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RELATION OF MOISTURE CONTENT TO QUALITY OF VANILLA BEANS

by

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INTROLUCTION

Vanilla beans undergo during curing a series of chemical transformations which lead to the formation of flavoring compounds. (*1, 3*). Curing consists usually (*5, 6, pp. 84-117, 7*) of an initial killing or wilting treatment which arrests the natural vegetative processes and hastens chemical changes. After this treatment, the beans are usually subjected to heating and subsequent sweating in blankets or else continuous heating. The process is completed by further partial drying at room temperature and finally aging or conditioning in wooden boxes.

Curing is accompanied by a loss of moisture which starts during sweating and continues throughout the drying and conditioning periods. The moisture left in the beans influences their appearance and flexibility. A relatively high percentage of moisture is desirable and produces higher returns as the beans are sold by weight. It is of importance, therefore, that the curer of vanilla controls moisture losses during curing.

Figure 1 shows some of the visible differences between freshly harvested and cured beans of *Vanilla fragrans* (Salisb.) Ames, the vanilla of commerce.

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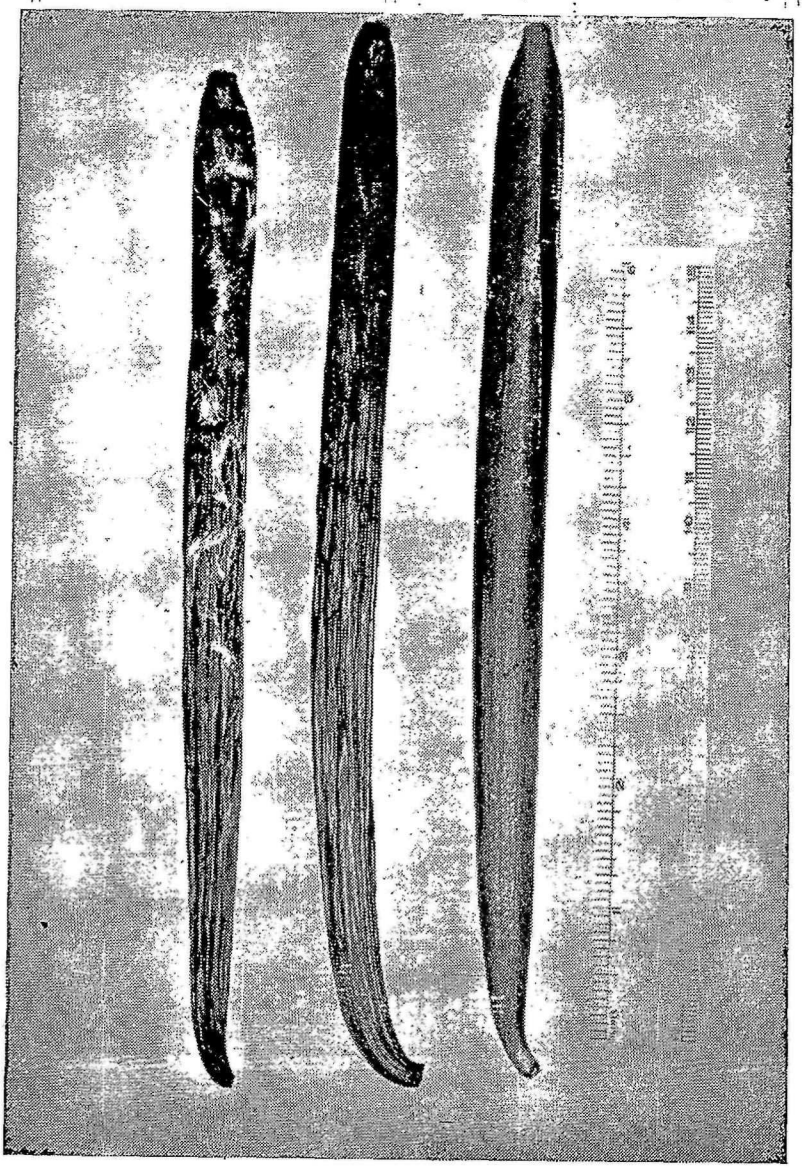

Figure 1. Vanilla beans; one at left, freshly harvested and two at right, cured. The white marks on the surface of the cured bean at the extreme right are crystals of vanillin, the most widely known of the aromatic constituents of vanilla.

