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Comparative Cooking Qualities of Some of the Common Varieties of Apples Grown in Oregon

BY

Ava B. Milam, Assistant Professor of Home Ecomomics
Harriet B. Gardner, Graduate Student in Home Economics

CORVALLIS, OREGON

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Foreword

Fruit is coming to occupy an increasingly important place in the diet. This statement is true not only for fresh fruit, but also for the many cooked products of which fruit forms an important part. More accurate information regarding the cooking properties of our various kinds of fruits is desirable from the viewpoint of both producer and consumer. It is believed that the data presented in this paper on the Cooking Qualities of Certain Apple Varieties add to the general fund of information on this subject.

The material upon which this article is based was presented as a thesis to the Faculty of the Oregon Agricultural College as part fulfillment of the requirements for a Master's Degree in Home Economics by Harriet B. Gardner.

A. B. CORDLEY,
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INTRODUCTION

The Apple is one of the most, if not the most, important of the fruits cultivated in the United States. In earlier years there were comparatively few varieties. Now, however, there are several thousand, each one of which has its own particular characteristics. It is necessary, therefore, for the housewife to be able to distinguish between some of the more common of these varieties, and to know their cooking qualities, if she is to obtain from them the best results.

Besides possessing a pleasing flavor and a small amount of food value, apples have a distinctly healthful influence upon the body, and should be used more in the diet than they are now.

In the hope of gaining definite knowledge of the cooking qualities of the more common varieties of apples grown in Oregon, a series of systematic experiments were carried out in the Oregon Agricultural College in 1913-14.

Object

In conducting the investigation three distinct objects were kept in view. First, to determine the relative value of a number of varieties of apples for certain cooking purposes. including sauce, pies, dumplings, jelly, and marmalade. It is hoped that the results obtained will aid the housewife in selecting varieties for her particular needs.

Second, to determine some of the general principles underlying these cooking properties and to trace the relationship of cooking in general to the dessert quality of the apple.

Third, to ascertain if differences in the cooking quality are associated with differences in the gross morphology and cell structure of the fruit.

Materials Used

The materials used in the investigation consisted in fruit of medium grade of 71 varieties of apples, a large percentage of which are standard commercial sorts. Most of this fruit was grown at Corvallis, Ore., though some was obtained elsewhere. Following is a table giving the names of the varieties and the season when each is most likely to be at its prime.

METHODS OF PROCEDURE

The apples were first washed, then weighed. To insure uniformity in results, one pound ten ounces, as purchased, was the weight taken each time for sauce, marmalade, and jelly. The apples were then pared and weighed

TABLE I. SEASON WHEN VARIOUS APPLES ARE AT PRIME FOR COOKING.

	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
Holland Pippin	X								
Keswick		X	X						
McMahon		X	X						
Maiden Blush		X	X						
Autumn Sweet		X	X	X					
Pumpkin Russet		X	X	X					
Twenty Ounce		X	X	X					
Wolf River		X	X	X					
Belmont			X	X					
Bismarck			X	X					
Beitigheimer			X	X					
Haas			X	X					
Melon			X	X					
Paradise Sweet			X	X					
Tompkins King			X	X					
Van Wyck			X	X					
Bailey Sweet			X	X	X				
Coos Bay Beauty			X	X	X				
Fameuse			X	X	X				
Delicious			X	X	X				
Jewett			X	X	X	X			
McIntosh			X	X	X	X			
Missouri Pippin			X	X	X	X			
Blue Pearmain			X	X	X	X			
Bethlehemite				X	X	X			
Dutch Mignonne				X	X	X			
King David				X	X	X			
Esopus				X	X	X			
Grimes				X	X	X			
Jonathan				X	X	X			
Western Beauty				X	X	X			
Baldwin				X	X	X	X		
Fallawater				X	X	X	X		
Ontario				X	X	X	X		
Opalescent				X	X	X	X		
Ortley				X	X	X	X		
Rambo				X	X	X	X		
Red Canada				X	X	X	X		
Wagener				X	X	X	X		
Washington Royal				X	X	X	X		
Winter Banana				X	X	X	X		
Bottle Greening				X	X	X	X	X	
Northwestern Greening				X	X	X	X	X	
Roxbury				X	X	X	X	X	
Salome				X	X	X	X	X	
Minkler				X	X	X	X	X	X
Domine					X	X	X		
Mann					X	X	X		
Northern Spy					X	X	X		
Ralls					X	X	X		
Rhode Island Greening					X	X	X		
Vanderpool					X	X	X		
Yellow Bellflower					X	X	X		
Arkansas					X	X	X	X	
Golden Russet					X	X	X	X	
Hyde King					X	X	X	X	
Romanite					X	X	X	X	
Rome					X	X	X	X	
Scott					X	X	X	X	
Stark					X	X	X	X	
Stayman Winesap					X	X	X	X	
Tolman					X	X	X	X	
Wismer					X	X	X	X	
York Imperial					X	X	X	X	
Arkansas Black					X	X	X	X	X
White Winter Pearmain					X	X	X	X	X
Winesap					X	X	X	X	X
Lady						X	X	X	
Lawver						X	X	X	
Rock Pippin						X	X	X	
Giant Jeniton						X	X	X	X
Black Ben Davis						X	X	X	X
Ben Davis						X	X	X	X
Gano						X	X	X	X
Yellow Newtown						X	X	X	X

again, the amount used for cooking being one pound six ounces. To the weighed apples, a certain amount of water was added in each case.

Recipes Used. Owing to the fact that there are many different recipes for making apple sauce, a few preliminary experiments were performed to find just which one would give the best results. For this test, the same variety of apple was cooked by each of the following methods, the weights of apples, water, and sugar used being the same.

1. Apples cut in small pieces, cooked in covered utensil, and sugar added just before removing from flame.
2. Apples prepared as above, but cooked in open utensil.
3. Apples prepared as in No. 1, then mashed.
4. Apples cut in small pieces, cooked in covered utensils with sugar added before cooking.

Results. 1. Sauce prepared by the first method was considered distinctly the best. The flavor, texture, and color were all good.

2. In the sauce cooked in open utensil, texture was not so good as that of the sauce prepared by the first method. It required almost double the amount of time for cooking, as well as more care, since water had to be added from time to time.

3. The sauce prepared by the third method was similar to that by the first. The flavor, texture, and color were all good, but a longer time was spent in its preparation

4. In the sauce prepared in the fourth way, the apples did not break apart so quickly or so completely, thus causing the sauce to be lumpy and poor in texture. The flavor, too, was not so good, due perhaps to the cooking of the sugar with the acid in the apple, thus changing part of the sugar to invert sugar.

The best recipe for simple apple sauce thus appears to be: wash, pare, and core apples; cut in small pieces; put in saucepan; pour over them enough cold water nearly to cover. Cook until soft; add sugar and cook until sugar is dissolved; then remove from fire. One pound six ounces, or four or five medium-sized apples, are used to one and one-half cups of water. Enough sugar to sweeten is added. This varies with the apple and with the individual taste, but generally about three-fourths to one cup is sufficient for the above amount.

Jelly

Wash and core apples; put into preserving kettle and add water nearly to cover. Cook until soft, then put into jelly bags and let drain over night. Measure juice and add three-fourths its measure of heated sugar. Cook until it reaches 217 degrees F. (jellying point). Remove from fire and pour into sterilized jelly glasses. Use materials in the proportions of one pound six ounces of apples to two cups of water. Take care not to squeeze the pulp, since with such treatment the jelly will not be clear; take care, also, not to over-cook the jelly, or it will be tough.

Pies

Crust:

4½ cups flour.
1 cup Crisco or other fat.
1 teaspoon baking powder.
¾ cup cold water.
¾ teaspoon salt.

Sift flour, baking powder and salt together. Cut in Crisco with a knife and when well blended add water enough to permit rolling. Roll out crust to ⅛ inch thickness and line a pastry tin with it.

Slice apples very thin and fill lower crust with them, add sugar (2 ½ tablespoons to 5 oz. apples) for individual pies. dot over with butter and sprinkle with cinnamon and a little flour. Put on upper crust and bake in moderate oven (280 degrees F.) until done.

Dumplings

Crust:

3 cups flour.
¾ cup Crisco or other fat.
¾ teaspoon salt.
8 tablespoons milk or water.
3 teaspoons baking powder.

Mix as pie crust. Roll out ⅛ inch thick on floured board and cut in squares large enough to cover the apple.

Wash, pare, and core apples; fill cavity with sugar (1 teaspoon sugar to 1 ounce apple); add small piece of butter and sprinkle with cinnamon. Fold the square of crust over this and stick together with cold water. Bake till apples are soft and crust is brown.

Marmalade

Wash, pare and core apples; put into preserving kettle and add enough water nearly to cover. Cook slowly until soft. Rub through a fine sieve and add ¾ its measure of heated sugar. Cook 20 minutes, stirring occasionally to prevent burning. Just before removing from the fire, add two slices of lemon. Use in the proportions of one pound six ounces apples to one and one-half cups water.

STANDARDS FOR JUDGING

For the purpose of giving a clear and definite conception of the qualities a good product should possess, the following descriptions are given:

An excellent apple sauce is a light colored product obtained by cooking the fruit with water until soft, so that the resulting mass is a smooth, even—not lumpy, syrupy or watery—product. It should have a pleasing aroma and retain, at least to a certain degree, the delicate flavor of the fresh fruit.

For an excellent apple pie, the fruit, when cooked, should be so tender that it has a smooth and even texture; the color should be bright, not dark and lifeless, and above all the product should possess a pleasing apple flavor.

An excellent dumpling is one that possesses a rich and pleasing flavor, and the fruit, when baked, shold not be tough; neither should it be too soft, but possess just enough body to hold its shape. The color, as in pies, should be bright and only slightly darker than the fresh fruit.

An excellent marmalade is the bright, clear product obtained by boiling

down the fruit pulp with water and sugar so that when finished it has a smooth, even—not granular—texture and a good flavor. It is usually a darker product than any of the above.

N. E. Goldthwaite has defined an ideal jelly as "a beautifully colored, transparent, palatable product obtained by so heating fruit juice that the resulting mass will quiver, not flow—when removed from its mold; a product with texture so tender that it cuts easily with a spoon, and yet so firm that the angles thus produced retain their shape; a clear product that is neither syrupy, gummy, sticky, nor tough; neither is it brittle and yet it will break and does this with a distinct, beautiful cleavage, which leaves sparkling, characteristic faces."

JUDGING OF PRODUCTS

That the products obtained in the course of the work might be accurately compared, the score-card method of judging was employed. In these score cards more emphasis may be placed upon certain features than is necessary; perhaps other features are not mentioned which some would consider important. It is hoped, however, that the points as given are of sufficient accuracy to make possible fair comparisons.

SCORE CARDS USED

Sauce and Marmalade		Pies and Dumplings	
Flavor	50	Flavor	65
Texture	25	Way cooked up	20
Color	25	Tenderness	15
Total	100	Total	100

Jelly

Flavor	35
Texture	
Tenderness	15
Consistency	20
Color	15
Clearness	10
Surface	5
	100

The products were judged each time by Professor E. J. Kraus and Professor V. R. Gardner, who considered them from the standpoint of the Pomologist, and by Miss S. L. Lewis, and the writers, who considered them from the viewpoint of the Domestic Scientist.

At no time while the products were being scored did the judges know what varieties they were judging, so that an opinion unprejudiced by any knowledge of the dessert quality of the variety was obtained from each one.

