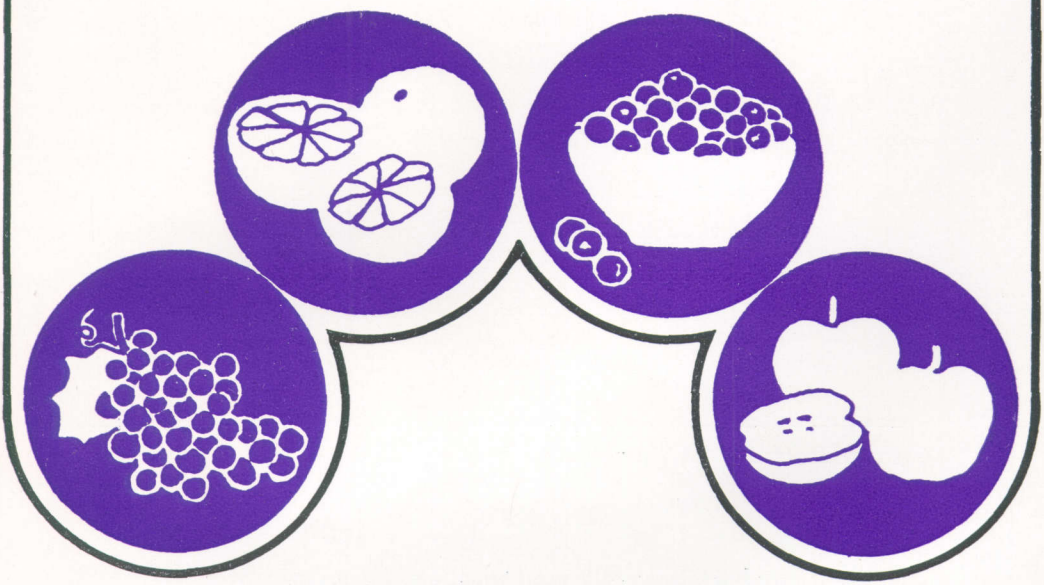
BULLETIN 480 JUNE 1976

Instant Jelly Concentrates for Home Processing



AGRICULTURAL EXPERIMENT STATION/AUBURN UNIVERSITY
R. DENNIS ROUSE, Director AUBURN, ALABAMA

CONTENTS

FIRST PRINTING 4M, JUNE 1976

INSTANT JELLY CONCENTRATES for HOME PROCESSING[1]

HUBERT HARRIS[2]

INTRODUCTION

THE CONCEPT of instant jelly is to offer the homemaker a high-fold packaged juice concentrate that can be used rapidly and reliably in the home for making high quality jelly. The juice concentrate is correctly fortified with pectin and acid and adjusted to the correct Brix level for making a jelly that conforms closely with USDA Food and Drug Standards when combined with specified quantities of sugar and water and heated briefly *(9,10)*.

Processing of jellies is appealing to many homemakers and empty jars suitable for packaging the products are easily accumulated. However, conventional home methods are laborious and problematical. Under-ripe fruit is often used, at least for part of the juice, because it enhances jelly set *(1,3,5)*. Such fruit contains more pectin than fully ripe fruit *(2,4)*, but is usually lower in soluble solids and aromatic flavors *(7)*. Pectin supplements, needed in greater amounts in fully ripe fruit, are readily available to homemakers only as retail items and, consequently, are relatively expensive.

Methods and equipment available in the home for juice extraction usually result in low recovery of soluble solids from the fruit and a dilute, unclarified juice *(1,3,5)*. In finishing the jelly, foaming and loss of aromatic flavors often occur during the conventional open-kettle boiling process *(1,3,5)*, and long boiling periods use considerable heat energy. Poor jelly set may result from in-

[1] This research was supported by Hatch (Project 626) and State Research (Project 9-705) Appropriations.

[2] Associate Professor, Emeritus, Department of Horticulture.

correct use of sugar, pectin or acid, or from incorrect concentration in finishing the jelly. As well as being fast and dependable, the instant jelly process is designed to minimize foam formation and flavor losses *(6,7,8,9)*.

Jelly concentrates might be marketed through food stores along with the frozen beverage concentrates. By processing the jelly frequently in relatively small batches and using recycled jars, a fresh supply of high quality jelly might be provided for the home with little effort and at a substantial savings in cost.

RESEARCH OBJECTIVES

Specific Objectives

1. To develop formulas for frozen jelly concentrates from different fruits that could be used rapidly and reliably in the home for making standard jellies of high quality.
2. To have samples of the concentrates tested by homemakers, and evaluations made by means of questionnaires on the instant jelly process, qualities of finished jelly and market potential for the concentrates.

EXPERIMENTAL PROCEDURE

Instant jelly formulas for apple, orange, Concord grape, and muscadine grape were developed in 1974. Commercial frozen juice concentrates were used in developing the formulas for apple, orange, and Concord grape. These juice concentrates are usually made by a vacuum concentration process *(12)*. Experimental freeze concentrated juice *(7,11)* of muscadine grape was used in formulating the instant muscadine jelly concentrate. All products were fortified with slow set, 150 grade citrus pectin *(2)* and anhydrous citric acid. The products were sufficiently concentrated for a yield of approximately 4.25 pounds of standard jelly from 12 fluid ounces of concentrate when combined with 2 cups of water and 5⅛ to 5¼ cups of cane sugar. This provided jelly concentrates of approximately 4.6 fold and considerable uniformity in measurement of added ingredients when finishing the jellies. Jellies are finished by mixing the sugar and water in a pan, heating to a low boil, boiling 1 minute, adding concentrate and pouring the jelly. Equilibration temperature of the jelly in the pan is above 190°F. which is ample for preservation of the product. The 12-ounce unit package seemed to be of a suitable size for experimental testing in homes and also for retail marketing if the products were manufactured on a commercial basis.

Concentration (percent soluble solids) of juices, concentrates and jellies was determined with a hand refractometer and expressed as Brix.

