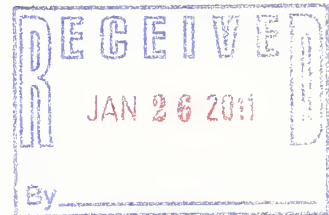


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QUALITY IN MANGOS

by

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QUALITY IN MANGOS 1/

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The mango (Mangifera indica Linn.) is one of the most interesting of all fruits. Most of the cultivated varieties in Florida produce attractive fruit with delicate shades of coloring ranging from green to bright red. The popular kinds are notable for their appealing aromatic flavor and fine eating quality. The flesh is usually deep apricot yellow, very juicy, and practically fiberless. To some people who know and like all mangos, even the small, fibrous, and so-called turpentine types are acceptable.

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The mango is sensitive to cold and other climatic conditions. Its commercial cultivation in the United States is largely confined to South Florida and to Dade County in particular. Desirable land on which to grow mangos is expensive, and maintenance of a grove up to bearing is costly. This specialty crop, therefore, must sell at fairly high prices.

Research has not kept pace with production and marketing and consequently there are no clear-cut facts on which maturity standards for a marketing agreement can be based. This study was started at the request of the Florida Mango Forum and was especially designed to determine the changes in physical characteristics and chemical constituents of mangos during maturing and ripening.

HISTORICAL

The mango is one of the oldest tropical fruits. Mukherjee (5) points out that it has been cultivated by man for over 4,000 years. He states that the "mango had an important place in horticulture during the rule of Mohammedan emperors in India. They promoted the practice of planting the best varieties available in big orchards. Akbar, the Moghul emperor who reigned in India from 1556 to 1605, planted near Darbhanga the Lakh Bagh, an orchard of 100,000 mango trees." Mukherjee mentions that a survey made by the India Council of Agricultural Research indicated that the total area in mangos in India in 1945 was about 2,200,000 acres. These data point up the importance of the mango as a food crop in India. The extent of cultivation in Florida is not very impressive by comparison. However, according to Ledin (4) there is in Florida a total of some 323,520 mango trees; of these, approximately 56 percent are in commercial plantings. If there were 40 to 50 trees to the acre, the total acreage of mangos in Florida would be between 6,000 and 8,000 acres. Areas that produce mangos in quantity besides India and the United States are Indonesia, Indochina, Philippines, South and Central American countries, Mexico, West Indies, South Africa, Egypt, and Israel.

MATERIAL AND METHODS

The fruit used in this study was grown in Dade County, Fla., and the tests were conducted at the U. S. Horticultural Field Station in Orlando, and at the University of Florida Sub-Tropical Experiment Station in Homestead. The fruit for the test at Orlando was shipped via Railway Express Agency with a transit period of about two days. Specific gravity was determined on each mango before and after shipment and again after ripening. A portion of the sample was retained at Homestead for ripening and observation. These principal varieties of mango were studied: Haden, Irwin, Zill, Lippens, Kent, Keitt, Sensation, and Brooks.

The samples were composed of 45 to 60 fruits of each variety. Each variety was tested over a fairly long period by sampling at intervals of 7 to 10 days. The entire period covered in the investigation was June 2 to August 23, 1954.

On arrival at Orlando, each large sample was divided into smaller subsamples of 10 to 15 fruits each. Analyses were made immediately on one of the hard, unripe subsamples. Other analyses were made on comparable subsamples of fruit after ripening at 80°, 55°, and 50° F. respectively. During the process of fruit ripening, daily inspection was made. Each mango was handled as a test fruit. On attaining the desired degree of softness it was removed from the controlled temperature room and placed at 32° F. Analyses were made only after all the fruit in the subsample had ripened. The determinations on the fruit included loss in weight during ripening, number of days required to ripen, specific gravity, firmness of flesh under pressure test, flavor, total soluble solids, total acid (as citric), ratio of total soluble solids to total acid, pH, and ascorbic acid.

