Vanilla - the food of the Gods

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ABSTRACT

Vanilla is the most widely used flavour in the food and confectionery industries. It is the most well-known and familiar flavour. Worldwide annual consumption today is estimated at 1500 tons, with 1250 tons imported to the USA alone. After a crisis during 2000-2005 the estimated world consumption of vanilla was reduced by almost 50 percent (1). Figure 1 shows the vanilla import statistics in the USA alone, from 1970 until the present. Vanilla has captured the imagination of many people for generations, including people involved in farming, greening, and curing. The love for vanilla flavour and aroma has challenged chemists to try and synthesize the major components in vanilla. Some synthetic chemical combinations do resemble vanilla, but nothing comes close to real vanilla, with over 300 individual components in a unique and specific ratio.

Vanilla flavour is extracted from the cured bean of *Vanilla planifolia* Andrew, a member of the orchid family, which originated in Mexico. Another species, *Vanilla tahitensis* Moore, grown exclusively in Tahiti and Papua New Guinea is also a source of vanilla flavour. Beans (pod-like fruit) are produced after 4-5 years of cultivation. Fruit maturation occurs 8-10 months after pollination. A characteristic vanilla flavour and aroma develops in the fruit after a process called "curing", lasting an additional 3-6 months, resulting from many chemical and biochemical processes that take place during the curing of vanilla beans. Vanilla species, growing conditions, nutrients, climate conditions, maturity of the beans, harvest time, and curing methods are some of the parameters affecting the quality of cured vanilla beans. Vanilla extract contains more than 300 chemicals, and chief among them is vanillin.

HISTORY OF VANILLA

Vanilla is the world's most popular flavour. Its fruity, floral fragrance combined with a deep, aromatic body makes it unique and universally favoured. Vanilla is an epiphytic orchid native to the tropical region of Mexico. The flavouring material is obtained from cured dried pod-like fruits commercially called "beans". The generic name Vanilla is derived from the Spanish "*vanillia*", a diminutive of *vaina*, a pod. Its species name, *planifolia*, refers to the broad flat leaf of the plant. Vanilla became known in Europe following Cortez's conquest of the Aztec kingdom in 1519. Many centuries earlier, vanilla was a source of flavouring and was used by Aztec emperors to flavour a cocoa drink, which in the present day is hot chocolate. The Indians called vanilla "*Tlixochitl*", or black flower (2). The Spanish took vanilla back to their homeland and, shortly after, began manufacturing chocolate with vanilla flavouring. In England, Hugh Morgan recommended that

