolute Oils**, (see Anhydrol).

Adulteration.

The reader may find that this term occurs rather frequently in this book. The author has endeavoured to reduce the frequency of the occurrence of this word, in order not to discourage the readers beyond the inevitable and justified measure. Terms like “**Sophistication**”, “**Cutting**”, “diluting”, “**Bouquetting**” (from the French: bouquetage), “rounding-off” etc. etc. are all more or less poor attempts to disguise the cruel truth: plain adulteration. Certain suppliers with highly developed imagination will even use the term “enobling” for the disfiguration of an essential oil.

The author has nothing in principle against the addition of foreign or “unnatural” materials to essential oils etc. as long as the intention *and the result* is an indisputable improvement in respect to perfumery performance and effect. To the author’s opinion it is up to every perfumer to improve perfume materials, and this may be achieved with no ban whatsoever on the means or materials used. The author is well aware that such statements are bound to release a landslide of disagreements, but it is his firm belief that most perfumers at the bottom of their hearts will agree that this matter is a development which we have to face. It is a natural result of the appearance of a rapidly growing number of interesting synthetic perfume materials.

The synthetic perfume materials are supposed to enhance and support the use of natural raw materials, not to replace them, nor in any way to beat them off the market. The synthetic chemicals present a certain challenge to nature, and the perfumer can assist nature in her fight by utilizing the synthetic materials to the advantage of the natural raw materials.

However, the above philosophy should not indicate that the author approves of **Adulteration** of natural perfume materials. On the contrary. But the meaning of the term **Adulteration** should be taken literally: with the intention of acquiring the business (order) through a devaluation of the oil in relation to the labeling of its container. The consumers of perfume oils are buying odor, not certain physicochemical data. If the odor and the perfumery (or flavor-) effect is in agreement with the customer’s standards, there is no reason to talk about adulteration: the oil is then worth the full price of a true, natural oil and the “adulteration”, if any, has not been a means of direct economical gains. One could speak only of a more or less ethical handling of the natural materials and their labeling. The author assumes in the above case, that the customer’s standards are representative of average commercial lots of the materials in question.

In certain cases there is a special reason for bouquetage” or “doctoring” of an essential oil. Cumin oil, e.g. and other umbellifer-fruit oils, oil of black pepper, etc. will, immediately after distillation often present a most obnoxious or putrid top-note. Other examples are the common ‘still-notes”, where a distinctly burnt-acrylic or sweet-furfuralic or protein-like note is present in freshly distilled oils, or in drums of crude oils, for a long time kept closed. Essential oils from primitive stills, from direct-fire stills and in general oils from stills in warm countries contain a substantial amount of water. When these oils are shipped to colder countries, the water separates (often ½ to 1% or more) in the drum. Through decay or other micro-organism activity, this water can produce quite unpleasant off-notes. Well-known examples are: bois de

rose oil, citronella oil, geranium oil, petitgrain Paraguay oil, etc. The aforementioned still-notes can be subdued or eliminated by a special bouquetage, e.g. an addition of one or more perfume materials which may conceal the putrid note. The latter “water-and-decay” note may often be eliminated by simple aeration (airing) of the oil, by washing and drying, by filtration etc. generally known as “conditioning”. A redistillation will also eliminate the water content in these natural oils.

Much emphasis has been attached to the mention of possible or known adulterations of materials listed in this book. The author wants to repeat, that this primarily aims at the numerous cases of “unethical” handling of the oil, where the customer is actually deprived of the full yield of natural odor or flavor effect when he buys such “cut” oils.

Anhydrol.

Anhydrols are processed perfume- or flavor materials. **Anhydrol** is the brand name of a series of distilled extracts, produced by L. Givaudan & Cie. in Geneva or by Givaudan-Delawanna Inc. in the United States. As indicated through the name, these materials are produced from natural raw materials without the presence of water (or steam). **Anhydrols** are usually viscous liquids of pale color. They are the results of a combination of extraction of the natural raw material and subsequent molecular distillation of the extract. The solvent may be ethyleneglycol, other glycols, isopropylmyristate or other high-boiling, odorless solvents, mostly of the oil-soluble type.

The resulting extract may then be distilled in a molecular still at approximately 10^{-3} torr. A molecular distillation is a physical process, during which a liquid or a low-melting solid of high boiling point is converted into vapor phase, removed from the liquid phase and condensed back to liquid phase, separated from the liquid in the still. The new liquid phase, the condensate, is the molecular distillate. There is no fractionation, no reflux, no column on the still. It is basically a simple distillation at very reduced pressure and under such circumstances, that the material to be distilled is exposed to the heat as briefly as possible. There are many types of stills and various designs of rotating heaters, where the liquid is spread as a film to speed the evaporation and reduce the heating time.

Obviously, the **Anhydrols** will contain significant amounts of the solvent with which they have been extracted. But this co-distillation is just one of the advantages of the process. The solvent may form so-called azeotropes with one or more of the odorous ingredients in the extract and thus reduce the distillation temperature. Plant colors and other odorless matter will be retained in the still. According to some theories, anything that has a measurable vapor pressure, also has an odor. According to that theory the **Anhydrols** should be ideal: no odorless material at all. Many aromatic components of the extracts, which are not distillable with steam, will distil in the molecular co-distillation process. Consequently, this method is mainly applied to such perfume or flavor materials which yield little essential oil on steam or water distillation or which are too high-boiling to yield an oil unchanged.

Among available **Anhydrols** are myrrh, olibanum, oakmoss, opopanax, patchouli, Peru balsam, Virginia tobacco leaf, tea leaf, tolu balsam, vetiver, etc.