Moisture Content of Uncured Beans

Maturation is indicated in uncured vanilla beans by the development of a yellow coloration at the blossom-end. As ripening increases, this coloration spreads along the entire bean and is often accompanied by longitudinal splitting. Fully mature beans finally acquire a chocolate color.

Analyses were made to determine variations in moisture content of beans of different maturities. Beans 6.5 to 7.5 inches in length, harvested about 5 days previously, were graded according to maturity as whole beans, entirely green; whole, blossom-end yellow; split, blossom-end yellow; and split, entirely chocolate. From each grade of beans three random samples were selected. Moisture determinations were made by vacuum oven-drying at 68° to 70° C. at 100 mm. pressure. (*2. p. 336*)

Whole beans, entirely green were found to have an average moisture content of 81.2 percent, whole beans with blossom-ends yellow 79.2; split beans with blossom-ends yellow 79.0, and split beans all chocolate 73.5. The moisture content of split beans varies to a large degree with the extent and time of splitting. The percentage of moisture in the beans thus decreased with maturity.

Losses in Weight During Curing

A study was made of vanilla beans subjected to different killing treatments to determine whether a significant weight loss other than that due to loss of water occurs during the chemical transformations which take place during curing.

The beans used were 6.5 to 7.5 inches long and were at different stages of maturity. The treatments consisted of freezing for 4 and 20-hour periods, three 10-second immersions at 30-second intervals in water heated to 80° C., exposure to ethylene gas for different periods at a concentration of 1 part to 10,000 parts of air, rubbing with alcohol, exposure to the sun, and placing in an oven at 65° C. These treatments, which were applied singly and in combination, were followed by sweating in an oven or in the sun, further drying on racks at room temperature to the desired loss in weight, and conditioning in closed wooden boxes for 3 months. The loss in weight of the beans during curing was recorded and the amount of moisture in the final, cured beans was determined. The results classified according to maturities and the killing treatments used, are shown in table 1.

Table 1. Loss in weight and moisture content of vanilla beans of five stages of maturity during curing after various killing treatments (1)

Killing treatment	*Total loss in weight during curing*	*Moisture content of cured beans*	*Loss in weight during curing plus moisture left in cured beans (2)*
	PERCENT	PERCENT	PERCENT
WHOLE BEANS, BLOSSOM-END GREEN			
Frozen for 4 hours	74.2	26.6	81.1
Frozen for 20 hours	72.7	28.8	80.6
Frozen for 4 hours; hot water	72.8	26.8	80.1
Hot water; frozen for 4 hours	72.5	26.5	79.8
Hot water	75.6	20.4	80.6
Rubbed with alcohol; hot water	72.2	26.9	79.7
Ethylene gas for 4 14-hour periods	76.0	20.3	80.9
Ethylene gas for 14 hours	75.1	19.8	80.0
WHOLE BEANS, BLOSSOM-END YELLOW			
Frozen for 4 hours	72.9	27.9	80.5
Frozen for 20 hours	70.2	27.8	79.0
Frozen for 4 hours; hot water	72.3	26.1	79.5
Hot water; frozen for 4 hours	72.1	28.5	80.1
Hot water	75.6	20.7	80.7
Rubbed with alcohol; hot water	71.4	26.7	79.0
Ethylene gas for 4 14-hours periods	74.9	21.3	80.3
Ethylene gas for 14 hours	74.1	20.1	80.0
SPLIT BEANS, BLOSSOM-END YELLOW			
Ethylene gas for 4 14-hour periods	73.4	20.8	78.9
Ethylene gas for 14 hours	73.6	21.1	79.2
SPLIT BEANS, BLOSSOM-END CHOCOLATE			
Hot water	70.2	20.6	76.3
Ethylene gas for 4 14-hour periods	73.7	20.4	79.1
Ethylene gas for 14 hours	71.4	21.7	77.6
SPLIT BEANS, ALL CHOCOLATE			
Sun	68.8	19.6	74.9
Oven at 65° C.	69.4	19.8	75.5

(1) Three- to 4-pound lots of beans were used in each treatment, except in split beans, all chocolate, in which 2-pound lots were used.