Two additional muscadine jelly formulas were developed in 1975 using freeze concentrated juices with Brix levels below and above the level of the muscadine juice concentrate used in 1974. These formulas were designed to be used with the same proportions of water and sugar as the 1974 formulas except that the 1975 formula made from the lower Brix concentrate required approximately 14 fluid ounces in the unit package of jelly concentrate to make 4.25 pounds of finished jelly.

All formulas were designed to produce jellies that conform to U.S. Food and Drug Standards of Identity *(10)*. These standards are based on the use of 45 parts by weight of a standard single strength juice to 55 parts of sugar (water-free basis) and 65 Brix in finished jelly.

Home tests on the jelly concentrates were conducted during 1974 and 1975. Cooperating participants were given a unit package of the frozen concentrate, instruction sheet for finishing the jelly, container for returning a sample, and a questionnaire for evaluating the product. Returned jelly samples were tested in the laboratory for soluble solids and pH.

FORMULATING INSTANT JELLY CONCENTRATES

Basic Computations

Compounding standard jellies from different fruit juices and concentrates normally entails considerable mathematical calculation. To minimize these calculations basic computations were made and the results tabulated, Table 1. From this table the quantities of ingredients for a given batch of jelly can be determined rapidly regardless of the kind of fruit or the soluble solids content of the juice or concentrate used. For example, the U.S. Standard Brix for single strength fruit juice varies widely with different fruits, ranging from 7.69 for guava to 18.18 for figs. Consequently, the number of pounds of sugar required per pound of fruit soluble solids in standard jelly varies from 15.89 for guava to 6.72 for fig. In all cases there is more water in a batch of standard single strength juice than in standard jelly compounded from the juice, and the excess water must be removed by pre-concentration of the juice, or by boiling the jelly mixture when making the product. The amount of water to be removed in making 100

TABLE 1. DATA FOR STANDARD JELLY FORMULATIONS FOR DIFFERENT FRUITS[1]

Kind of fruit	Standard juice	Lb. sugar per lb. fruit soluble solids	Formulation—per 100 lb. finished jelly[2]		
			Fruit soluble solids	Added sugar[3]	Excess water from standard juice[4]
	Brix	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Guava	7.69	15.89	3.85	61.15	11.19
Strawberry	8.00	15.28	3.99	61.01	10.93
Gooseberry	8.33	14.67	4.15	60.85	10.65
Grapefruit, prickley pear	9.09	13.44	4.50	60.50	10.01
Blackberry, dewberry, youngberry, boysenberry	10.00	12.22	4.92	60.09	9.25
Cranberry, loganberry, raspberry, currant	10.53	11.61	5.16	59.85	8.82
Black raspberry	11.11	11.00	5.42	59.58	8.34
Peach	11.76	10.39	5.71	59.29	7.81
Orange	12.50	9.78	6.03	58.97	7.23
Apple, quince	13.33	9.17	6.39	58.61	6.57
Concord grape, apricot, cherry, plum, pineapple	14.29	8.55	6.81	58.20	5.82
Crabapple	15.38	7.95	7.27	57.74	4.98
Muscadine grape[5]	16.00	7.64	7.53	57.47	4.50
Pomegranate, fig	18.18	6.72	8.42	56.58	2.88

[1] Based on US Food and Drug Standards of Identity for jellies (Ratio of 45 lb. standard fruit juice to 55 lb. sugar, 65 Brix in finished jelly).

[2] Weight of jelly is theoretically increased by 1.54 × weight of pectin and acid supplements used.

[3] Exclusive of water, if any, contained in sugar source used.

[4] Water component of standard single strength juice in excess of 35 lb. needed in finished jelly. More water is added if substandard juice is used, or if sugar, pectin or other ingredients contain water. Less water is added if juice concentrate is used. Approximately 2 lb. of water is evaporated in compounding the jelly without boiling (190 to 200°F). Final water is regulated by calculated pre-concentration of juice or by boiling the jelly mix to 65 Brix. Finished standard jelly contains 65 lb. soluble solids/100 lb. jelly.

[5] 16.00 Brix is used provisionally.

pounds of standard jelly from standard single strength juice varies from 2.88 pounds for fig to 11.19 for guava, Table 1. Greater quantities must be removed if the fruit juice is substandard in soluble solids as is usually the case when under-ripe fruit is used or when water is added in the extraction process. If the fruit is of exceptionally high quality, or if a method of extraction is used that results in partial concentration of the juice (for example, the freeze-press method) the extracted juice may be above standard in Brix. Juice that has been pre-concentrated threefold or more may be used in compounding standard jelly by adding the correct amount of water when the jelly is finished.

Dissolving Pectin

In formulating a high Brix instant jelly concentrate, it is desirable to use as little water and sugar as possible for dissolving the pectin supplement before adding it to the juice concentrate. By using a special impeller-type stirrer it was possible to dissolve the pectin satisfactorily with the water and sugar reduced to a 1-2-12 mixture (pounds pectin, sugar, water), Table 2. The impeller was designed to rapidly disperse a dry mixture of pectin and sugar in the water and to maintain suitable agitation. When mixed in this manner with the water at approximately 200°F., the material dissolved rapidly. There was no coagulation or gelatinous

TABLE 2. METHODS OF DISSOLVING PECTIN[1]

Cane sugar (form)	Mixing method	Ratio of ingredients: pectin,[2] sugar, water	Solution	
			Brix	Quality
		Lb.	*Pct.*	
Granular	Hand stirring	1-2-12	20.2	Poor, coagulated
	Hand stirring	1-4-15	25.1	Very good
Powdered	Impeller[3]	1-2-12	21.0	Very good
Granular	Impeller[3]	1-2-12	19.7	Very good
	Impeller[3]	1-3-12	25.6	Very good

[1] Water heated to low boil, removed from heat, dry mixture of pectin and sugar stirred into water by methods given in table.

[2] 0.23 lb. pectin, other ingredients in ratio shown.

[3] Two-blade impeller with one hole in each blade. Variable speed power drive. Dry pectin-sugar mixture fed into rotating impeller.

masses of the pectin-sugar mixture as resulted from hand stirring the 1-2-12 mixture. To obtain a satisfactory solution by hand stirring, it was necessary to increase the sugar and water ratio to a 1-4-15 mixture.