In comparing sample score cards of each judge, it was easily seen that while there were differences in the total scores of each, the ranking of the varieties was nearly the same. In each case the scores given in this paper represent the average of those of the five judges just mentioned.

CAUSES OF EXPERIMENTAL ERROR

The greatest care was exercised in the experiments, so that the results would be accurate. There were certain unavoidable circumstances, however, which might cause slight errors. The fuel used was gas, and its pressure varied from time to time, making it impossible to keep the temperature always constant. The fruit was cooked at different times, thus making it possible for the individual judges to differ in their opinions of good products, for even though the same standards were used throughout the investigation, the judges would unconsciously be more critical, and consequently score lower, some days than others. While some of the fruit was first grade, a large amount of the work was carried on with fruit that would rank in the market as second or third grade.

THE EXPERIMENTS

A portion of the fruit experimented with was under normal size, while again, perhaps some was above the normal size. It was therefore deemed necessary to ascertain whether the size of the fruit has any considerable influence upon the cooking quality of a given variety. An experiment, having this question in mind was made, with results as indicated in Table II.

TABLE II. COOKING QUALITY OF APPLES AFFECTED BY SIZE OF FRUIT

Variety	Flavor	Texture	Color	Total	Remarks
Large ripe Grimes	41.6	21.8	21	84.4	Good
Small ripe Grimes	40.4	20.2	20.4	80.2	Good
Small Yellow Newtown	31	10.3	21.3	62.6	Poor
Large Yellow Newtown	32	12	22	66	Poor

From the above data the conclusion seems warranted that while large apples are slightly better for sauce than small ones of the same variety, size of fruit makes comparatively little difference in the cooking quality of apples for sauce.

The fruit used also varied considerably in degree of maturity. Consequently the question was raised, as to whether the ripeness of the fruit materially influences its cooking quality. Sauce from fully mature and rather immature fruits of the same variety was prepared at different times and was scored as indicated in Table III.

TABLE III. COOKING QUALITY OF APPLES AS AFFECTED BY MATURITY OF FRUIT

Variety	Flavor	Texture	Color	Total	Remarks
Grimes (early)	46.8	25.6	23.6	96	Excellent
Grimes (late)	45.6	23.6	23	92.2	Excellent
Northern Spy (early)	39.4	21	19.2	79.6	Fair
Northern Spy (late)	43.6	21	22.3	86.9	Very good
Yellow Newtown (early)	35	12	14	61	Poor
Yellow Newtown (late)	32	12	22	66	Poor

TABLE IV. SHOWING AVERAGE SCORE OF VARIETIES USED IN SAUCE

VARIETY	Flavor	Texture	Color	Total	Remarks
Rambo	46	24.5	23.5	94	Excellent
Tompkins King	46.4	23.2	24.2	93.8	Excellent
Grimes	46.8	22.8	22.6	92.2	Excellent
Ortley	43.8	32.4	23.6	90.8	Excellent
Wagener	44.4	22.4	22.8	89.6	Very good
Northern Spy	43.6	21	22.3	86.9-	Very good
Yellow Bellflower	43.8	20.2	21	85	Very good
Ontario	40.4	22.2	22.2	84.8	Good
Missouri Pippin	40	22.6	22	84.6	Good
Western Beauty	40.4	21.6	21.6	83.5	Good
Twenty Ounce	42	18.8	22.7	83.5	Good
Melon	44.4	20	18	82.4	Good
Lawver	39.8	19.2	23.4	82.4	Good
Gano	37	21.5	23.5	82	Good
Esopus	40.6	19.2	20.4	80.2	Good
Stayman Winesap	36.6	20	23.1	79.7	Fair
Jewett	38	20.8	20.4	79.2	Fair
York Imperial	40.6	20.4	18.1	79.1	Fair
Northwestern Greening	41.2	19.2	18.4	78.8	Fair
Canada Red	36	21.5	21	78.5	Fair
McMahon	39.2	18.2	21	78.4	Fair
Ralls	39	20	19	78	Fair
Salome	39	19	19.5	77.5	Fair
Rhode Island Greening	38.6	16.6	21.7	76.9	Fair
Bottle Greening	35.6	29.6	20.8	76	Fair
Beitigheimer	37.4	20.1	18.5	76	Fair
Winesap	37.5	16.5	21	75	Fair
Arkansas (Mammoth Black Twig)	37.5	17.7	19.5	74.7	Fair
McIntosh	36.6	18.6-	18.8	74	Fair
Domine	36	17	21	74	Fair
Delicious	32.8	19	22	73.8	Fair
Black Ben Davis	38	16.5	19	73.5	Fair
Washington Royal	34.3	16.6	22.3	73.2	Fair
Jonathan	36.4	17.6	19.2	73.2	Fair
Bethlehemite	36.4	15.6	20.6	72.6	Fair
Rome	31.3	20.2	20.7	72.1	Fair
Winter Banana	38.2	15.2	18.4	71.8	Fair
Vanderpool	34	21	16.6	71.6	Fair
Roxbury	39	14.6	17.6	71.2	Fair
Belmont	39.6	21	20.6	71.2	Fair
Van Wyck Sweet	35.4	19.4	16.2	71	Fair
Maiden Blush	37	17	17	71	Fair
Coos Bay Beauty	37.8	15.8	17.2	70.8	Fair
Bismarck	34.4	17	18.6	70	Fair
Fallawater	35.6	16	18.2	69.8	Poor
Keswick	32.2	18.1	19.2	69.5	Poor
Ben Davis	32.2	18	18.7	68.9	Poor
Hyde King	33.6	15	19.3	67.9	Poor
White Winter Pearmain	30.7	19.2	19.8	67.7	Poor
Rock Pippin	31.5	18	17.5	67	Poor
Mann	36.5	14.5	16.5	67.5	Poor
Baldwin	29.6	23	14.6	67.2	Poor
Yellow Newtown	32	12	22	66	Poor
Holland Pippin	34.9	17	15	66	Poor
Golden Russet	35.6	13.3	17.1	66	Poor
Romanite	31	17.5	16.2	64.7	Poor
Opalescent	33	14.3	17.3	64.6	Poor
Lady	35	15.6	14	64.6	Poor
Sutton	30.6	16.6	17	64.2	Poor
Haas	33.1	15.1	14.5	62.7	Poor
Stark	30.6	12.8	19	62.4	Poor
Bailey Sweet	31.2	15	15.8	62	Poor
Dutch Mignonne	30	14	17.5	61.5	Poor
Blue Pearmain	24.3	10.6	13	60.9	Poor
Autumn Sweet	26.6	13	21.2	60.8	Poor
Scott	25	14	20.5	59.5	Poor
Wismer Dessert	22	16.5	15.7	54.2	Poor
Paradise Sweet	20.5	14.7	14	49.2	Poor
Minckler	25.3	10.6	13	48.9	Poor
Pumpkin Russet	26.5	8.6	11.6	46.7	Poor
Tolman Sweet	15.7	12.2	10	37.9	Poor
Fameuse	40.4	19.1	17.7	77.2	Fair

It is evident from an inspection of Table III that the cooking quality of some varieties is slightly influenced by the degree of maturity of the fruit. In the case of the varieties studied it seems that fruits at their prime, and even a little later, make better sauce than those that are underripe.

Tables IV, V, VI, VII and VIII given here show the average score for certain products for each variety experimented with. From them, a fair idea may be obtained as to the quality of product given by each variety and how they compare with one another.

TABLE V. SHOWING AVERAGE SCORE OF VARIETIES USED IN PIES

Variety	Flavor	Tenderness	Way cooked up	Color	Total	Remarks
Northern Spy	57	15	19.7	5	96.7	Excellent
Bottle Greening	55.7	14.7	19.7	5	95.1	Excellent
Mountain Sweet	56.2	14	19.2	5	94.4	Excellent
Rambo	56.5	14.2	19	4.4	94.1	Excellent
Bethlehemite	55.2	14.5	18.7	4.5	92.9	Excellent
Beitigheimer	53.75	14	18	5	90.75	Excellent
Maiden Blush	53.5	14	18	5	90.5	Excellent
Ribston Pippin	53.2	14.7	18.3	4	90.2	Excellent
McMahon	50	15	19.5	5	89.5	Very good
Gano	53.5	14.2	17	4.5	89.2	Very good
Wagener	52.2	13.3	18.7	4.6	88.8	Very good
Ontario	52.5	13.7	18.2	4.5	88.7	Very good
Arkansas	53.3	13	17.3	5	88.6	Very good
McIntosh	51.5	13.8	17.7	4	87	Very good
Jonathan	52.6	13	18.4	3.98	87.98	Very good
Western Beauty	50.5	14	18.7	4.3	87.5	Very good
Grimes	51.6	13.8	17.4	4.5	87.3	Very good
Winesap	51.7	13.2	17.2	4.7	86.8	Very good
Belmont	48	14.7	19	5	86.7	Very good
Rome	51	14.3	17.2	4.7	86.2	Very good
Domine	51.7	13	17	4.6	86.3	Very good
Lawver	49.7	14	18	4.5	86.2	Very good
Yellow Bellflower	47.5	14.6	19	5	86.1	Very good
White Winter Pearmain	51.5	15	15.5	4	86	Very good
Giant Jeniton	51.2	12.5	17.8	3.9	85.4	Very good
York Imperial	50.2	12.2	17	4.5	83.9	Good
Red Canada	48.2	13.2	17.7	4.2	83.3	Good
Mann	49.2	13.2	16.5	3.7	82.9	Good
Salome	47	13	18	4.3	82.3	Good
Twenty Ounce	46.4	14	18.2	3.6	82.2	Good
Vanderpool	46.3	13.6	16.3	4.5	80.7	Good
Coos Bay Beauty	46.2	12	18.5	4	80.7	Good
Scott	42.6	14	18.6	4.6	79.8	Good
Rhode Island Greening	43.7	14.2	17.2	4.1	79.2	Good
Holland Pippin	47.6	13.8	15	3	79.4	Good
Melon	43.2	15.4	13.8	5	77.4	Good
Fameuse	40.25	14	17.75	5	77	Good
Fallawater	42.7	13.2	15.2	2.2	73.3	Good
Haas	40	14	15.75	4.75	74.5	Good
Opalescent	43.5	13	13.2	3.5	73.2	Good
Tompkins King	39.6	13.2	17.4	4.2	74.4	Good
Yellow Newtown	45	9.3	13.6	4.5	72.4	Good
Rock Pippin	41.2	12.5	14.5	3.7	72.2	Good
Jewett	40	12.6	14.3	4	70.9	Good
Missouri Pippin	40.5	12.5	15.2	2.5	70.7	Good
Winter Banana	39	13.2	14.8	2.3	69.3	Poor
Wolf River	32.5	14	17.5	4	68	Poor
Tolman Sweet	32.5	14.3	16	3.5	66.3	Poor
Paradise Sweet	34.5	13.5	15	3.2	66.2	Poor
Stayman Winesap	37.2	11.2	14.2	2.3	64.9	Poor
Hyde King	35	13.2	14.5	2	64.7	Poor
King David	33.7	11.2	15.5	2.4	62.8	Poor
Pumpkin Russet	26	11	11.2	1	49.2	Poor