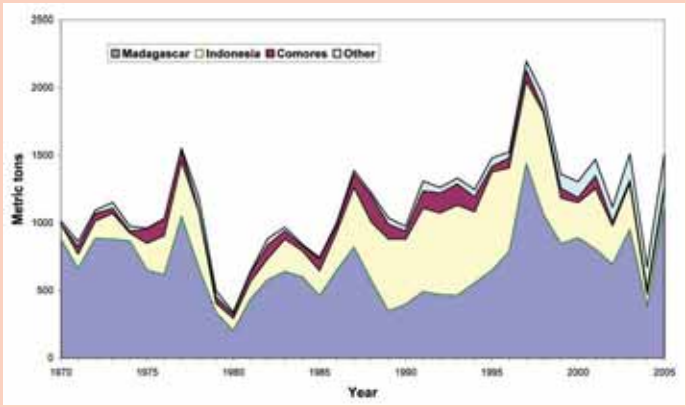

Figure 1. USA vanilla import during 1970 to 2005

vanilla flavouring should be used with chocolate to serve Queen Elizabeth I, following the example of the Aztecs. For more than three centuries after the Henán Cortés era, Mexico was the only vanilla producing country in the world. Many attempts were made to grow the plant in other tropical countries but these efforts failed since the plant or vine grew and flowered, but no fruits were produced. It was not until 1836 that Charles Morren, a Belgian botanist, discovered why vanilla was not able to produce fruit out of Mexico. The anatomy of the flower is such that self-pollination is impossible. Moreen discovered that pollination is carried out by a tiny bee of the Mellipone family, which lived in the vanilla growing region of Mexico. It is difficult for other insects to replace the tiny bees (3). To achieve pollination one needs to remove the rostellum, a flower structure that is a modification of the stigma lying between the male and female organs and prevents access of the pollen to the stigma. Pollination is done by removing the rostellum with a sharp object, so that the pollen from the anther can be in contact with the stigma. Because the blossom lasts for a very short time (less than a day), pollination must take place as soon as the flower opens (2). Charles Morren was the first to propose hand-pollination and he was the first to produce vanilla beans outside of Mexico. This discovery laid the foundation for a new vanilla industry and broke Mexico's monopoly. In 1841 Edmond Albium, a slave in the French-owned island of Reunion, discovered a rapid pollination method. With the use of a pointed tip of a small bamboo stick, he picked up the adhesive pollen and prying up the flap-like rostellum inside the flower, he pressed the male pollen mass onto the sticky female stigma. This method of pollination is still used commercially today. Using the technique described above, the French started vanilla cultivation on many of the islands in the Indian Ocean. Vanilla plantings were established in Reunion, Mauritius, Madagascar, Comoros, Jamaica and other islands in the West Indies. Vanilla was first introduced to the island of Java in 1819 by a Dutch scientist, using vines from Madagascar. Commercial production in central Java started in the early 20th century and is known as "Java Vanille" (3). Today, the primary growing regions are Madagascar,

Indonesia, Papua New Guinea, Uganda, India and Mexico. Beans grown in Madagascar and Reunion are called Bourbon. Other countries that produce small amount of beans are Tahiti, Tonga, Guatemala and Costa Rica. Although vanilla started in Mexico, at present Mexico produces a small percent of the world's consumption.

CULTIVATION

Species

Vanilla is tropical climbing orchid. From more than 110 species that have been described in the *Vanilla* genus, only 2 are of commercial value. They are *Vanilla panifolia* Salisb Ames (Vanilla fragrans Andrews), and *Vanilla tahitenesis*, Moore. Only *V. planifolia* and *V. tahitenesis* are permitted to be used in food. *V. planifolia*, the most important commercially, is cultivated in all the vanilla growing areas, except for Tahiti and Papua New Guinea. The beans are 10 to 25 cm long and 1 to 1.5 cm wide. *V. tahitenesis* is indigenous to Tahiti and differs from *V. planifolia*, with slender stems and narrower leaves. The pods are also shorter than *V planifolia* (2). The V. tahitenesis beans are perfumed and contain anisyl alcohol, anisyl aldehyde, anisic acid, and maybe heliotropine which are absent or in very small amount in V. planifolia beans.

Climate

Vanilla needs a warm and moist tropical climate with frequent, but not excessive rain. Under excessive rainfall, vanilla may be attacked by mildew and root disease. Under drought conditions, the vanilla plant can suffer considerable damage, which will result in a small number of flowers and low yield. In general, sloping land that has soil with high organic matter, high water holding capacity and access to irrigation in dry years will overcome the problems caused by weather (4). Vanilla grows best in 40-50 percent of normal sunlight intensity. In excessive sunlight, the apical buds tend to lose moisture and the growth of the vines is stunted. Heavy shade will result in vines with thin stems, small beans, and a reduced number of flowers and fruits. A shaded area, rainfall between 1000-3000mm and an average temperature of 23° to 29° C year round are preferred conditions.

Soil and Nutrients

Vanilla is a shallow rooting plant and grows well in well-drained humus-rich soil. A top layer of mulch helps keep the moisture in and the roots to spread. Soil parameters, such as texture and mild acidity, appear to be more important than nutrients. In a heavy rainfall area, good drainage is essential. The best soil appears to be limestone with a pH of 6.0 to 7.0

and a deep layer of mulch, which provides the nutrients, over and around the roots. Although the level of calcium, nitrogen, potassium, phosphorous, and micronutrients in vanilla are essential for the growth and production of beans, much more attention has been given to the type of mulch, because mulch appears to be more important than nutrients (5).

