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Tahitian Vanilla (*Vanilla xtahitensis*): A Vanilla Species with Unique Features

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Additional information is available at the end of the chapter

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Abstract

This chapter reviews the main findings on Tahitian vanilla (*Vanilla xtahitensis*) over the last 10 years. It brings new insights into the hybrid origin of *V. xtahitensis* and its diversification in French Polynesia. It details then the different analytical methods used to characterize the flavour properties and the aroma impact compounds of Tahitian vanilla, with a special emphasis on how they can be used to differentiate Tahitian vanilla from other vanillas. Finally, the effect of the curing process on the chemical composition and the sensory properties is discussed. These results highlight the need to include some of the key volatile compounds into a more adapted quality control, in order to describe the characteristic sensory properties of Tahitian vanilla but also those from other origins.

Keywords: *V. xtahitensis*, Tahitian vanilla, genetic biodiversity, aroma chemistry, high performance liquid chromatography, gas chromatography, sensory properties, quality control, curing process

1. Introduction

Though Tahitian vanilla production represents less than 1% of the world vanilla production [1], it possesses a unique aura, due to an original anise flavour, highly prized especially in gastronomy and perfumery. In order to better develop and organize the vanilla sector and to promote Tahitian vanilla specificities abroad, a dedicated institute “Vanille de Tahiti” was created in 2003 in French Polynesia [2]. One of its main objectives is to provide support to local

actors and help controlling pests and diseases threatening vanilla vines, with the sponsored supply of insect-proof shade houses for instance. A research department was also established in order to characterize Tahitian vanilla in comparison to other vanilla species, through the study of the flavour composition and genetic diversity. The institute has been part of a larger project, which focused on characterizing, protecting and promoting the sustainable use and valorisation of vanilla biodiversity (VaBiome 2012–2015). This chapter aims at capturing the most significant results that have been acquired over the last 10 years at the institute “Vanille de Tahiti” through different collaborations inside and outside French Polynesia, with a particular focus on genetic diversity and aroma chemistry.

2. Origins and diversification of *Vanilla ×tahitensis*

The introduction of vanilla in French Polynesia is estimated to have occurred during the mid-nineteenth century. The elucidation of the origin of Tahitian vanilla is difficult due to different reports of at least three introduction events from various origins (Philippines, France and West Indies) [3–5]. On top of that, the origin of *Vanilla* introduced in the Philippines was not solved and believed to be in Central America [5, 6]. Furthermore, the number of different vanilla morphotypes or species that were introduced is unknown, as authors described the introduction of *Vanilla planifolia* or *Vanilla pompona*, and even used different names (*Vanilla aromatic* and *Vanilla sativa*) [3, 4] for species known today as synonymous of *V. planifolia*. So it remains unclear, whether the Tahitian vanilla specificities appeared before its introduction in a still indeterminate cultivation area, or after through cultivation in French Polynesia.

Even if the origin of Tahitian vanilla is still confused, it is obvious that Tahitian vanilla, as we know it today, is different from other vanillas and in particular *V. planifolia*, the most cultivated species in the world. Since 1915, about 60 years after the first well-documented introduction events, various new vanilla morphotypes were described in French Polynesia [7]. Four morphotypes were early distinguished as “Tahiti”, “Haapape”, “Tiarei” and “Potiti” [3, 5, 7, 8]. Based on morphological differences between vanillas found in French Polynesia and other cultivated vanillas, Moore went a step further and claimed that Tahitian vanilla was a new species and therefore called it *Vanilla tahitensis* [9]. Indeed, Tahitian vanilla differs morphologically by having thinner stems, narrower leaves and shorter pods when compared to *V. planifolia* [5, 9] (**Figure 1**).

In 1951, Porteres suggested that Tahitian vanilla could be a hybrid offspring between *V. planifolia* and a complex *V. pompona* – *V. odorata* [10]. More recent assessment of the Tahitian vanilla genetic diversity gave new insight into its hybrid origin. A genetic analysis based on universal markers widely dispersed through the genome [amplified fragment length polymorphism (AFLP)] was carried out to compare the presence/absence of a set of AFLP markers. It showed that 31% of *V. ×tahitensis* AFLP markers were shared only with *V. planifolia*, while 6% of them were shared only with *V. odorata*, and other markers were shared with more than two other *Vanilla* species [11, 12] (**Figure 2**). Another study based on the analy-



Figure 1. *Vanilla xtahitensis* from French Polynesia: (a) vine in an insect-proof shade house, (b) flower, (c) mature pods and (d) cured vanilla pods.

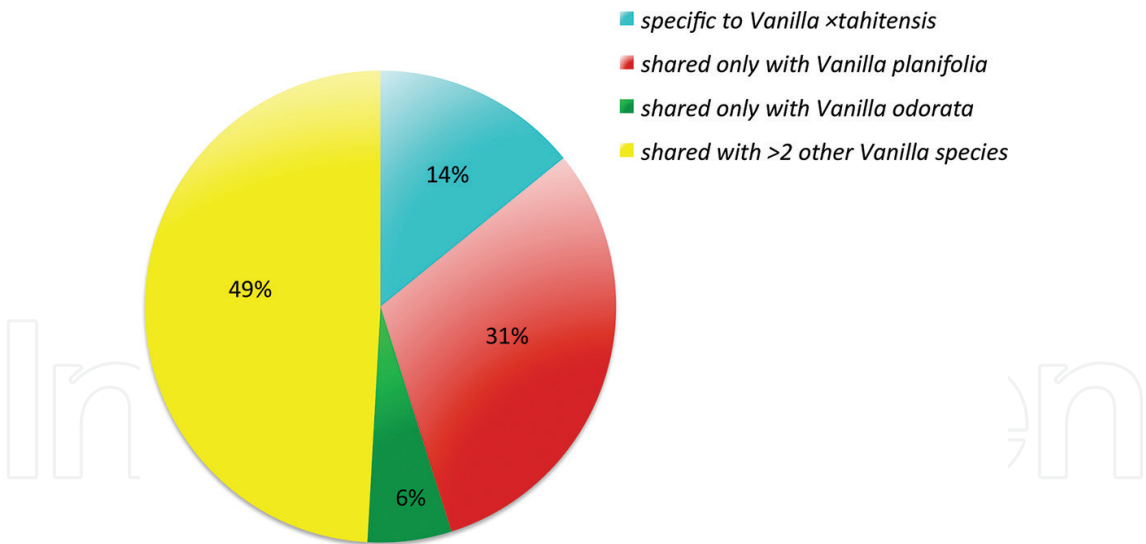


Figure 2. Specificity of the AFLP markers amplified from Tahitian vanilla accessions (*Vanilla xtahitensis*) compared to other *Vanilla* species.

sis of a part of the genome preferentially inherited from the maternal parent (non-coding region of chloroplast DNA trnH-psbA) confirmed that *V. planifolia* was the maternal parent of Tahitian vanilla [6]. Since then, Tahitian vanilla is called *Vanilla xtahitensis*; the “x” referring to its hybrid nature [13].

