

Preparation of a Frozen Avocado Mixture for Guacamole

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Avocados (*Persea americana* Mill.) are produced in quantity in Florida and California, (USDA Agricultural Statistics, 1954; California Avocado Society Yearbook, 1953-54), and, if present" plantings mature, avocados will become an important commercial crop in the Rio Grande Valley of Texas. Seedlings of the Mexican race, which according to Hodgson (1947) are cold-tolerant, are being planted throughout the Valley, with largest plantings in the Rio Grande City area. Some of these seedlings appear to be fairly resistant to certain diseases. Most of the trees in this area originated from chance seedlings found in the Rio Grande Valley and northern Mexico. There are a few seedlings of the Guatemalan and West Indian races and some hybrids which are being grown in test plantings.

Local nurserymen and future grove owners have requested information about ways in which avocados may be processed in event a sizeable avocado industry is developed in the Valley. Under these circumstances there would be a quantity of fruit which would make an excellent food product but which could not meet market standards for fresh fruit because of wind scars, damaged spots, small size, and other minor physical defects.

Cruess, Gibson, and Brekke (1951) observed that, "sieved or finely ground avocado flesh mixed with one part by weight of sugar to three parts of fruit kept well when frozen in well filled hermetically sealed cans and stored at 0° F. In cartons or other packages accessible to air, browning and off flavor developed."

McColloch, Nielsen and Beavens (1951) recommend making an avocado spread using 100 parts of avocado puree, 8 to 10 parts lemon or lime juice, 1 to 2 parts salt, and 3 parts dehydrated onion powder. This spread retained a satisfactory color and flavor for a year when stored at 0 to -10° F. Attempts to substitute citric acid for lemon juice, or a mixture of citric acid and ascorbic acid, resulted in a product of less desirable flavor and color retention.

A similar mixture made with Valley-grown avocados resulted in a good sandwich spread, but was acid and too finely divided to resemble the salad the Mexican people call "Guacamole." However, a satisfactory guacamole "base" was made by mashing the avocados into a coarser textured product, using less lemon juice and adding fresh chopped onions instead of onion powder. The term "guacamole base" is used because good guacamole salad has many and varied ingredients, depending upon the household recipes handed down from mother to daughter.

A new product, Avocado Whip, developed by Stahl, and reported in Industrial South (1955) combines avocado, onion, lime juice, salad dressing, and salt into a puree suitable for freezing. In a consumer preference questionnaire, 99% of the people who purchased Avocado Whip said they would buy it again. Marketing trial samples were frozen in six-ounce tin cans.

The investigators whose publications have been briefly reviewed, were concerned principally with the development of avocado products. Their experimental work did not emphasize the method of packaging— particularly with reference to replacement of the headspace air in hermetically sealed containers with a vacuum or an inert gas. Neither did their work emphasize the importance of the variety of avocado. The exploratory experiments reported in this paper, on the other hand, are intended to reveal how such variables as method of packaging and variety may affect the quality of an avocado product such as a guacamole base.

MATERIALS AND METHODS

The avocados used in the experiments were grown in the Lower Rio Grande Valley within a radius of 20 miles of Weslaco, and represented varieties and strains of potential commercial importance in the area. Sound ripe fruit was used in the preparation of the guacamole base. It was weighed, washed, hand peeled, and all discolored spots, damaged portions, and seeds removed. The edible portion, seeds, and trimmings were weighed separately and the percentage of each determined. Edible flesh was blended with a coarse potato masher and to each 100 parts by weight, was added 5 parts of lemon juice, 4 parts of fresh chopped onion and 1 part salt. This ratio of ingredients, one of several tested in the laboratory, gave a very acceptable guacamole base.

A pH determination was made on the blended avocado flesh before other ingredients were added and also on the prepared guacamole base.

