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The Effect of Thickening Agents in Reducing the Watery Separation of Frozen and Thawed Guacamole Products

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The avocado *(Persea americana* Mill) according to Cruess, Gibson and Brekke (1951), has been used in processed products for a number of years. However, considerable difficulty has been encountered in preparing products which would retain an avocado flavor without discoloring or becoming soft.

McColloch, Nielsen and Beavens (1951) modified a household recipe of an avocado spread called "Guacamole" and reported that the addition of 8 to 10 parts lemon juice, 1 to 2 parts salt, and 0.3 part dehydrated onion powder to 100 parts of pureed avocado, retained a satisfactory color and flavor for a year in frozen storage at 0 to —10° F.

Avocado Whip, developed by Stahl and reported in Industrial South (1955) combines avocado, lime juice, salad dressing and salt into a puree suitable for freezing. The puree will retain its color longer at refrigeration temperatures than sliced fresh avocado, but will darken upon standing.

The Canner and Freezer (1957) mentions a new fresh frozen avocado paste marketed under the trade name of Kendall which is becoming popular on the Miami, Florida, market.

This product, which contains avocados, lime juice, vegetable oil, onion, salt, and monosodium glutamate, was developed through the University of Miami's Food Technology laboratory and is being manufactured by the Parman-Kendall Corp. of Kendall, Florida.

Seven varieties and 6 strains of avocados grown in the Rio Grande Valley of Texas, were tested by Stephens, Lime and Griffiths (1957) for the preparation of an avocado mixture for guacamole. Some of these varieties and strains retained a thick butter-like consistency after being frozen and thawed. Others became soft and released a watery phase. Individuals asked to evaluate the guacamole objected to the watery separation because it detracted from the appearance of the product. Freshly prepared unfrozen guacamole does not separate as badly as the frozen and thawed product. This watery separation was not mentioned by the other investigators whose publications have been briefly reviewed.

The objectives of the experiments reported in this paper were to determine whether thickening agents such as waxy rice flour and sodium alginate, used singly or in

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[2] The mention of trade products or companies does not imply that they are endorsed or recommended by the *U.S.* Department of Agriculture over other similar products or companies not mentioned.

combination, would reduce or prevent the watery separation of guacamole; and whether they would impart an objectionable flavor.

MATERIALS AND TESTS

Avocados. Two lots of Lulu variety avocado were obtained from a planting near Harlingen, Texas. The first lot of approximately 60 pounds was obtained in November, 1956, and the second lot of approximately 200 pounds in December, 1956. Because all of the fruit was not the same stage of ripeness it was necessary to place the fruit in 68° F. storage until each fruit became soft. The soft ripe stage is considered ideal for fresh consumption. Twice each day the ripe fruit was moved to 40° F. storage and held until sufficient fruit had ripened to the desired stage for preparing an experimental batch of guacamole. At no time did the fruit remain in the 40° F. storage room for more than 3 days before use. All fruit used in the experiments was considered to be of excellent uniform quality.

Thickening Agents. Two thickening agents were tested singly and in combination in guacamole formula for the prevention of separation. These were a waxy rich flour manufactured by the Rice Products Company,[2] San Francisco, California, and sodium alginate manufactured by the Algin Corp. of America,[2] Rockland, Maine. These products were used because Hansen, Campbell and Lineweaver demonstrated the stability of waxy rice flour in prepared frozen gravies and sauces, and because sodium alginate has been used as a stabilizer in ice cream for a number of years (Sommer, 1947).

Guacamole Formula. The basic (No. 1) formula used is a modification of the guacamole formula recommended by McCulloch, Nielsen and Beavens (1951), and by Stephens, Lime and Griffiths (1957). It consisted of 94.07 per cent avocado flesh, 4.70 per cent lemon juice, 0.28 per cent onion powder, and 0.95 per cent salt. Each time other ingredients were added, the formula was recalculated so that the percentage of avocado flesh and flavoring materials remained in the same proportion.

Sensory Evaluation Tests. Only sensory evaluation tests of the experimental guacamole products were undertaken. These were made by a panel of eight members. In examining some products the panel members determined only whether each had a waxy rice flour flavor, and the degree of watery separation. In examining other products they graded each on a 10 point hedonic scale for flavor and consistency, i.e. whether thin or watery, and thick or pasty. In each series of tests a sample of guacamole made according to the basic formula (Table 1, No. 1) was used as a control.

Waxy Rice Flour as a Thickening Agent for Frozen Guacamole

The first series of experiments in this study were to determine the mixture of waxy rice flour and water that would be most desirable to maintain or improve the consistency of guacamole. Test batches of 5, 10, 15, 20, 30 and 40 per cent waxy rice flour were mixed thoroughly with water; heated in a double boiler with constant stirring, and cooked 3 minutes after the mixture reached the boiling point. Hansen, Campbell and Lineweaver (1951), in their studies of the preparation of stable frozen sauces and gravies, cooked the waxy rice flour mixtures for only one minute, but this procedure was modified because the "paste" appeared to be more translucent after the longer cooking

time. Of the above preparations it was observed that the mixture of 15 per cent waxy rice flour and 85 per cent water produced a paste which most nearlv resembled the consistency of the mashed avocados.

