CRITERIA FOR TESTING VANILLA IN RELATION TO KILLING AND CURING METHODS

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INTRODUCTION

The widely known flavor, vanilla, is prepared from the vanilla bean which is the fruit of a tropical orchid, Vanilla fragrans (Salisb.) Ames. Actually, the fruit is not a bean but a pod, 5 to 10 inches long, one-quarter to three-quarters of an inch in diameter, and somewhat triangular in cross section. Inside the thick fleshy outer wall are numerous small black seeds. The pods are harvested from the plant when a yellow color develops on the blossom end of the pod. They are then cured in four steps as follows:

1. Killing—by wilting, or killing by immersion in hot water or by sunning;
2. Sweating—by exposure to the sun and wrapping in blankets, or warming in an oven;
3. Drying (the beans now dark brown and flexible) to 15 to 30 percent;
4. Conditioning—storing the product for several months in closed boxes at room temperature, during which time the flavor develops.

The cured material has the characteristic vanilla aroma and is ready for market.

For use as a flavor, the beans are ground with sugar and other ingredients or extracted with alcohol or some other nontoxic solvent to obtain the well-known vanilla extract. To enhance its flavoring value, the final product is often fortified with vanillin prepared from lignin or from clove oil.

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2 The authors are indebted to Mr. Robert Rosenbaum of David Michael and Company, Philadelphia, Pa., vanilla processors. Mr. Rosenbaum examined various extracts referred to in this paper and furnished written opinions of his results. His tests were based on the aroma of the extracts as they are slowly evaporated without heating.

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CRITERIA FOR TESTING VANILLA

It is generally agreed that the criteria usually applied to vanilla do not constitute a true measure of the quality of the product. An analysis of vanillin and determination of phenol value, lead number, and resin content may be useful in identifying vanilla and detecting adulteration, but they are of little value in measuring quality. Even the usual grader's examination for texture, color, aroma, and appearance, which is valuable in obtaining rapid estimation of quality, is not entirely satisfactory. Each of these properties is only symptomatic of quality; that is, the product may appear to be excellent according to several of these criteria and yet may be quite inferior when used as a flavor. Or, two samples may appear fairly equal according to these tests and still differ markedly in flavoring strength and other characteristics.

Vanilla, as well as other similar materials, can be tested organoleptically in ice cream by several testers and the results analyzed statistically to evaluate the degree of difference among the samples. This method was tried on a set of extracts, to evaluate both the products and the techniques of testing.3

The same extracts were used numerous times at various strengths and in different recipes. The most satisfactory ice cream recipe to date calls for 1 pint of cream (40-percent butterfat), 4 pints of milk (4-percent butterfat), 15 percent sugar, and 0.3 percent gum tragacanth. The mix was divided into separate portions, one for each sample and the extract added at the rate of 2 cc. per 100 cc. of mix. To one sample in each series, the blank, no extract was added. After cooling to 10° C. the samples were churned in a hand freezer to a hard consistency and stored at −10° until tested.

The vanilla extracts used throughout these curing experiments were prepared as follows: The moisture content of the cured beans was determined so that the extracts could be made with a known proportion of alcohol to dry vanilla tissue. The beans were cut to 1-cm. slices and soaked in 10 cc. of 50-percent alcohol per gram of dry matter. The beans and alcohol were kept in a flask fitted with an air condenser. Over a period of 2 weeks the flasks were warmed twice daily in a water bath at 60° C. At the end of this time, the extracts were filtered through cotton to remove the solids.

The ice cream samples were tasted from 3 to 22 hours after freezing in two series with coded designations. The ranking of each tester was checked for reliability by calculating the correlation coefficient between the two separate rankings made by the same tester. The data were accepted as reliable if the tester obtained the same ranking both times, or if in the second run he interchanged two samples other than the blank that were consecutive in the first run. However, if the tester interchanged first and third rank, the correlation coefficient, then below 0.77, was considered too low and the tester's data were rejected. Using the ranks obtained by reliable testers, the

data were then treated statistically as though each ranking were made by a different tester. For example, if three reliable testers made two acceptable determinations, the final statistical analysis was made as though there were six testers.

The same set of extracts was used on several different dates and scores for the samples calculated each time. If, on any given date, the differences between scores were not considerably greater than that necessary for high significance, the data for that date were discarded on the assumption that the recipe used was such that the differences between samples were not brought out sharply. Of course, if this occurred consistently, the data were accepted and the conclusion drawn that the differences among the samples were not great. However, where appreciable differences were obtained on some dates, the data from runs in which differences were small were discarded and the weakness of the data attributed to the recipe.