Coming back to the analysis of genetic diversity based on AFLP patterns, all Tahitian morphotypes were (i) distinct from the other *Vanilla* species studied (*V. planifolia*, *V. pompona* and *V. odorata*), (ii) genetically close to each other (mean dissimilarity index $D = 0.0596$) [11] and strongly grouped (**Figure 3**). Amongst Tahitian vanilla cultivars, the genetic diversity was higher than expected. While only 16 vanilla morphotypes were distinguished, more than 30 AFLP patterns were found. “Parahurahu” was the morphotype most genetically different from “Tahiti”. It also differentiated by its morphological traits such as leaf size, pod shape and its aromatic composition. The genetic diversity amongst Tahitian vanilla was also explained by ploidy level differences. Indeed, the two mainly cultivated Tahitian vanilla morphotypes “Tahiti” and “Haapape” shared the same AFLP pattern, however “Tahiti” appeared to be diploid while “Haapape” was tetraploid [14]. Since vanilla is mainly propagated by stem cuttings, such variability was unexpected. The comparison of molecular markers patterns led to suggest that the recent genetic diversification in French Polynesia originated from self-pollination rather than from mutation events.

Biodiversity of Tahitian vanilla is preserved in the Genetic Resources Centre “Vanille de Tahiti” created on the island of Raiatea. About 140 accessions of *V. ×tahitensis* collected on different Polynesian islands are grown under insect-proof shade houses. These accessions, which are part of a vanilla-breeding programme, can be diffused on demand to scientists from any research institute for genetic or new flavour sourcing projects. Accessions are continuously assessed for various agronomical traits, resistance to diseases and aroma composition of their pods for further improvement.

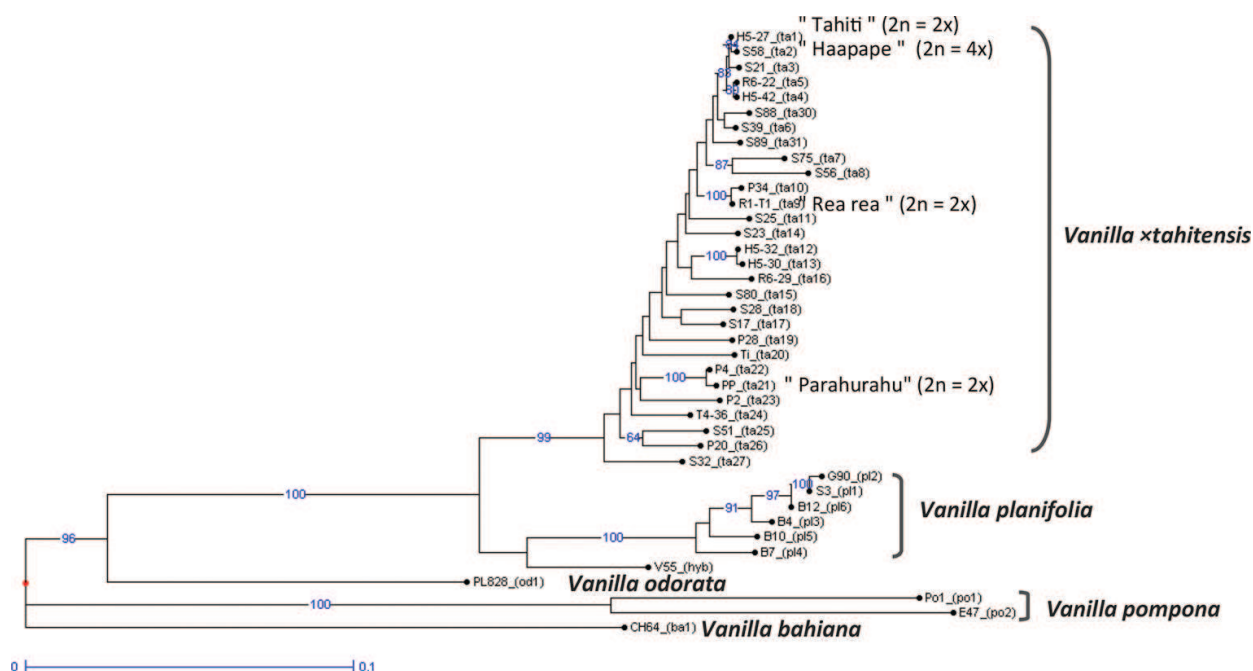


Figure 3. Phylogenetic tree of *Vanilla* species based on AFLP markers. Obtained from the Sokal and Michener genetic dissimilarity index and neighbour joining clustering; bootstrap values are expressed in percentage.

3. Tahitian vanilla flavour and differentiation from other vanillas

V. xtahitensis is mainly cultivated in French Polynesia but is also found, together with *V. planifolia*, in New Guinea (Papua New Guinea and Indonesia). The origin of the introduction of *V. xtahitensis* is unknown and the cultivar(s) grown have not been identified. Moreover the pods are sometimes not differentiated according to their species and commercialized as a mixture of *V. planifolia* and *V. xtahitensis* [15]. It results in products with sensory properties completely different, when compared to those of Tahitian vanilla (see Section 3.2).

In French Polynesia, the quality of Tahitian vanilla is guaranteed by the training of different actors of the sector and several controls, after harvest and before exportation, are realized by sworn experts, as specified in the designation of origin “Vanille de Tahiti” recently released [16, 17]. Until 2014, there were no official analytical criteria to authenticate Tahitian vanilla in the international trade context, which would enable to differentiate it with vanilla from Papua New Guinea.

In order to determine what specifically differentiates Tahitian vanilla from other vanillas (*V. planifolia* the most cultivated in the world, *V. pompona* and vanilla from Papua New Guinea), in terms of flavour properties, the content of some chemical compounds of interest was assessed using different analytical techniques. Due to ease of implementation, the analysis by high performance liquid chromatography (HPLC) of vanilla extracts is still a method of reference. However, other analytical methods developed to assess the olfactory (gas chromatography-olfactometry) and gustative properties of vanilla, appear more appropriate to characterize the sensory properties of the pods. In order to correlate sensory properties and chemical composition, gas chromatography/mass spectrometry (GC/MS) analysis was also considered because of its ability to quantify a much larger number of compounds, when compared to HPLC.

3.1. Authentication based on HPLC profile

To authenticate natural vanilla (i.e. *V. planifolia*), quality control is usually based on the analysis by HPLC of some characteristic compounds (vanillyl and p-hydroxybenzyl derivatives) (Figure 4) extracted with ethanol as recommended by the International Organization for Standardization and the AOAC International [18, 19]. The ratios between those compounds are quite stable for the different origins of *V. planifolia* and throughout years of production, and are therefore recommended as quality markers by the Direction Générale de la Concurrence, de la Consommation et de la Répression des Fraudes (DGCCRF) guidelines [20]. However, these ratios are not appropriate to authenticate Tahitian vanilla, as data fall without ranges. It is worth noting that typical chromatograms obtained from Tahitian vanilla analysis are composed not only of p-hydroxybenzyl or vanillyl derivatives but also and predominantly of anisyl derivatives, which are actually not taken into account for those criteria (for compound structures see Figure 4).