TABLE VI. SHOWING AVERAGE SCORE OF VARIETIES USED IN DUMPLINGS

Variety	Flavor	Tender-ness	Way cooked	Color	Total	Remarks
Fameuse	56.6	14.6	15.8	5	92	Excellent
Maiden Blush	52.2	14	17.6	4.4	88.2	Very good
Minkler	43	12.5	16	4.7	86.2	Very good
Grimes	50.8	14.2	16.4	4.4	85.8	Very good
Northern Spy	51	14.3	16	4.3	85.6	Very good
Red Canada	50.5	13.7	16.5	4.3	85	Very good
Tompkins King	50	12.16	18.16	4.55	84.9	Very good
Scott	49.7	13.5	17.2	4.5	84.9	Good
Rambo	47	15.4	17.4	4.4	84.2	Good
Domine	46.6	15	17.8	4.4	83.8	Good
Bottle Greening	47.6	15	17	4	83.6	Good
Jonathan	49.6	13.4	16.2	4.2	83.4	Good
Belmont	46	14.6	17.6	4.8	82.8	Good
Mann	45.5	13.7	17.2	4.5	80.9	Good
Yellow Bellflower	45.6	14.3	17.3	3.6	80.8	Good
Rome	44	14	17.2	4.1	79.3	Fair
Bethlehemite	44	13.6	17	4.3	78.9	Fair
Beitigheimer	46.8	14	17.6	4	78.4	Fair
Salome	44	13.7	17	4	78.7	Fair
York Imperial	42.6	13	17.6	4.6	77.8	Fair
Twenty Ounce	45	13.16	15.5	3.83	77.49	Fair
Coos Bay Beauty	45	13.2	15.8	3.3	77.3	Fair
Rhode Island Greening	40.3	14.6	17.6	4.3	76.8	Fair
McMahon	41.6	14.4	16.8	3.4	76.2	Fair
Gano	43	12.7	16.5	4	76.2	Fair
Ben Davis	42.5	13.7	15.2	3.1	74.5	Fair
Lawver	49.3	4.6	17.3	3.3	74.5	Fair
Haas	37	13.4	15.8	3.2	69.4	Poor
Romanite	37	12	12.5	3.5	65	Poor
White Winter Pearmain	34.5	12.2	14	3.2	63.9	Poor
Rock Pippin	27.5	11.7	12.5	3.5	55.2	Poor
Paradise Sweet	28.7	10.7	12.2	2.7	54.3	Poor
Jewett	25.6	11.8	13.6	2.9	53.9	Poor
Tolman Sweet	26.5	11.5	13	2.7	53.7	Poor

TABLE VII. SHOWING AVERAGE SCORE OF VARIETIES USED FOR JELLY

Variety	Flavor	Tender-ness	Consist-ency	Color	Clear-ness	Surface	Total	Remarks
Scott	33.62	14.5	17.25	13.75	9	4	92.12	Excellent
Lawver	32.25	14.25	18.75	13.75	8.75	4	91.75	Excellent
Twenty Ounce	31.6	14.2	17.6	13.4	9.6	5	91.4	Excellent
Maiden Blush	30.8	14	18.4	14.4	9.2	4.4	91.2	Excellent
Melon	30.5	14.5	17.2	13	9.7	5	90.2	Excellent
Dutch Mignonne	29.25	13.5	18.5	14	10	4.5	89.75	Very good
Jonathan	28.7	11.7	17.5	16.7	9.2	4.2	88	Very good
Rome	28.5	14.2	18.5	13.5	8.7	4.2	87.6	Very good
Vanwyck	31.2	13.5	18	11.7	8.5	4.5	87.4	Very good
Fameuse	28.2	14	17.6	13.6	8.8	4.8	87	Very good
White Winter Pearmain	29.5	14	18.5	12.7	8	4.2	86.9	Very good
Salome	28.5	14.5	16.75	11.75	7.87	4	86.75	Very good
Coos Bay Beauty	30	13.7	16.2	13.2	9	4.5	86.6	Very good
Northern Spy	29	14	16.1	15	9	4	87.1	Very good
Tompkins King	28.6	13	17.8	13	8.6	4.3	85.3	Very good
Wegener	29.5	13	17.5	12.5	8.2	3.5	84.2	Very good
Belmont	29.5	14.5	16.75	11.75	7.87	4	84.37	Good
Rock Pippin	29	13	17	17	8.5	4.2	83.9	Good
Western Beauty	27.25	13.75	17.25	13.12	8.62	4	83.74	Good
Bethlehemite	29.5	13	16	12.62	8.12	4	83.24	Good
Beitigheimer	28.4	13	17	11.8	8.8	4.2	83.2	Good
Rambo	26.5	13.74	17	13.5	8	4.25	83	Good
Winesap	28.75	14.25	16.75	14.5	8.25	4.3	82.8	Good
Yellow Newtown	26.75	12	16	13.5	8.25	4	80.5	Good
Yellow Bellflower	26.75	12.5	16	12.5	8.75	3.25	79.25	Fair
Red Canada	26.25	12.5	16	12.5	8.75	3.25	79.25	Fair
York Imperial	25.75	14	15	12	8.25	3.75	78.75	Fair
Bottle Greening	25.25	13.5	17	11.75	7.5	3.5	78.5	Fair
Romanite	27	10.7	14	13	8.7	3.5	76.9	Fair
Gano	26	13.25	13	12.5	7.5	3.75	76	Fair
Haas	28.6	13.2	11.4	11.6	7.8	2.6	75.2	Fair
Bailey Sweet	23.9	9.3	15	13.5	9.5	4	75.2	Fair
Grimes	26.7	14	12.5	10	8	3.7	74.9	Fair
Black Ben Davis	24.5	11	14.25	13.5	7.75	3.75	74.75	Fair
Mann	25.5	13.28	9.25	13	8.75	3.25	73.03	Fair
Domine	25.5	12.5	12.75	11	5.75	4	71.5	Fair
Holland Pippin	26.2	13.8	9	11.2	8.6	2.6	71.4	Fair

Pumpkin Russet makes no jelly, only a syrup. Paradise Sweet makes no jelly, only a syrup.
Tolman Sweet makes no jelly, only a syrup.

TABLE VIII. SHOWING AVERAGE SCORE OF VARIETIES USED FOR MARMALADE

Variety	Flavor	Texture	Color	Total	Remarks
Belmont	46.75	22.12	20.75	89.62	Very good
Bottle Greening	43.5	22.8	22.5	88.8	Very good
Maiden Blush	43	23.3	22	88.3	Very good
Rome	44.2	22.2	21.5	87.9	Very good
Beitigheimer	46	20.6	20.5	87.1	Very good
Dutch Mignonne	43.5	21.5	22	87	Very good
Vanwyck Sweet	42.7	23.7	20.5	86.0	Very good
Twenty Ounce	44.1	22.8	19	85.0	Very good
Jonathan	40.5	22	23.2	85.7	Very good
Scott	41	21.25	23	85.25	Very good
Holland Pippin	42	22	20.8	84.8	Good
Salome	38.75	22.5	22.75	84	Good
Rhode Island	38.75	22.5	22.75	84	Good
Romanite	41.7	21	20.7	83.4	Good
Yellow Bellflower	38.75	22.5	22	83.25	Good
Fameuse	43.1	19.5	20.3	82.9	Good
Western Beauty	40.25	21.5	21	82.75	Good
Haas	42.8	18.3	21.6	82.7	Good
Melon	42.2	18.7	21.7	82.6	Good
Winesap	39.75	20	22.5	82.25	Good
Northern Spy	38.75	21.25	21.75	81.75	Good
Red Canada	37.25	21.37	22.75	81.37	Good
Tompkins King	41.8	20.5	18.3	80.6	Good
Domine	37.75	21.25	21.25	80.25	Good
Fallawater	38.3	21.6	19.75	79.65	Good
Mann	37	20.75	21.87	79.62	Fair
Gano	36.25	20.75	22.25	79.25	Fair
Yellow Newtown	36.25	19.5	23.25	79	Fair
York Imperial	35.5	20.25	23.25	79	Fair
Rambo	35	21.5	21.5	78	Fair
Autumn Sweet	34.7	20	22.7	77.4	Fair
Black Ben Davis	36.25	19.25	21.5	77	Fair
Rock Pippin	39.2	18.5	18.2	75.9	Fair
Jewett	37.33	21	17.25	75.58	Fair
Grimes	38.2	18.5	18.7	75.4	Fair
White Winter Pearmain	30.2	20.7	20.7	71.6	Fair
Coos Bay Beauty	37.25	19.25	14.5	71	Fair
Pumpkin Russet	29.5	16.5	20.7	66.7	Poor
Bailey Sweet	28	17	21.2	66.2	Poor

If the preceding tables are carefully examined it may be seen that the variety of apple which makes a good sauce does not necessarily rank equally high for other methods of cooking. This would indicate that certain varieties are to be specially valued for certain specific cooking quality, rather than for cooking quality in general.

In Table IX are listed a few varieties which will give "good" to "very good" products with any of the methods of cooking employed during this investigation.

TABLE IX. FEW VARIETIES GIVING GOOD PRODUCTS WITH ANY OF THE COOKING METHODS EMPLOYED.

Variety	Sauce	Pie	Jelly	Marmalade	Dumplings	Season
Maiden Blush	Fair	Excellent	Excellent	Very good	Excellent	Sept.-Oct.
Tompkins King	Excellent	Fair	Very good	Good	Very good	Oct.-Nov.
Jonathan	Fair	Very good	Very good	Very good	Good	Nov.-Jan.
Grimes	Excellent	Very good	Fair	Fair	Very good	Nov.-Jan.
Rambo	Excellent	Excellent	Good	Fair	Good	Nov.-Feb.
Northern Spy	Very good	Excellent	Very good	Good	Very good	Dec.-Feb.

Sauces, Pies, and Dumplings

The most marked difference in the cooked product was in the sauce. The color of the best sauces was light, the flavor pleasing and the texture fine and smooth. On the other hand, the color of the finished product of those varieties that made a poor sauce was dark and unappetizing, the flavor insipid, and the texture coarse and lumpy. One very interesting point noted was that the Fameuse, which is an apple with snow-white flesh, makes one of the darkest sauces. Another observation of equal interest is that an apple whose flesh discolors quickly on exposure to air often gives a dark sauce.

The Correlation Between Sauce-, Pie-, and Dumpling-making Qualities

The apples which make a good to excellent sauce as a rule make from a good to excellent pie; and in like manner those which score poor for sauce also score poor for pie. This also holds true for the apples used in making dumplings. This is probably due to the fact that much the same methods of cooking are employed in their preparation.

Jellies

The flavors of the jelly obtained from different varieties are very different. Some are sweet, some tart or acid, and still others are almost tasteless. The texture also varies, some of the varieties making a very tender, others a tough jelly. The juice of the majority of the sweet varieties would not jell, but remained in a thick syrup. This may be due to either of two causes: there was not enough pectin* in the variety used, or else the necessary amount of acid was lacking. In color, the jelly varied from a light, almost colorless substance, to a bright red. Those apples which have bright-colored skins are the ones which make a bright-colored jelly.