The flavor of mangos was rated by a taste test. Unpalatable fruit was rated 60 to 69, fair 70 to 79, good 80 to 89 and very good 90 to 100. The minimum for consumer approval was set at 70. Each sample was rated on its own merit and no attempt was made to compare quality among varieties. Official methods were

used in the determination of the various chemical constituents.

DISCUSSION OF RESULTS

The findings presented herein are for one season only and consequently should be regarded as tentative. This paper deals only with fruit ripened at 80° F. The results for fruit ripened at 50° and 55° F. will be reported later.

It should be noted that the first samples of each variety were picked while the fruit was supposedly immature as determined by the number of days from bloom and color break. Results presented herein show, however, that all of the fruit ripened to satisfactory quality at 80° F.

Weight of Fruit

General findings showed a comparatively small range in original weight among individual fruit within a variety. There was, however, a wide variation in average weight among varieties. In Table 1, it will be observed that Keitt fruit was largest, with an average weight of 612 grams, and Zill smallest, 319 grams. Kent and Haden could be classed with Keitt as large-fruited, Brooks and Irwin as intermediate, and Sensation and Lippens with Zill as small. Changes in weight during ripening at 80° F. were substantial in some cases. Three of the early-maturing varieties, Irwin, Zill and Lippens, lost 4 to 5 percent of original weight and Haden lost 8 percent. Late varieties, Kent, Keitt, Sensation, and Brooks, decreased 3 to 5 percent in weight. Fruit picked late in the season tended to lose less weight than that picked early.

Days Required for Ripening

There was a marked degree of uniformity among fruit of a given variety in number of days required for ripening at 80° F. The ripening period for the 5 pickings of Haden varied from 6 to 15 days while those of the other varieties ranged from 4 to 11 days. As shown in Table 1, Haden required an average of 10 days at 80° F., and the others 6 to 8 days. There was apparently little relation between number of days required for ripening.

Table 1. Changes in physical characters of mangoes during ripening at 80° F.

[Each value is the mean of 4 to 6 lots of 10 to 15 fruits each.]

Variety 1/	Lots tested	Weight of hard fruit		Loss in weight during ripening	Ripening period	Specific gravity		Pressure-test reading	
		Grams	Percent			Hard fruit	Ripe fruit	Hard fruit 2/	Ripe fruit 3/
	Number				Days				Pounds
Haden	5	427	8	8	10	1.014	1.001	15	4
Irwin	4	356	4	4	8	.990	.999	13	4
Zill	4	319	5	5	6	1.021	1.027	12	3
Lippens	4	329	5	5	7	.999	1.009	12	3
Kent	6	567	4	4	6	1.007	1.014	12	3
Keitt	5	612	4	4	7	1.012	1.020	20	3
Sensation	5	330	5	5	8	1.009	1.009	17	4
Brooks	5	393	3	3	6	1.007	1.017	13	3

1/ Tested on arrival at Orlando approximately two days after picking.

2/ Plunger of 3/16-inch diameter.

3/ Plunger of 7/16-inch diameter.

Specific Gravity

The specific gravity of hard fruit varied over a wide range. The averages ranged from 0.990 for Irwin to 1.021 for Zill (Table 1). In one or more lots of Haden, Irwin, Lippens, Sensation, and Brooks the specific gravity was less than unity, while one or more lots of Haden, Zill, Kent, Keitt, Sensation and Brooks had a specific gravity above 1.021. Usually, specific gravity increased gradually over the picking season. The ripe mangos of all varieties except Haden and Sensation showed increases in specific gravity over the unripe fruit. In most instances the increase or decrease during ripening at 80° F. was less than 0.010.

These results are in contrast to data published by Harkness (1, 2, 3) and Ruehle (7) who stated that Haden fruit of specific gravity less than 1.010 were definitely immature and would not ripen properly. The difference in specific gravity of fruit tested the day they were picked and after 2 or 3 days in transit rarely exceeded 0.010 so that the discrepancy in results must be attributed to other causes. On the evidence presented herein, it appears that specific gravity cannot be utilized as one of the criteria to predict either the stage of maturity of unripe fruit or the quality of ripe fruit.