Testing and Revising Jelly Formulas

The original instant jelly formulas developed in 1974 were tested in the laboratory for making finished jellies. These formulas were fortified with 6.5 grams of citric acid per 12-ounce package of concentrate. Jellies from the Concord grape and muscadine grape concentrates were very satisfactory, but jellies from apple and orange concentrates did not set satisfactorily. Tests were repeated on these using increased rates of citric acid. Re-

TABLE 3. EFFECT OF ACID SUPPLEMENT IN INSTANT JELLY CONCENTRATE ON pH AND JELLY SET

Jelly concentrate[1]		pH concentrate	Jelly	Jelly set
Fruit	Citric acid supplement			
	g./batch			
Apple	6.5	2.90	3.25	Fair
	11.5	2.81	3.02	Excellent
Orange	6.5	3.20	3.50	Failed
	15.0	2.90	3.16	Very good

[1] Except for difference in acid rate, jelly concentrates were as presented in Table 4. Twelve fluid ounces of concentrate combined with 2 cups of water and 5¼ cups of sugar in finishing jelly.

sults of the tests with the original and higher acid rates are presented in Table 3.

Revisions were made in the original jelly concentrate formulas to conform with results of the preliminary tests. Each formula was then computed to batches large enough for 14 of the 12-fluid-ounce packages of jelly concentrate. This provided 4 packages from each product for further laboratory testing and 10 of each for evaluation by cooperating homemakers. The revised formulas are presented in Table 4. Each formula shows the ingredients used in making the jelly concentrate and the water and sugar to be added in finishing the jelly.

Jelly Tests on Revised Formulas

Miscellaneous data from laboratory tests on three of the jelly concentrates are presented in tables 5 and 6. It is noteworthy that the muscadine jelly concentrate sample was unaltered by −27°F. storage for 40 days, and that only 16 minutes total time was required to make a batch of jelly from the concentrate, Table 5. In the test reported in Table 6, the temperature of packaged jelly was 20°F. higher when the pan was left resting on the burner (heat turned off) as compared with moving it to a metal table for adding concentrate and mixing. However, the temperatures that prevailed when the pan was moved to the metal table were high enough for preservation of the jelly *(2,4)*. No spoilage was observed in any of the laboratory tests on jelly concentrates, nor were there any incidents of spoilage reported by participants in the home evaluation tests.

TABLE 4. FORMULATIONS FOR INSTANT JELLY CONCENTRATES AND FINISHED STANDARD JELLIES FROM DIFFERENT FRUITS, 1974

Kind of jelly	Jelly component	Ingredients: Sugar	Other solids (1) pectin (2) fruit solids (3) acid	Water	Totals	Brix	pH
		Lb.	*Lb.*	*Lb.*	*Lb.*	*Pct.*	
Apple (made from "Tree Top," unsweetened concentrate)	**Concentrate:**						
	Pectin solution	0.85	(1) 0.24	2.80[2] 2.60[3]	3.69	29.5	
	Apple conc.		(2) 3.84	4.88	8.72	44.0	
	Citric acid		(3) 0.36		0.36		
	Totals, conc.	0.85	4.44	7.48	12.77[4]	41.5	2.8
	Finished jelly:						
	Added ingr.	34.31		14.62[2] 13.84[3]	48.15	71.3	
	Totals, jelly	35.16	4.44	21.32	60.92	65.1	3.0
Orange (made from "Frosty Acres," unsweetened concentrate)	**Concentrate:**						
	Pectin solution	0.85	(1) 0.24	3.14[2] 2.92[3]	4.01	27.2	
	Orange conc.		(2) 3.62	4.61	8.23	44.0	
	Citric acid		(3) 0.45		0.45		
	Totals, conc.	0.85	4.31	7.53	12.69[4]	42.0	2.9
	Finished jelly:						
	Added ingr.	34.53		14.62[2] 13.84[3]	48.37	71.5	
	Totals, jelly	35.38	4.31	21.37	61.06	65.0	3.2
Concord grape (made from "Welch," sweetened concentrate)	**Concentrate:**						
	Pectin solution	0.70	(1) 0.23	2.22[2] 2.07[3]	3.00	31.0	
	Grape conc.	0.50	(2) 4.09	5.28	9.87	46.5	
	Citric acid		(3) 0.15		0.15		
	Totals, conc.	1.20	4.47	7.35	13.02[4]	42.8	2.8
	Finished jelly:						
	Added ingr.	33.72		14.62[2] 13.84[3]	47.56	70.8	
	Totals, jelly	34.92	4.47	21.19	60.58	65.0	3.0
Muscadine grape[1] (made from experimental freeze-concentrate)	**Concentrate:**						
	Pectin solution	0.76	(1) 0.23	2.03[2] 1.89[3]	2.88	34.7	
	Muscadine conc.		(2) 4.52	5.50	10.02	45.0	
	Citric acid		(3) 0.20		0.20		
	Totals, conc.	0.76	4.95	7.39	13.10[4]	43.7	
	Finished jelly:						
	Added ingr.	33.72		14.62[2] 13.84[3]	47.56	70.8	2.8
	Totals, jelly	34.48	4.95	21.23	60.66	65.0	2.8

[1] 16 Brix is used provisionally as standard for single strength muscadine juice.
[2] Water added.
[3] Water remaining in product after heating.
[4] 14 packages, 12 fluid oz. each of jelly concentrate, preserved by freezing.

TABLE 5. LABORATORY TESTS ON MAKING JELLIES FROM 12-OUNCE PACKAGES OF FROZEN INSTANT JELLY CONCENTRATES, 1974

Muscadine jelly concentrate in 12-ounce sealed packages was unaltered by —27°F. storage for 40 days.
Above concentrate was defrosted satisfactorily by taking from —27°F. storage, tempering in tap water, defrosting in hot water: 30 min. total time.
5⅛ c. sugar should weigh 2.41 lb. Lab. test weights were: (a) 2.43, (b) 2.41.
Time required to make a batch of jelly from concentrate, starting with clean jars and covers, equipment, sugar, and defrosted concentrate on hand:

	Minutes
Measuring sugar and water	2
Heating sugar-water mixture	9
Boiling sugar solution	1
Mixing, pouring, closing, tightening covers	4
Total time	16

Net weights on batches of jelly:

	Pounds
Orange	4.20
Apple	4.24
Muscadine	4.32

Jelly qualities: All of the finished jellies were considered to be very acceptable.