The Correlation Between Sauce- and Jelly-making Qualities

The process of jelly making is entirely different from the other methods of cooking that have been discussed. All the fruit pulp is removed, and only the fruit juice is used. The way in which the apples cook up, therefore, theoretically would seem to make but little difference in the resulting products. That this is true at least to a certain extent is illustrated by the fact that while Grimes and King are both varieties that cook up well, King makes a good jelly and Grimes only a fair one. On the other hand, while both Scott and Pumpkin Russet cook up very poorly, Scott makes a most excellent jelly and Pumpkin Russet makes only a syrup that will not jell. There appears to be

*Pectin—"the fundamental jelly-making substance of fruit juices, the gelatinizing substance which makes these juices jell, is a substance which is apparently akin to starch chemically; it has no relationship whatever to gelatin"
—N. E. Goldthwaite "Principles of Jelly Making", Univ. of Ills. Bul. Vol. VII, No. VII.

but little correlation between the sauce-making and jelly-making qualities of apple varieties, or perhaps more accurately between the factors which go to make a good jelly and those which go to make excellence in other products. An exact measure of this correlation or lack of it, is afforded by a correlation table between the scores of the two products. In Table IX, the first column gives the values of the apples as scored for sauce and the first row their values for jelly. For example, Scott, which scores almost 60 for sauce and 92 for jelly, will be found in column 60, row 92. The usual formula,

$$\left(\frac{D_x \cdot D_y}{n} - C_x \cdot C_y \right) \frac{1}{\sigma_x \cdot \sigma_y}$$

was employed for obtaining the coefficient of correlation.

This shows that the correlation between the cooking quality of certain varieties of apples for sauce and the same varieties of apples for jelly is very small. The coefficient of correlation of .05 may be interpreted as meaning that *on the average* an apple variety that is above the average for sauce purposes stands about equal chances of being either above or below the average for jelly purposes. In fact, the bias in favor of its making a better-than-the-average jelly amounts to only five per cent. It affords reason for believing that both texture and flavor of apple jelly is almost entirely dependent upon the chemical composition of the fruit rather than upon its texture or anatomical structure, and that the chemical compounds which give character to jelly are different from those which give flavor to sauce.

Marmalade

It apparently makes but little difference what variety is used for marmalade, for the flavor is largely concealed by the lemons and the large amounts of sugar used. The color does not differ greatly, either, for the long continued cooking tends to make the product of each variety dark and uniform in color. But the texture differs to quite an extent. Some of the apples seem to mash more completely than others, thus giving a smoother and finer product.

The Correlation Between Dessert and Cooking Qualities in Apples

The dessert quality of the more common varieties of apples is generally recognized. Without doubt dessert quality is associated with cooking quality in the minds of many people. As the evidence seems to show that high quality in sauce depends upon one set of factors and high quality in jelly upon a different set of factors, the question arises as to the degree of correlation between dessert quality and cooking quality. Consequently a correlation table (Table XI) was constructed between the scores for sauce-making and dessert qualities to determine the amount of correlation between them. The rating taken for dessert quality is that given by the American Pomological Society and may be found in Bul. 6, Div. of Pom. U. S. Dept. of Agri. 1897.

TABLE X. CORRELATION TABLE BETWEEN SCORES FOR SAUCE AND JELLY

V	60	62	64	66	68	70	72	74	76	78	80	82	84	86	88	90	92	94	f	fV	V-G	(V-G)²	f(V-G)²
60	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	—22	484	0
62	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	—20	400	0
64	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	—18	324	0
66	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	—16	256	0
68	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	—14	196	0
70	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	—12	144	0
72	....	....	....	1	....	....	....	1	....	....	....	....	....	....	....	....	....	....	2	144	—10	100	200
74	....	....	....	....	1	....	....	1	....	....	....	....	....	....	....	....	1	....	3	222	— 8	64	192
76	....	2	1	....	....	....	....	....	1	....	1	1	....	....	....	....	....	....	4	304	— 6	36	144
78	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	2	156	— 4	16	32
80	....	....	....	1	....	....	....	....	....	1	....	....	....	1	....	....	....	....	3	240	— 2	4	12
82	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	1	82	0	0	0
84	....	....	....	....	1	....	2	....	1	....	....	....	1	....	....	1	....	1	7	588	2	4	28
86	....	....	....	....	1	1	....	....	....	1	....	....	....	....	....	....	....	1	4	344	4	16	64
88	....	....	....	....	....	....	2	1	....	1	....	....	....	....	....	....	....	....	4	352	6	36	144
90	....	1	....	....	....	....	....	....	....	....	....	2	....	....	....	....	....	....	3	270	8	64	192
92	1	....	....	....	....	....	1	....	....	....	....	....	1	....	....	....	....	....	3	276	10	100	300
f	1	3	1	2	3	1	5	3	3	3	1	3	2	1	0	1	1	2	36	2978	.....	.....	1308
fV	60	186	64	132	204	70	360	222	228	234	80	246	168	86	....	90	92	188	....	.....	.....	.....	.....
V-G	—16	—14	—12	—10	— 8	— 6	— 4	— 2	0	2	4	6	8	10	12	14	16	18	....	.....	.....	.....	.....
(V-G)²	256	196	144	100	64	36	16	4	0	4	16	36	64	100	144	196	256	324	....	.....	.....	.....	2962
f(V-G)²	256	588	144	200	192	36	80	12	0	12	16	108	128	100	0	196	256	648	....	.....	.....	.....	.....

Standard deviation for sauce scores, 9.05.
Standard deviation for jelly scores, 6.07.
Correlation coefficient, .05.

TABLE XI. CORRELATION TABLE BETWEEN SCORES FOR SAUCE AND RATING FOR DESSERT QUALITY

V	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10	f	fV	V-G	(V-G)²	f(V-G)²
38	..	..	..	..	..	..	1	..	..	..	..	..	..	..	1	38	—36	1296	1296
40	..	..	..	..	..	..	..	..	..	..	..	..	..	..	0	0	—34	1156	0
42	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	1	—32	1024	0
44	..	..	..	..	..	..	..	..	..	..	..	..	..	..	0	0	—30	900	0
46	..	..	..	..	1	..	..	..	..	..	..	..	..	..	1	46	—28	784	784
48	..	..	..	..	..	..	..	1	..	..	..	..	..	..	1	48	—26	688	688
50	..	..	..	..	..	..	..	..	..	..	..	..	..	..	0	0	—24	576	0
52	..	..	..	..	..	..	..	..	..	..	..	..	..	..	0	0	—22	484	0
54	..	..	..	..	..	..	..	..	..	..	..	..	..	..	0	0	—20	400	0
56	..	..	..	..	..	..	..	..	..	..	..	..	..	..	0	0	—18	324	0
58	..	..	..	..	..	..	..	..	..	..	..	..	..	..	0	0	—16	256	0
60	..	..	..	..	..	1	..	..	..	..	..	..	..	..	1	60	—14	196	196
62	..	..	1	1	1	..	..	..	..	..	..	..	..	..	3	186	—12	144	432
64	..	..	..	..	..	..	1	..	1	..	..	..	..	..	2	128	—10	100	200
66	..	2	..	..	..	..	..	..	..	..	..	..	..	1	3	198	— 8	64	192
68	..	1	..	1	2	..	..	..	..	..	..	..	..	..	4	272	— 6	36	144
70	..	1	..	..	1	..	..	..	..	..	..	..	..	..	2	140	— 4	16	32
72	..	..	1	1	2	..	..	..	1	..	..	1	..	..	6	432	— 2	4	24
74	..	..	..	1	1	..	..	..	..	..	1	1	..	..	4	296	0	0	0
76	..	1	..	..	..	..	..	1	1	..	2	..	..	..	3	228	2	4	12
78	1	..	..	..	..	1	1	..	..	..	..	..	..	..	5	390	4	16	80
80	..	..	..	1	1	..	..	..	..	..	..	..	..	..	2	160	6	36	72
82	..	..	..	1	1	..	..	..	..	..	..	..	..	1	3	246	8	64	192
84	1	..	..	1	..	1	1	..	..	..	..	..	..	..	4	336	10	100	400
86	..	..	..	..	..	..	..	..	1	..	1	..	..	..	2	172	12	144	288
88	..	..	..	..	..	..	..	..	..	..	..	..	..	..	0	0	14	196	0
90	..	..	..	..	..	..	..	..	1	..	1	..	..	..	2	180	16	256	512
92	..	..	..	..	..	..	..	..	..	1	..	..	..	..	1	92	18	324	324
94	..	..	..	..	1	..	..	..	..	..	1	..	..	..	2	188	20	400	800
f	2	5	2	7	11	8	4	2	5	1	6	2	..	2	52	.....	.....	.....	6668
fV	7	20	9	35	60.5	18	26	14	37.5	8	51	18	0	20					
V-G	—2.5	—2	—1.5	—1	.5	0	.5	1	1.5	2	2.5	3	3.5	4					
(V-G)²	6.25	4	2.25	1	.25	0	.25	1	2.25	4	6.25	9	12.25	16					
f(V-G)²	12.5	20	4.5	7	2.75	0	1	2	11.25	4	37.5	18	0	32					

Standard deviation of dessert scores, 1.72.
Standard deviation of sauce scores, 11.31.
Correlation coefficient, .205.

TABLE XII. CORRELATION TABLE BETWEEN SCORES FOR JELLY AND RATING FOR DESSERT QUALITY

V	72	74	76	78	80	82	84	86	88	90	92	f	fV	V-G	(V-G)²	f(V-G)²
4.....	1	1	....	....	....	....	1	....	....	....	....	3	12	2.5	6.25	18.75
4.5.....	....	....	....	....	....	....	....	....	1	1	....	2	9	2	4	8
5.....	1	1	2	....	....	....	....	....	....	....	1	5	25	1.5	2.25	11.25
5.5.....	....	....	....	1	....	....	2	1	1	....	1	6	33	1	1	6
6.....	....	....	....	....	....	....	....	....	....	....	....	0	0	.5	.25	0
6.5.....	....	....	....	....	....	....	....	....	....	....	1	1	6.5	0	0	0
7.....	....	....	....	....	....	....	....	....	....	....	....	0	0	.5	.25	0
7.5.....	....	....	1	....	1	1	....	....	....	....	....	3	22.5	1	1	8
8.....	....	1	....	....	....	....	....	....	....	....	....	1	8	1.5	2.25	2.25
8.5.....	....	....	....	....	1	....	1	1	3	....	....	6	51	2	4	24
9.....	....	....	....	....	....	....	....	....	....	....	....	0	0	2.5	6.25	0
9.5.....	....	....	....	....	....	....	....	....	....	....	....	0	0	3	9	0
10.....	....	....	....	....	1	....	....	....	....	1	....	2	20	3.5	12.25	24.5
f.....	2	3	3	1	3	1	4	2	5	2	3	29	187	.....	.....	97.75
fV.....	144	222	228	78	240	82	336	172	440	180	276	....	....	.....	.....	.....
V-G.....	—10	—8	—6	—4	—2	0	2	4	6	8	10	....	....	.....	.....	.....
(V-G)².	100	64	36	16	4	0	4	16	36	64	100	....	....	.....	.....	.....
f(V-G)².	200	192	108	16	12	0	16	32	180	128	300	1184	....	.....	.....	.....

Standard deviation for dessert rating, 1.83. Standard deviation for jelly rating, 6.42.
Correlation coefficient, .07.

The correlation coefficients are not so large as many would naturally expect. Only 7 per cent correlation is found between the dessert and the jelly-making qualities of varieties of apples, and 20.5 per cent between their deserts and sauce-making qualities. The tables certainly show that good dessert and good cooking qualities are not necessarily associated. They indicate, however, that a good dessert apple is more likely to be a good sauce-making than a good jelly-making fruit. Furthermore, they go to show, or, perhaps better, suggest, that cooking an apple up into sauce is not so likely to cover up the flavor and other good qualities of the fresh fruit as cooking in the way employed for jelly making. The tables help to substantiate the theory that different varieties must be used for certain definite purposes, if their best qualities are to be brought out. Conversely, certain methods of cooking tend to suppress the good features of certain varieties.

