Volatiles for the Perfume Industry

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Introduction

The various industries that produce perfumes and related odorants rely to a great extent on plant volatiles for many of their most important products. The global perfumes industry is immensely lucrative – estimates of the annual trade in perfumes in France alone are well in excess of US$25 billion, much of which is plant-derived. In addition to traditional scents and perfumes, which continue to grow in use for both men and women, there are many additional markets that utilize plant volatiles as a key selling point. These include the essential oils and new higher-value scented cleansing products, such as soaps and creams. Together, these trends ensure a buoyant market for plant volatiles.

Diversity of Volatiles

Plants accumulate a bewildering diversity of volatile compounds that serve many important physiological roles. Some volatiles act as deterrents to potential pests while others may attract predators of pest species. For example, as caterpillars graze on certain plants, the damaged plant tissues release specific volatiles, which attract parasitic wasps that then paralyze and lay their eggs in the caterpillars. Plant volatiles may also attract pollinators or other beneficial animals. In some cases, plants even attract insects by mimicking their sex pheromones in what has been termed a "sexual swindle." In the case of *Ophyris* orchids, the cuticle of the flower contains a standard mixture of straight chain saturated and unsaturated hydrocarbons of 21–29 carbons chain length. However, the relative proportions of the hydrocarbons closely mimic that found in sex pheromones of pollinators like male bees. The male bees repeatedly attempt to copulate with the orchid flowers, hence ensuring an efficient transfer of pollen.

Aroma Compounds

Typical aroma compounds produced by plants include the following:

- the largest group is undoubtedly the ubiquitous lower isoprenoids (mono- and sesquiterpenoids)
- aliphatic straight-chained hydrocarbons and aldehydes that are found in many fruits and flowers
- highly odoriferous derivatives of benzoic acid and phenylpropane that are especially common in the Apiaceae
- a wide range of sulfur- and nitrogen-containing volatiles.

Many plant volatiles are (coincidentally) attractive to humans, ranging from the relatively simple hexenals and hexenyl acetates, etc., that are the main signature from mown grass, to the extremely complex bouquets produced by flowers like jasmine (*Jasminum* spp.) and honeysuckle (*Lonicera* spp). Some of the most important and widely used plant volatiles used in the fragrance and perfume industry are the products of so-called "essential oils." The term essential oils is not truly accurate as many of the volatiles are alcohol-soluble and are not true oils at all, but this traditional term remains in widespread use. Essential oils are very volatile fragrances that easily evaporate and are very different in character from true oils such as olive oil or safflower oil. Essential oils are complex mixtures of plant produced chemicals, for example essential lavender oil contains more than 50 different compounds.

The active ingredients of most essential oils occur in minute quantities in plants – rose (*Rosa* spp.) petals yield just 0.2% w/w essential oil. This means that the extracts must be highly concentrated in order to be marketed for human use. One feature shared by all volatile fragrances is that they all readily bind to receptors in olfactory neurons. Another important character is that they evaporate at room temperature. Indeed, the fragrances used in perfumes are classified on a scale from 1 to 100, according to how readily they dissipate. Pure essential oils are expensive and must be obtained from reputable sources. Adulteration of essential oils is very common. For example, the finest natural French lavender (*Lavandula* spp.) oils harvested in the Haute Provence contains up to 70% linalyl acetate as its most potent fragrance. However, while many other lavender oils from France may have even higher levels of linalyl acetate, some of these oils are fortified with synthetic products and may have no traces of natural lavender. Sandalwood (*Santalum album*) oil can be adulterated with diverse oils such as castor, palm, and linseed.

List of Technical Nomenclature

Pheromone A volatile hormone secreted by animals (especially insects), that influences the behavior of other animals of the same species.

See also: **Genetic Modification of Secondary Metabolism**: Terpenoids. **Photosynthesis and Partitioning**: Primary Products of Photosynthesis, Sucrose and other Soluble Carbohydrates. **Primary Products**: Oils.

Further Reading

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Rubber Production

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Definitions

The term ‘rubber’ encompasses any material that is highly elastic, i.e. a material that can be stretched without breaking and that returns to its original length on removal of the stretching force. Natural rubbers are produced by many plant species, often (though not always) as a constituent of latex. A plant latex is defined simply as a milky fluid present in laticifers, or latex ducts, which seeps out on wounding (tapping). Natural rubbers belong to the class of natural products termed polyisoprenoids (polymers of isoprene).

History

The elastic properties of the rubber that could be extracted from certain plants were known and appreciated by the ancient civilizations of Central and South America long before the arrival of Europeans. Aztec murals reveal that rubber was collected as a tribute from subject peoples and used in religious ceremonies. After its “discovery” by Europeans as a novelty material for making balls, it began to be used in the manufacture of waterproof clothing and footwear for the European market. Since no method of preserving latex was known at the time, proofing of clothing and leather was carried out locally and the product exported.

The first challenge to be met to enable the large-scale use of rubber was to identify an efficient solvent for the material. In 1818, James Syme discovered that coal tar naphtha could be used to this end, and this discovery was exploited by Charles Mackintosh for the fabrication of a rubber waterproof layer sandwiched between two layers of fabric. However, the unstabilized natural material remained generally unsatisfactory because changes in temperature resulted in changes in its texture and elasticity. It was soft and tacky when hot, and hard and brittle when cold. Interest in natural rubber as a commodity was waning when, in 1839 (and after some 5 years of effort during which he and his family were largely destitute), Charles Goodyear discovered that a combination of heat and sulfur somehow stabilized rubber whilst retaining its desirable properties. Later termed “vulcanization”, the perfected process opened the door for exploitation of natural rubber on a commercial scale.

After the discovery of vulcanization, rubber would be inextricably linked to modern industrial development, and particularly to transportation. North American imports of natural rubber more than doubled every decade of the nineteenth century after 1840, to over 15000 tons (representing around half the total world production) by 1890. A sad and sobering consequence of this expansion in demand is the fact that, in the latter half of the nineteenth and early part of the twentieth centuries, it was satisfied largely by slave labor. Millions of people living in “colonial” territories of Amazonia in South America and The Congo in Africa were exploited unmercifully in the collection of “wild rubber.”

Large-scale rubber collection in Amazonia began near the Brazilian Atlantic port city of Pará, and expanded westwards into the amazon basin. A number of rubber-producing trees were exploited initially, including various *Sapium* species (yielding a latex called *caucho blanco*), *Castilloa* (*Castilla*) species (yielding *caucho negro*), and *Hevea* species. *Hevea brasiliensis*, yielding the high-quality rubber termed *jebe fino* or *siringa fina*, was to be found only in a specific region near the Putumayo river, a