Jelly Formulas Developed in 1975

Two additional muscadine jelly formulas were developed in 1975, using freeze concentrated juices with Brix levels below and above the level of the muscadine juice concentrate used in 1974. These are designated as muscadine II, (from lower Brix juice) and muscadine III, (from higher Brix juice), Table 7.

TABLE 6. TEMPERATURE REACHED IN FINISHING JELLY BY DIFFERENT PROCEDURES[1]

Item	Location of pan when concentrate added, jelly mixed, poured	
	Pan left on burner, heat turned off	Pan moved to metal table
	°F	°F
Sugar-water, heated, boiled 1 minute	223	223
Pre-warmed jelly concentrate, as added	110	110
Mixed jelly in pan	205	190
Poured jelly in pint jars	195	175

[1] 12 fluid oz. muscadine jelly concentrate, 2 c. water, 5⅛ c. sugar. Jelly made in 3 qt. stainless steel pan with copper-clad bottom.

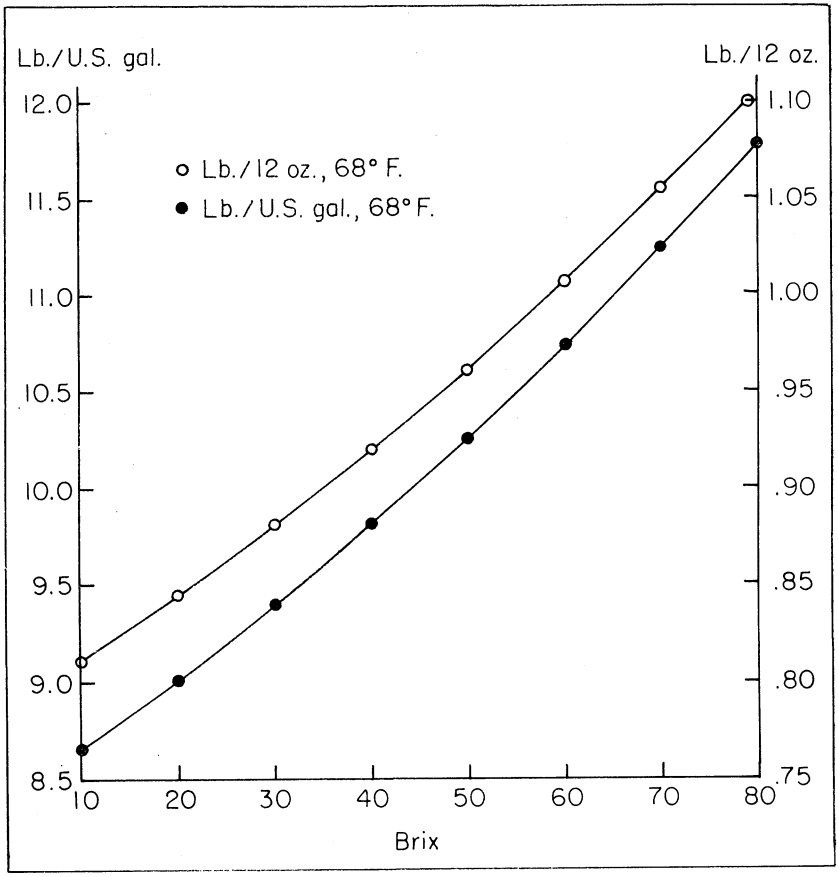
Densities of Concentrates and Jellies

Densities of sucrose sugar solutions (lb./gal. and lb./12 oz.) are presented graphically in the figure. For practical purposes, these values apply also to jelly concentrate and finished jellies. These data are useful in formulating and packaging jelly concentrates from different fruits and in making and packaging finished jellies from the concentrate. Actual weight and volume per unit package of concentrate from each instant jelly formula are presented in Table 8. In all cases the volume per unit package of concentrate was within the 12-ounce limitation with the excep-

TABLE 7. FORMULATIONS FOR INSTANT JELLY CONCENTRATES AND STANDARD JELLY FROM DIFFERENT MUSCADINE JUICE CONCENTRATES, 1975[1]

Kind of jelly[2]	Jelly component	Ingredients				
		Sugar	Other solids: (1) pectin (2) fruit solids (3) acid	Water	Totals	Brix
		Lb.	*Lb.*	*Lb.*	*Lb.*	*Pct.*
Muscadine grape II (made from 39.5 Brix concentrate)	**Concentrate:**					
	Pectin solution	0.76	(1) 0.23	2.54[3] 2.34[4]	3.33	30.0
	Muscadine conc.		(2) 4.52	6.92	11.44	39.5
	Citric acid		(3) 0.20		0.20	
	Totals, conc.	0.76	4.95	9.26	14.97[5]	38.2
	Finished jelly:					
	Added ingr.	33.72		12.74[3] 11.96[4]	45.68	74.0
	Totals, jelly	34.48	4.95	21.22	60.65	65.0
Muscadine grape III (made from 49.0 Brix concentrate)	**Concentrate:**					
	Pectin solution	0.46	(1) 0.23	2.90[3] 2.70[4]	3.39	20.3
	Muscadine conc.		(2) 4.52	4.71	9.23	49.0
	Citric acid		(3) 0.18		0.18	
	Totals, conc.	0.46	4.93	7.41	12.80[6]	43.6
	Finished jelly:					
	Added ingr.	34.08		14.62[3] 13.84[4]	47.86	71.2
	Totals, jelly	34.54	4.93	21.25	60.66	65.1

[1] Made from experimental freeze concentrated muscadine juice.
[2] Formulated by USDA Standards with 16 Brix used provisionally as standard for single strength muscadine juice.
[3] Water added.
[4] Water remaining in product after heating.
[5] 14 packages, 16 fluid oz. each, frozen. Later, each package combined with 2 cups water and 5⅛ cups sugar, yielding approximately 4.25 lb. of jelly.
[6] 14 packages, 12 fluid oz. each, frozen. Later, each package combined with 2 cups water and 5¼ cups of sugar, yielding approximately 4.25 lb. of jelly.