**COMPARISON OF KILLING METHODS**

In 1943 an experiment in which different curing methods were compared showed that scratching the beans was a good way to kill them. Recently, further trials were made with combinations of the following killing methods singly and in combination: (1) Dipping in water at 80° C. three times for 10 seconds at 30-second intervals; (2) scratching each face 1 mm. deep from end to end (some beans were scratched only 2 cm. from the stem end to decrease the brittle nature of the stem end in the cured product); and (3) frozen at −10° for 24 hours. After killing the samples were oven-sweated at 45° and dried at room temperature to 28.6 percent of the fresh weight, after which they were conditioned in closed boxes at room temperature for 6 months. Duplicate 260-gm. samples of 6- to 8-inch blossom-end-yellow beans were used. No mold developed in any of the samples and splitting was negligible.

Those killed with hot water were smooth, oily, and dark brown during sweating. During drying the oiliness changed to stickiness and a very slight vanilla aroma became noticeable. The conditioned product was very dark brown, somewhat rough, and not flaccid. The beans were shiny and had no vanillin crystals on the outside. The aroma was prunelike with strong vanilla character.

Beans killed by scratching required about 1 day to become brown, which was somewhat longer than in the other treatments. The beans were oily during sweating, but somewhat less after drying. Some flowery aroma developed during drying. Those scratched to 2 cm. from the stem end had a firm lump in this position which later disappeared and left the stem end flexible. Those scratched along the entire length became woody at the stem end. The texture was more flaccid than those killed with hot water but was nevertheless firm. After conditioning, the color was dark brown with some reddish cast and the oiliness had subsided. The aroma was strong, flowery, very agreeable, and fully developed. Of all the treatments, only this one resulted in vanillin crystals being formed on the surface of the beans. It was also noted that the samples were completely cured in about

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2 months of conditioning. Those scratched the entire length of the bean had woody stem ends, but those scratched to 2 cm. from the stem end did not.

The combination treatments consisting of a hot-water kill followed by scratching, as well as that consisting of scratching followed by a hot-water kill, resulted in a product similar to that of hot-water kill alone. However, the vanilla aroma was not so strong in the scratched beans, and plugs of resin formed in the scratches which lent a fermented aroma to the beans.

The samples killed by freezing were characterized by a reddish-brown color and a very flaccid texture that persisted throughout the curing process. During sweating the beans were slightly oily, but this had subsided by the time conditioning was over. The product was smooth and of sweet, suave aroma with less vanilla character than those killed by the hot-water or scratching process.

The combination treatments, hot water-freeze, freeze-hot water, scratch-freeze, and freeze-scratch, resulted in a product like that of frozen beans except that the aroma was a little stronger in the double-treated samples. The color was reddish brown and the aroma sweet, similar to beans killed by freezing. Of the combinations the scratch-freeze process resulted in the strongest vanilla aroma.

According to the foregoing observations on aroma the three single-killing processes ranked as follows: First, scratching; second, hot water; third, freezing. The scratching method was best when the scratch was not carried all the way to the stem end; woody stem ends were thus avoided. None of the combination procedures were outstanding improvements over the single methods. However, the freezing method was improved to some extent when it was preceded by a scratching or a hot-water kill.

Extracts were prepared from vanilla beans killed by different methods, and the vanillin analyses on a dry-weight basis gave the following results: Hot-water killing method, 2.80 percent; scratched, 3.30; frozen, 2.86; hot water, scratched, 2.85; scratched, hot water, 2.86; hot water, frozen, 3.00; frozen, hot water, 2.66; scratched, frozen, 2.86; and frozen scratched, 1.93 percent.

Scratching the beans resulted in the highest vanillin content and it was previously noted that the product appeared to be superior. However, organoleptic tests made with ice cream prepared from the extracts indicated that the extract made from beans killed by hot water scored best and those killed by freezing scored second. The difference between the two was not significant. Both were superior by high significance to the extract of beans killed by scratching. The latter was significantly superior to the blank. In appearance, the scratched beans seemed to be superior because of the rapid rate of curing, vanillin crystallization, high vanillin content, and good aroma. However, according to the organoleptic ice cream test, which is a more objective criterion, the beans killed by hot water and freezing were superior. This indicates again that the appearance criteria are not necessarily related to final quality.
EXPERIMENTAL CURING METHODS
WHOLE, CUT, AND GROUND BEANS

