

## MULTI-PURPOSE GELS USED IN PREPARING NEW CITRUS PRODUCTS<sup>1</sup>

E. L. MOORE, A. H. ROUSE, C. D. ATKINS, AND  
E. C. HILL

*State of Florida, Department of Citrus  
Florida Citrus Experiment Station  
Lake Alfred*

### ABSTRACT

A new gel blend was developed for use in preparing citrus salad gels, jellied citrus sauces, and edible citrus gels for filling center cavity and sealing cut surface of fresh ready-to-serve grapefruit halves. No noticeable color or flavor changes occurred in salad gels and jellied sauces stored at 32° or 40°F for 1 year. Salad gels prepared from crushed grapefruit sections, either grapefruit or mint flavored, changed the least in flavor of the salad gels after 1 year storage at 80°F. Studies of jellied sauces stored at 80°F indicated that it would be preferable for manufacturers to prepare these products as needed from frozen concentrates. Fresh ready-to-serve grapefruit halves with center cavity filled and cut surface sealed with an edible citrus gel, shrink wrapped with polypropylene film, retained their freshness longer at 40°F than controls without gel coating under similar conditions.

### INTRODUCTION

In 1946, Moore, Atkins, and MacDowell mentioned the commercial possibilities of a citrus salad gel in a report to the Florida Citrus Commission (now State of Florida, Department of Citrus). The Florida Citrus Research Council in 1967 expressed an interest in and an immediate need for new citrus products, which led to the request by Dr. L. G. MacDowell, (then Scientific Research Director of the Florida Citrus Commission, that research work be started on the development of a tasty non-caloric sweetened citrus salad gel with "eye-appeal." Salad gels could not only utilize broken sections

from sectionizing plants but could become an outlet for surplus and possibly non-surplus grapefruit and oranges.

The work to be reported in this paper is on the use of multi-purpose gels in preparing not only citrus salad gels, but also jellied citrus sauces, and as an edible gel for filling center cavity and sealing cut surface of fresh ready-to-serve grapefruit halves. Results on storage of these products will also be presented and discussed.

### EXPERIMENTAL

*Gel blend.*—A new gel blend was developed that contained, by weight, 36.9% Sunkist No. 3466 low methoxyl pectin, 22.3% Gelcarin FC and 22.3% Gelcarin DG (both carrageenans), and 18.5% locust bean gum (carob gum). This gel blend is now available commercially from Marine Colloids, Inc., Springfield, New Jersey under their trade name "Sea Gel PCL-2."

*Gel formulations.*—Examples of 2 typical formulations developed, by weight, of salad gel and jellied sauce for packing in 300 x 407 cans are as follows:

	Grapefruit salad gel	Jellied orange sauce
Gel blend (Sea Gel PCL-2)	1.000%	1.000%
Sugar	10.309	21.799
Potassium chloride (if needed)	0.175	0.175
Water	39.865	48.728
Calcium chloride (anhyd.)	0.015	0.015
Grapefruit concentrate (60.85° Brix)	8.480	—
Orange concentrate (60° Brix)	—	28.220
Grapefruit sections	40.000	
Citrus oil emulsion (12% oil w/w)	0.156	0.063
	100.000	100.000

Other forms of edible calcium salts may be used. Quantity of added calcium ion needed for gelation usually ranges from 14 to 28 mg/g of low methoxyl pectin in the gel blend.

For best gelation with the above formulations,

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preferably the pH of the citrus product should not be below 3.5. If a solution of potassium hydroxide is added to the citrus concentrate to adjust the pH upward, it usually furnishes sufficient potassium ion to increase the gelling power of the carrageenan portion of the gel blend. If so, the addition of potassium chloride or other edible potassium salt is not needed.

*Processing of salad gels and jellied sauces.*—An example of the processing procedure developed for a citrus salad gel using concentrated grapefruit juice is given below. All processing should be carried out without delays to minimize hydrolysis of ingredients in the gel blend.

The gel blend, mixed with the sugar and potassium chloride (if needed), was dispersed in the proper amount of water. This was done in a steam-jacketed kettle at room temperature with vigorous agitation. The agitated mixture was then heated to 180°F. A solution of calcium chloride, previously heated to just below the boiling point, was added slowly to the hot dispersed mix being agitated in the kettle. The grapefruit concentrate and citrus sections had been combined, heated to about 120°F, and were added to the hot mix. The greater the agitation at this point, the more the citrus sections were broken into smaller particles. Citrus oil emulsion was added, and the mixture was ready for filling. The product was maintained at about 165°F during filling to prevent gelling. Products containing whole and broken sections were generally hand filled. The crushed product was filled easily from a modified hot water-jacketed Simplex, Model A, filler. For pasteurizing, the sealed 300 x 407 cans were placed on rotating rolls (approximately 120 rpm) in a hot water bath at 185°F for 15 minutes. For cooling, cans were placed on rotating rolls (about 18 rpm) under water spray (78°-85°F). One problem in cooling this product is that the outer part may gel as a ring with a softer center. In our cooler the temperature of the water spray and the rpm of the revolving cans could be varied to help overcome this problem.