Weight-volume relations of sucrose solution at different brix levels.—Prepared by aid of circular of Bureau of Standards, No. 375 (1929).

TABLE 8. WEIGHT AND VOLUME PER UNIT PACKAGE OF DIFFERENT INSTANT JELLY CONCENTRATES

Year	Fruit	Juice concentrate used	Formulated jelly concentrate: Batch weight	Soluble solids	Per unit package: Weight	Volume[1]	Sugar[2]
		Brix	*Lb.*	*Brix*	*Lb.*	*Oz.*	*Cup*
1974	Apple	44.0	12.77	41.5	0.912	11.82	5¼
	Orange	44.0	12.69	42.0	0.906	11.70	5¼
	Concord grape	46.5	13.02	42.8	0.929	11.98	5⅛
	Muscadine	45.0	13.10	43.7	0.932	12.01	5⅛
1975	Muscadine II	39.5	14.97	38.2	1.069	14.01	5⅛
	Muscadine III	49.0	12.80	43.6	0.914	11.47	5¼

[1] Fluid ounces/pkg. $= \frac{\text{Batch wt. of formulation} \times 128}{\text{Wt./gal. of formulation} \times 14}$

[2] Sugar added in finishing jelly, two cups of water added in all cases.

tion of muscadine II formulation. Due to a relatively low Brix level of the juice concentrate used, the volume of each of the 14-unit packages of this jelly concentrate was 14 fluid ounces. Twelve-fluid-ounce packages of this product would have required smaller quantities of water and sugar per package in making a standard jelly, and the yield of jelly would have been reduced.

HOME EVALUATION OF INSTANT JELLY CONCENTRATES

Evaluation in 1974

Three of the jelly concentrates, apple, orange, and muscadine grape, were evaluated in homes in 1974. Each concentrate was evaluated by 10 homemakers which included faculty, secretaries, and laboratory technicians employed at Auburn University as well as wives of faculty members. All individuals contacted about the study were willing to participate. The number of products tested by a participant ranged from 1 to 3.

Each participant was supplied with 12-fluid-ounce jar of the jelly concentrate, an instruction sheet for making the jelly, Table 9, a questionnaire to be returned, Table 10, and a container for returning a sample of the finished jelly.

Most of the participants returned their questionnaires and jelly samples promptly, but a few were slow in doing so. When asked about the delay, they gave "lack of time" as the reason. However, when they finally made their jelly, they invariably reported that

TABLE 9. INSTRUCTIONS SUPPLIED WITH SAMPLES OF FROZEN INSTANT JELLY CONCENTRATE

This sample jar of_____frozen jelly concentrate will make 4.25 lb. of standard jelly when combined with_____of sugar and 2 cups of water as follows:

1. To defrost: Remove the concentrate from freezer and defrost at a time most convenient to your schedule. One of the following procedures may be followed:
   a. Hold in refrigerator at least 10 hr. (may hold 1 week)
   b. Hold at room temperature for 1 hr. (may hold 10 hr.)
   c. Temper jar of frozen concentrate briefly in cold water and warm water, then hold in hot water for 30 minutes.
2. Clean jars and covers for packaging the jelly and place in hot water.
3. If defrost method "a" or "b" is used, place jar of concentrate in hot water for pre-warming.
4. Add specified sugar and water to sauce pan, heat on high burner and stir until sugar dissolves and mixture boils. Continue boil for 1 minute. Immediately, turn off heat but leave pan on burner, add pre-warmed concentrate, stir until uniformly mixed, pour immediately in pre-warmed jars, cap. Put caps on jars immediately after pouring jelly, but delay tightening of caps for one or two minutes to permit the escape of air from jar head-space. Cool product in air, or temper and cool in tap water.

TABLE 10. QUESTIONNAIRE ON INSTANT JELLY CONCENTRATE

Cooperators testing this instant jelly concentrate will please complete the following questionnaire and return to Hubert Harris, Horticulture Dept., Auburn University, Auburn, AL 36830. Also please return a small sample (approximately an ounce) of your finished jelly.

Were the instructions for making jelly adequate and easy to follow? If not, please explain._____

With possible ratings of **poor, fair, good, very good** or **excellent,** how would you rate the jelly you made as to:
jelly set_____; color_____; flavor_____; convenience in making product_____; a way to reuse jars on hand_____.
Please give your opinion on market potential for this product. If jelly concentrates of different fruits were stocked in food stores along with other frozen juice concentrates, and prices were reasonable, do you think the products would move poorly_____, fairly well_____, or well_____?
Name_____

they were surprised at the speed and simplicity of the process. Interest of participants appeared to increase as they evaluated the second and third product.

Results of 1974 Home Evaluation Tests

Laboratory tests on returned jelly samples are presented in Table 11. Evaluations by participants on jelly set, color, flavor, convenience in making product, and reuse of jars on hand are presented in Table 12. Opinions of participants on potential sale of instant jelly concentrates are presented in Table 13.

TABLE 11. LABORATORY TESTS ON HOME PROCESSED JELLIES FROM INSTANT JELLY CONCENTRATE, 1974[1]

Jelly product	Jelly samples from 10 participants			
	Brix		pH	
	Range	Mean	Range	Mean
Apple	65.2 to 68.6	66.6	2.97 to 3.05	3.02
Orange	65.3 to 69.0	66.8	3.10 to 3.22	3.17
M. grape	64.5 to 67.5	65.7	2.75 to 2.85	2.80

[1] Small samples of jelly supplied by participants.