In the following work the above criterion of vanilla quality was used in some cases in conjunction with the ordinary tests. The curing of vanilla using whole, cut, and ground beans has been the subject of extensive investigation at this station. A previous report \(^4\) presented the results obtained in experimental curing procedures as well as in biochemical studies of the enzymatic processes involved in curing.\(^5\) These experiments emphasized the importance of oxidative changes that occur during curing. It was found that the principal oxidizing reactions of the vanilla enzyme system were brought about by an oxidase. That this oxidase could also oxidize vanillin and other phenols has been determined. Thus it becomes of interest to study the role of oxygen in the process. The present experiment was designed primarily to show the effects of aeration on the bean tissue during curing. A second objective was to determine whether such a method could be used to simplify the curing methods commonly used.

Duplicate 200-gm. samples of fresh beans, harvested when the blossom end became yellow, were used in four different degrees of fineness: (1) Whole, (2) 1-cm. slices, (3) ground through a food chopper, and (4) ground with a pestle with sand in a mortar. The main difference between treatments (3) and (4) was that, in the former, few cells would be ruptured while in the latter most cells would be broken. The samples were then oven-killed at 60° C. for 24 hours, sweated until the whole beans were flexible, dried to 28.6 percent of the fresh weight, and conditioned in closed jars at room temperature.

The whole beans became dark brown, oily, and developed a suave, flowery vanilla aroma. The beans cut to 1-cm. slices became dark brown and shiny, but showed a green undeveloped character which, during conditioning, turned to a prunelike aroma; vanilla aroma was weak. Samples ground in the food chopper turned brown on top where exposed to air, but became dark brown throughout only after mixing. The aroma was like that of the cut beans except that the prunelike note was even stronger; in fact, it was so strong that no vanilla aroma could be detected. Beans crushed in the mortar also turned brown on top where exposed to air and had to be mixed to obtain a uniformly dark brown mass. While drying, a slight vanilla aroma developed, somewhat like that of the controls but not so strong.

Extracts were prepared from these samples for vanillin analysis and organoleptic tests. It was found that beans cured whole contained 3.45 percent of vanillin, those cut to 1-cm. slices 3.21 percent, those ground in the food chopper 3.65 percent, and those ground with sand 3.79 percent. Apparently the sliced beans lost some vanillin, probably by sublimation, while the ground beans had even more vanillin than the controls because of the intimate contact brought about between the glucovanillin and the hydrolyzing enzyme and because

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\(^5\) See second paper of this series in the Journal of Agricultural Research, vol. 78, No. 11, for further results in enzyme studies. 

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of the decreased exposure during which vanillin could sublime. Organoleptic tests made with ice cream showed no differences among the products of these four treatments.

After organoleptic examination of these extracts, Mr. Rosenbaum made the following comments: The extract of the beans cured whole, No. 5, had "a full bodied aroma, a rich Mexican type characteristic well rounded. The best of No. 5 to 10." The extract of the beans cured in slices, No. 6, was "clean and fairly well rounded; more flowery than No. 5, and somewhat lighter in depth and character." The extract of the beans passed through a food chopper, No. 7, was "well rounded with a full-bodied aroma that was close to No. 5 in all characteristics, but seemed to be slightly less full than No. 5." The extract of the beans crushed with sand, No. 8, was "more insipid than Nos. 5, 6, and 7; slightly flowery in character. Lacks well rounded body. Similar to No. 6 generally, but apparently not as well developed." He regarded the products from whole beans and from beans ground in a food chopper as the best.

It is concluded from this experiment that excessive aeration such as that obtained with cut or coarsely ground beans resulted in excess oxidation and a consequent development of a prunelike note in the aroma. Because of the simplicity of curing chopped vanilla these processes appear promising. In spite of the differences in vanillin content, aroma, and color, it is interesting to note that little difference in the flavor of the extracts could be demonstrated.

CURING THE SEPARATE PARTS OF THE FRUIT

Two-hundred-gram samples of beans were sectioned longitudinally to give one sample of the pod wall, or fleshy part of the bean, and another sample consisting of the central seed portion with placental tissue. On curing, the seed and placental tissue turned brown but developed no aromatic character. The pod wall without central seed portion and placental tissue turned brown and developed a strong sweet aroma with some vanilla character during the sweating and drying period. These samples were especially oily inside where the seeds had been removed. The oil became sticky and finally hardened to a resinous film. During conditioning a fermented acid note became noticeable, but vanilla aroma was still present. After conditioning, the vanilla character predominated; however, this character was incomplete as compared to whole cured beans.