Support

The vanilla plant is a climbing orchid and needs mechanical support. Support is also needed to provide convenient access for pollination and harvesting. Fast growing trees with small branches are preferred and also provide shade. However, it is important that the supporting tree will not compete for water and nutrients. Trees native to the tropics are commonly used, such as avocado, coffee, orange, etc. In some cases, it is possible to use support trees, which, themselves, can produce cash crops. In Madagascar, casuarina pine trees are also widely used. In most plantations, the support trees are planted before the vanilla plants (4). In greenhouses, vanilla can be grown falling down or hanging.

Propagation

Vanilla is commonly propagated from cuttings usually with 8-12 nodes. Small cuttings will produce vines, but the larger the cutting, the faster the plant will flower. The simplest way to plant is to lay the cutting on the ground and cover it with thick layers of mulch. However, this propagation method limits the amount of plant material that may be used.
Also, the many origins of the cuttings represent genetic variability. A vine becomes productive after 3-4 years, depending upon the weather and soil conditions, and the health of the vine. The vine flowers once a year for 5 or 6 successive years. After 8 to 10 years, productivity goes down. Drought, insufficient mulching, overexposure to sun, and over-pollination can contribute to a reduction in the productive period of the vine (6). When planning a new plantation, one has to account for the life expectancy of the vines. A hectare of land can hold about 4,000 productive vines. The average yield is 1.5 to 2 kg green beans per vine. A mature good quality beans weighs between 15 to 30 grams (4).

Flowering, Fruit Set, Growth and Maturation

It is well known that vanilla vines need to reach a certain maturity before starting to flower. Apparently this is to accumulate growth factors or nutrient needed for blossoming. The factors affecting the timing and abundance of the flowers are not fully understood. However, according to Childers et. al. (6) drought, temperature, pruning, and the size of the original cutting may all influence the flowering. Removal of 4 to 6 inches of the apical bud 6 to 8 weeks before blossoming promotes flowering. Vines usually blossom for 1 to 2 months. The flowers open early in the morning and last for one day. Pollination must be done the same day.
Also, in a raceme (the flower cluster) only one flower opens per day and about 15 to 20 flowers open in daily succession, although not all of them will be fertile. It is desirable to pollinate to obtain between 5-10 beans because over pollination will result in small beans and a short production life. Because self-pollination is impossible to achieve, hand-pollination must be used to obtain a commercial crop. Hand-pollination is done as originally described by Edmond Albium in 1841 in Reunion, which consists of removing the restellum back so that the pollen-bearing anther can be pressed against the stigma. Once pollination takes place, the development of the pod ensuing with the enlargement of the ovary is completed in about 1 and a half to 2 months (3). After the fruit has attained its full size, it takes an additional 5 to 6 months to mature and ripen. During the maturation period, the dry weight and the protein content increases. Many other

physiological changes occur, as yet of unknown nature that results in the production of flavour precursors.

Curing

The green, mature vanilla bean has no flavour or vanilla aroma. If the bean stays on the vine, the typical vanilla flavour will develop after a prolonged ripening period. However, in commercial practice, the characteristic flavour and aroma of vanilla beans is due to changes taking place during the curing process (7) (8). The curing process consists of four steps: 1. Killing 2. Sweating 3. Drying, and 4. Conditioning.

Killing designates a process aimed at abolishing tissue and cellular activity but retaining heat tolerant enzymatic activity which is important for the curing process.

The most common processes are hot water killing, sun killing, and oven killing. Beans are placed in a wire basket and dipped in 65°C water for a few minutes. Killing by heat can also be done in an oven or by exposure to the sun for a prolonged time. There is a patent for using freezing as another killing method (7). The killing process apparently entails the breaking of cell membranes and mixing of previously compartmentalized substrates and enzymes.