Evaluation of Jelly Concentrates in 1975

Instant jelly concentrates of apple and Concord grape made by the formulas developed in 1974, and of muscadine II and muscadine III developed in 1975 were evaluated in homes in 1975. Procedures used in the 1974 home tests were followed. Results of laboratory tests on returned jelly samples are presented in Table 14. Results of scores from returned questionnaires are presented in Table 15. Opinions of participants on potential for sale of

TABLE 12. HOME EVALUATION OF INSTANT JELLY CONCENTRATES, 1974

Jelly product and factors evaluated	Score distribution of 10 participants					Total score
	Poor (0)	Fair (2.5)	Good (5)	V. good (7.5)	Exc. (10)	
Apple:						
Jelly set	0	0	1	4	5	85
Color	0	0	1	0	9	95
Flavor	0	0	0	2	8	95
Convenience	0	0	1	0	9	95
Reuse of jars	0	0	1	2	7	90
				Mean score		92.0
Orange:						
Jelly set	0	0	1	3	6	87.5
Color	0	0	1	2	7	90
Flavor	0	0	1	2	7	90
Convenience	0	0	0	1	9	97.5
Reuse of jars	0	0	1	2	7	90
				Mean score		91.0
M. grape:						
Jelly set	0	0	0	3	7	92.5
Color	0	0	1	2	7	90
Flavor	0	0	0	4	6	90
Convenience	0	0	0	0	10	100
Reuse of jars	0	0	2	2	6	85
				Mean score		91.5

instant jelly concentrates through food stores are summarized in Table 16.

Summary of Home Evaluation Tests

Results of the 1975 home evaluation tests were highly favorable as was true of the tests made in 1974. Of more than 90 tests made during the two seasons, only one jelly failure resulted. This resulted from a gross error in reading instructions. Instead of using 5⅛ cups of sugar in finishing the jelly, ⅝ cup was used. When given another sample, this cooperator's jelly tested very close to standard.

This study indicates that instant jelly concentrates can be used successfully in the home for making high quality jellies. The

TABLE 13. OPINION OF PARTICIPANTS ON POTENTIAL SALE OF INSTANT JELLY CONCENTRATES, 1974

Jelly product	Number of participants that thought jelly concentrate would sell		
	Poorly	Fairly well	Well
Apple	0	0	10
Orange	0	0	10
M. grape	0	1	9

TABLE 14. LABORATORY TESTS ON HOME PROCESSED JELLIES FROM INSTANT JELLY CONCENTRATES, 1975

Jelly product	Jelly samples from 10 participants			
	Brix		pH	
	Range	Mean	Range	Mean
Apple	64.0 to 71.2	67.2	3.00 to 3.10	3.05
Concord grape	65.7 to 68.0	67.2	2.90 to 3.00	2.95
Muscadine II	58.8 to 69.1	66.1	2.70 to 2.70	2.70
Muscadine III	64.5 to 70.5	66.2	2.59 to 2.63	2.61

method is appealing to home processors with regards to convenience and reliability in making the jelly, quality of the product, and reuse of accumulated jars. Eighty percent of cooperators

TABLE 15. HOME EVALUATION OF INSTANT JELLY CONCENTRATES, 1975[1]

Jelly product and factors evaluated	Score distribution of 10 participants[2]					
	Poor (0)	Fair (2.5)	Good (5.0)	V. good (7.5)	Exc. (10)	Total score
Apple:						
Jelly set	0	0	2	6	2	75.0
Color	0	0	2	4	4	80.0
Flavor	0	0	5	2	3	70.0
Convenience	0	0	1	5	4	82.5
Reuse of jars	0	0	3	5	2	72.5
				Mean score		76.0
Concord grape:						
Jelly set	0	0	1	4	5	85.0
Color	0	0	1	2	7	90.0
Flavor	0	0	1	5	4	82.5
Convenience	0	0	1	2	7	90.0
Reuse of jars	0	0	1	1	8	92.5
				Mean score		88.0
Muscadine II:						
Jelly set	0	0	2	3	5	82.5
Color	0	1	0	3	6	85.0
Flavor	0	0	1	3	6	87.5
Convenience	0	0	0	2	8	95.0
Reuse of jars	0	0	0	3	7	92.5
				Mean score		88.5
Muscadine III:						
Jelly set	0	0	1	3	6	87.5
Color	0	0	1	2	7	90.0
Flavor	0	0	2	4	4	80.0
Convenience	0	0	1	2	7	90.0
Reuse of jars	0	0	1	3	6	87.5
				Mean score		87.0

[1] Each jelly product evaluated by 10 persons interested in home processing of foods.

[2] Mean scores of all tests: Jelly set, 82.50; Color, 86.25; Flavor, 80.00; Convenience, 89.38; Reuse of jars, 86.25. Mean of all scores 84.88.

TABLE 16. OPINION OF PARTICIPANTS ON POTENTIAL SALE OF INSTANT JELLY CONCENTRATES, 1975

Jelly product	Number of participants that thought jelly concentrate would sell		
	Poorly	Fairly well	Well
Apple	0	3	7
Concord	0	2	8
Muscadine II	0	2	8
Muscadine III	0	1	9
Total	0	8	32

thought the products would move well if marketed through food stores, 20 percent thought they would move fairly well, and none thought they would move poorly.

Comments by Home-Test Participants

Comments were not asked for on the Home-Test Questionnaire. Following are typical comments that were voluntarily submitted at the bottom of the questionnaire sheet.

"It is really surprising to see how fast and easy this makes up. . . . I would be pleased to conduct further experiments in this category."

"I have never made jelly because it was too hard or I didn't have the time. This was so quick and easy I would make it all the time as the flavor and quality were great."

"I thought all aspects of the product were 'great'!"

"I processed apple jelly by home-dripping using commercial pectin, and compared it with jelly made from the instant concentrate. Home-dripped jelly was less clear and noticeably more foam to skim off. I had problem of consistent set with my home-dripped jelly which is frustrating."

"I would buy it if the price was reasonable."

"It is a very easy way to make good jelly."

"I believe this product would have excellent market potential due to the convenience."

"I know I would buy it."

"The products would move well after they were tried and the consumer recognized the simplicity of the process."

"Really sets fast. Underline 'pour immediately'."

"My 2-year-old selects this jelly over other jellies on the table. The rest of my family has to get used to a 'new' flavor." (This was orange jelly.)

"My family doesn't eat apple jelly very well, but they loved this."

"I didn't believe it could be so easy."

"I believe this excellent product will have formidable marketing problems due to consumers lack of familiarity with muscadine grapes." (Sample was muscadine jelly.)