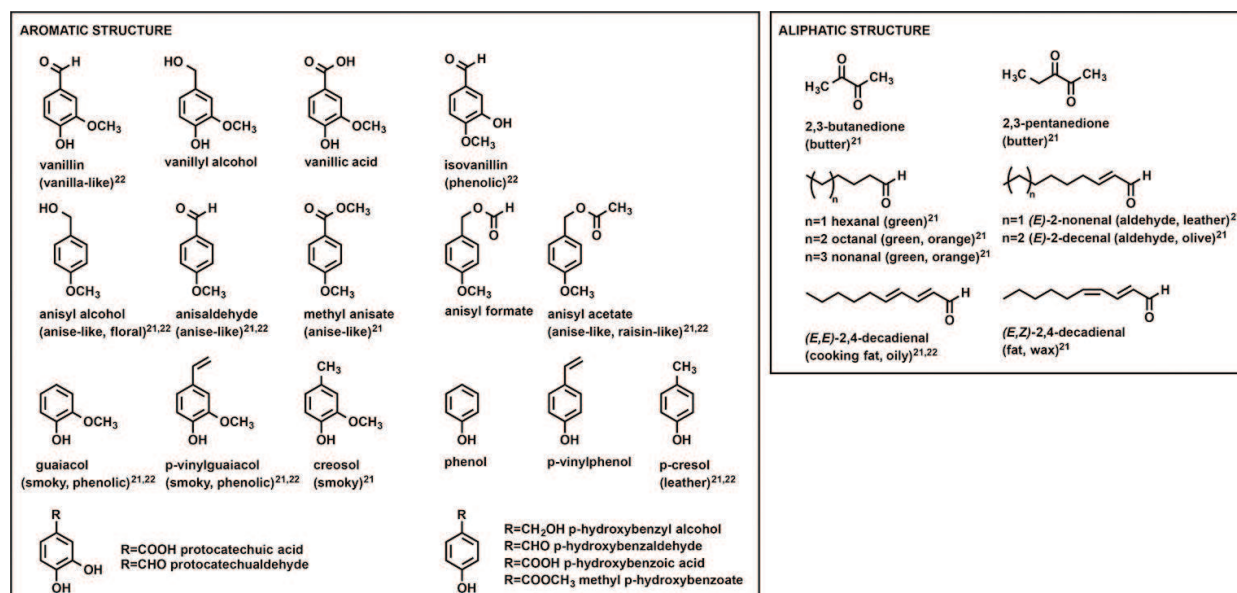


Figure 4. Structure of key compounds in the aroma chemistry of Tahitian vanilla (*V. x tahitensis*). Odour descriptors are specified into brackets when compounds have been detected by GC-olfactometry in Refs. [21, 22].

This is exemplified by a study carried out between 2005 and 2007 at the Institute “Vanille de Tahiti”. More than 300 vanilla samples, collected from vanilla curers based on the islands of Tahaa and Raiatea, where most of the vanilla was produced in French Polynesia at that time, were analysed by HPLC, together with 22 samples of *V. planifolia* and 9 samples from Papua New Guinea. The results showed that contrary to *V. planifolia*, which was composed almost only of vanillin (80% of the total quantified), Tahitian vanilla was characterized by a more subtle distribution: vanillin (25%), anisyl alcohol (30%), anisic acid (15%) as well as p-hydroxybenzyl compounds (20%) and protocatechyl derivatives (5%) for a total content of 47,000 ppm (**Figure 5**), which exceeded the values typically reported for *V. planifolia* (40,000 ppm) [23–25].

The HPLC composition of Tahitian vanilla was homogeneous between the three years of production, for compounds whose concentration was higher than 1000 ppm (relative standard deviation <15%). As a result of this, low variability shown by principal component analysis using the HPLC composition and vanilla samples from various origins, it was possible to differentiate a set of Tahitian vanilla samples from *V. planifolia* of different origins and also from vanilla of Papua New Guinea, independently of the species (**Figure 6**).

The HPLC compositions of “Tahiti” and “Haapape” cultivars, which are the two main cultivars produced in French Polynesia, were found to be very close. The slight variations consisted in more vanillin and less p-hydroxybenzyl compounds in “Tahiti” pods. Consequently to this study, recommendations based on the contents of characteristic HPLC aroma compounds and their ratios have been made to assess Tahitian vanilla quality in French Polynesia. They have been integrated into official decrees published recently