Cooking Qualities of Apples Belonging to the Same Group

Owing to the large number of varieties in existence, a great amount of time and effort would be required to determine the cooking qualities of each one. It was therefore thought advisable to determine whether varieties belonging to the same pomological group score about the same; for if they do, the determined cooking qualities for one member of a group become an index to what may be expected of the other members. The classification of apples according to groups is taken from Hendrick and Howe. Bul. 361, New York Exp. Sta., pp. 81–88, 1913.

GROUP

Aport. Beitigheimer, Bismarck, McMahon, Wolf River.
Baldwin. Baldwin, Sutton.
Ben Davis. Ben Davis, Black Ben Davis, Gano.
Blue Pearmain. Blue Pearmain, Jewett.
Fameuse. Fameuse, McIntosh.
Jonathan. Jonathan, Esopus, Red Canada, King Davis.
Northern Spy. Melon, Northern Spy, Ontario, Wagener.
Rambo. Rambo, Domine.
Reinette. Holland Pippin, Maiden Blush, Winter Banana, Bottle Greening, Northwestern Greening, Rhode Island Greening, Belmont, Grimes, Yellow Newtown.
Ralls. Ralls, Salome.
Russet. Golden Russet, Roxbury.
Tompkins King. Ribston, Tompkins King.
Winesap. Arkansas, Arkansas Black, Stayman, Winesap.
Romanite. Minkler, York Imperial, Romanite.

In a majority of the groups, the different varieties tended to rank very nearly the same in cooking qualities; in others there seemed to be quite a difference in the average score. This would indicate that in the majority of cases the rating of one variety in a group may be used as a guide to the cooking qualities of the other varieties in this same group.

SOME OF THE CAUSES OF DIFFERENCE IN COOKING QUALITIES

Thus far there have been presented definite facts that have been learned regarding the cooking qualities of different varieties of apples. In discussing these facts, incomplete analysis has been made of them. The next question that presents itself is: what is the reason, or what are the reasons, for these differences in cooking quality? Why is it that one variety makes a good sauce and a poor jelly, that another variety makes a good jelly and a poor pie? One would naturally reason that differences in flavor and color would be due to differences in chemical composition, and that differences in texture—at least of sauces, pies, and dumplings—would be due to differences in structure. To determine differences in chemical content of the fresh fruit and associate these differences with variations in the flavor of the cooked products, would require a large amount of analytical work, time and opportunity for which was not afforded. Opportunity was afforded, however, for making a brief study of morphology and cell structure of the fresh fruit and its relation to the texture of the cooked products.

THE GROSS MORPHOLOGY OF THE APPLE; ITS RELATION TO COOKING QUALITY

According to Kraus,[1] the fleshy portion of the apple is made up of three distinct regions, namely, pith, cambium, and cortex. The pith is that portion of the apple which (except for the region of capillary tissue) immediately surrounds the seed cavities and, roughly speaking, constitutes a large part of what is generally called the core. Enveloping the pbit is the cambial region, observable as the area of blending of the pith and the cortical area, presently to be described. The cambial region is indicated roughly by what is known as the coreline section or area. Probably the only true cambium present is confined to the primary vascular bundles. Outside of this core line is the cortical region which, as a rule, constitutes the main fleshy part of the fruit. It is an extremely important part for cooking purposes, as a large portion of the pith and cambial tissues are removed in coring. Especially is this true when one of the mechanical coring machines is used.

As it was considered possible that these different portions of the apple vary in their cooking quality, sauce was made from the pith, cambial, and cortical tissue of each of four varieties and scored in the same way as in previous experiments. Table XIII presents the results of this experiment.

Very little difference is noted in the flavor and color of the sauces made from the different portions, but there is a great difference in their texture. It is evident that the pith does not cook up as well as the cortical layer, which suggests that the cooking properties of apples vary in proportion to their pith areas. To put this theory to a test certain varieties which scored high, medium

[1]The Pollination of the Pomaceous Fruits, Part I. The Gross Morphology of the Apple. Res. Bul. I, Oregon Agricultural College Experiment Station, April 1913.

TABLE XIII. PITH, CAMBIAL AND CORTICAL TISSUES SCORED FOR SAUCE

Portion of apple	Flavor				Texture				Color				Totals			
	W. W. Pearmain	Ben Davis	Romanite	Rock Pippin	W. W. Pearmain	Ben Davis	Romanite	Rock Pippin	W. W. Pearmain	Ben Davis	Romanite	Rock Pippin	W. Pearmain	Ben Davis	Romanite	Rock Pippin
Pith	38	38.2	32.7	30.2	22	14.2	16	12	22.2	19.17	19.2	17.2	82.2	72.1	67.9	59.4
Cambial tissue	32	35.1	31.5	31	15.7	10.5	14.7	13.2	20.5	16	19.2	18.5	68.2	61.5	65.4	62.7
Cortical tissue	39	37.7	34	33.7	22.5	20.2	18.5	18	22.5	22.2	20	21.2	84	80.1	72.5	72.9

and low in texture for sauce were selected for study. Among these were Rambo, which scored 24.5; Salome, 19.0; and Yellow Newtown, 12. Cross-sections one-eighth inch thick were cut, and as nearly as possible from the same portion of the apple. These were first dehydrated in 95% alcohol and then in absolute alcohol for several days. When thoroughly dehydrated they were covered with cedar oil for two to three days in order to clear them. This method of preparation makes possible a rapid comparison of the proportions of pith and cortex of the fruit. Large variations were found between the varieties studied in the proportions of pith area present.

Some, as for instance, the Tolman (Fig. 1) and Paradise Sweet (Fig. 2), contain a large amount of pith, while others, as the Grimes and Rambo (Figs. 3, 4), contain a comparatively small amount. The Romanite (Fig. 5), an apple which makes a fair sauce, has a pith area which is between those of the other two in size. This statement is approximately true for other varieties studied. This would tend to prove the correctness of the theory that the greater the proportion of pith area, the poorer the texture of the sauce that the variety makes.

Exterior to the pith is the core-line or cambial region. The most noticeable feature of this region consists of the fibro-vascular bundles, five of which are found opposite and five alternating with the carpels. (Kraus; loc. cit.) These bundles possess distinct phloem, cambial, and xylem regions. Branches are given off from these bundles which branch and rebranch and anastomose with branchlets from the bundles forming a fine network throughout the entire cortical region. The degree of compactness of the cells in the cambial region and the closeness of approach of the vascular fibers to the pith region, vary with the variety of apple. Some varieties, such as the Rambo, Tompkins King, and Grimes, have the cambial region slightly compacted and with few bundles, while others, such as the Yellow Newtown, Tolman, and Scott, are compact or with generally many bundles. Photographs of the cleared sections (Figs. 1 to 12) will make clear these statements. By referring to the table in which the scores of the sauces made from the cambial regions of the different varieties are given, it will be found that the sauce made from this intermediate and

cambial tissue is decidedly inferior to that made from either the pith or cortex. The Rambo, which made a most excellent sauce, contains but a very little woody tissue, and its branches are very fine. In direct contrast to this is the Yellow Newtown, which contains a large amount of the woody tissue. Besides varying in quantity, the fibrous tissue also varies in structure. In the Yellow Newtown it seems to be more compact and the bundles are much larger than in the Rambo. In general, those varieties studied which have a large amount of woody tissue, make a rather poor sauce.

The Relation of the Microscopic Structure of the Apple to Its Cooking Quality

Pith Region. The pith contains no fibrous tissue whatever. It is generally made up of small elongated cells which closely adhere to one another. The size of the cell, as well as cell cohesion, however, varies with the different varieties. This may be illustrated best by drawings made with the aid of the camera lucida. Figures 12-b, 14-b, and 15-b are from samples of pith cells of the cooked fruits of Tompkins King, Salome, and Scott.

The pith of Tompkins King (Fig. 13-b), which is an excellent apple for sauce, is made up of cells which are elongated, more or less regular, and large. These cells seem to cling together to some extent, but the cohesion is not great when compared with the cells of the Salome or Scott.

The pith cells of the Salome (Fig. 14-b) are much smaller than those of Tompkins King. The cohesion is greater, and the cells are not so uniform in shape, varying from an oval to an elongated form.

The Scott (Fig. 15-b), which has a very poor texture in sauce, contains cells which are larger than those of Salome but smaller than those of King. It is to be noted that they cohere so closely that it is almost impossible to separate them from each other. On the whole the cells of the Scott seem to be oval rather than elongated.

Cortical Region. The cortex, like the pith, is made up of small cells which vary in size and shape according to the variety. Fig. 16 shows the cells of the Rambo, which are large, irregular, and loosely connected toward the center of the cortical layer. Those which are nearer the epidermis are much smaller and more compact. Upon further examination it is found that the cells of Yellow Newtown and Rock Pippin (Figs. 17, 18) are much smaller than those of varieties which make good sauce. The cells near the epidermis or skin are very small and very compact. They seem to be almost wedged in. The Grimes (Fig. 19), which makes a good sauce, contains cells which are between those of the Rambo and Yellow Newtown in size and cohesion. The other varieties studied were similar in their characteristics. The cooked cortical regions of King, Salome, and Scott (Figs. 13-a, 14-a, 15-a) were also examined. It was found that these, too, showed differences in cell size and cohesion.

Table XIV gives a summary of the relative proportion of the pith area, vascular tissue, size of cell, and cell cohesion of some of the varieties studied.

TABLE XIV. SHOWING COMPARISON OF CERTAIN VARIETIES, SAUCE SCORES AND RELATIVE DEVELOPMENT OF CERTAIN CONTROLLING FACTORS

Variety	Texture (score for)	Proportion pith area	Vascular tissue	Cell-size (scale 0–10)	Cell cohesion (scale 0–10)
Rambo	24.5	1.5	1	10	1
Tompkins King	23.2	3	1.5	.....	.5
Grimes	22.8	1	2	8	3
Rome	20.2	2	3	7.5	3.5
Salome	19	2.5	3	7	4
Rock Pippin	18	.....	.....	3.5	5
Romanite	17.5	2.5	3.5	5.5	4
White Winter Pearmain	17.2	2.5	3.5	6.5	4
Paradise Sweet	14.7	5	4.5	6	5
Scott	14	4	5	7.5	5.5
Tolman	12.2	5.5	5.5	4.5	6
Yellow Newtown	12	.....	.....	4	6

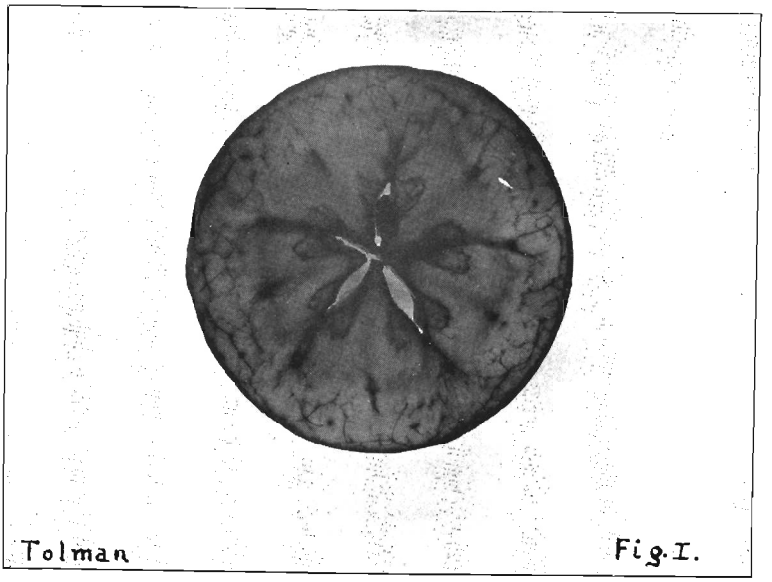
GENERAL SUMMARY

During the course of this investigation the following facts were established:

