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This study was conducted to determine the retention of calcium and of phosphorus in frozen okra and spinach cooked in a steam jacketed kettle, a low-pressure steamer, and a high-pressure steamer.

Frozen institutional packages, each weighing 3 pounds, of okra and of spinach were obtained from a local wholesale food company. The vegetables were cooked according to the times recommended by the manufacturers of the equipment used in the study. When cooking times were not available for a particular vegetable, the times were established by preliminary tests. Samples of cooked and uncooked okra and spinach were taken from individual packages and were ashed with nitric and perchloric acids on a hot plate. The ashed samples were transferred to volumetric flasks and were diluted with distilled water. Appropriate aliquots of the diluted samples were analyzed for calcium and for phosphorus.

Experimental results indicated some loss in calcium and in phosphorus from okra and from spinach cooked in the steam jacketed kettle and the low-pressure steamer, respectively. The overall results of the study, however, indicated that the retention of these minerals was quite similar in okra and in spinach, regardless of the method of cooking.

CALCIUM AND PHOSPHORUS RETENTION IN FROZEN OKRA AND SPINACH COOKED IN A STEAM JACKETED KETTLE, A LOW-PRESSURE STEAMER, AND A HIGH-PRESSURE STEAMER

by

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APPROVAL SHEET

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF APPENDIX MATERIALS

APPENDIX A

CHAPTER I

INTRODUCTION

Although cooking equipment has been used for the preparation of large quantities of food early in the history of civilized man, recent trends and developments in social, economical, and technical conditions have resulted in a greater need for food service organizations which are engaged in volume feeding. Within the past ten years, the practice of eating some or all meals outside the home has increased rapidly. This change in the eating habits of people has resulted in an increased need for commercial food services.

Many food service kitchens use steam in some form or way to cook vegetables for consumption, but scientific evaluations concerning the effects of these steam methods on the nutrient retention of vegetables is not readily available to food service management. Little information is available on the effect of high-pressure steaming, a relatively new method of steam cooking, on the nutrient retention of vegetables. The lack of this type of information makes it virtually impossible to compare the capabilities and/or limitations of various food service cooking equipment with respect to nutrient retention.

Although vegetables are generally considered good sources of some of the vitamins, some of them are also good secondary sources of some of the mineral nutrients, particularly calcium and phosphorus. Under conditions where the major bulk of a diet consists of materials of plant origin, the importance of vegetables as a source of mineral nutrients is apparent.

The change in eating habits of many people, particularly in the United States, within the past decade has resulted in the increased use of convenience foods. Today, many commercial food services use various types of convenience foods, including frozen vegetables, to speed cooking and to combat the rising costs of labor and a shortage of trained food service personnel. Information concerning the mineral retention of frozen vegetables cooked by various boiling and steaming methods is generally lacking.

This study was directed towards some of these problems in an effort to obtain additional information concerning the mineral retention of frozen vegetables cooked with some types of food service steam equipment.

CHAPTER II

REVIEW OF LITERATURE

Technological developments in the operation of commercial and institutional kitchens have led to the wide use of several types of specialized cooking appliances and equipment (1). One type of cooking equipment which has become one of the most common means of cooking several types of food, including vegetables, involves the use of steam. In general, food service steam equipment can be classified as steam jacketed kettles and cabinet cookers (2).

The steam jacketed kettle, oldest of the steam cooking equipment, first involved the use of copper or iron cooking devices with a half or quarter jacket to hold the steam. Aluminum or stainless steel later replaced the copper or iron, and the incorporation of a three quarters or full jacket resulted in a cooking device which could heat large quantities of food at a more rapid rate.

The standard steam jacketed kettle is basically two stainless steel hemispheres, or bowls. One of the hemispheres is sealed inside the other with about 2½ inches of space in between for the passage of steam. As the steam enters the jacket, the molecules come in contact with the cold inner wall and condense. The heat of the steam molecule is conducted by the metal to the food product being cooked, and the steam does not come in contact with the food (1).

According to Macfarlane (1) the advantages of a steam jacketed kettle are that heat is transferred rapidly at a very low temperature and that there is an even distribution of heat over the entire heated surface. Avery (3) has also pointed out that the possibility of burning food in a steam jacketed kettle is quite low if adequate cooking liquid is kept around the cooking food.