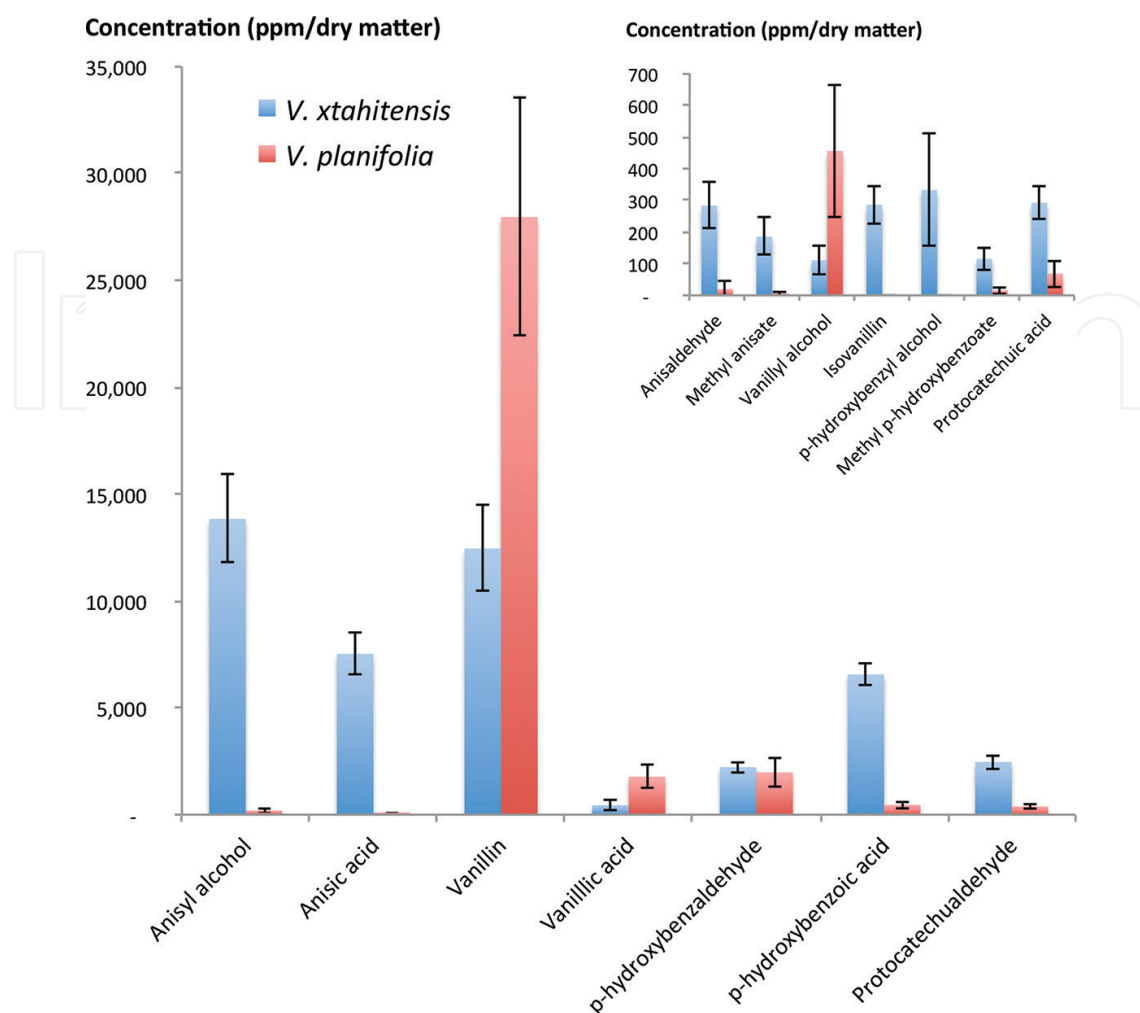


Figure 5. HPLC composition of Tahitian vanilla (*V. xtahitensis* from French Polynesia; $n = 300$ samples over 3 years of production 2005–2007) and *V. planifolia* (20 samples from various origins: Madagascar, la Réunion, Mexico, Costa Rica).

[16, 17]. These decrees define the Tahitian vanilla's designation of origin ("Vanille de Tahiti"), its production area, the cultivars to be produced ("Tahiti" and "Haapape") with their genetic characteristics, the production and the curing process methods, as well as the pods quality based on moisture content (45–50%), aroma content and characteristic ratios using the concentrations of anisyl, vanillyl, p-hydroxybenzyl and protocatechuyll compounds determined by HPLC. These criteria can also be used to authenticate Tahitian vanilla abroad.

3.2. Towards a better authentication based on the relevant flavour compounds

Though HPLC is a reliable analytical technique to analyse some characteristic compounds of the vanilla pods, it appears as more convenient to use complementary analytical and sensory techniques to quantify more compounds, in particular those likely to contribute/to affect the vanilla flavour. The perception of a flavour is due to the detection of a complex mixture of

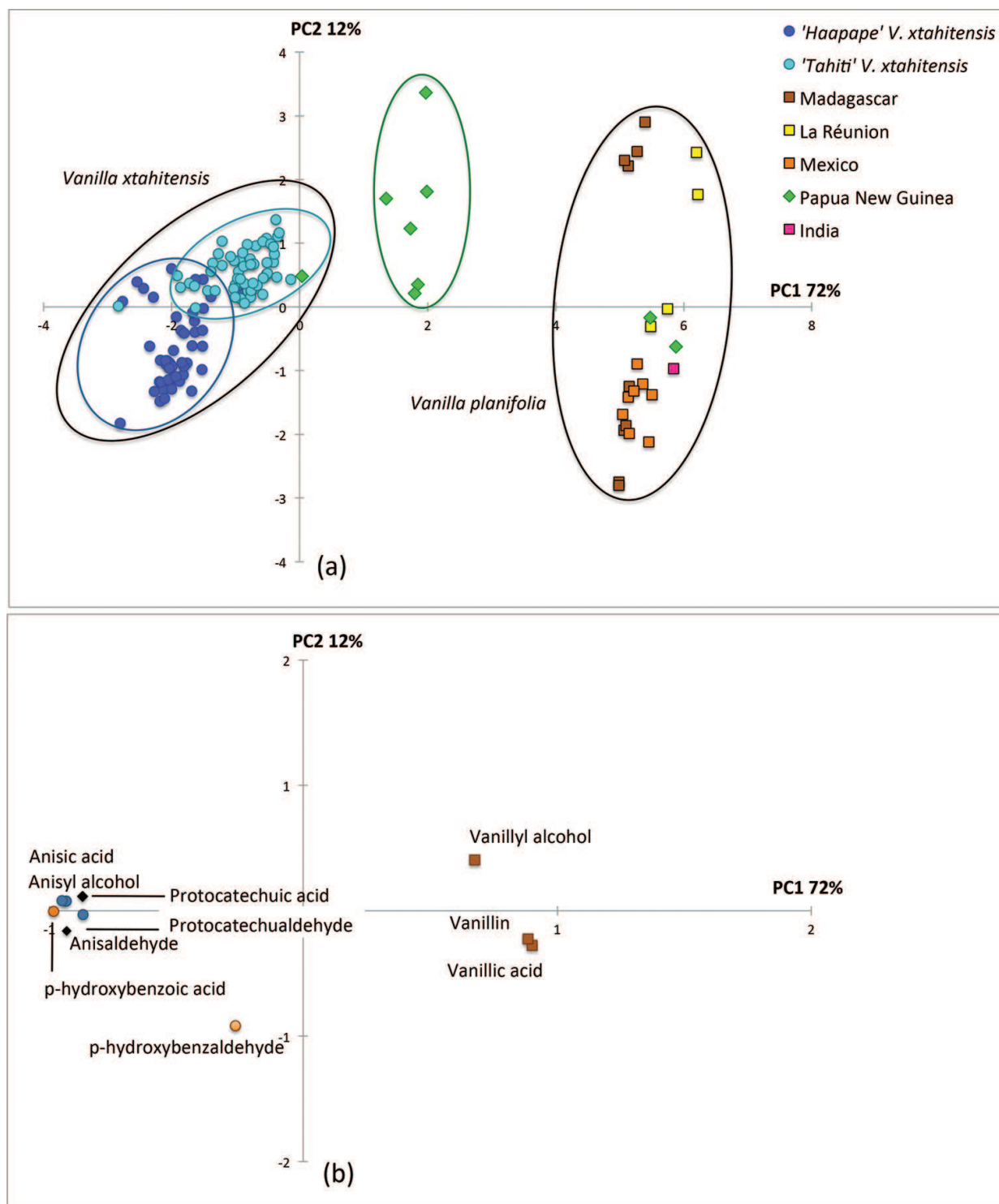


Figure 6. Projection plots on Principal Components of (a) observations scores (dataset of vanilla samples from different origins and (b) variables coefficients (compound concentrations analysed by HPLC). PC1 and PC2 explained, respectively, 72% and 12% of the total variance in the data.

compounds having various physico-chemical properties. Non-volatile (or less volatile) compounds, like essential fatty acids, have the ability to fix some non-polar aroma constituents. Volatile compounds, which have various odour-detection thresholds, can sometimes have

a preponderant impact on the aroma, even when present in low amounts. Tahitian vanilla aroma chemistry has been therefore investigated using additional analytical techniques, such as gas chromatography-mass spectrometry (GC-MS), sensory analysis and a hyphenated technique, gas chromatography coupled with olfactometry (GC-O) designed to detect more volatile compounds.