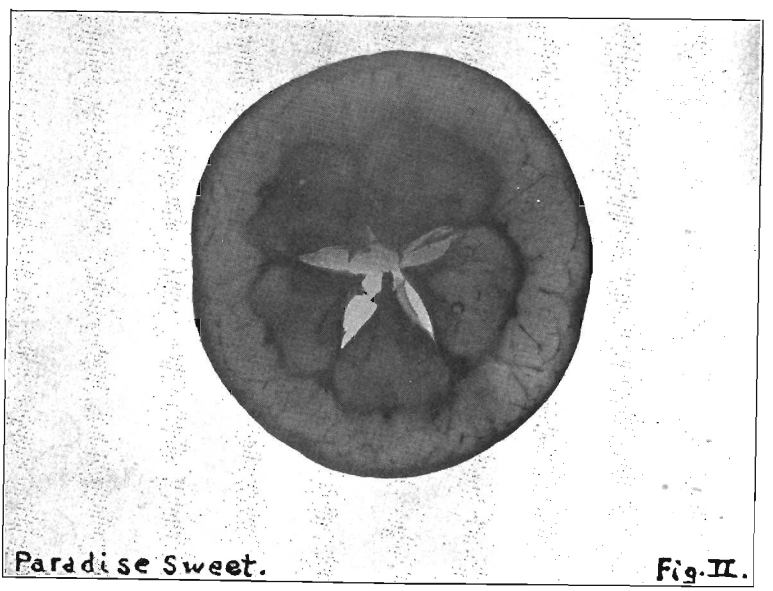
1. Different varieties of apples must be used for certain specific cooking purposes in order to obtain the best product.
2. The size of fruit makes but little difference in the cooking quality of apples for sauce.
3. Fruits that are at their prime or even a little over-ripe are apparently best for sauce.
4. There is comparatively little correlation between the scores of apples for sauce and those of the same varieties for jelly. This indicates that the flavor and texture of the jelly is almost entirely dependent upon the chemical composition of the apple rather than its texture and morphological structure.
5. Good dessert apples do not necessarily make equally good products when cooked.
6. Apples belonging to the same pomological group tend to have similar cooking qualities.
7. The sauce-cooking qualities of an apple vary inversely with the proportion of pith area and vascular tissue present.
8. The sauce-cooking qualities of an apple vary directly as the size of cell and inversely as the cell cohesion.

ACKNOWLEDGMENT

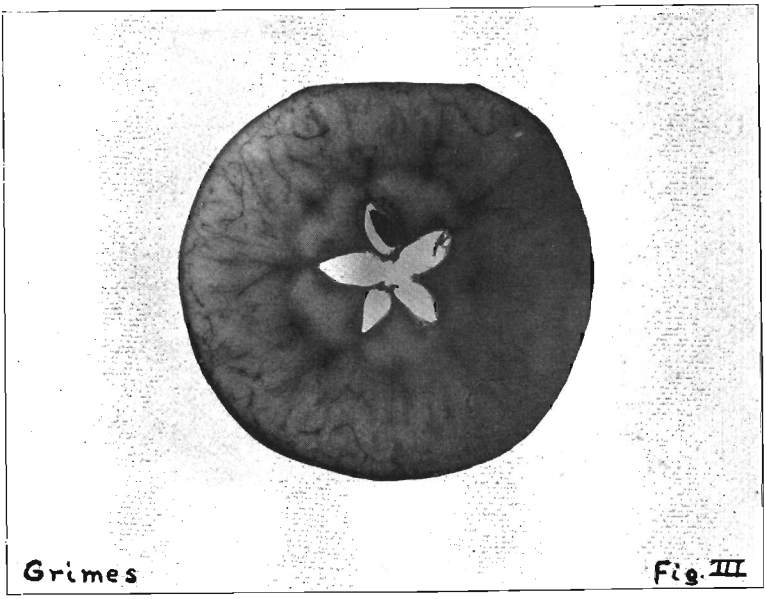
The writers desire to express their indebtedness to Professors E. J. Kraus and V. R. Gardner. The study of the morphological structure of the apple was made in the research laboratory of the Division of Horticulture under the direction of Professor Kraus, and through the suggestions of Professor Gardner it has been possible to make the work of greater interest from the viewpoint of the pomologist. In addition to those mentioned, Miss Sarah L. Lewis helped in the scoring of the cooked products. Fruits for this investigation were furnished through the courtesy of the Division of Horticulture of the Oregon Agricultural College.



Tolman Fig. I.

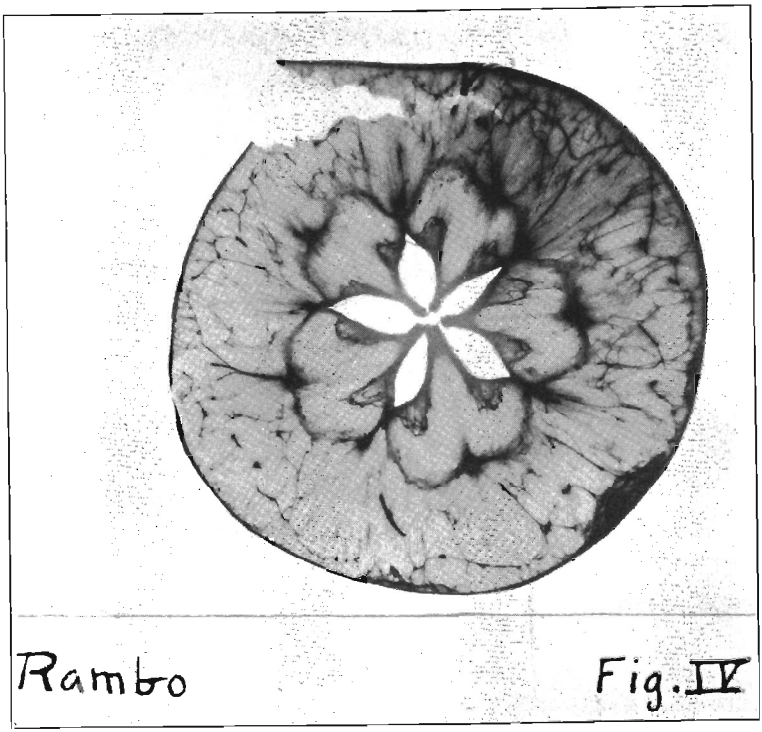


Paradise Sweet. Fig. II.