"Would move well on market after reputation established."

"Would move well if good marketing program involving demonstrations used."

SUMMARY

This study was concerned with developing and testing frozen instant jelly concentrates suitable for home processing of fruit jellies with less labor and greater reliability, as compared with conventional home methods. Formulas for jelly concentrates of apple, orange, Concord grape, and muscadine grape were developed, each having correct amounts of fruit solids, pectin and acid to produce standard jellies when later combined with specified quantities of water and sugar and heated briefly. The formulas were designed to yield 4.25 pounds of standard jelly from 12 fluid ounces of concentrate when combined with 2 cups of water and 5⅛ to 5¼ cups of sugar. Jelly is finished by mixing sugar with water, heating, boiling 1 minute, adding concentrate, pouring. Total time required is 16 minutes.

More than 90 12-ounce samples of the concentrates were tested by homemakers with highly favorable results. The method appears to be appealing to homemakers with regard to convenience and reliability in making the jelly, quality of products, and reuse of jars on hand. Eighty percent of the cooperators thought the products would move well if marketed through food stores, 20 percent thought they would move fairly well and none thought they would move poorly.

Making fruit jellies by conventional home methods is laborious and problematical. Products are often substandard in fruit solids, flavor, set, or other qualities as a result of maturity of fruit used, methods used in juice extraction, acid and pectin supplementation, boiling, and/or finishing the jelly. Foam formation may also be a problem.

LITERATURE CITED

(1) ANONYMOUS. 1972. Ball Blue Book, Edition 29. Ball Corp. Muncie, Indiana. pp. 85-94.

(2) ANONYMOUS. 1949. Preservers Handbook. Calif. Fruit Growers Exchange, Ontario, Calif. pp. 46-52.

(3) ANONYMOUS. 1974. Home Canning and Freezing Book. Kerr Glass Manufacturing Corp., Sand Springs, Okla. pp. 33-36.

(4) DESROSIER, N. W. 1963. The Technology of Food Preservation. AVI Publishing Co., Westport, Conn. pp. 268-75.

(5) DOWNEY, ISABELLE. 1975. Food Preservation in Alabama. Ala. Coop. Ext. Service, Auburn Univ. Cir. HE-1, pp. 59-79.

(6) HARRIS, HUBERT. 1954. Retaining Volatile Flavors in Fruit Jellies and Jams. Proc. 51st Annual Conv. Assoc. Sou. Agr. Workers, p. 133.

(7) ----------, AND R. L. SPIGNER. 1956. Freeze Concentration Process for Making Fruit Jellies and Jams with High Retention of Volatile Flavors. Proc. 53rd Annual Conv., Assoc. Sou. Agr. Workers, pp. 169-70.

(8) ----------. 1957. New Process for Superior Jams and Jellies. Auburn Univ. (Ala.) Agr. Exp. Sta., Highlights of Agr. Res. Vol. 4, No. 4.

(9) ----------. 1975. Instant Jelly Concentrates. 72nd Annual Conv. Sou. Assoc. Agr. Sci., Food Sci. Sec. Abstracts, Vol. 12, p. 45.

(10) JUDGE, E. E. 1972. Food and Drug Standards of Identity, Quality and Fill – Jellies. The Canning Almanac of the Canning, Freezing, Preserving Industries, Westminister, Md. pp. 218-22.

(11) MULLER, J. G. 1967. Freeze Concentration of Food Liquids: Theory, Practice, and Economics. Food Technol. 21: 1, 49-61.

(12) SARAVACOS, G. D., J. C. MOYER, AND G. D. WOOSTER. 1970. Concentration of a Liquid Food in a Pilot-Scale Falling Film Evaporator. New York State Agr. Exp. Sta., Food and Life Sci. Bull. No. 4.

APPENDIX

Juice Extraction

Extraction methods. Different methods are used in extracting juice from different fruits. Apples and grapes are usually extracted with a rack-and-cloth hydraulic press, or the pneumatic press which is similar in principal to the rack-and-cloth press.

Freeze-press extraction. A special freeze-press process has been developed. This process results in substantial concentration of the juice during extraction and has proven to have other advantages. By this method, harvested fruit is cleaned, crushed, packaged, and stored at approximately 0°F. Later it is partially defrosted in storage containers, emptied, mashed into an icy slurry at approximately 28°F and pressed in a rack-and-cloth, hydraulic press using approximately 80 psig on the press cloths. Concentration of the juice varies with pressing temperatures. Using grapes with original soluble solids content of 16 percent it is feasible to freeze-press a juice with soluble solids content of 19 percent. This eliminates approximately 23 percent of the water to be removed in making a final concentrate with 50 percent soluble solids. Additional advantages resulting from the ice in the product during pressing as compared with conventional pressing are:

No filter aid is needed during pressing. The ice serves as a filter aid and provides excellent clarification of juice.

Extrusion of pulpy material through cloth is greatly reduced as a result of the presence of ice crystals. This greatly reduces stress on press cloths and the labor requirements for removing the press cake from cloths and for cleaning cloths between batches.

The load in the press is stabilized against crawling or shifting of individual "cheese" during pressing.

Double the quantity of material can be put in each press cloth and a higher stack of "cheese" can be pressed in a given batch.

Two-step extraction by freeze-pressing results in very high recovery of soluble solids from the original fruit.

Data on freeze-pressing muscadine grapes are presented in Appendix Table 1. Included in the data is a comparison on recovery of soluble solids from freeze-pressing muscadines with and without a pectinolytic enzyme treatment.

Juice Concentration

Advantages of freeze concentration. Freeze concentration results in higher retention of volatile flavor constituents in the concentrate than any other concentration process, including freeze drying. Basic physical principles account for this unique feature. During freeze concentration, latent heat is removed from the product, and water in the crystalline form is separated from the dissolved solids. By other concentration processes except reverse osmosis, latent heat is added to the product and water vapor is removed. Even if the volatile flavors driven off by evaporative processes are recovered and returned to the product, the heat required to evaporate the water can easily cause change in flavor and some loss of vitamin content *(11)*. Furthermore, there is an additional cost in recovering the volatile materials and in blending them back into the finished concentrate.