In a second series of experiments the 15 per cent waxy rice flour paste was incorporated in batches of guacamole in concentrations of 0, 10, 20, 30 and 40 per cent.

In preparing the paste for the guacamole the lemon juice, onion and salt were first mixed with the water and then the flour was added slowly with continuous stirring to prevent excessive lumping. The mixture was cooked 3 minutes in a double boiler and then allowed to cool. In the interim uniformly ripe avocados were peeled and mashed with a potato masher to give a rather coarse textured product. The cooled paste was folded into the mashed avocado flesh. The finished product was immediately dispensed in 6 oz. plain tin cans. These were uniformly filled so as to leave a minimum head space, sealed, and frozen and stored in still air at 0° F. Ten cans of each of the five guacamole products—containing 0, 10, 20, 30 and 40 per cent of the paste mixture—were packed.

Table 1. Guacamole formulas tested in the evaluation of thickening agents.

Formula No.	Avocado Flesh (%)	Lemon Juice (%)	Onion Powder (%)	Salt (%)	Waxy Rice Flour (%)	Sodium Alginate (%)	Water (%)
1	94.07	4.70	.28	.95	....	....	....
2	75.57	3.78	.23	.76	3.02	....	16.63
3	75.57	3.78	.23	.76	2.77	.25	16.63
4	75.57	3.78	.23	.76	2.52	.50	16.63
5	75.57	3.78	.23	.76	2.27	.75	16.63
6	75.57	3.78	.23	.76	2.02	1.00	16.53
7	75.57	3.78	.23	.76	1.01	2.00	16.63
8	75.57	3.78	.23	.76	....	3.02	16.63

The first evaluation study was made after a three day storage period. Two cans of each frozen product were brought up to room temperature. Each member of the sensory testing panel was then presented with five portions of guacamole; one without waxy rice flour paste, and four containing the paste in the varying amounts described above. Each member was asked to designate those samples in which he could detect the flour and which would be objectionable for this reason. He was also requested to rank the samples from the most watery separation to the least. Portions of the five products were then rearranged and judged a second time. These examinations were repeated on the fourth and fifth days.

The incorporation of waxy rice flour paste in guacamole products for freezing did not reduce watery separation of the thawed products except at the higher concentrations which slightly affected flavor. Six of the eight panel members could consistently detect the presence of waxy rice flour at the 20 per cent paste concentration (15 per cent waxy rice flour, 85 per cent water), but did not consider it objectionable. All 6 considered the

30 and 40 per cent concentration objectionable. Of the two panel members who could detect the flour only at the 30 per cent paste concentration, neither thought it objectionable, but one did find it objectionable at the 40 per cent concentration. The greatest amount of watery separation occurred in the guacamole product containing 10 per cent of the paste; the least amount in that containing 40 per cent. Some separation occurred in guacamole containing 20 per cent paste, but all factors considered, this was selected as the more desirable concentration. In this experiment there was very little difference in the degree of watery separation in the control guacamole product made without waxy rice flour paste and in the guacamole made with 20 per cent paste.

The flavoring materials should be added to the waxy rice flour paste during its preparation so that all ingredients can be folded into the mashed avocado flesh in one operation with a minimum of stirring. Too much stirring not only divides the avocado flesh too finely but it also incorporates excessive amounts of air into the guacamole. The paste should be thoroughly cooled before it is added to the mashed avocado flesh. If the paste is added hot an objectionable bitterness develops in the product.

A Combination of Waxy Rice Flour and Sodium Alginate as a Thickening Agent for Frozen Guacamole Products

It was shown in the preceding series of experiments that a concentration of 20 per cent by weight of a paste containing 15 per cent waxy rice flour in frozen guacamole, reduced watery separation on thawing, but did not entirely prevent it. Experiments were therefore undertaken to determine whether the use of sodium alginate in combination with waxy rice flour would yield a non-separating guacamole product of good consistency and flavor.

In a third series of experiments eight batches of guacamole were prepared employing the formulas listed in Table 1. the preparation procedures were the same as before except that the sodium alginate was dusted into the mixture while the waxy rice flour paste was being folded into the avocado flesh. Care was taken to obtain as uniform mixing and distribution of the sodium alginate as possible. The products were canned and frozen as in the preceding series of experiments and they were evaluated by the sensory panel after three days at 0° F.