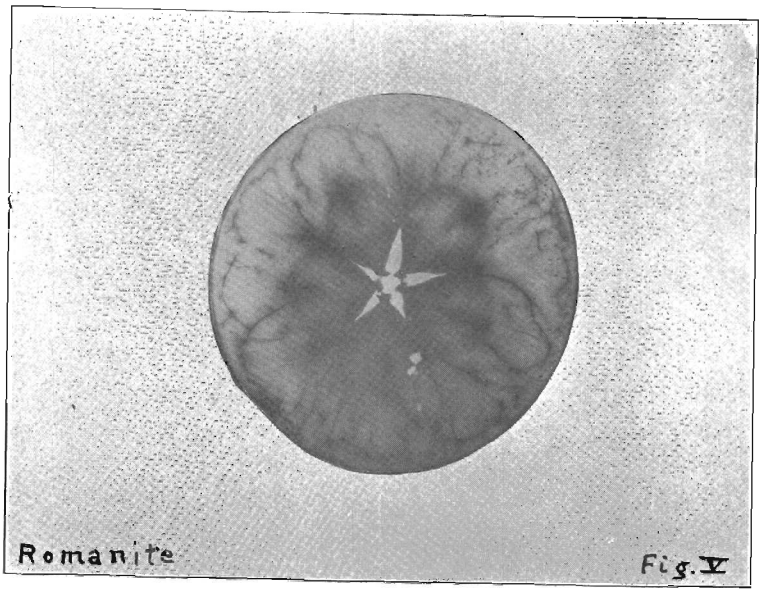
Grimes

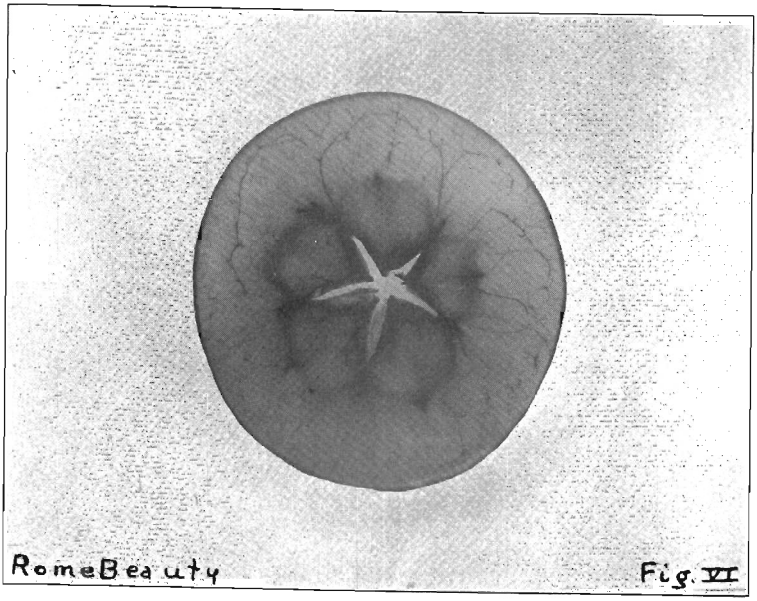
Fig. III

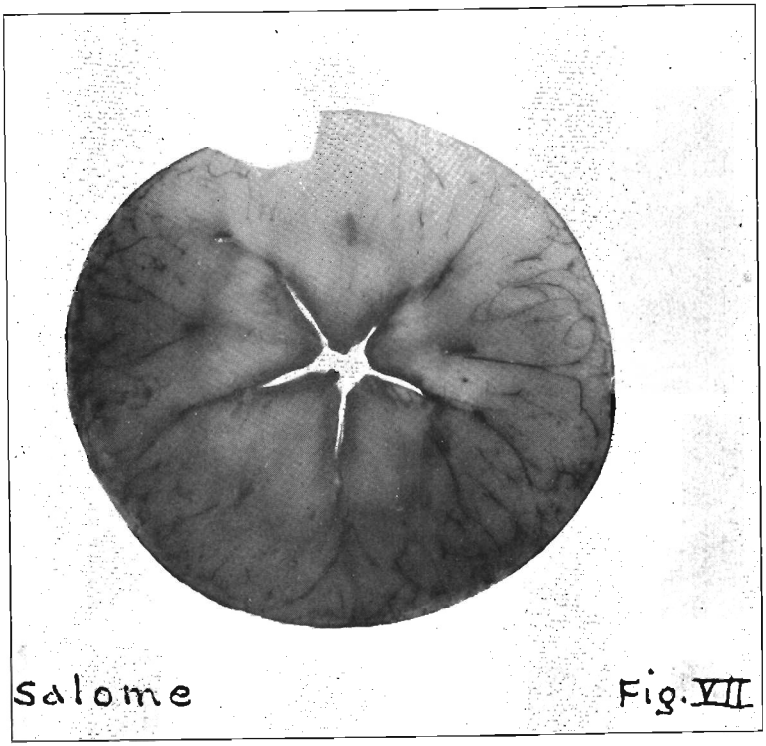


Rambo

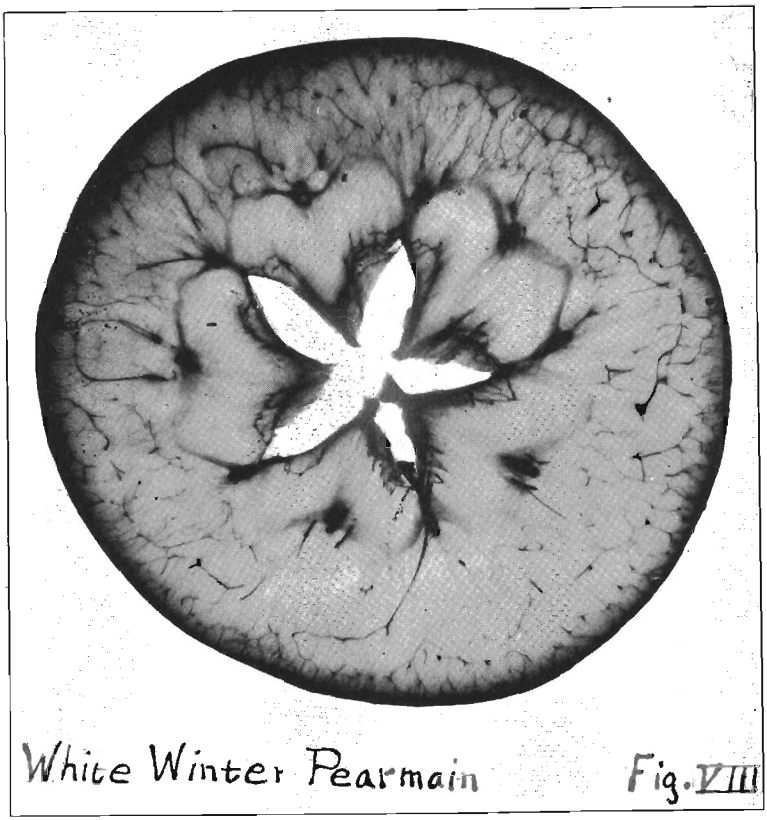
Fig. IV


Romanite
Fig. V

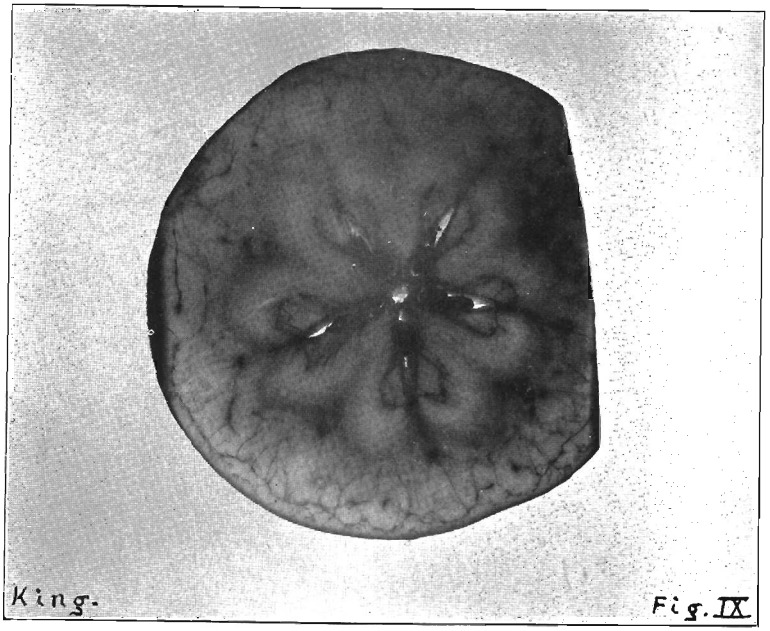

RomeBeauty
Fig. VI



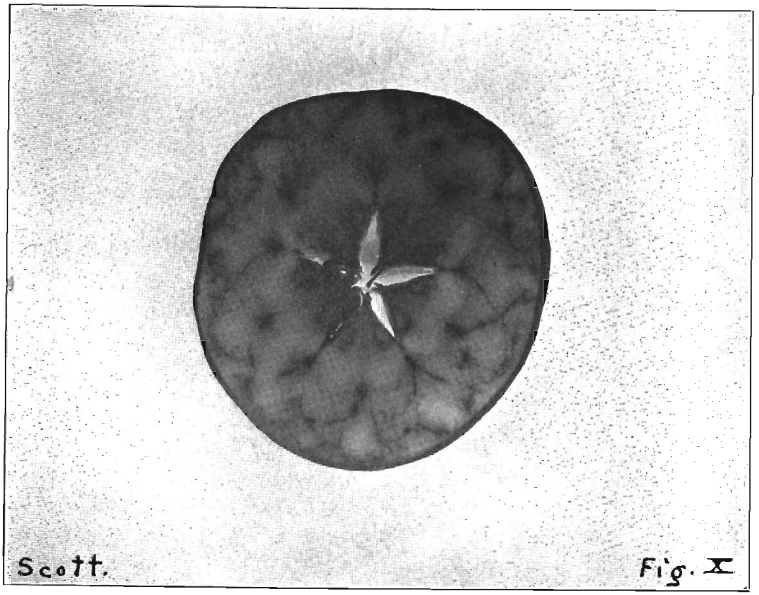
Salome Fig. VII



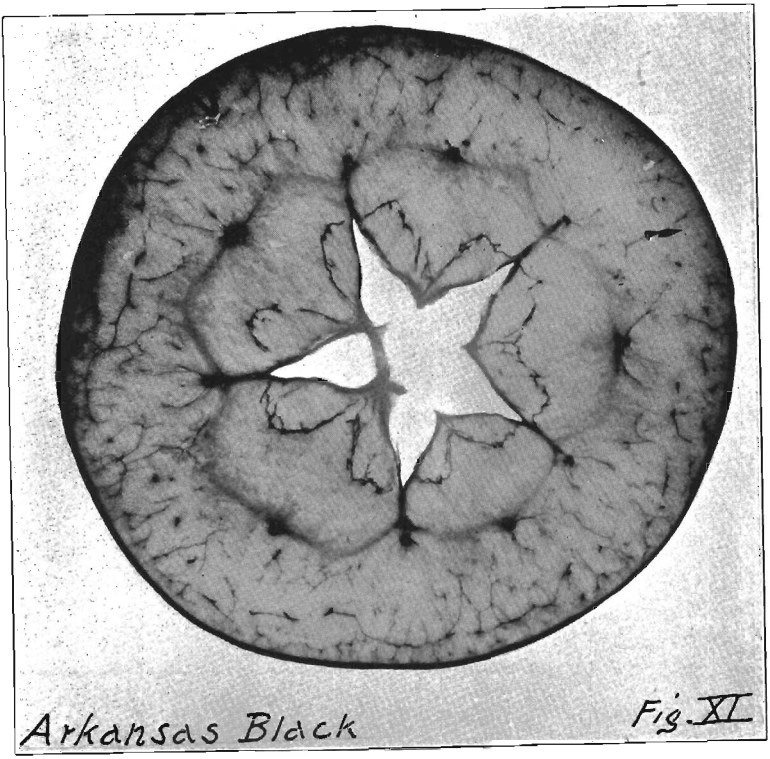
White Winter Pearmain Fig. VIII



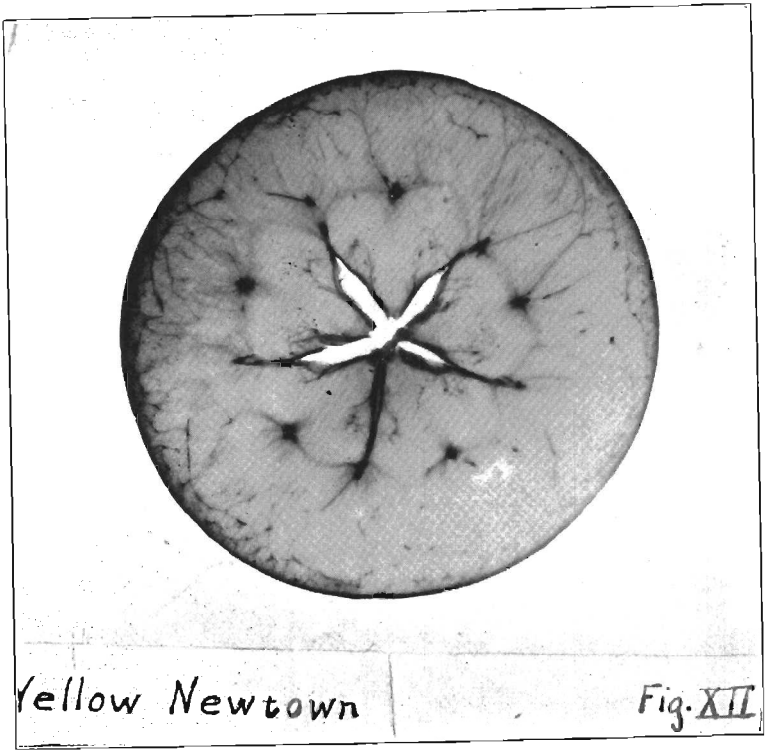
King. Fig. IX



Scott. Fig. X



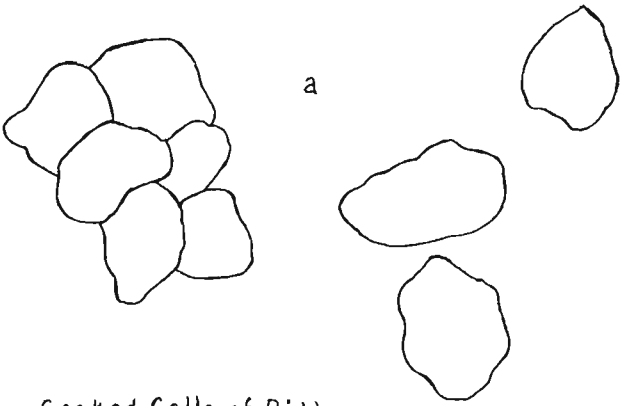
Arkansas Black Fig. XI



Yellow Newtown Fig. XII

King

Cooked Cells of Cortex.



Cooked Cells of Pith

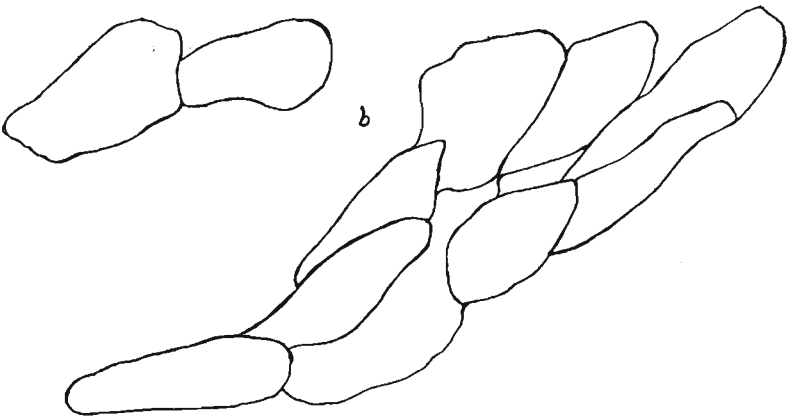


Fig. XIII

Salome

Cooked Cells of Cortex.