Centrifuge test on frozen muscadine juice. A test was made to determine the minimum fruit solids loss in the discarded ice that could be achieved during freeze concentration of storage-frozen muscadine juice by centrifugation. Results are presented in Appendix Table 2. The outcome of this test indicates good possibilities for freeze concentration of storage frozen juice, and for reducing the fruit solids loss in the ice to a low level.

APPENDIX TABLE 1. EFFECT OF PECTINOLYTIC ENZYME[1] ON SOLUBLE SOLIDS RECOVERY IN FREEZE-PRESSING MUSCADINE GRAPES

Treatment before pressing[2]	Pressing treatment[3] Item	Temperature	Weight	Brix	Total solids	Equivalent weight per 100 lb. crushed grapes[4] Single strength juice[5]	Insoluble solids	Soluble solids	Recovery of soluble solids
		°F.	Lb.	Pct.	Pct.	Lb.	Lb.	Lb.	Pct.
Without enzyme	Crushed grapes		186.0	14.3	20.2	93.12	6.8		
	First pressing	28.0							
	Juice		115.8	15.8		68.80		9.84	73.54
	Cake		70.2				6.8		
	Second pressing[6]	30.5							
	Juice		47.8	7.5		13.49		1.93	14.42
	Final cake		57.4	6.7		11.26	6.8	1.61	
	Total sample					93.55		13.38	87.96
With enzyme	Crushed grapes		186.0	14.6	20.4	93.17	6.8		
	First pressing	28.0							
	Juice		115.8	17.2		73.35		10.71	78.90
	Cake		70.2				6.8		
	Second pressing[6]	30.5							
	Juice		47.0	6.9		11.93		1.74	10.81
	Final cake		58.0	4.7		7.88	6.8	1.15	
	Total sample					93.16		13.60	89.71
Without enzyme	Crushed grapes		185.9	14.4	20.2	93.22	6.8		
	First pressing	28.0							
	Juice		104.7	16.9		66.11		9.52	71.31
	Cake		81.3				6.8		
	Second pressing[6]	29.5							
	Juice		44.2	9.3		15.35		2.21	16.55
	Final cake		55.6	7.0		11.22	6.8	1.62	
	Total sample					92.68		13.35	87.86

(Con't.)

APPENDIX TABLE 1 *(Con't.)*. EFFECT OF PECTINOLYTIC ENZYME[1] ON SOLUBLE SOLIDS RECOVERY IN FREEZE-PRESSING MUSCADINE GRAPES

Treatment before pressing[2]	Pressing treatment[3] Item	Temperature	Weight	Brix	Total solids	Equivalent weight per 100 lb. crushed grapes[4] Single strength juice[5]	Insoluble solids	Soluble solids	Recovery of soluble solids
		°F.	Lb.	Pct.	Pct.	Lb.	Lb.	Lb.	Pct.
With enzyme	Crushed grapes		186.3	14.4	20.2	93.18	6.8		
	First pressing	26.0							
	Juice		95.8	18.7		66.78		9.62	71.79
	Cake		90.5				6.8		
	Second pressing[6]	29.5							
	Juice		51.4	8.6		16.50		2.38	17.76
	Final cake		57.7	5.8		9.72	6.8	1.40	
	Total sample					93 00		13.40	89.55

[1] Enzyme treatment consisted of 1 ml of Pectinol 59L (Rohn Haas) blended with each 32-pound can and holding period of 40 hours at 40°F. before storing at 0°F.

[2] Grapes were washed, hand sorted, crushed, packaged in 32-pound cans, enzyme treatment applied to some of the cans, all cans stored at 0°F. until pressed.

[3] Grapes partially defrosted, crushed, pressed in rack-and-cloth press for 20 minutes at 80 psig on cloths.

[4] Calculated on basis of all of the water and soluble solids in the batch of grapes, and Brix and total solids on sample after defrosting and equilibrating.

[5] Absolute juice as represented by the water-soluble solids and the water in the sample.

[6] Cake from first pressing broken up, 1 pound boiling water added to each 2 pounds cake, mixture frozen, partially defrosted, crushed, pressed.

APPENDIX TABLE 2. CONCENTRATION OF MUSCADINE JUICE BY FREEZING IN STORAGE CANS AND SEPARATING BY CENTRIFUGING[1]

Material	Treatment[1]		Centrifugation		Data on fractions		Soluble solids	
	Test no.	Temp. °F.	Stage	Time, min.-sec.	Weight	Brix	Weight	Recovery
					Lb.		*Lb.*	*Pct.*
Muscadine juice, 17.5% soluble solids	1	15	Start		8.00			
			concentrate	5:00	2.70	46.6	1.258	89.2
			Intermediate	3:00	0.41	26.0	0.107	7.6
			1st wash[2]	3:00	0.33	7.6	0.025	1.8
			2nd wash[3]	3:00	0.42	2.5	0.011	0.8
			Ice		4.10	0.2	0.008	0.6[4]
			Total	14:00	7.96		1.409	100.0
Removed from 0°F. storage, crushed without thawing, centrifuged.	2	7	Start		8.00			
			concentrate	10:00	2.77	47.5	1.316	96.0
			Intermediate	2:00	0.30	9.0	0.027	2.0
			1st wash[2]	3:00	0.33	4.0	0.013	1.0
			2nd wash[3]	2:00	0.40	1.4	0.006	0.4
			Ice		4.32	0.2	0.009	0.7[4]
			Total	17:00	8.12		1.371	100.1
Ice fractions from 1 and 2 above were held 24 hr. at 32°F., crushed, centrifuged.	3	34	Start		8.42	0.2	0.017	0.6
			Effluent	5:00	1.94	0.6	0.012	0.4
			Final ice		6.25	.08	0.005	0.2[4]

[1] International laboratory centrifuge with 11⅛" diameter basket 4" deep, ⅛" diameter perforations on ½" centers. Operated in room at 75°F., speed 3,500 rpm.

[2] Wash was from melting ice in product. No water was added.

[3] "Puff" of steam admitted to centrifuge as the 2nd wash treatment.

[4] Lost in ice fraction.