(2) Calculated by adding the total loss in weight during curing to the water present in the remaining percent weight of cured beans. These figures represent approximately the average moisture content of these types of uncured beans. Thus weight loss in curing, other than that due to loss of water, was negligible.

It can be observed in table 1 that regardless of the killing treatment and the final moisture content of the cured beans, the total loss in weight during curing plus the water present in the cured product was from 79.7 to 81.1 percent of the original weight for whole green beans, and from 79.0 to 80.7 percent of the original weight for blossom-end-ye low beans. These figures represent approximately the average moisture content of these types of uncured beans, as stated previously. In the blossom-end chocolate split beans the values for the losses in weight during curing plus the moisture of the cured beans showed greater variation. However, this is to be expected inasmuch as the extent of splitting and the degree of maturation of these types cause appreciable variations in the moisture content. Therefore, it can be concluded that weight loss, other than that due to loss of water, was negligible.

Loss in Weight During Conditioning

Moisture losses in curing vanilla occur principally during the sweating and drying treatments. Weight losses also occur during the conditioning or

Table 2. Losses in weight on a fresh basis in vanilla beans during the conditioning period (1)

At the end of drying	*During the first 3-month period of conditioning (2)*	*During the second 3-month period of conditioning (2)*
Percent	Percent	Percent
75.8	— 0.2	— 0.2
75.3	.2	.1
72.3	.8	— .3
72.2	1.7	.3
72.1	.1	.0
71.2	1.2	.1
70.9	2.0	— .4
70.5	3.1	.6
70.4	2.3	— .4
70.3	2.5	.4
70.0	1.7	.6
69.8	2.7	— .2
69.8	1.9	.3
69.4	3.5	.6
69.4	2.0	.3
69.3	1.8	.3
68.9	2.9	.9
67.8	4.5	1.1
66.6	3.4	.9
63.3	6.7	1.0
62.0	5.9	1.3

(1) Three-pound lots of whole beans with blossom-end either green or yellow were used.
(2) A negative loss of weight signifies an actual gain.

final phase of the processing during which vanillin crystallizes on the surface of the beans and the characteristic vanilla aroma gradually develops.

The moisture losses during the conditioning treatment in 21 3-pound lots of beans were determined. These samples had lost from 62.0 to 75.8 percent of their weight at the end of the drying period. The beans were weighed before being placed in the conditioning boxes and at the end of 3 and 6 months. The data are listed in table 2.

As shown in table 2, there was an appreciable loss in weight in most of the lots during the first 3 months of conditioning, ranging from a gain of 0.2 to a loss of 6.7 percent. The loss in weight was negligible, however, during the last 3 months not reaching in any case more than 1.3 percent. It is apparent that moisture content approached an aquilibrium during conditioning and that the loss in weight during this period was generally greatest in the beans containing the most moisture.

Nomograph for Moisture Calculations

A nomograph is given in Figure 2 showing the weights to which 100-pound lots of beans of different moisture contents should be reduced during curing to obtain a predetermined moisture content in the end-product.

Example: To cure100 pounds of green beans to a desired final moisture of 30 percent, assuming or knowing 80 percent moisture content of fresh beans, run a straight line from point 80 on left axis to point 30 on right inclined axis. Read off on center axis final weight of beans after curing, including conditioning. To obtain the weight to which the beans should be dried before conditioning, the loss during conditioning should be added to that obtained from the chart. The loss during conditioning depends principally upon the moisture content of the beans at the beginning of conditioning, the number and length of times the beans are examined, and the amount of wiping to remove molds. However, for approximate purposes, the following losses may be assumed: For30-40 percent final moisture in the cured product, 4-7 pounds of 100 pounds fresh and for 20 to 30 percent moisture, 1-3 pounds.

Evaluation of Cured Beans with Different Moisture Contents

An experiment was conducted to determine the variation in physical characteristics, phenol value including vanillin (4), and aroma of vanilla beans cured by different procedures to varying moisture contents. Data are shown in table 3.