Anhydrols are soluble in alcohol and essential oils as well as in most synthetic perfume materials.

Resinoines are purified, partially decolorized, concentrated products. Some are low-pressure-distillates of extracts, others are mixtures of distillates and extracts. Resinoine is a brand name of the Grasse house, P. Robertet et Cie. Well-known **Resinoines** are, e. g. labdanum, patchouli, tabac, thé, tolu, etc.

Aroma.

The term **Aroma** is often used for the rather intangible conception “odor + flavor”. In the following, however, Aroma refers to a processed raw material used by the flavorist. Thus we meet again wild confusion, if we try to establish a standard, not to speak of a definition.

The conventional **Aroma** is a highly concentrated solution of a partially terpeneless oil or plant extract in a solvent which also contains a certain amount of water.

Alcohol-aromas: The essential oil is stirred vigorously with one, two or more parts of pure ethylalcohol. If the oil is clearly soluble in the alcohol, it serves no purpose to stir the solution. If the oil is not clearly soluble, stirring is continued for some time, whereafter water is added to the mixture. The amount of water is calculated according to the character of the oil and to the ratio of the solvent to the oil. Separation takes place, but stirring is continued for an hour or two. The mixture is then left in a cool place to complete the separation. Terpenes, sesquiterpenes, waxes and other components which are poorly soluble in diluted alcohol will usually rise to the surface. The diluted alcohol contains most of the “aromatic” principles in solution. This solution is drained off and filtered. The filtrate constitute the **Aroma**. As an example is given below: **Bitter Orange Aroma:**

1000 grams Guinea (or Spanish) bitter orange oil dissolve in
1000 grams pure ethylalcohol, add under continuous stirring
1000 grams distilled water.

Stir, leave, and chill. Separate and filtrate the alcoholic layer. Yield approximately 2000 grams. The terpene-layer amounts to 900 to 920 grams and may appear on the market under the name of “washed citrus oil” or “citrus terpenes”, see monograph on **Lemon Aroma** in Part Two of this book. The alcoholic filtrate is occasionally distilled at atmospheric pressure until the distillate shows an alcohol percentage of 65 or 60, according to the needs of the consumer. The product is called **Aroma-Distillate** from essential oil. See also **Aroma-Distillate** in Part One of this book.

Glycol-Aromas: These are prepared in a similar way as described under **Alcohol-Aromas**. However, the glycol is usually not diluted quite as much as was the case with alcohol. Generally, the water addition amounts to 20% up to almost 50% in rare cases, calculated upon the amount of glycol. Propylene glycol is considered one of the best and most suitable solvents for flavors. It is far less toxic than ethylene glycol. It has similar solvent effects and is also miscible with water. It is a commercial solvent, available in almost unlimited quantities and at a price only slightly higher than taxfree, pure ethyl alcohol. **Glycol-Aromas** are not redistilled and the filtrate is used as is.

Diolane (brand name for hexylene glycol, presumably 2-methylpentane-2,4-diol) is a solvent with the rare ability of being miscible with water and at the same time to a certain degree being miscible with hydrocarbons, e.g. terpenes. **Diolane** is not suitable for the production of the above **Aromas**. This solvent is distinctly bitter of taste even at the dilution of 2 mg%, contrary to the frequently published statement, that **Diolane** is “virtually odorless and tasteless”.

Aromas are slowly being replaced in the flavorist’s formulas by solutions of terpeneless oils, although these are not really comparable materials to the above aromas. It is still customary to prepare Aromas of such natural raw materials, where the botanical drug material is not locally at hand or not a commercial article, e.g. bitter orange, bergamot, lime, vetiver etc. while it is usually preferred to prepare Aroma-Distillates from the botanical plant material wherever possible, e. g. orange, lemon, angelica-root, spices etc.

Aroma-Distillate.

Aroma-Distillates or **Distillates** are prepared materials for use in flavor compounding.

If there is little by way of standardization and specifications in the processing of perfumery intermediates, e.g. resinoids, tinctures, etc., there is practically none with respect to flavor ingredients. In the processing of **Aroma-Distillates**, however, the principles are as follows, in broad outline:

The natural raw material is coarsely chopped, sliced, or cut. Peels from citrus fruits often come out of the peeling machine as long, thin strings, 100 to 200 cm. long; these can be used as is. Apples can be peeled in a machine to advantage, since the meat of the apples yields very little flavor. Berries are usually cold-pressed since the juice by itself is a valuable flavor material. The press-cake from berries offers an excellent starting material for the production of aroma-distillates.

The natural raw material is percolated at room temperature or at less than 50°C. The heat may be supplied by a steam jacket. The menstruum (usually pure ethyl alcohol) is circulated through the botanical material by action of a pump which returns the solvent to the top of the extractor. By means of gravity, the solvent penetrates the botanical material which is spread out on wire- trays or perforated plates stacked inside the extractor. The alcohol strength is adjusted to the nature of the raw material. Citrus peels are usually extracted with 99% or 90% alcohol, berries with weaker alcohol. The temperature and the time of extraction varies according to the construction of the automatic percolator and the nature of the raw material.

The alcoholic extract is now drained from the percolator. The adherent alcohol on the plant material is distilled off under gentle heat from the steam jacket. The distillate is collected in a reservoir beneath a cooling system. Steam is then blown directly through the botanical material in the percolator, partly to recover all alcohol with dissolved aromas, partly in order to recover steam distillable aromatic principles in the raw material. The aqueous distillate in the condenser is mixed with the alcoholic percolates, and left for 24 hours to cool and separate terpenes and other poorly soluble matter.