Firmness of Flesh

The firmness of unripe mangos as measured by pressure-test readings varied from one variety to another, but only minor differences existed between different pickings of a given variety. It will be noted in Table 1 that Keitt fruit had an average pressure-test reading of 20 pounds, Sensation 17 pounds, Haden 15 pounds, Irwin and Brooks 13 pounds, and Zill, Lippens and Kent 12 pounds. The hard fruit ripened to essentially the same quality as less firm fruit regardless of size or number of days required for ripening.

On the other hand, ripe fruit showed no important difference in firmness among varieties. The pressure test did prove useful as a means of confirming the uniformity with which soft or ripe fruit could be selected by feel or hand pressure.

Correlation of firmness with quality was good since fruits which were firmer than 5 or 6 pounds or softer than 1 or 2 pounds were inferior in flavor.

Flavor

Although the early pickings of each variety of fruit appeared to be green and immature all the mangos ripened at 80° F. developed fair to very good flavor, and, according to the taste judges, met consumer approval. In Table 1, it will be observed that Kent, Zill, Haden and Keitt were rated as very good (90-100), while Brooks, Lippens, and Irwin were rated good (80-89). Some lots of Sensation and Haden, infected with anthracnose or bruised during transit, were found to be less acceptable and rated lower.

Total Soluble Solids

Total soluble solids increased with the length of time that the fruit remained on the tree. Total soluble solids were consistently lower in the fruit of earlier pickings and gradually increased during the season. The total soluble solids content of hard, unripe mangos usually varied between 7 and 10 percent and averaged 7.87 to 11.52 percent. In some of the later pickings partially ripe fruit of Zill and Sensation were included in the samples with the result that the total soluble solids were markedly increased (Table 2).

Fruit ripened at 80° F. contained appreciably more solids than comparable samples of unripe fruit. In general, the increase amounted to 3 to 8 percent points, indicating a very rapid conversion of insoluble solids. Higher percentages of total soluble solids were found in Brooks, Kent, Zill, Keitt, Sensation, and Haden than in Irwin and Lippens. Total soluble solids were definitely related to fruit quality as ripe fruit having high soluble solids were noticeably sweeter than those with low solids.

Total Acid

The total acid content of mangos decreased with the length of time the fruit was held on the tree. Total acid was comparatively high in fruit of the earlier

Table 2. Changes in chemical constituents of mangoes during ripening at 80° F.

[Each value is the mean of 4 to 6 lots of 10 to 15 fruits each.]

Variety ^{1/}	Lots tested	Total solids		Total soluble		Total acid		Ratio of solids to acid		Active acidity		Ascorbic acid		Flavor rating of ripe fruit								
		Hard fruit	Pct.	Ripe fruit	Pct.	Hard fruit	Pct.	Ripe fruit	Pct.	Hard fruit	Pct.	Ripe fruit	Pct.									
Haden	5	8.60		14.00		0.93		0.09		9:1		156:1		3.3		4.9		53		32		92
Irwin	4	8.09		12.96		.64		.18		13:1		72:1		3.4		4.3		57		52		86
Zill	4	11.15		15.56		.74		.17		15:1		92:1		3.5		4.6		41		15		94
Lippens	4	7.87		12.21		.51		.09		15:1		136:1		3.6		4.6		53		19		88
Kent	6	9.50		16.21		.55		.20		17:1		81:1		3.6		4.3		43		30		95
Kellett	5	8.37		15.56		.67		.16		12:1		97:1		3.4		4.3		66		31		90
Sensation	5	11.52		15.37		.28		.10		41:1		154:1		3.9		4.4		82		47		78
Brooks	5	9.65		16.34		.89		.26		11:1		63:1		3.2		4.0		100		59		88

^{1/} Tested on arrival at Orlando approximately two days after picking.

pickings and gradually decreased during the season. As shown in Table 2, unripe fruit of Haden contained the highest total acid content, 0.93 percent, and Sensation had the lowest, 0.28 percent. Marked changes in total acid occurred during ripening at 80° F. It may be noted in Table 2, that ripe Haden fruit contained only 0.09 percent acid and Brooks 0.26 percent.

