B Vitamin Content of Avocados

studies reveal California-grown avocados are in superior group of foods as source of pantothenic acid and vitamin B_6

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Three varieties of California-grown avocados—Fuerte, Anaheim, and Hass—of four crop years, were examined for content of most of the B vitamins. The fat and water contents, and the effect of various periods of refrigeration and ripening at room temperatures also were given attention.

Avocados grown in California are of two races of Mexican and Guatemalan origin. The Fuerte—comprising about 80% of the state's avocado crop—is a hybrid of the two races. The Anaheim and the Hass are of the Guatemalan race. The Fuerte ripens from October to June. The Anaheim—the most prominent of the low-oil avocado varieties—ripens from June to September and the Hass—a sturdy variety—ripens from May to October.

The samples analyzed for each crop year were obtained from the same area. Boxes of the fruit were shipped at intervals during the two- to three-month tree ripening periods. All fruits were stored at once in the refrigerator at 39.2°F to 41°F and samples removed at intervals of one to 61 days. The removed samples were kept at room temperature from none to five days to determine the effect of any further ripening. Then fruits were peeled and ground, packed in Pliofilm, and stored at freezer temperature of -50°F until the analyses were completed.

Analyses were carried out on representative samples of each variety, and water and fat determinations were made on most of the individual fruits used for the vitamin assays. The vitamin analyses were done by microbiological and fluorometric methods.

Bioassays which generally yield a higher apparent concentration of vitamins in foods than do the other types of analyses were made to validate the effectiveness of the extraction procedures preceding the chemical or microbiological tests. Comparisons of this type have also been made in prunes, figs, turkey tissues, and walnuts in this laboratory.

Bioassays for thiamine, riboflavin, pantothenic acid, and vitamin B_6 were carried out on Fuerte samples of four different crop years. A vitamin B_6 bioassay was also made on Hass samples. In the thiamine and one of the pantothenic acid biological assays the values were greater—36% thiamine and 40% pantothenic acid—than those obtained by other means. The other bioassay for pantothenic acid and that for vitamin B_6 on the Hass sample yielded excellent agreement with the results of the microbiological analysis, 101% and 109% of the latter values. This was true also of the riboflavin assay. In the other vitamin B_6 assay, on the Fuerte fruit, the bioassay showed about one third smaller value than that obtained by microbiological procedure. This may reflect the improved extraction procedures used in the microbiological analyses. Also, it might reflect poor absorption of the rather large avocado test doses—one to three grams—fed daily to young rats used in the rat-growth bioassay.

The proximate analyses indicated the variability of the water and fat content of the fruits because increased fat was usually accompanied by decreased moisture. The Anaheim variety had little more than half to two thirds of the fat content shown by the Fuerte and Hass samples. Seven shipments of Fuertes were examined for effects of tree ripening. These samples were shipped between January 23 and April 26, thus covering most of the harvesting season in southern California. No pattern could be seen in the moisture, fat, thiamine, and riboflavin contents of the samples. Neither was there a discernible trend in any of these constituents that might be traceable to season. The mean values and standard errors calculated from 56 analyses presented a fair picture of the composition of the Fuerte avocado.

The subject fruits were kept under refrigeration up to 61 days after they were received. The periods were divided into five groups ranging from eight to 13 days up to 43 and 61 days. In these 45 analyses again there was little discernible pattern, although a slight increase in fat and decrease in moisture appeared with lengthened storage period.

When the period of room temperature ripening was varied from none to five days, again there was no significant trend. The storage periods preceding these varied ripening periods were sometimes different also, but the differences between individual fruits of the same storage period and the same room temperature ripening period were as great as those of different storage and ripening history.

B vitamin analyses for riboflavin, niacin, folic acid, pantothenic acid and thiamine were made of each variety. Three sets each of assays were made for vitamin B_6—pyridoxine—and biotin.

The Fuerte avocado had a higher mean content of thiamine than either Anaheim or Hass but riboflavin was nearly the same in all three varieties and in all crop years. The values found by microbiological means were usually about 85% of those yielded by the fluorometric method. Niacin was found in about the same amount in the Fuertes and Anaheims, but the Hass had a significantly larger content. Pantothenic acid was slightly lower in the Fuertes than in the other two varieties. Vitamin B_6 was lower in the Anaheims than in the Fuertes and Hass. Folic acid likewise was lower in the Anaheims than in the Fuertes and Hass. The same was true of

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B Vitamin Distribution in Three Varieties of California-Grown Avocados

Variety and year	No. of analyses	Moisture %	Fat %	Thiamine mg. %	Microbiological methods					
					Riboflavin mg. %	Niacin mg. %	Pantothenic acid mg. %	Folic acid mg. %	Vit. B_6 mg. %	Biotin γ/g.
Fuerte										
1950	5–6	74.1	16.8	0.11	0.19	...	...	...	...	...
1951	4–8	70.6	19.8	0.13	0.25	1.52	0.97	0.029	...	...
1952	4–8	69.8	...	0.13	0.23	1.25	0.85	0.034	0.61	...
1954	2–5	73.7	17.3	...	0.19	1.57	0.89	0.026	...	0.055
Anaheim										
1951	3–8	80.0	10.1	0.09	0.20	1.60	1.01	0.018	...	...
1953	7–15	78.6	12.3	0.08	0.21	1.52	1.21	0.019	0.39	0.034
Hass										
1953	7–12	68.4	20.0	0.09	0.23	2.16	1.14	0.040	0.62	0.056
Avocados*	...	65.4	26.9	0.06	0.13	1.1	...	0.017 to 0.056**	...	...