Samples of guacamole prepared according to formula 1 through 6 were of sufficiently good quality to warrant additional study. Guacamole products containing 1.01 per cent waxy rice flour and 2.00 per cent sodium alginate (formula No. 7); and 3.02 per cent sodium alginate (formula No. 8) were unsatisfactory. Guacamole prepared according to formula No. 7 had a slick feel to the tongue and was considered objectionable. The use of 3.02 per cent sodium alginate without the waxy rice flour paste rapidly thickened the mashed avocado flesh to the extent that a uniform product could not be obtained.

In a fourth series of experiments six batches of guacamole were prepared according to formula 1 to 6 inclusive (Table 1). These were prepared from the December-harvested Lulu avocados for storage study.

After 9 months storage, three 6-oz. cans of product of each of the six guacamole products were thawed in tap water, thoroughly mixed, and portions served to taste panel members. Each member was presented a reference portion of formula No. 1, and

6 unidentified (coded) portions of formula Nos. 1, 2, 3, 4, 5 and 6. The reference portion was given an arbitrary value of 7. The panel members were instructed to evaluate the flavor and consistency of each formula using a 10 point scale. After the first series of tests it was necessary to select more descriptive terms than consistency. Some panel members rated a formula lower than the reference formula because it was thin or watery, while others rated it lower because the product was thick or pasty. To correct this misunderstanding the terms "thin or watery" and "thick or pasty" were substituted for the single term "consistency." Portions of the guacamole products were rearranged and judged a second time. The tests were repeated three times on succeeding days. The mean scores together with an analysis of variance are reported in Table 2.

The addition of waxy rice flour paste and sodium alginate to guacamole reduced the watery separation which may occur upon thawing after storage at 0° F. without adversely affecting the flavor. Guacamole made by formula No. 6 received a mean score flavor rating of 5.8 (Table 2), which may mean that some taste panel members were able to detect the presence of 2.02 per cent waxy rice flour and 1.00 per cent sodium alginate. An analysis of variance, however, failed to show a significant difference in flavor attributable to differences in formula.

Watery separation was less in those guacamole products which had the higher percentage of sodium alginate. The addition of 3.02 per cent waxy rice flour without sodium alginate (formula No. 2) resulted in a product which was considered to be more watery than the control (formula No. 1). The water used in making the flour paste was not sufficiently bound in the mixture. The incorporation of 1.00 per cent sodium alginate (formula No. 6) resulted in a product which the sensory panel members considered to be slightly too thick and pasty, but the flavor was acceptable. Guacamole products prepared by either formula No. 4 or No. 5 were considered acceptable after 9 months frozen storage.

The experiments demonstrate that thickening agents such as waxy rice flour and sodium alginate may be incorporated in frozen guacamole formula to give acceptable products. Proportions of the thickening agents sufficient to reduce watery separation of the thawed guacamole may be added without any appreciable effect on flavor, and with the maintenance of good, if not actual improvement in the consistency of the product. The formulas tested, which incorporated thickening agents, increased the volume of the products by approximately 20 per cent. Incorporation of thickening agents in the formula for guacamole may permit the use of varieties and strains of avocados which would not otherwise be acceptable for a frozen guacamole product.

SUMMARY

The use of waxy rice flour and sodium alginate, a product derived from kelp, was investigated for use as thickening agents to reduce or prevent the watery separation of frozen guacamole, an avocado product, upon thawing for table use.

Waxy rice flour when used alone in high enough concentration to reduce watery separation, affected the flavor of the guacamole.

By using a combination of waxy rice flour and sodium alginate the proportion of waxy rice flour could be reduced so that the flavor of the guacamole was not significantly

affected, the watery separation of the product was reduced, and its consistency was stabilized if not actually improved.

The waxy rice flour was folded into the mashed avocado flesh as a seasoned paste and in the formulas tested, resulted in a 20 per cent increase in product volume.

Table 2. Sensory evaluation of guacamole using waxy rice flour and sodium alginate as thickening agents.

Formula	*Flavor*	*Thin or Watery*	*Thick or Pasty*
1. No waxy rice flour No sodium alginate	6.8[1]	6.8[1]	6.8[1]
2. 3.02% waxy rice flour No sodium alginate	6.4	5.1	6.6
3. 2.77% waxy rice flour .25% sodium alginate	6.2	6.1	6.6
4. 2.52% waxy rice flour .50% sodium alginate	6.3	6.3	6.3
5. 2.27 waxy rice flour .75% sodium alginate	6.3	7.0	6.1
6. 2.02% waxy rice flour 1.00% sodium alginate	5.8	7.4	5.5
Least Significant Difference			
.01 level	1.6	.5	.4
.05 level	1.3	.4	.3

[1] These numbers represent numerical opinions of the judges. The word description of each number in the scale is:

1. Very poor
2. Poor
3. Fairly poor
4. Fair
5. Acceptable
6. Fairly good
7. Good
8. Very good
9. Excellent
10. Ideal

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