The first experiment was intended primarily to determine the effects of different conditions of packaging on some of the quality characteristics of the frozen stored guacamole base. Several varieties of avocados harvested in January of 1955 were composited to provide sufficient material for 10.5 pounds of guacamole base. Immediately upon preparation, 2 pounds was dispensed in single strength polyethylene bags, (Commonly used for household frozen food storage) approximately 8 ounces per bag. Excessive air was removed and the bags were promptly sealed and frozen in still air at 0° F. The remainder of the base was dispensed in glass jars, 14 ounces to the jar, 9 jars in all. Approximately 3/16 inch headspace was left in each jar for expansion of the guacamole base. Three jars were sealed with 1-piece screw-type lids, without further treatment, i.e. without deaeration. The lids were loosely fitted on three of the remaining six jars and these were placed in a large vacuum desiccator for 3 minutes. As air was released back into the desiccator the lids sealed the jars. The lids were loosely fitted on the other three jars and placed in a vacuum desiccator for three minutes. Nitrogen was released into the desiccator, then the top removed and the jars sealed. The jars were also frozen and stored in still air at 0° F.

The second experiment was intended primarily to determine the effect of variety or strain on the yield and quality characteristics of a guacamole base. Advantage was taken, however, of the opportunity which it provided to obtain additional information on

the effects of packaging on quality.

Twelve varieties and strains of avocados were harvested in August 1955. A guacamole base was prepared from each variety or strain as described and a portion of each dispensed into 4-ounce plain tin cans (8 cans per variety). The remainder of the guacamole base for each variety or strain was placed in bulk in a large vacuum desiccator, vacuum applied for 3 minutes, then carefully dispensed in 4-ounce plain tin cans (16 cans per variety). The lids were placed on 8 cans of each variety or strain and these put back into the vacuum desiccator and deaerated for 1 minute, removed and sealed. The remaining 8 cans were handled in the same manner except nitrogen was released in the vacuum desiccator prior to sealing the cans. As in the preceding experiment, all canned samples were frozen and stored in still air at 0° F.

Samples of guacamole base made in January and packaged in polyethylene bags and glass jars were evaluated for flavor differences at the end of 3 and 7 months storage intervals. Care was taken to mask the color so it would not influence the flavor evaluation given by the panel of nine judges. Each judge was given 3 portions of guacamole base from the glass jars; one portion from a vacuum pack, one from a nitrogen pack, and one from an undeaerated control. He selected the portion he liked best and described those of particularly poor flavor as rancid, bitter or acid. If he could detect no differences among the portions he was asked to write "no difference" on his evaluation card. The test was repeated three times with different arrangements of the portions. The guacamole base packaged in polyethylene bags was presented as a fourth sample for only the first test.

Samples of guacamole base made in August and packaged in plain tin cans were examined for changes in flavor which might be attributable to packaging in the same manner as undertaken with the glass jars. Each judge was given 3 portions at a time of each variety or strain, one from a vacuum pack, one from a nitrogen pack, and one from an undeaerated control.

Representative portions of the undeaerated control made from each of the 12 varieties and strains were arranged in a row. The judges mutually agreed on one as a preferred sample or "control," then compared the others with this as to flavor, color, and consistency. Consistency was judged as the amount of breakdown and separation which occurred during frozen storage and subsequent thawing. The samples were judged as excellent with a value of 4 points, good 3 points, fair 2 points, or poor 1 point. The test was repeated 3 times with different arrangements of the samples. The scores given by the judges were averaged and each sample given a numerical value for comparison.

A portion of the undeaerated control samples made from each variety or strain of avocado was transferred to a paper cup without a lid and stored at 35 to 40° F. Examinations for discoloration were made after 12 hours and again after 72 hours storage.

RESULTS AND DISCUSSION

A composite sample of guacamole base was prepared and packaged in single strength polyethylene bags and vacuum packed samples, nitrogen packed samples and

undeaerated control samples packaged in glass jars. At the end of a 3-month storage period at 0° F. each member of a taste panel consistently rated samples packaged in single strength polyethylene bags as having a rancid flavor (Table 1). The off flavor was so pronounced that further storage tests of guacamole in polyethylene bags was discontinued. The bags used in this evaluation were single strength and did not prevent the development of discoloration and off flavor during storage.

The same judges could detect no differences after 3 months' storage between the composited samples packaged in glass jars, or the guacamole base made from the varieties and strains and packaged in tin cans (Table 1).