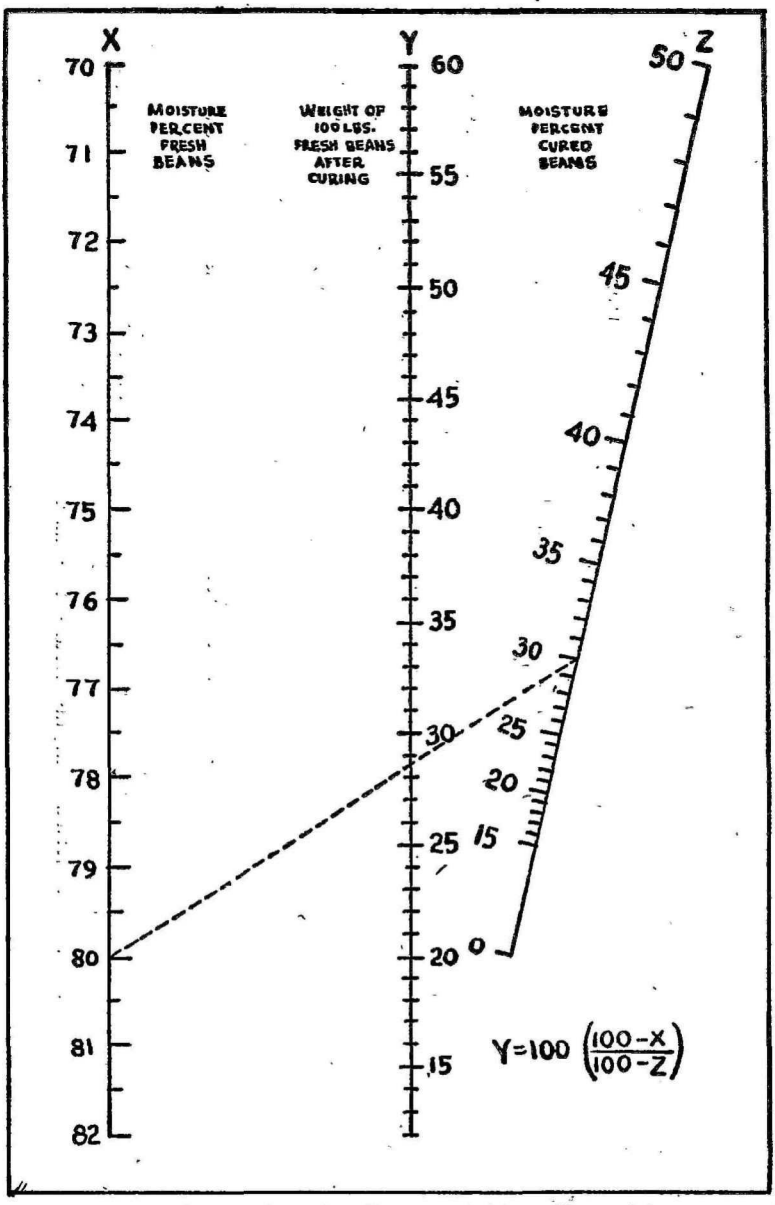

Figure 2. Nomograph relating the three variables: X=moisture content of fresh vanilla beans in percent fresh basis, Y=weight to which each 100 lbs. should be reduced during curing, and Z=moisture content of cured beans in percent cured weight basis. See example given in the text.

Table 3 Evaluation of vanilla beans cured to different moisture contents (1)

Killing treatment (2)	*Final moisture content*	*Chocolate color*	*Degree of flexibility*	*Vanillin crystals*	*Mold development* (3)	*Phenol value dry basis*	*Aroma*
	PERCENT				PERCENT	PERCENT	
Hot water	26.5	Dark	Medium	Few	0.0	6.3	Developed, suave
Hot water	30.7	Dark	Very	None	0.0	6.3	Developed, not suave
Hot water	49.9	Light	Very	None	0.0	6.4	Crude, slightly fermented, not suave
Freezing	26.2	Reddish	Very	Some	0.0	6.8	More developed, suave
Freezing	32.6	Reddish	Very	None	0.0	6.7	Developed, very suave
Freezing	50.5	Light	Very	None	0.0	6.9	Developed, slightly fermented, suave
Sun	26.5	Dark	Medium	None	0.0	6.7	More developed, suave
Sun	30.9	Light	Very	None	4.0	6.3	Developed, suave
Sun	53.0	Light	Very	None	7.0	6.9	More developed, slightly fermented, not suave
Ethylene	24.2	Dark	Little	Few	0.0	7.3	More developed, suave
Ethylene	33.6	Light	Medium	Few	3.0	7.5	More developed, suave
Ethylene	54.3	Light	Very	None	3.0	6.9	Developed, slightly fermented, not suave

(1) Beans killed by hot water and freezing were obtained from the same batch and beans killed by sun and ethylene from another batch.