* (16) ** (15)

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biotin. The sum of moisture and fat in most of the samples was fairly constant —about 91%—so that the differences in vitamin content may be considered valid even though total solids varied.

Avocados as a source of thiamine compare favorably with nearly all fruits and vegetables, with fish, milk, and eggs, and with all meats except pork. Avocados are exceeded in thiamine content chiefly by the whole grains.

As a source of riboflavin avocados are exceeded in concentration chiefly by evaporated milk, cheese, liver, and other organ meats. They are equal or superior to most other fruits, vegetables, meat, fish, cereals, and legumes.

Avocados contain more niacin than most fruits and vegetables, milk, cheese, and eggs, but less than most meats, fish, whole grains, and some legumes. The fruit appears to be in the middle range of all foods as a source of folic acid, but data are not numerous or consistent enough as yet to make valid comparisons. This is true also of pantothenic acid, vitamin B_6, and biotin.

It is plain that the avocado is in the superior group of foods as a source of both pantothenic acid and vitamin B_6. The fact that the fruit is eaten uncooked adds to its value as a source of the water-soluble B vitamins.

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cations for each of the plants. However, if all ice-packing plants were consolidated in a single location, additional economies might be realized. These have not been evaluated but could occur in the better integration of such operations as lidding, and ice and crate distribution facilities.

Consolidation in a few plants should also improve the opportunity for continuous employment which would be attractive to labor and thus help provide a fairly reliable labor supply. Also, contractual arrangements in regard to minimum hours and crew organization could be more easily met.

Certain administrative problems do arise with consolidation. Questions of labeling, coordinating field and house operations, decisions as to whose lettuce and how much of it will be packed in a given day, require considerable administrative skill. It is assumed that any increased administrative costs would be relatively small and more than offset by the indicated savings through consolidation.

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LEMONS

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tively stable. And, in terms of f.o.b. prices, those of lemon-juice products also compare favorably with other processed fruits. Yet, at both the consumer and f.o.b. levels, the prices of lemon-juice products have not been markedly more stable than those of other processed juices, excepting—perhaps—processed orange juice.

In the legislation on which the state lemon products order is based, one may interpret the term, price-stability, as pertaining primarily to grower prices and returns from processed lemons. During several of the years of the order's existence, grower on-tree returns from processed lemons were at higher than previous levels. However, the extent to which that was due to the order itself or due to the introduction and rapid market penetration of a new product—such as frozen lemonade concentrate—cannot be wholly untangled. Yet, it is likely that the effects of the order were substantial. Although higher grower on-tree returns from processed lemons were attained—if not maintained—substantial price stability to growers was not introduced. During that past five or six years, the relative variation in on-tree grower returns from processed lemons has not—on the average—been markedly less than in earlier periods.

Whatever the reason, significant price stability to growers for processed lemons has not been a result of the lemon products order. But the validity of price stability as a goal in itself might be questioned, because price stability—itself—often can be attained only through the creation of other and less attractive types of uncertainty.

To growers, processors, and distributors, a more rational goal than price stability is income maintenance and growth. It is true that—when oriented to price—the order's operation does have an impact on income. However, with income maintenance and growth as a direct rather than indirect orientation, a more basic objective is established.

In the question of interrelations between the stabilization pool percentages and prices, the stabilization percentages by themselves tell only part of the story. The actual tonnages, resulting from the application of the percentages, are more meaningful as influences on product prices and the flow of lemons into processed products.

During the first year of the order, there was a rough tendency for the stabilization pool percentages and prices to trend in opposite directions; but such tendency did not continue. In the following years no unique or consistent pattern of relationship prevailed between the stabilization pool percentages and prices.

Supply and Price Effects

Control over both stabilization pool percentages and prices gives the Board a different type of influence than if only the percentage or only the price were controlled. Yet, if the Board can change the percentage, or price, or both simultaneously, it has the burden of maintaining some appropriate relationship between the percentages—and corresponding volumes—and prices of the pool.

When the stabilization pool percentage is decreased—with no revision in the projected crop or total volume available for processing—the effect is to ease the supply situation in lemons for products. This increased supply, by itself, tends to depress the market value of processing lemons and, in more or less time, the market value of lemon products. But if the pool stabilization price is increased, while the stabilization percentage is decreased, the price effect tends to dampen the supply effect.

Since the stabilization pool percentage can only be decreased or maintained at its initial level, lowering the stabilization percentage eases the short-run—within the marketing season—supply situation. However, the order does permit the Board to raise or lower the stabilization pool price. Raising the pool price tends to raise the market value of processing lemons. Lowering the pool price tends to lower their market value. But the effectiveness of the stabilization pool price—with respect to its impact on market developments—depends not only on the availability and current market price of free tonnage of California lemons but also of lemons from other states and imported supplies. Only when the Board does, in fact, regulate the flow of lemons into processing, does the stabilization pool price have full meaning and impact.

Every permissible combination of stabilization pool percentages—and corresponding volumes—and prices is unique in its actual or potential impact on market prices. In view of the practical oper-