3.2.1. Gas chromatography-olfactometry and volatile compounds

GC-olfactometry enables to decompose the individual odours of an aroma extract and attribute these odours to specific compounds, which are called aroma impact compounds. GC-olfactometry was applied to the analysis of different vanilla extracts: *V. planifolia* from Mexico [26], *V. planifolia* from Madagascar and Uganda [27], *V. xtahitensis* from French Polynesia [21, 22] and *V. pompona* from Mexico [28]. The unique sensory fingerprint of Tahitian vanilla was highlighted by the detection of about 60 notes using the odour-specific magnitude estimation (OSME) method for both cultivars “Tahiti” and “Haapape” [21]. Amongst them, 38 were attributed to a specific compound. Anisaldehyde and guaiacol were found to be the main aroma impact compounds of Tahitian vanilla. These two compounds were also found to be primary impact aroma compounds of *V. pompona*, although the overall aroma characteristics of the two species were quite different. Main aroma impact compounds of *V. planifolia* were vanillin derivatives and phenolic compounds such as guaiacol, creosol, p-cresol or phenol. It is noteworthy that despite a relatively low content in the pods, anisyl compounds such as anisaldehyde and anisylalcohol were also identified as odour-impact compounds in *V. planifolia* [26, 27]. The GC-O profile of *V. xtahitensis* was more balanced compared to other species; enabling the co-expression of multiple notes such as phenolic-vanilla like notes, anise-spicy and floral notes, while *V. planifolia* flavour was mainly characterized by phenolic-vanilla notes and *V. pompona* by floral notes (Figure 7).

3.2.2. Sensory properties and volatile compounds

In addition to the compounds analysed by HPLC, various volatile compounds such as phenolic compounds, aliphatic aldehydes, ketones and esters contributing to the flavour of Tahitian vanilla were identified and quantified by GC-MS [29]. Still, this method highlighted

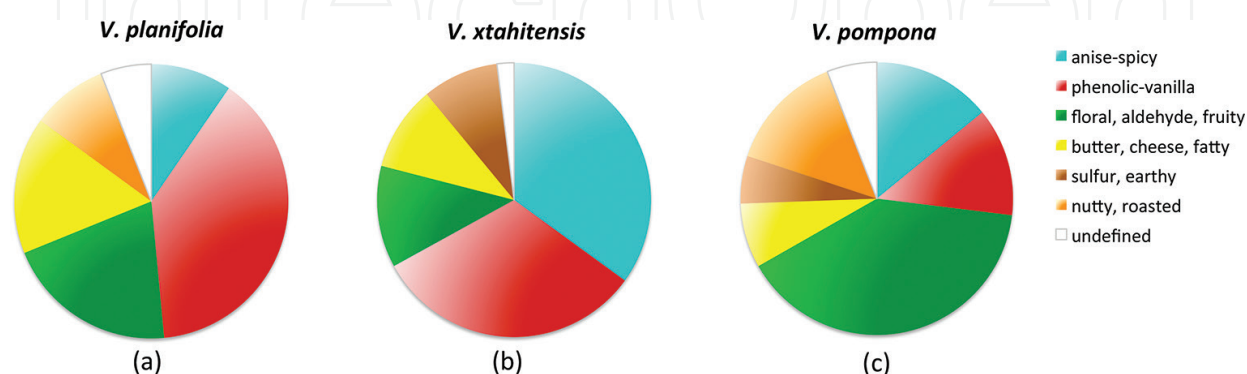


Figure 7. Distribution of odour vanilla notes based on the analysis by GC olfactometry of the impact aroma compounds of (a) *V. planifolia*, (b) *V. xtahitensis*, and (c) *V. pompona* (adapted with permission from Ref. [21, 27, 28]).

that compared to *V. planifolia*, *V. ×tahitensis* had a higher content of anisyl compounds, which represented 70% of the total volatile content against 7% for *V. planifolia*; amongst them anisyl alcohol, anisaldehyde, methyl anisate and anisyl acetate were the major ones (for compound structures see **Figure 4**). The other characteristics of *V. ×tahitensis* were a much lower vanillin content than *V. planifolia* (5–10% against 30%, respectively), as well as lower contents of phenolic compounds and aliphatic aldehydes (less than 10% against more than 40% and 0.5–1% against 2%, respectively). The volatile composition of Papua New Guinea vanilla showed some similarities to that of Tahitian vanilla especially regarding anisyl compounds, but some key compounds could differentiate them such as methyl esters, anisyl formate, p-cresol or p-vinylguaiacol [29].

In relation to their volatile composition, it was also possible to clearly differentiate the sensory properties of Tahitian vanilla from *V. planifolia* and also from vanilla from Papua New Guinea. The method used, called quantitative descriptive analysis, consisted in a panel of judges who tasted aroma extracts. Compared to the other vanillas, Tahitian vanilla displayed more intense anise, caramel and vanilla notes despite a relatively low vanillin content. *V. planifolia* was characterized by more intense phenolic, woody and smoky notes (**Figure 8**) [29]. Similarly, another sensory study depicted Tahitian vanilla aroma as less resinous, less dried fruit-like and more floral compared to *V. planifolia* from Madagascar [22]. The sensory profile of vanilla from Papua New Guinea was well differentiated from that of Tahitian vanilla with strong fruity, spicy and brown rum notes [29], the latter being probably related to the curing method as those were found to become stronger throughout the curing process (see Section 4).

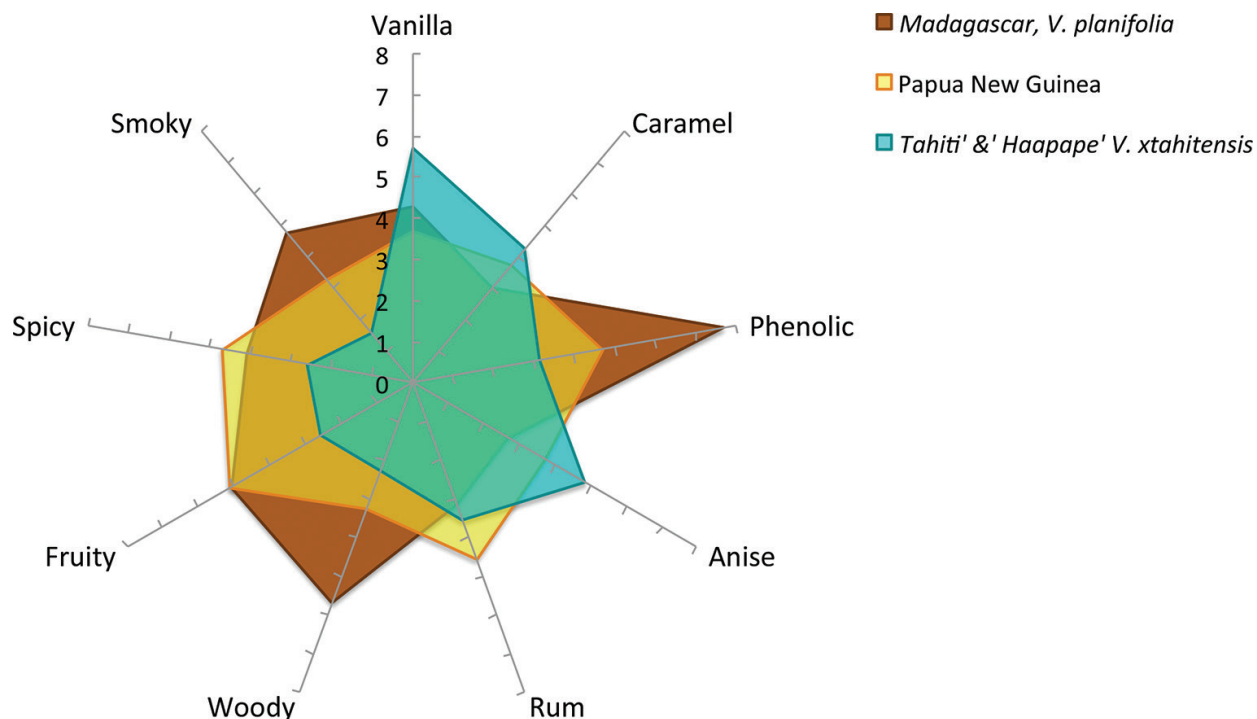


Figure 8. Sensory profiles of Tahitian vanilla (*V. ×tahitensis*, mix of “Tahiti” and “Haapape” cultivars) compared to vanilla from other origins (adapted with permission from Ref. [29]).