Ratio of Total Soluble Solids to Total Acid

The general findings revealed a rather large variation among varieties in solids-to-acid ratios of hard fruit although the range within a variety was usually small. As shown in Table 2, the ratios ranged from 9 to 1 for Haden to 41 to 1 for Sensation. Haden fruit showed relatively low soluble solids and high acid while Sensation contained high soluble solids and low acid.

Ripe fruits presented an unusual situation in that Haden and Sensation, which were previously at opposite extremes, had almost identical ratios. Brooks had the lowest ratio of any variety in spite of its high solids content. Ratios in excess of 200 to 1 were obtained in one lot each of Haden and of Sensation, and below 60 to 1 in one of Keitt, in one of Kent, and in three lots of Brooks. In general, the highest ratios were obtained during the middle portion of the picking season.

pH

Little variation was found in the active acidity, or pH, of hard and ripe fruit. It will be observed in Table 2, that during the ripening of mangoes pH increased about one unit. The lowest pH recorded for hard fruit was 3.2 and the highest 3.9; the range for ripe fruit was 4.0 to 4.9. In general pH increased as the picking season of a variety progressed.

Ascorbic Acid

Hard fruit showed considerable variation in the ascorbic acid (vitamin C) content of different varieties but subsamples within a given variety were remarkably uniform. In general, ascorbic acid decreased very gradually as the

picking season of the variety progressed. It may be noted in Table 2, that late-maturing varieties except Kent contained appreciably more ascorbic acid than the early ones. Most of the varieties showed a decided loss during ripening at 80° F. Brooks and Irwin retained 59 and 52 milligrams ascorbic acid per 100 grams of pulp, respectively, Zill and Lippens 15 and 19 milligrams. These values are higher than those reported by Mustard and Lynch (6) and Stahl (8).

SUMMARY

The principal varieties of mango, Haden, Irwin, Zill, Lippens, Kent, Keitt, Sensation and Brooks, were tested at intervals of 7 to 10 days during their respective picking seasons, June 2 to August 23, 1954. Subsamples of each variety were analyzed before and after ripening at 80° F.

Although fruit in the early pickings of each variety appeared to be green and immature, actual tests showed this fruit to be fair to very good in flavor when properly ripened.

Fruit quality was associated with moderately high percentages of total soluble solids and total acid (as citric) in hard fruits. On the other hand, there seemed to be little connection between maturity or quality in hard and ripe fruit and size, loss in weight, days to ripen, specific gravity, firmness, and ascorbic acid.

Mangos lost an average of 3 to 8 percent of their original weight during the 6 to 10 days required for them to ripen. The specific gravity of hard unripe fruit ranged from 0.990 to 1.021 and that of ripe fruit from .999 to 1.027. The firmness of hard fruit tested 12 to 20 pounds (plunger of 3/16-inch diameter) and of ripe fruit 3 to 4 pounds (plunger of 7/16-inch diameter). Total soluble solids ranged from 7.87 to 11.52 percent, total acid from 0.28 to .93 percent, and solids to acid ratio from 9 to 1 to 41 to 1 in hard unripe fruit. Ripe fruit varied from 12.21 to 16.34 percent total soluble solids, from 0.09 to .26 percent total acid, and from 63 to 1 to 156 to 1 solids to acid ratio. The pH of hard fruit ranged from 3.2 to 3.9 and of ripe fruit from 4.0 to 4.9. Hard fruit contained 41 to 100 milligrams of ascorbic acid per 100 grams pulp and of ripe fruit 15 to 59 milligrams.

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