Killing is followed by "sweating", which allows excess moisture to escape. This reduces bacterial and fungal spoilage, and yet leaves enough moisture for enzymatic activity.

This is the most important step. Glucosides, like glucovanillin, are broken down to vanillin. This is the step by which the typical characteristics of the vanilla bean flavour, aroma, and colour are developed. The duration of the sweating process is between 7-10 days

Following the sweating step is "drying", which reduces the moisture content from 60-70 percent to 20-30 percent. The reduced moisture content is typical for a good quality cured bean and helps to eliminate any microbial activity and to secure a long shelf life. In this step it is necessary not to obtain too hot a temperature, because some of the flavour and aroma components can evaporate or break down. The drying takes 7-10 days in the sun, for 2-3 hours a day. Oven drying can be employed at 45°-50°C. Oven drying of the bean will result in an inferior quality bean.

The last stage is "conditioning", or aging. This can last from a month to several months. During this period, the vanilla bean obtains the typical "full flavour". Chemical reactions, such as oxidation and hydrolysis are the main events during the drying process (4) (8).

COMPOSITION OF VANILLA FLAVOUR

The flavour of cured vanilla beans contains around 300 different constituents, although vanillin is the most important and most studied compound. However, the entire spectrum of vanilla components contributes to the deep prized vanilla flavour. From each country of origin we obtain a different profile of aroma and flavours, creating a unique profile for both beans and extract (1)(9).

Vanilla flavour Terminology	Vanilla aroma terminology
Anisic	Anisic
Aromatics	Aromatics
Balsamic	Barnyard
Caramelized	Floral
Chocolate	Hay like
Creamy	Phenolic
Floral	Prune
Fruity	Raisin
Hay like	Resinous
Prune	Rummy
Raisin	Smoky
Resinous	Sweet
Smokey	Spicy
Sweet	Tobacco like
Tea like	Vanillin
Vanillin	Woody
Woody	

Table 1. Vanilla flavour and aroma terminology

Vanilla planifolia is a species that is grown in cultivation in most of the growing areas.

The following are examples of vanilla bean aroma and flavour profiles from different origins:

- Bourbon vanilla- Madagascar, Comoros, and Reunion (also known as the Bourbon Islands): Bourbon vanilla is the best of its kind: rich, full, aromatic, sweet, creamy, full body of flavour, with a little note of tobacco-like and woody. *Vanilla planifolia* from Mexico- Vanilla beans from Mexico are rare and many people have never smelled or tasted the extract. They are more sweet and spicy than the Bourbon.
- *Vanilla planifolia* from Indonesia- Java beans are more smoky, lack the creamy and sweet aroma, and are not as full-bodied as Bourbon.
- *Vanilla planifolia* from India-These beans have the full body of flavour but it is less prominent than in Bourbon. They also lack the balsamic, sweet, and creamy note.
- *Vanilla planifolia* from Uganda- These beans are similar to Bourbon, but on a lower scale. Uganda beans have a noticeable chocolate and pruny note.
- *Vanilla tahitensis* from Tahiti- These beans have strong anisic, fruity, distinguished notes.
- *Vanilla tahitensis* from PNG- Very similar to the beans from Tahiti, with a perfumey, creamy, anisic character. But overall, a weaker flavour.

REGULATIONS

In the United States, vanilla is the only flavour that has its own standard of identity, which defines how it is produced and labelled. For more details, visit 21 CFR 169.175. Only two species *Vanilla planifolia* and *Vanilla tahitensis* are allowed to be used in food. The beans need to be properly cured, with no more than 25 percent moisture content. 1X vanilla extract is defined as the total of flavour and odour principles of 13 oz of beans per gallon, of water and alcohol. Alcohol content should be at a minimum of 35 percent by volume. Additional ingredients also permitted are glycerin, propylene glycol, sugar, and corn syrup. Vanilla flavours contains less than 35 percent alcohol.

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