As we tried to correlate the sensory properties of vanilla from different origins to their volatile composition, it remained difficult to link single volatile compounds to specific notes, as there are many interactions between volatile and non-volatile compounds. However, we were able to show that the strongest correlations were between phenolic, woody, smoky notes and a pool of phenolic compounds such as guaiacol and creosol. Such correlation between guaiacol and woody notes has also been highlighted for *V. planifolia* [25] and led to the development of more appropriate analysis methods to characterize vanilla flavour also based on the detection of negative compounds such as guaiacol [30]. Anisyl compounds, especially methyl anisate were well correlated with anise notes. p-Vinylguaiacol was another compound of interest, as it was in higher amounts in vanilla from Papua New Guinea compared to Tahitian vanilla and differentiated the two origins [29]. These results stressed the need to integrate volatile compounds belonging to the phenolic series (guaiacol, creosol, p-cresol and p-vinylguaiacol) and to the anisyl series (anisyl alcohol, anisaldehyde and methyl anisate but also anisyl formate and anisyl acetate) in a more appropriate quality control, be it to authenticate *V. xtahitensis* or more generally to assess vanilla quality independently of its origin.

4. The effect of curing process on vanilla flavour

Since we started our journey studying Tahitian vanilla characteristics, there was a question that needed to be answered: how much of the aroma is inherent to the vanilla species and what is the influence of the curing process on the aroma development? To get an answer, we first have to go back to the curing process as it is performed in French Polynesia. First, Tahitian vanilla pods are harvested when fully ripe, then they are cured following three main steps [31]:

- (1) Shade browning: vanilla pods have 80% moisture and are exposed on the shade until being entirely brown.
- (2) Sun drying and sweating: for several weeks, pods are alternatively exposed for a short period of time (2–4 h) in the sun every day, then wrapped into a cotton fabric and leave to sweat overnight in closed wooden cases. As pods become increasingly flexible and glossy due to water loss, they are massaged to ensure seeds are spread lengthwise.
- (3) Air drying and refining: finally pods are left in the shade so that the moisture and aroma contents stabilize in order to obtain homogeneous batches (around 50% moisture).

Unlike other vanilla species, *V. xtahitensis* pods do not split when fully ripe. It means they can be kept on the vine until full maturity when aroma content is at its optimum. Late harvest is also likely to limit the risk of mould formation during storage. Another consequence is that there is no need for any initial heat treatment in hot water or in an oven, as it is performed commonly in the Indian Ocean region, in Central America or in New Guinea. During curing, many biotransformations take place due to the presence of intrinsic enzymes located in the pods and/or the action of colonizing microorganisms on the surface as evidenced by the latest

findings on *V. planifolia* [32]. Even if the different biotransformations involved are still unclear, they will definitely contribute to the development of the final vanilla flavour that one can experience when smelling cured vanilla pods.

4.1. Effect of curing on aroma composition using HPLC

The evolution of the aroma composition of Tahitian vanilla pods was monitored by HPLC analysis of “Tahiti” and “Haapape” samples collected at various steps of the curing process. It was observed that through drying, the aroma content of the pods decreased by around 30%, from around 70,000 ppm at 80% moisture content to 50,000 ppm for a final moisture content of 50–55% (**Figure 9**). This loss could be attributed to co-evaporation of the compounds with water while sun drying and/or loss in liquid form during pod sweating, as evidenced by the oily substance observed at the surface of the fabric wrap.

Within a same compound series, acids concentrations (in red) remained stable during the curing process; while alcohols concentrations (in blue) tended to decrease linearly over time. The fate of aldehydes (in black) varied across the series, as anisaldehyde concentration remained stable, while vanillin concentration decreased linearly. These different trends were related to many interdependent factors such as the oxidation state of the compounds (alcohols can be oxidized into aldehydes then into acids within a series), their physico-chemical properties (volatility and lipophilicity), and the fact that the compounds can be potential substrates or