Extracts were prepared from these samples for vanillin analysis and organoleptic tests. The seed and placental tissue contained 2 percent vanillin, dry basis, but when the tissue was incubated with emulsin the percentage increased to 2.74, indicating that unhydrolyzed glucovanillin was present. The cured outer wall contained 4.03 percent of vanillin. From the fresh and final weights and the vanillin and moisture contents it was calculated that the outer portion constituted 64.7 percent of the dry matter of the beans and contained 72.8 percent of the vanillin. The remainder in the seed and placental tissue was 35.3 percent of the dry matter and 27.2 percent of vanillin.

Concerning these extracts Mr. Rosenbaum said: The extract of the seed and placental portion has "a very heavy character with a strong
flowery note and a distinct Mexican end aroma. A well rounded extract.” The extract of the outer portion has “a fatty odor seemingly somewhat scorched in character. Almost lacking in sweet note but has a heavy Mexican type end product. Not well rounded at all.” The extract of whole beans from this same lot was considered to have a “full bodied aroma with a rich Mexican type characteristic; well rounded; best” of samples submitted.

CONDITIONING TEMPERATURES

Previous experimental work in vanilla curing has involved different methods of killing, sweating, and drying but no attention has been given to the final stage, conditioning. It is recognized that considerable change takes place during the initial stages of curing but the principal development of aroma occurs during conditioning. It is therefore of interest to condition the product in different ways to determine whether the final product is affected. One variable that is readily changed is the temperature at which conditioning is carried out. In commercial curing, if warm temperature were desired, conditioning could be done in a loft or a sun-heated shed. If cool temperature were desired, conditioning could be carried out in a basement or a similar cool place.

To determine the effect of temperature during the conditioning stage, two trials were made. In the first trial three lots of 250 gm. each of blossom-end-yellow beans were cured as follows: The beans were frozen solid overnight at $-10\degree$ C, thawed and dipped in hot water ($80\degree$) for three 10-second periods at 30-second intervals. After sweating and drying to 30 percent of the fresh weight, conditioning was carried out in closed cans at three temperatures, $13\degree$, $27\degree$, and $35\degree$. Weekly examinations were made to observe weights, aroma, color, vanillin crystallization, and mold development.

During the curing process no mold developed on any of the samples and no differences in color appeared among the treatments. Within 1 month after the beginning of the conditioning period, the beans at $35\degree$ C. had developed a slight aroma. Subsequently the aroma of these warm-conditioned beans developed more fully and had a pungent note characteristic of Mexican vanilla. Those kept at room temperature were characterized by a more flowery aroma typical of Puerto Rican vanilla and eventually the aroma was more developed than was the case with those conditioned at $13\degree$. However, the cold-conditioned beans had a sweet odor early in the experiment before either of the other groups developed a definite aroma.

Vanillin crystals appeared after 6 months’ conditioning on the beans kept at low temperature. Those at room temperature had crystals within 10 days, but those conditioned in the oven produced no crystals.

Samples for tasting were taken 6 months after conditioning was started. In all samples the seeds were tasteless and sandy. Those kept at the lowest temperature had the most pleasant aroma but, as the conditioning temperature increased, the aroma was stronger. The outer wall of those kept at $35\degree$ C. was bitter and aromatic and had a taste similar to that of chewing tobacco.
After 7½ months of conditioning, moisture determination showed that beans kept at low temperature contained 27.9 percent of moisture, those kept at room temperature 21.9, and those in the oven 15.8 percent. Vanillin analysis by the method used by the Association of Official Agricultural Chemists showed that on the dry basis all the samples contained about 3.5 percent vanillin.

Ice cream samples were made with the extracts from the lots of vanilla beans that had been conditioned at the three different temperatures. The samples from the beans conditioned in the oven had the most superior flavor, those stored in room temperature the second best flavor, and those stored in the refrigerator the least desirable flavor.

In a second trial beans treated according to the following procedure were used. The samples were killed by immersing them three times in hot water at 80° C. for 10 seconds at 30-second intervals. Following this the beans were kept in blankets for 1 day and then oven-sweated in blankets at 45° until flexible. After drying at room temperature to 28.6 percent of the freight weight, the beans were conditioned in sealed cans using four different temperatures: 45°, 35°, 27°, and 13°. After conditioning for 6 months it was found that those conditioned at 45° had the strongest vanilla aroma accompanied by a sweet prunelike note. The beans conditioned at 35° were not so strong but were more suave. Those kept at 27° and 13° were comparatively poor. Apparently high-temperature conditioning brought out background fixative qualities not so noticeable in the ordinary cured material. It is also important to note that the beans at 45° were completely cured after about 3 months of conditioning.