At the end of 7 months' storage, 7 of the 9 judges could consistently detect an off flavor in the vacuum packed samples in glass jars which they described as rancid. Two of the judges could detect an off flavor only 66% of the time. The method of vacuum packing the samples in glass jars probably is responsible for the off flavor. As the air was removed in the vacuum desiccator, the guacamole pulled apart leaving hundreds of small open pockets or "bubbles" throughout the mixture. The jars were sealed under vacuum, therefore the small open pockets remained during the storage period and discoloration occurred adjacent to each open space. This condition did not exist with the nitrogen packed samples because as the nitrogen was released into the vacuum desiccator, the small air pockets were compressed from the guacamole base.

Table 1. Flavor in samples of Guacamole Base observed when method of packaging is the major variable.

Sample	Container	Storage at 0° F					
		3 months			7 months		
		Control	Vacuum	Nitrogen	Control	Vacuum	Nitrogen
Composite	Polyethylene bags	R°	—	—	—	—	—
Composite	Glass jars	ND°°	ND	ND	ND	ND	R
All varieties	Tin cans	ND	ND	ND	ND	ND	ND

° Rancid
°° No difference

The judges could detect no differences due to packaging in any of the other samples at the end of 7 months storage, whether it was the composited mixture or the guacamole made from the varieties and strains.

The second experiment designed to determine the effects of varieties or strains on yield and quality showed a yield difference (Table 2) as much as 30.4% in the amount of edible portion and that quality of guacamole as determined in this experiment, varied considerably among the varieties and strains.

The Topa variety, a large fruit with a relatively small seed, yielded 71% flesh, while the Y-7 strain, the smallest fruit tested with the largest seed, yielded only 40.6% flesh. The seed of the Y-7 adhered tightly to the flesh, making preparation of a guacamole base difficult.

There was little difference in pH of the fresh fruit, and the addition of lemon juice, chopped onion and salt to each variety or strain lowered the pH from about 6.4 to 4.6

(Table 2). During the sensory evaluation the same three judges commented each time that guacamole base made from the Paz variety appeared to taste slightly acid but was not objectionable. According to Table 2 the pH of Paz does not differ appreciably from that of any other variety.

At the end of 3 months storage and again at the end of 7 months storage all judges rated guacamole base made from the Y-7 strain as having the best flavor and color (Table 2), and was equalled only by Topa variety in consistency. With the exception of 19-1 strain and Topa variety, there was little difference in the flavor of any one variety or strain from the 3-month storage period to the 7-month storage period. The 19-1 strain had become slightly rancid, therefore was given a rating of poor at the end of 7 months storage. The Topa variety was given an increased flavor rating from 2.4 at the end of 3 months storage, to 3.3 at the end of 7 months storage (Table 2).

The color evaluation of all varieties and strains, except Paz variety, was about the same at the end of 7 months storage as it was at the end of 3 months storage. The Paz variety had darkened somewhat at the end of 7 months. This could have been due to differences in maturity at the time of processing, or it was more susceptible to oxidation than the other varieties or strains.

The color of guacamole base made from 16-5, Y-6 (Pancho) and C-3 strains was light green. Amidon variety was yellow green, and 21-6 blue green. These four strains and one variety were rated less desirable in color than the other six varieties and strains tested, but all would make a commercially acceptable guacamole base.

The consistency of some varieties and strains was thick butter-like and retained this characteristic through frozen storage, while others became soft and a thin watery phase separated from the guacamole base. The Topa variety and 19-1 and Y-7 strains retained their thick consistency, while 16-5 strain became very mushy and watery. The Santa Engracia and Paz varieties and Y-6 (Pancho) and C-3 strains were softer after freezing and thawing than before, but would be commercially acceptable for a guacamole base.

The Lulu variety yielded 59.1% edible portion and the guacamole base made from this variety was slightly above average in flavor, color and consistency (Table 2). This variety is specifically mentioned because it appears to be adapted to the climate and soil in this locality and constitutes large percentages of present plantings.