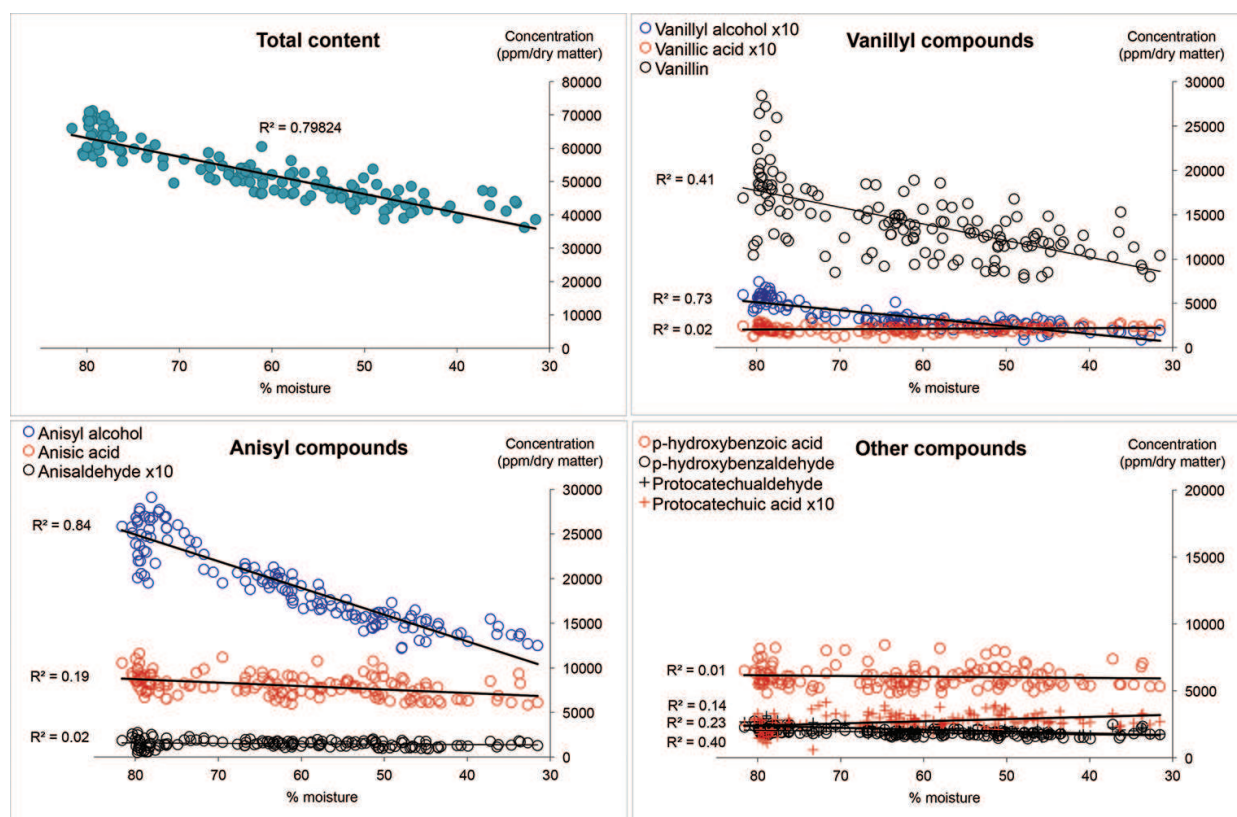


Figure 9. Variations of Tahitian vanilla composition obtained by HPLC during the curing process (*V. ×tahitensis*, “Tahiti” and “Haapape” cultivars).

metabolites of intrinsic enzymes or colonizing microorganisms. The relatively high variability of the compounds concentration, especially vanillin, observed at the beginning of the curing process progressively decreased, resulting in more homogeneous vanilla batches at the end of the curing process.

4.2. Effect of curing on sensory properties and volatile compounds

In order to get a better understanding of how the pod aroma was developed, we studied the evolution of sensory properties by quantitative descriptive analysis and of relative volatile compounds concentration by GC-MS at different steps during the curing process: (i) step S1—shade browning (80% moisture), (ii) step S2—sun drying (60–65%, pods are wrinkled); (iii) step S3—air drying (50–55% moisture); (iv) step S3*—enhanced drying: sun drying was extended to mimic curing methods of vanillas from other origins and obtain vanilla pods at 40% moisture.

Some of the sensory notes of “Tahiti” cultivar varied significantly during the curing process (**Figure 10**), while the variations for “Haapape” were not significant (data not shown). Regarding the “Tahiti” cultivar, vanilla, anise, rum and caramel notes remained as intense as they were initially or slightly decreased while woody, phenolic, smoky, spicy and fruity notes progressively (and significantly for most of them) built up during the curing process. It is noteworthy that even when *V. xtahitensis* pods were taken to the enhanced drying step until

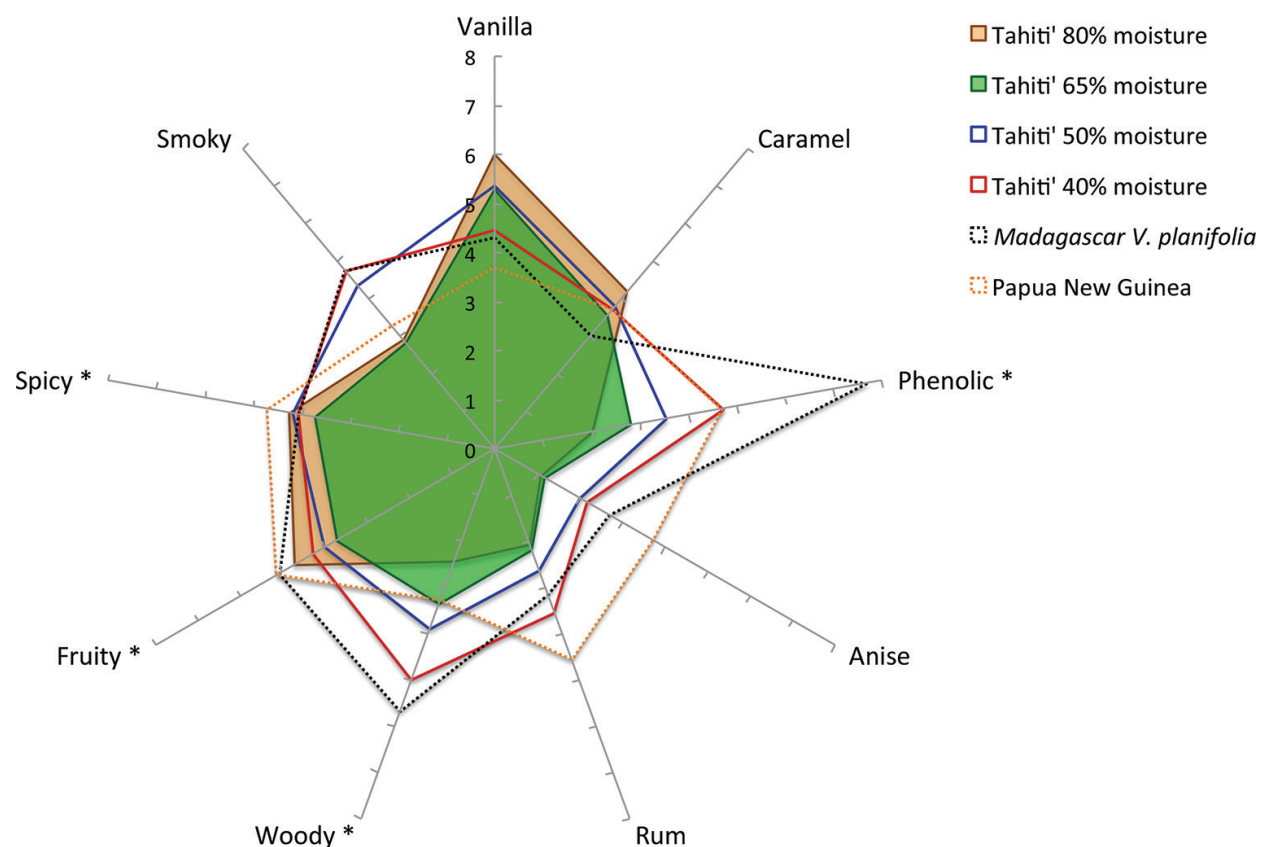


Figure 10. Sensory scores of Tahitian vanilla (*V. xtahitensis*, “Tahiti” cultivar) at different moisture contents during the curing process compared to other vanillas. *indicate that sensory scores were significantly different between Tahitian vanilla samples during the curing process ($p < 0.05$).

reaching 40% moisture, they still had a sensory profile different from other vanillas. However, some sensory characteristics, especially phenolic, woody, fruity and spicy notes tended towards that of *V. planifolia* or vanilla from Papua New Guinea, which is not required as the development of such notes is not seen as an improvement. Based on these findings, curing should be processed judiciously in order to enable the perfect balance of phenolic and anise-floral notes to develop. Drying up to 50% appeared to be the optimal conditions in order to retain as much as possible the initial organoleptic properties of Tahitian vanilla (vanilla and caramel) while limiting the woody, smoky and phenolic notes.

