

## **Average Weights of Selected Avocado Cultivar**

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### **Summary**

Avocado packing house weekly inventory records of packed fruit collected over a span of fifteen years were analyzed to ascertain, for major varieties produced in California, the average size of California avocados available in the market place and the percentage of the total pack contributed by each of the commercial sizes. The data were also used to measure the change in sizes shipped to market week by week. A companion study was made to determine the percentage of avocado fruit weight represented by the edible portion at the time of consumption.

### **Introduction**

This study was initiated to determine from a large sample, for purposes of both marketing and nutritional analyses, the average weights of the major cultivars of California-grown avocados offered to consumers. It was subsequently expanded to provide additional potentially useful information.

### **Data Sources and Methodology**

For purposes unrelated to this study, the Marketing Division of Calavo Growers of California customarily produces each week a "Pack Report" that summarizes by variety and size the avocado package production of all Calavo packing houses on hand on the report date.

Copies of a substantial number of such inventory records were collected by the author over a period of fifteen years. Because the use of the records for this study was not foreseen, retention of them was not consistent. Records for some parts of the total period analyzed were not retained and, accordingly, were not available for inclusion in the study. The data samples are relatively enormous, however; and the accuracy of the conclusions appears to rest on a sound base.

The data presented in the tables are in terms of "flats" — containers holding 12.5 pounds of avocados, except for sizes 48 and 42 at 11 pounds — with regard to fruit size designations. Though the flat has largely given way to the 25-pound net weight carton as the commercial container used in the California avocado industry, the flat was used in the study because most of the inventory records were in terms of that unit. Such records as were made in terms of containers were converted to flats.

For the purposes of this study, the inventory records were converted from flats to fruit counts by multiplying each number of flats by its size. For example, 100 flats of size 24 avocados contain 2,400 pieces:  $100 \times 24 = 2,400$ . Similarly, 90 flats of size 30 avocados contain 2,700 pieces:  $90 \times 30 = 2,700$ . For each inventory record, the total number of avocados thus determined was divided by the total number of flats to calculate the mathematical average count of avocados per flat. Again, to illustrate by example:  $(2,400 + 2,700 \text{ pieces} = 5,100) / (100 + 90 \text{ cartons} = 190)$  equals 26.842 avocados per flat on average in this example. At 12.5 pounds per flat (200 ounces), the average avocado in this example would weigh 7.451 ounces; i.e.,  $200 \text{ ounces} / 26.842 \text{ avocados} = 7.451$  ounces per avocado.

In the course of the study, it became apparent that the data were adequate also to measure the changes in the size of avocados shipped to market from week to week. The initial study was broadened accordingly. All calculated averages for each year for which there were data were tabulated by week numbers; that is, 1 (the first week in November) through 52 (the last week in the following October). The data for each week then were averaged to produce a theoretical year of average sizes of avocado fruit shipped to market, week by week, as set forth in Table 4. The few instances where entries are absent in that table reflect lack of data in low-volume weeks.

An ancillary study was conducted by the author in 1983 to determine the edible portion percentage of the total weight of avocados of the Fuerte and Mass varieties. Thirty pieces of table-ready fruit (10 Fuerte, 20 Mass) of typical size were weighed individually on a laboratory scale immediately prior to consumption. The seeds and the "kitchen-peeled" skins were separately weighed, and the pulp weights were calculated by difference. The resulting data are summarized in Table 5.

## Discussion

The principal study took into account more than 225 million pieces of sized fruit of the California avocado industry's two major varieties of avocado, using records summarized in Table 3 that covered a time span of 15 years. The Fuerte is represented in data from nine of those years; the Hass, from twelve. It is unlikely that any other study of avocado fruit sizes has involved so large and so comprehensive a sample. The two varieties together represented in 1982-83 about 73% of the total of California avocados marketed — Fuerte 11.6%, Hass 61.6%.

Table 1 summarizes 2,839 entries of fruit counts (Fuerte 1,322; Hass 1,517) developed from the described inventory records.

As shown in the table, the composite average weight of Fuerte variety avocados is 7.765 ounces; of the Hass variety, 7.584 ounces. In their 1982-83 proportionate marketed volumes, the combined average commercially-distributed avocado of these two major varieties is 7.613 ounces. Inasmuch as Fuerte and Hass avocados are distributed to all markets and together account for approximately three-fourths of all California avocados marketed (the balance comprising many varieties, each of relatively small volume), it is reasonable to define the "average California avocado" as weighing 7.6 ounces (215 grams).

It is also of interest that, as shown in the Table 1, the average size of commercially-offered avocados varies from season to season in both the Fuerte and Hass varieties. The extremes of variation found in this study are from 12% above the varietal average to 9% below that average in the Fuerte, and from 16% above its varietal average to 13% below in the Hass. What marketing implications there may be in this finding are beyond the scope of this study.