Extracts were prepared from these samples and when they were filtered through paper to remove fine solids it was noted that the higher the temperature at which the vanilla was conditioned the more rapid was the filtration. This indicated that more fine solids were suspended in the extracts of the beans conditioned at lower temperatures.

Mr. Rosenbaum said concerning these samples conditioned at 13° C., “No. 1 has a typically Puerto Rican light, flowery bouquet that is somewhat insipid all the way down. It has only a light flavor body that owes much of its character to vanillin. The deeper tones are almost lacking.” Of those conditioned at 27°, he said: “No. 2, not quite as sweet and flowery as No. 1, but possesses more body, and a slightly better rounded character. Both No. 1 and 2 are lighter in body and depth than No. 3 and 4.” Of the third sample, conditioned at 35°, he said: “No. 3 has a rich, winey character backed by the lighter fruity and flowery fractions. Much heavier and better rounded character. Both No. 1 and 2, having a different shading which is closer to No. 4 in type. Some Mexican character.” And he described those conditioned at 45° as follows: “No 4 slightly leathery odor indicative of higher fat content. Similar in character to No. 3 with rich, sweet body, and yet a note of the Puerto Rican character. Apparently heavier in end bouquet than any of the others, with a rich Mexican character.”

Mr. Rosenbaum summed up his conclusions for all four tests as follows: “No. 1 and 2 are inferior to No. 3 and 4, with No. 1 a shade less desirable than No. 2. No. 3 and 4 are closer together in character,
with No. 3 being my first choice as the best of the lot, but a second examination changed my choice to No. 4 as the best rounded because of its heavier end bouquet."

Vanillin contents were 2.07 percent for the beans conditioned at 45° C., 2.21 percent for those at 35°, 2.55 percent for those at 27°, and 2.73 for those at 13°. The corresponding moisture contents were 14.1, 18.3, 20.5, and 18.5. Organoleptic tests of the extracts in ice cream showed that the extract from beans conditioned at 45° was superior by high significance to the others. Likewise, the extract from beans conditioned at 35° was significantly superior to those from beans conditioned at room and at refrigerator temperatures. Of the latter two, the extract from room-temperature-conditioned beans scored higher than that from cold-conditioned beans, but the difference was not significant.

It is concluded that conditioning at 45° C. was best, but that the beans should not be too dry at the beginning of conditioning. If the beans were dried to one-third of their fresh weight and then conditioned in closed containers at 45°, the product would not be so dry and the conditioning process would be complete in about 3 months.

RECOMMENDED CURING PROCEDURE

On the basis of the experimental work of the authors, the following curing procedure for whole beans is recommended:

1. As soon as possible after harvest, wipe the beans with a damp cloth and kill by immersing them three times for 10 seconds in hot water (80° C.) at 30-second intervals.
2. Sweat in sun in blankets, or in a closed oven at 45° C. containing a pan of water.
3. Dry at room temperature to one-third of the original fresh weight.
4. Tie beans in bundles, wrap the bundles in heavy paper or seal in jars or cans, and condition at 45° C. for 2 to 3 months until the batch has dried to one-fourth of the original fresh weight.
5. Remove cured product and allow to air for 2 days.
6. Wrap and pack for shipment.

SUMMARY

The criteria by which cured vanilla is judged were considered. It is concluded that, since no purely objective methods are available, the best procedure is to apply a subjective method, the results of which can be treated statistically to yield a valid measure of goodness. An organoleptic test well suited for this purpose is described. The test is made with ice cream containing the vanilla extract.

The effect of several killing methods on quality of the cured product was determined. The hot-water kill gave the best product, with freezing second, and scratching third. However, the latter had the highest vanillin content.

Beans cured whole, cut, and ground yielded extracts that were not greatly different in flavoring properties. The cut beans had a prune-like aroma but yielded a satisfactory extract. The ground beans were highest in vanillin.
Curing the pod separate from the seed and placental tissue showed that the pod portion accounted for the main part of the flavor of the bean.

Vanilla conditioned at 45° C. was superior to that conditioned at 35° which, in turn, was superior to the product stored at 27° or 13°.

These experiments show that vanilla-curing methods may be modified in two important respects: (1) Beans may be cut or ground before curing, thus simplifying the handling processes, and (2) conditioning may be carried out at 33°–45° C. to yield a superior product.