The curing method induced variations in the volatile composition, which impacted greatly the final flavour. Despite a relatively low concentration in the Tahitian vanilla extracts, some aliphatic aldehydes and ketones played a pivotal role by GC-olfactometry [21] due to a low odour threshold [29]. They originate from the oxidation of essential fatty acids such as linoleic and oleic acids, the major fatty acids in Tahitian vanilla pods [33]. Indeed, the fatty acid content was found to decrease from 2.7% of dry matter to 1.6% during the curing process (cultivar “Tahiti”). The increase in the concentration of saturated aldehydes (hexanal, heptanal, octanal and nonanal) linked to fruity notes was seen as positive, contrary to the increase of monounsaturated (heptenal, octenal, nonenal and decenal) and diunsaturated aldehydes (2,4 decadienal) (**Figure 11a**), which displayed less pleasant notes like leather, olive, wax and cooking fat by GC-O [21]. Thus, drying the pods until 40% moisture is not recommended. Similar variations of aliphatic aldehydes were observed during the curing process of *V. planifolia* [34]. Aliphatic ketones, such as 2,3 butanedione and 2,3 pentanedione perceived as butter, were found to have an optimal content at 50% moisture, while 3-hydroxybutanone decreased, being metabolized by bacili bacteria into 2,3-butanediol as suggested for cocoa [35].

The overall content of odour-active anisyl compounds was stable during the curing process of Tahitian vanilla, even though individual compounds contents varied (**Figure 11b**). When comparing the evolution between steps S1 and S3*, anisyl alcohol and methyl anisate contents were found to decrease, while anisaldehyde, anisyl acetate and anisyl formate contents slightly increased. The overall content of phenolic compounds (guaiacol, p-cresol, creosol, phenol, p-vinyl-phenol and p-vinyl guaiacol) increased during the curing process, in tune with the development of phenolic notes. Particularly, there was a dramatic increase of p-vinyl guaiacol by five-fold (**Figure 11c**). The increase of such phenolic compounds was also observed when Tahitian vanilla was stored for a long period of time (five years, data not shown). Overdrying vanilla pods to 40% moisture, as usually performed in other countries, was not beneficial to the Tahitian vanilla aroma, due to the concomitant increase of phenolic compounds concentration and the development of phenolic notes. The higher levels of p-vinylguaiacol and other phenolic compounds detected in vanilla from Papua New Guinea can find its roots in the way the curing process is performed.

Single compounds variations such as anisaldehyde, methyl anisate, guaiacol or p-vinyl guaiacol could not explain all the variations observed while monitoring sensory properties during the curing process, as aroma compounds also interact with less volatile components and between them. However, they were found to be overall good indicators of the development of the targeted sensory properties and it would be advisable to monitor their concentrations.

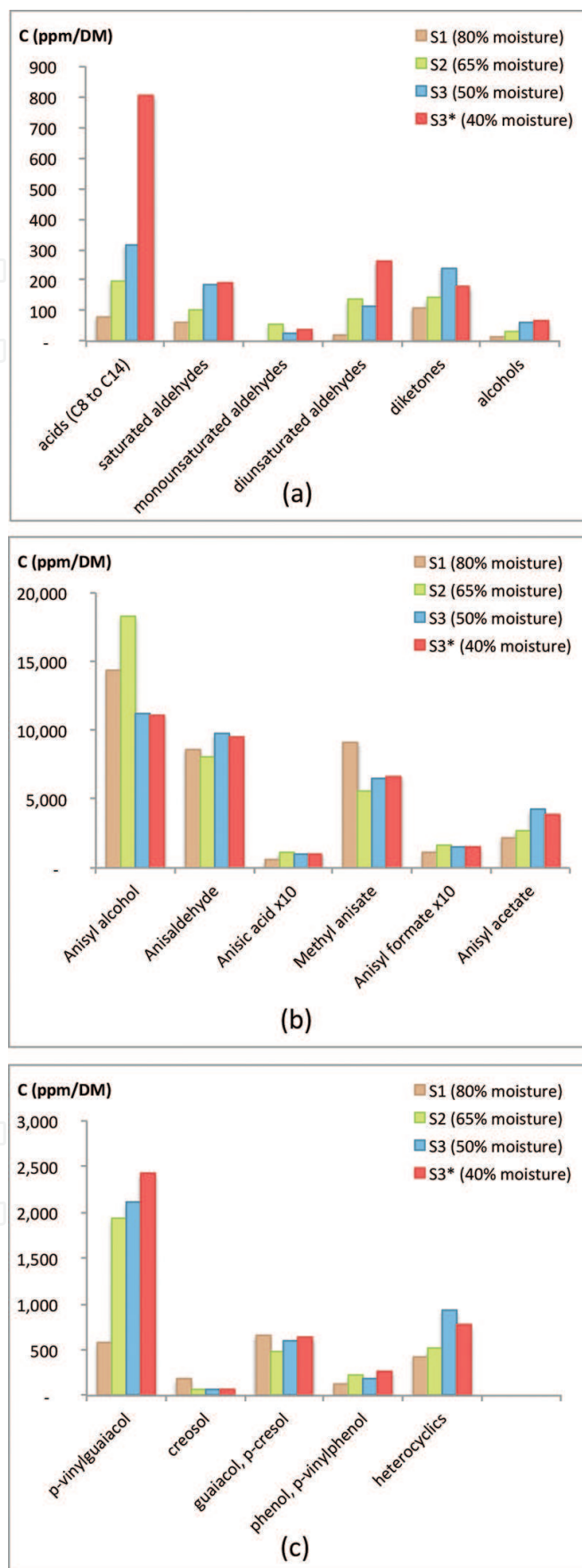


Figure 11. Evolution of key volatile compounds of Tahitian vanilla during the curing process (*V. xtahitensis*, Tahiti cultivar) (a) aliphatic compounds, (b) anisyl derivatives, (c) phenolic compounds and heterocyclics. DM: dry matter.

5. Conclusion

Tahitian vanilla has come a long way to be as it is known today. Various vanilla vines from different species have travelled around the world and been introduced in French Polynesia, to give the hybrid *V. ×tahitensis*, which is currently grown in French Polynesia. Polynesian vanilla growers have selected over time the best cultivars to be produced, “Tahiti” and “Haapape” and have refined the curing method according to the specificity of Tahitian vanilla. This study showed that HPLC analysis and vanillin content of the pods were not always appropriate to assess the flavour properties of the pods. Modern analytical techniques have highlighted the subtle aroma chemistry of Tahitian vanilla. The use of sensory techniques has enabled to show that the flavour of Tahitian vanilla differentiated from other vanilla by stronger anise, vanilla and caramel notes. The weaker phenolic and woody notes appeared to be linked to the curing process, which plays a very important role in the development of volatile compounds. Curing vanilla pods at 50% moisture seems to be the optimal content so that Tahitian vanilla aroma develops fully and keeps its distinctive characteristics compared to other origins.

New authentication criteria of Tahitian vanilla based on HPLC profiles and specific anisyl compounds have been published recently in French Polynesia and could be used to certify its origin. In order to maintain Tahitian vanilla originality, quality control should also be orientated towards odour-active compounds, which impact definitely the aroma. This will help protecting the specificities of this unique spice.

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