It may be, in fact, that this finding of product variation is of less importance with regard to marketing than it is with regard to crop estimating. The historical inaccuracy of the industry's crop estimates is notorious, and these data may point to at least one reason therefore.

To illustrate, the Hass portion of a hypothetical "normal" crop (that is, one comprised of fruit of long-term "average" size) might amount to 400 million pounds. Another crop comprised of the same number of avocados would amount to 464 million pounds if its average fruit weight were at the high end of the Table 1 scale. It would amount to only 348 million pounds, however, if the average fruit weight were at the low end of the scale. There is a swing between the extremes of average fruit size amounting to 116 million pounds.

It appears that thought given to devising a method for factoring size variation into the crop estimating procedure might be productive.

Tables 1 and 2 present evidence that the Fuerte variety of avocado tends to be slightly larger than the Hass variety, averaging 2.4% heavier, and having about 3% more of its total in 24-count and larger sizes. Table 2 also reveals that one-third of all California-grown Fuerte-Hass avocados shipped are in the single fruit-size range that brackets the "average" avocado, and that about 85% of the Fuerte-Hass avocado volume is in the 35 to 20 count size range. This suggests that industry concern sometimes expressed over the impact of very small and very large sizes on the market price structure may be exaggerated.

Other research, empirically supported, has established that avocados of harvestable maturity generally continue to grow as long as they remain on the tree. The data presented in Table 4 of this paper were developed with a different objective than measurement of fruit growth on-tree: instead, the objective was definition of the size of the California product typically available to consumers over a year's time.

It will be seen in the tabulated data that there is a fairly high coefficient of size uniformity in California avocados shipped week by week — especially in the Fuerte. Hass picked early in its season — that is, winter and spring — tend to be smaller than the varietal average; Hass shipped in the summer and fall are likely to be larger than that average. The Hass variation is greater than the Fuerte variation. The raw numbers in Table 4 can mislead, however, if volume is disregarded in an analysis of them, since the tabulated weekly size averages are not weighted by volume. Fuerte volume is low in the summer/fall months, when average sizes are shown to be larger than the variety's seasonal average. Conversely, Hass volume is relatively heavy in summer/fall, when Hass average sizes tend to exceed the seasonal varietal average.

One inference to be drawn from Table 4 data is that the practice of "size picking" by

growers produces a more uniform product, in terms of fruit weight, than would likely be the result of "strip picking."

## Conclusions

The average California avocado, as represented by the Fuerte and Hass varieties, weighs 7.6 ounces (215 grams). The edible portion of this "average" avocado weighs 5.4 ounces (153 grams). A typical serving of one-half avocado weighs 2.7 ounces (77 grams).

The California avocados typically in the market place are reasonably uniform in size throughout the year. At least one-third of the avocados shipped in a typical year will be in the weight range of the commercially-designated size that includes the "average" avocado. Selective picking by fruit size appears to be a factor in this desirable result.

Fruit size variability from year to year appears to be a factor of significance to crop estimating accuracy that should have more attention.

Table 1. Average Fruit Size

Fuerte Variety: Nine Seasons, 1965-66 through 1978-79

Season	Count of Flats	Count of Fruit	Average Fruit per Flat	Average Fruit Size (Ozs.)
1965-6	252,305	6,450,463	25.566	7.823
1966-7	387,242	9,476,030	24.471	8.173
1967-8	39,324	904,910	23.012	8.691
1972-3	263,456	6,682,642	25.365	7.885
1973-4	62,240	1,533,754	24.643	8.116
1975-6	222,646	6,314,261	28.360	7.052
1976-7	858,365	22,336,072	26.022	7.686
1977-8	265,060	6,701,412	25.283	7.910
1978-9	413,809	10,805,632	26.113	7.659
Totals	2,764,447	71,205,176		
Grand Average			25.757	7.765

Hass Variety: Twelve Seasons, 1964-65 through 1978-79

Season	Count of Flats	Count of Fruit	Average Fruit per Flat	Average Fruit Size (Ozs.)
1964-65	51,101	1,286,245	25.171	7.946
1965-66	209,353	6,338,559	30.277	6.606
1966-67	182,118	4,483,960	24.621	8.123
1967-68	18,210	414,696	22.773	8.782
1971-72	16,530	445,630	26.959	7.419
1972-73	1,172,282	30,811,682	26.284	7.609
1973-74	75,977	2,055,983	27.061	7.391
1974-75	715,325	18,492,325	25.852	7.736
1975-76	624,221	17,294,005	27.705	7.219
1976-77	1,764,252	45,551,688	25.819	7.746
1977-78	581,731	14,367,181	24.697	8.098
1978-79	425,501	12,375,824	29.085	6.876
Totals	5,836,601	153,917,778		
Grand Average			26.371	7.584