A processing procedure developed for the jellied citrus sauce differed from that for the salad gel above in a few respects. Only part of the sugar was mixed with the gel blend and potassium chloride (if needed). The remainder of the sugar was added before the addition of the warm concentrate (120°F). The product

was pasteurized in a tubular heat exchanger to 190°-195°F, filled directly into cans, sealed, and cooled. As an alternate cooling method, a belt cooler with water spray or drip or combination was used.

*Storage of salad gels.*—Results are presented in Table 1 on the effect of storage at 80°F on non-caloric sweetened citrus salad gels adjusted to pH 3.8 with potassium hydroxide. The citrus sections were gelled in grapefruit juice. Products were examined monthly, but only the results for the 6 and 12 months examinations are shown. Initially these products were of very good quality.

At 6 months storage and longer, Table 1, the crushed grapefruit salad gel was better in flavor than those gels containing whole sections or the gel containing the mixture of crushed orange and grapefruit sections. Gel containing crushed grapefruit sections with added mint extract retained most of its mint flavor but lost some of its added green food color. The other 4 products showed more of the off-flavor that develops in hot-pack orange and grapefruit products stored at room temperature. The amount of syneresis increased from none to slight over the period of 12 months and followed the pattern for the loss in gel strength.

Salad gels were also envisioned as chilled products and similar packs without the final pasteurization were stored at 32° and 40°F. Not presented in tabular form, the first change noticed in these chilled products stored at 40°F was very slight or slight syneresis at the 9 weeks examination. Flavor, in general, was good at 28 weeks, but 1 can showed evidence of fermentation at that examination. The findings for stor-

Table 1. Effect of storage at 80°F on non-caloric sweetened citrus salad gels packed in plain cans.

Months at 80°F	Type-Gel	Flavor	Color	Syneresis (after 1 hr)
<b>Whole Grapefruit Sections</b>				
6	Good	Fair	Good	Slight
12	Good-	Poor	Good-	Slight
<b>Whole Grapefruit and Orange Sections</b>				
6	Good	Fair	Good	V. slight
12	Fair	Poor	Good-	Slight
<b>Crushed Grapefruit Sections</b>				
6	Fair	Fair+	Good	Slight
12	Fair+	Fair	Good-	Slight
<b>Crushed Grapefruit and Orange Sections</b>				
6	Fair	Fair	Good	Slight
12	Fair	Poor	Good-	Slight
<b>Whole Orange Sections</b>				
6	Good	Fair	Good	V. slight
12	Fair	Poor	Good-	Slight
<b>Crushed Grapefruit Sections with Mint and Food Color Added</b>				
6	Fair	Fair+	Lost color	Slight
12	Fair	Fair	Lost color	Slight

age of these salad gels at 32°F were equal to or better than those found for storage at 40°F. On the basis of our results, we would recommend that salad gels be fully pasteurized even for sale as chilled products.

A fully pasteurized pack of salad gel, containing broken orange and grapefruit sections and added non-caloric sweetener, was stored at 40°F. After 1 year, (data not shown in tabular form), the salad gel was judged to have no change in flavor or color.

We do not have sufficient data at this time on salad gels sweetened with sugar to estimate their storage life. Based on preliminary work, our results do indicate that salad gels prepared from tangelo or tangerine sections should be kept chilled.

*Storage of jellied sauces.*—Results are presented in Table 2 on the effect of storage at 60° and 80°F on jellied orange sauce (pH 3.6) and jellied grapefruit sauce (pH 3.4) containing 40% soluble solids,—a combination of 17% juice solids and added sugar. Products were examined monthly, but only the results for the 7 months examination are shown. Initially these products were of very good quality. Samples were also stored at 40°F but did not show significant changes.

As would be expected, flavor and color of the jellied sauces stored at 60°F were better than for those products stored at 80°F. In general, the results for 7 months storage indicated that preferably these jellied sauces should not be packed in enamel-lined cans for prolonged storage at 80°F, or even at 60°F where some very slight browning took place.

Table 2. Effect of storage at 60° and 80°F for 7 months on jellied citrus sauces packed in 3 types of cans.