The color of some varieties and strains darkened badly when exposed to air during refrigerated 35°-40° F. storage, while others changed very little. The C-3 and 19-1 strains darkened considerably after 12 hours' storage and the Topa and Paz varieties and the Y-6 (Pancho), Y-7 and 21-6 strains did not discolor after 12 hours. After 72 hours storage the Santa Engracia variety and Y-6 (Pancho) strain were the only samples which had not discolored.

The sensory evaluation of the Diaz variety and R-I strain were not included in Table 2 because the fruit of these two varieties ripened unevenly. Apparently the fruit was harvested too green because the stem end would decay before the distal end ripened. Although care was taken to select sound fruit, some were used which were too green; consequently, the guacamole base was bitter. This condition is not a regular

characteristic of the Diaz variety or R-1 strain.

Table 2. Yield and Quality of Guacamole Base from several Avocado varieties and strains.

Variety or Strain	Flesh %	Seed %	Peel %	pH		Sensory evaluation ¹								
				Fresh Fruit	Guacamole Base	3 mo. storage			7 mo. storage			Consistency		
						Flavor	Color	Consistency	Flavor	Color	Consistency			
Topa	71.0	12.3	16.7	6.7	4.5	2.4	3.3	3.4	3.3	3.2	3.3	3.3		
16-5	68.7	19.3	12.0	6.4	4.5	2.2	1.9	1.8	2.0	2.2	1.6	1.6		
19-1	65.5	25.9	8.6	6.4	4.4	2.0	2.3	3.1	1.1	2.0	2.6	2.6		
Y-6 (Pancho)	61.4	23.6	15.0	6.2	4.4	2.7	1.6	2.2	2.0	1.7	2.0	2.0		
Diaz	61.0	19.5	19.5	6.5	4.5	—	—	—	—	—	—	—		
Santa Engracia	59.6	23.1	17.3	6.5	4.5	2.8	2.0	2.2	2.8	2.3	2.2	2.2		
Lulu	59.1	24.8	16.1	6.3	4.6	2.9	2.7	2.6	2.8	2.8	2.4	2.4		
Paz	58.5	19.5	22.0	6.4	4.4	2.6	2.8	2.2	2.5	2.0	3.0	3.0		
R-1	57.4	20.1	22.5	6.7	4.8	—	—	—	—	—	—	—		
Amidon	56.7	27.7	15.6	6.3	4.6	2.2	1.6	2.6	1.8	1.7	2.8	2.8		
C-3	52.2	29.3	28.5	6.3	4.5	1.4	1.8	2.2	1.5	2.0	1.8	1.8		
21-6	44.0	44.9	11.1	—	4.4	1.2	1.8	2.6	1.0	1.6	2.4	2.4		
Y-7	40.6	41.8	17.6	6.6	4.7	3.6	3.6	3.0	3.7	3.7	3.5	3.5		

¹The numbers represent numerical opinions of the judges: 4 Excellent, 3 Good, 2 Fair, 1 Poor

SUMMARY

An acceptable guacamole base was prepared by blending 100 parts by weight of

avocado flesh with 5 parts of lemon juice, 4 parts fresh chopped onion and 1 part salt.

The guacamole base kept well for 7 months at 0° F. storage, when packaged with minimum headspace in glass jars or plain tin cans.

Samples packaged in polyethylene bags were discolored and rancid at the end of 3 months storage.

Glass jars of guacamole base which had been sealed under vacuum developed open spaces or "bubbles" throughout the mixture, permitting discoloration and off flavor at the end of 7 months storage.

The amount of edible portion of the varieties and strains tested, varied from 71% to 40.6 %.

Under the conditions of these tests the Topa variety rated high for making guacamole base and the C-3 and 21-6 strains were the poorest. The Y-7 strain made the most flavorful and best colored base, but unfortunately was the lowest in yield of edible flesh and was the most difficult to prepare.

Some of the varieties and strains tested retained a butter-like consistency after frozen storage, while others became very mushy and a watery phase separated from the thawed mixture.

After 72 hours storage exposed to air at 35-40° F. the Santa Engracia variety and Y-6 (Pancho) strain were the only samples which did not discolor.

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