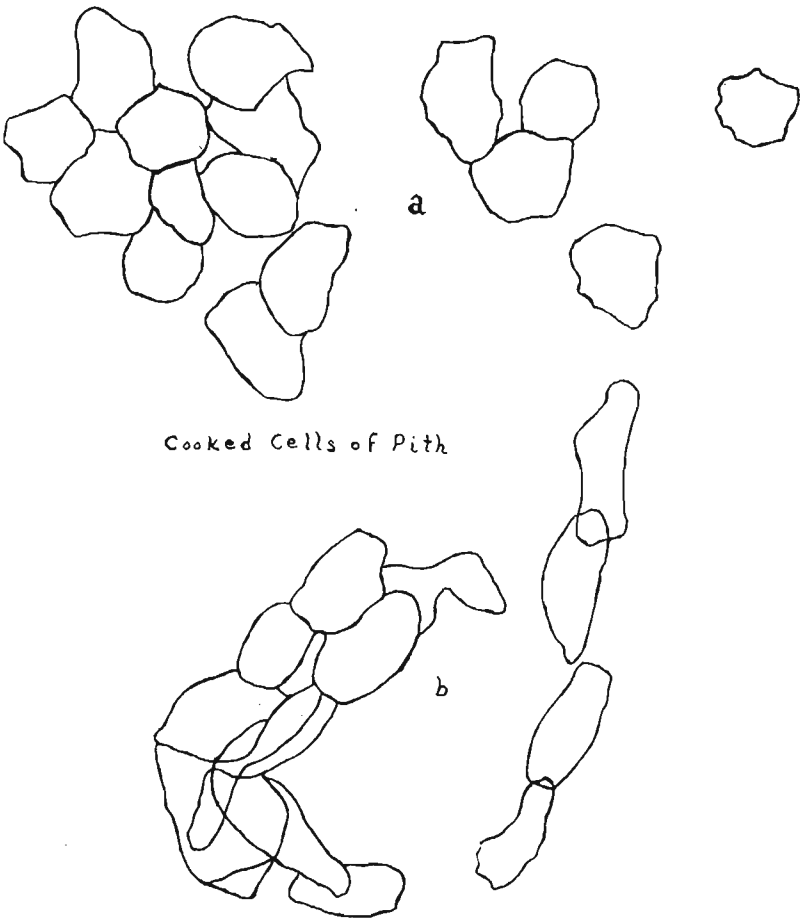
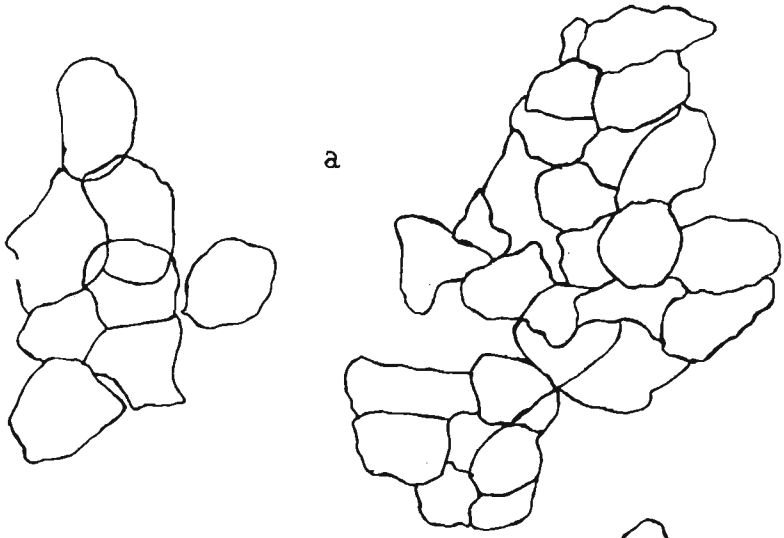


Fig. XIV

Scott

Cooked Cells of Cortex



Cooked Cells of Pith

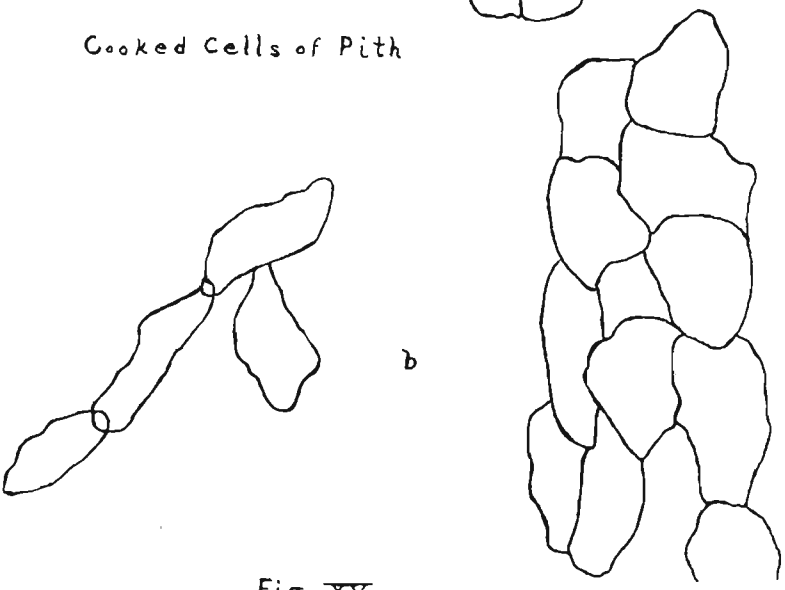
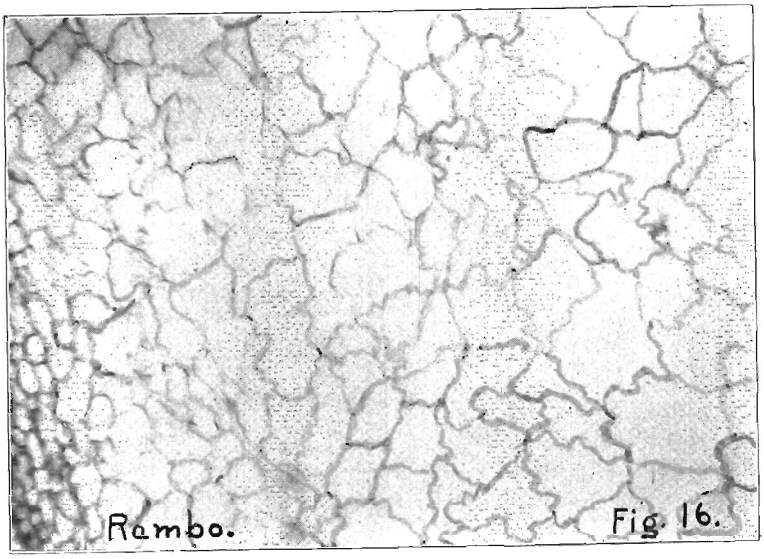
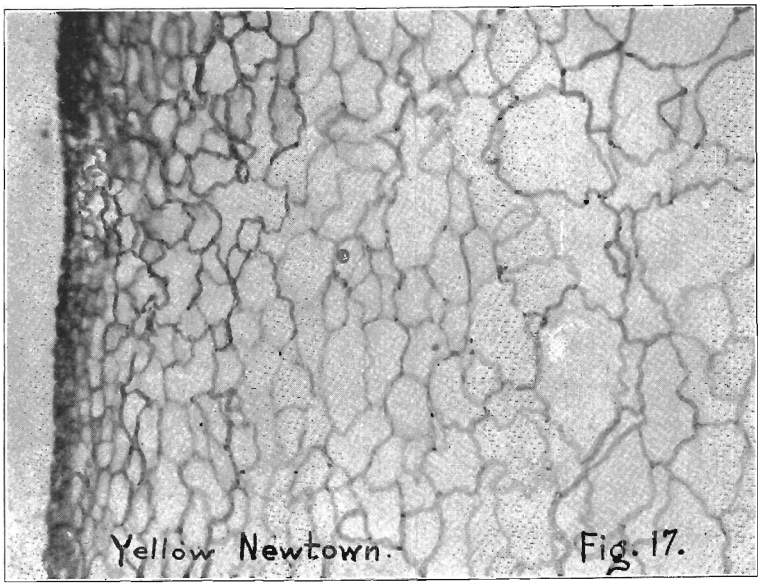


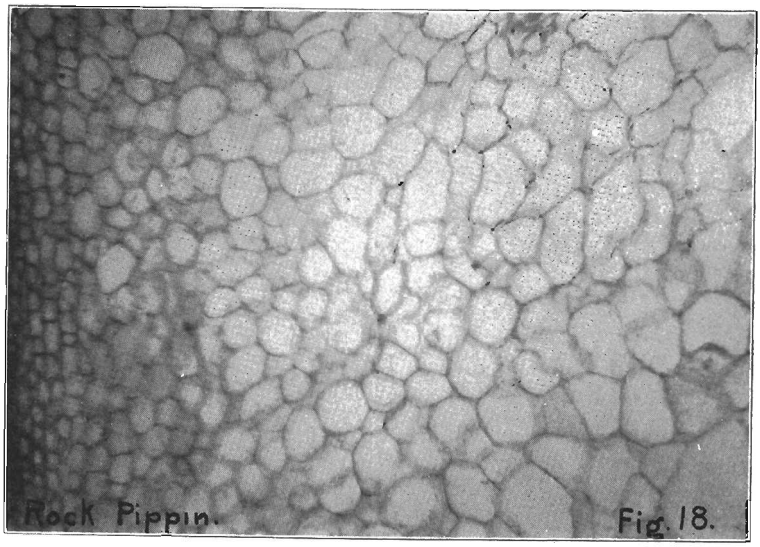
Fig. XV

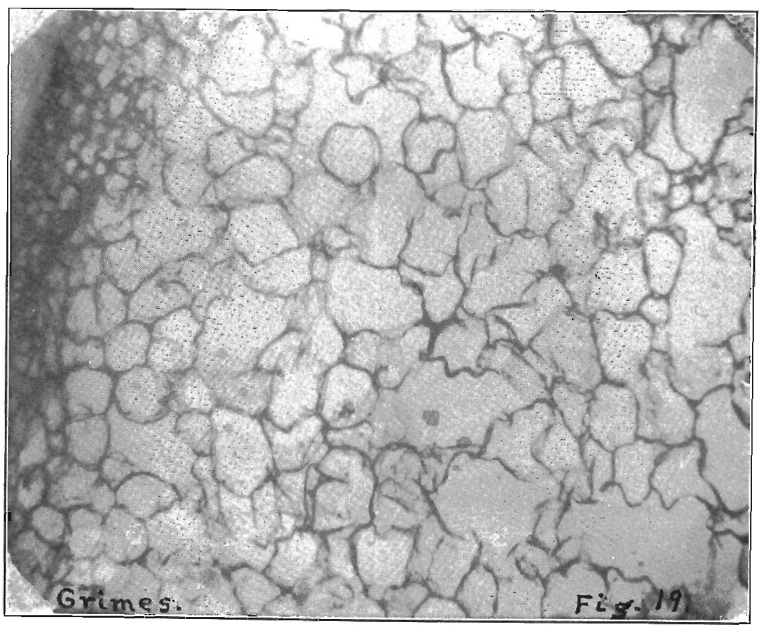


Rambo. Fig. 16.



Yellow Newtown. Fig. 17.


Rock Pippin.
Fig. 18.


Grimes.
Fig. 19