Temp. °F	Type-Gel	Flavor	Color	Syneresis (after 1 hr)
<b>JELLIED ORANGE SAUCE</b>				
<i>Plain Can</i>				
60	Good	Fair	Good	None
80	Good	Poor	Sl. brown	None
<i>Plain Can with Enamel-Lined Ends</i>				
60	Good	Fair	Good	None
80	Good	Poor	Sl. brown	None
<i>Enamel-Lined Can</i>				
60	Good	Fair	V. sl. brown	None
80	Good	Poor	Med. brown	None
<b>JELLIED GRAPEFRUIT SAUCE</b>				
<i>Plain Can</i>				
60	Good	Fair-Good	Good	None
80	Fair	Poor	Sl. brown	Slight
<i>Plain Can with Enamel-Lined Ends</i>				
60	Good	Fair-Good	Good	None
80	Good	Poor	Sl. brown	V. slight
<i>Enamel-Lined Can</i>				
60	Good	Fair	V. sl. brown	None
80	Good	Poor	Dark brown	None

The 17% juice solids in these jellied sauces gave them a very good initial quality, but is greater than the soluble solids in the usual orange or grapefruit juice. This higher concentration of juice solids may be responsible for some of the browning and flavor changes observed during storage of the products. It would be our recommendation for a manufacturer to warehouse frozen concentrates and prepare these jellied sauces as needed, rather than to store the canned sauces for prolonged periods.

*Microbiological study of salad gels and jellied sauces.*—A microbiological study was made of 4 products:—salad gels containing either broken grapefruit sections or broken orange gelled in grapefruit juice, jellied orange sauce, and jellied grapefruit sauce.

Initial examinations of the 4 products showed plate counts (dextrose agar) ranging from 50 to 140 per gram. Periodic examinations over a period of 5 months on these products stored at 40°, 60°, and 80°F showed plate counts ranging from 20 to 280 and indicated no build-up in microorganisms in any product at any of the 3 temperatures. By using the entire contents of a can for analysis, it was insured that isolated pockets of microbiological growth would not be missed as might have been possible with only partial sampling of the contents of a can.

*Storage of gel-coated ready-to-serve grapefruit halves.*—The effect of storage at 40°F on ready-to-serve grapefruit halves (2) prepared with and without center cavity filled and cut surface sealed with an edible citrus gel, shrink wrapped with polypropylene film, is shown in Table 3. These results indicated that wrapped, gel-coated, ready-to-serve grapefruit halves should have a potential marketing life of up to 2 weeks if stored at 40°F.

Table 3. Effect of storage at 40°F on ready-to-serve grapefruit halves prepared with and without edible citrus gel coating on cut surface and shrink wrapped in polypropylene film.

Days at 40°F	Fungal growth	Drying and shrinkage	Flavor
<i>Without Gel Coating</i>			
7	None	Noticeable	Fair
10	None	Definite	Fair
14	None	Very definite	Tasted old
19	Yes	Extreme	Poor
21	Yes	Extreme	Poor
<i>With Gel Coating</i>			
7	None	None	Good
10	None	None	Good
14	None	None	Good
19	None	None	Good
21	None	Noticeable	Fair

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## GEL-COATED READY-TO-SERVE GRAPEFRUIT HALVES

A. H. ROUSE, E. L. MOORE, C. D. ATKINS, AND  
W. GRIERSON

*State of Florida, Department of Citrus  
Florida Citrus Experiment Station  
Lake Alfred  
and*

D. S. BRYAN

*Florida Citrus Mutual  
Lakeland*

## ABSTRACT

Center cavity and cut surface of fresh grapefruit halves were filled and sealed with a citrus gel to prevent shrinkage and leakage, thus extending the life of ready-to-serve grapefruit halves for restaurant and supermarket trades. The prepared product is wrapped with polypropylene shrink film and stored at 40°F. After three weeks storage at 40°F., the gel-coated halves appeared free of fungal growth with only slight shrinkage, whereas, the control samples without gel coating had mold growth on the surface of the cut fruit after 19 days and severe shrinkage and leakage of the grapefruit sections occurred within one week. The gel was made attractive with certified food colorings and each grapefruit half was garnished with a disc of colored, candied citrus peel in its center. Flavor of the gel was enhanced with the addition of sugar, honey, or non-caloric sweeteners and grapefruit oil essence.

## INTRODUCTION

Ready-to-eat grapefruit halves, a new 'convenience' food sealed with a grapefruit gel that is over 98% citrus, resulted this past year from the combined efforts of three organizations to prepare and place before restaurant operators, home economists, and other interested groups for their evaluation.

In 1966-67, seven tests were carried out to determine if grapefruit halves could be prepared for eating and marketed under refrigeration. These exploratory studies indicated that: a) complete loosening of each segment was not practical; b) removal of seeds could be done with a simple instrument but juice accumulated in the resultant cavity; c) Saran film was unsuitable for wrapping; d) shrinkfilm wrapping made an acceptable package for three days, but after seven days at 40°F. perceptible drying of the albedo caused an old appearance; and e) of four types of shrinkfilm tested, the most suitable was Reynolds GSP polypropylene film. Very short term marketing might be practiced, not more than 5 days from preparation to consumption.

During the past two years, we have formulated several types of gels. We speculated that one of these formulations could be used for pre-coating the surface of freshly cut grapefruit halves to prevent shrinkage and leakage and that grapefruit essence might enhance the grapefruit odor and taste of the product. The grapefruit water and oil essences might also act as a deterrent to fungal growth on the cut grapefruit surface and peel.

The purpose of this paper is to present in-