(2) Beans killed by hot water, freezing and ethylene were oven-sweated and beans killed in the sun were also sun-sweated. All the lots were then dried further at room temperature to the desired loss in weight and conditioned for 3 months.

(3) Beans examined for mold at periods varying from 4 to 9 days.

As can be observed in table 3, the moisture content of the beans affected the physical appearance and aroma of the beans in each of the different curing treatments but did not produce any significant effect in the phenol value.

In all treatments, beans with moisture contents varying from 50 to 54 percent, had a fermented aroma generally lacking suavity and development. Beans containing 24 to 27 percent moisture had a more developed and suave aroma but little flexibility while beans with 31 to 34 percent moisture had a well developed and suave aroma and also possessed a high degree of flexibility.

Beans with lower moisture content were generally darker in color and as expected their vanillin crystallization was greater except in the sun-cured beans in which no crystals appeared. The beans killed by freezing were characterized by great flexibility even when their moisture content was low and had a reddish color.

No appreciable molding occurred in any of the treatments when the beans contained 24.2 to 26.5 percent moisture nor in the beans subjected to hot water or freezing having 30.7 to 50.5 percent moisture. Beans subjected to the ethylene and sun-killing procedures developed more mold than did those subjected to hot water or freezing. This may be due to the fact that in the former procedures the beans were not as thoroughly and uniformly killed. The effectiveness of the killing treatment is usually evidenced by a change in coloration which takes place in the beans during the sweating period or exposure to heat. The beans killed in hot water and by freezing became dark brown in color after a shorter period of sweating in electric ovens at 45°C., than the ethylene and sun-treated beans. Moreover, freezing and hot water treatment may have a sterilizing effect in the beans.

Moisture Content of Foreign Beans

Moisture contents were determined of several samples of beans from Mexico, Comores, Tahiti, Madagascar, and Guadeloupe, which are among the most important vanilla-producing countries of the world. Results are shown in table 4.

Table 4. Moisture content of cured vanilla beans from different countries

Source	*Moisture content*
	PERCENT
Mexico	40.3
Mexico (1)	38.3
Comores	35.4
Tahiti	37.5
Tahiti (1)	33.4
Madagascar	31.3
Guadeloupe (1)	17.8
Guadeloupe	15.2

(1) The moisture contents of these beans were determined several months after receipt.

As can be seen in table 4, the moisture content was over 30 percent in the beans of all the countries except those of Guadeloupe.

SUMMARY

The moisture content of uncured vanilla beans was found to decrease with maturity. The average value obtained for whole beans entirely green was 81.2 percent and for whole, blossom-end yellow 79.2 percent. The moisture of split beans varied to a large degree with the extent and time of splitting.

Losses in weight in vanilla beans, other than those due to loss of moisture, were shown to be negligible during the curing process, regardless of the procedure used.

Although the greatest loss in weight in the beans occurred during the sweating and drying periods, a significant loss in weight also occurred during the first 3 months of the conditioning period. Moisture losses during conditioning were greater for beans of higher moisture content.

A nomograph is included showing the weights to which 100-pound lots of beans of different moisture contents should be reduced during curing to obtain a known moisture content in the end-product.

Moisture content was found to affect the appearance and aroma of the beans but did not produce any effect in the phenol value. Beans cured by different procedures with a moisture content of over 50 percent had a fermented aroma generally lacking suavity and development. Beans with 24 to 27 percent moisture had a more developed and suave aroma but little flexibility while those with 31 to 34 percent had well-developed and suave aroma and good flexibility. Beans with similar moisture content, sub-

jected to hot-water or freezing treatments were found to be less liable to mold infection than sun or ethylene-treated beans.

Commercial lots of vanilla beans from Mexico, Madagascar, Comores, and Tahiti were found to contain over 30 percent moisture.

Puerto Rican vanilla beans should be cured to a final moisture content of 30 to 35 percent if good flexibility and development and suavity of aroma, which are the principal factors affecting the sales value are to be obtained, judging from the results of our experiments.

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