Table 2. Distribution of Sizes

Seasons 1965-66 through 1978-79:

Fuerte = Nine Seasons; Hass = Twelve Seasons

Size	Range of Weight (ounces)	Average Weight (ounces)	FUERTE	HASS
			Percent of Pack	Percent of Pack
48	3.50 - 3.75	3.67	0.787%	1.083%
42	3.75 - 4.75	4.19	6.573%	9.015%
35	4.75 - 6.25	5.71	12.286%	15.135%
30	6.25 - 7.50	6.67	24.867%	22.016%
24	7.50 - 9.50	8.33	37.024%	35.937%
20	9.50 - 11.50	10.00	11.776%	11.018%
18	11.50 - 12.50	11.11	3.403%	3.690%
16	12.50 - 14.00	12.50	2.887%	1.901%
14	14.00 - 15.75	14.29	0.375%	0.199%
12	15.75 - 18.75	16.67	0.021%	0.006%
10	18.75 - 22.00	20.00	0.001%	0.00+%



Table 4. Weekly Average Size of Avocados

Fuerte Variety: Actual and Relative to 7.765-ounces Varietal Average  
(Nine Seasons, 1965-66 through 1978-79)

Week Number	Fruit Size (Ozs.)	Percent of Average	Week Number	Fruit Size (Ozs.)	Percent of Average
1	8.28	1.066	27	7.58	.9763
2	8.46	1.0896	28	8.21	1.0574
3	8.31	1.0703	29	8.33	1.0729
4	8.26	1.0639	30	8.58	1.1051
5	8.31	1.0703	31	8.55	1.1012
6	7.79	1.0033	32	8.61	1.1090
7	7.50	.9660	33	7.61	.9802
8	7.59	.9776	34	7.97	1.0265
9	7.16	.9222	35	6.91	.8900
10	7.70	.9918	36	9.08	1.1695
11	7.78	1.0021	37	9.58	1.2339
12	7.68	.9892	38		
13	7.62	.9815	39	7.76	.9995
14	7.73	.9956	40		
15	7.58	.9763	41	7.16	.9222
16	7.69	.9905	42	7.65	.9953
17	7.84	1.0098	43	8.54	1.0999
18	7.66	.9866	44	8.02	1.0330
19	7.90	1.0175	45	8.55	1.1012
20	7.62	.9815	46	8.23	1.0600
21	7.80	1.0046	47	8.33	1.0729
22	8.13	1.0471	48		
23	7.85	1.0111	49	7.16	.9222
24	7.79	1.0033	50	7.65	.9853
25	7.84	1.0098	51	8.54	1.0999
26	7.96	1.0252	52	8.44	1.0871

Table 4. Weekly Average Size of Avocados [Cont.]

Hass Variety: Actual and Relative to 7.584-ounces Varietal Average  
(Twelve Seasons, 1964-65 through 1978-79)

Week Number	Fruit Size (Ozs.)	Percent of Average	Week Number	Fruit Size (Ozs.)	Percent of Average
1	7.57	.998	27	7.03	.927
2	7.66	1.010	28	6.65	.877
3	7.97	1.051	29	7.03	.927
4	8.07	1.064	30	6.68	.881
5	7.96	1.050	31	7.30	.963
6	6.96	.918	32	7.18	.947
7	6.53	.861	33	7.22	.952
8			34	7.22	.952
9	6.43	.848	35	7.21	.951
10	6.06	.799	36	7.27	.959
11			37	7.54	.994
12	6.38	.841	38	7.51	.990
13	6.48	.854	39	7.64	1.007
14	6.23	.821	40	7.66	1.010
15	6.76	.891	41	7.98	1.052
16	6.40	.844	42	7.92	1.044
17	5.96	.786	43	7.94	1.047
18	6.47	.853	44	8.11	1.069
19	6.52	.860	45	8.18	1.079
20	6.93	.918	46	8.18	1.079
21	7.02	.926	47	8.11	1.069
22	6.92	.912	48	7.91	1.043
23	7.13	.940	49	8.09	1.067
24	7.30	.963	50	7.99	1.054
25	6.45	.850	51	8.14	1.073
26	7.06	.931	52	7.41	.977

Table 5. Edible: Inedible Components of Avocado Fruit.

	<u>Fuerte</u> (10 avocados)	<u>Hass</u> (20 avocados)
Average Weight of Fruit	249 g	249 g
Average Weight of Inedible Seed	42 g	42 g
Seed:Fruit Weight	16.9%	16.9%
Average Weight of Inedible Skin	27 g	31 g
Skin:Fruit Weight	10.8%	12.4%
Average Weight of Edible Pulp	180 g	176 g
Pulp:Fruit Weight	72.3%	70.7%