Cooking with steam under pressure is probably one of the most efficient and economical methods of preparing many foods in large quantities. The steam injected into the chamber of a cabinet cooker comes in direct contact with the food, and the use of cooking liquid is generally not necessary. Cabinet cookers can be divided into low-pressure and high-pressure units. The low-pressure unit operates under 3 to 5 pounds of pressure per square inch, while the operation of a high-pressure unit requires 12 to 15 pounds of pressure per square inch.

The low-pressure cabinet cooker is probably the most common type of steam pressure equipment found in the majority of commercial and institutional kitchens, but the increase in use of convenience foods has resulted in the need for equipment with some capabilities that the low-pressure steamers do not have. The high-pressure steamer has been developed to cope with some of the problems associated with the use of convenience foods.

In contrast to the low-pressure cooker, the high-pressure steamer provides an atmosphere of dry steam to the cooking chamber. The absence of water in the cooking chamber and the decrease in cooking time as a result of this high pressure would supposedly result in a cooking environment which would increase the retention of nutrients, color, and flavor over the low-pressure steamer. With some of the high-pressure cookers, frozen foods are defrosted automatically prior to cooking, and the cooking cycle does not start until the food has reached a specific internal temperature. When using a low-pressure cooker to cook frozen food, the food is usually defrosted first unless special precautions are taken to prevent the overcooking of food. In a low-pressure cooker, the cooking cycle starts immediately, and there is no defrost cycle built into the system. Frequent small batch cooking has been found to be advantageous in commercial and institutional kitchens under certain conditions. This practice, however, requires a cooker which cooks food rapidly. The high-pressure steamer appears to be well suited for small batch cooking.

According to Wilkinson (4) the number one use of the steam jacketed kettle is the preparation of vegetables. The use of steam pressure units for vegetable cooking is also recommended. Although manufacturers of both types of these cooking devices make similar claims concerning the nutrient retention of vegetables cooked by their equipment, information concerning the effect of standard food service cooking methods on the mineral retention of frozen vegetables is lacking.

One factor which affects the retention of nutrients in vegetables is the amount of water used for cooking. Peterson and Hoppart (5) reported that string beans lost approximately 22.3 and 21.4 per cent of calcium and of phosphorus, respectively, when boiled for 30 minutes in sufficient water to cover. When twice as much water was used, the loss of calcium and of phosphorus was approximately 29.3 and 27.6 per cent, respectively. Similar studies with other vegetables indicated an increase loss of calcium and of phosphorus with a corresponding increase in cooking liquid. Thus, it would appear that in order to retain the maximum amount of calcium and of phosphorus, vegetables should be cooked in as little water as possible.

Data reported by Market Forge[1] indicated that under steaming conditions more calcium and phosphorus were retained in fresh vegetables than were retained under boiling conditions. This data was obtained with a low-pressure type of cooker, and data on the cooking of vegetables under high-pressure conditions was not included.

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[1]Market Forge test kitchen bulletin No. 12, Everett, Massachusetts.

CHAPTER III

EXPERIMENTAL PROCEDURES

The purpose of this study was to compare the retention of calcium and of phosphorus in frozen okra and spinach when cooked in a steam jacketed kettle, a low-pressure steamer, and a high-pressure steamer.

The frozen food used for the study was obtained from a local wholesale company.[2] The food was transported from the company in a refrigerated truck and was stored at 0° F until it was used for cooking and analytical purposes. Institutional packages which weighed 3 pounds each were used throughout the study. The brands of these products were Delta cut okra[3] and Mity-Fresh chopped spinach.[4]

Representative packages of each vegetable were randomly selected for uncooked samples and for samples of the vegetables cooked by the three pieces of equipment used for the study. From each package of vegetable, okra or spinach, three randomly selected sub-samples, each weighing approximately 4 grams in weight, were taken for ashing purposes. All sub-samples, cooked or uncooked,

[2]W. I. Anderson Company, Greensboro, North Carolina.

[3]Humboldt Foods, Inc., Humboldt, Tennessee.

[4]Watsonville Canning Company, Watsonville, California.

were ashed with nitric and perchloric acids on a hot plate. The ashed residues were dissolved in 3 ml. of 0.6N HCl and diluted to either 50 or 100 ml. with distilled water. Appropriate aliquots of the diluted samples were taken for subsequent calcium or phosphorus analyses.

Calcium content of the vegetables was determined by the method of Weybrew et al. (6), while the method of Simonsen et al. (7) was used for the phosphorus determinations. Details of these methods are given in Appendix A.

The data was analyzed statistically by standard analysis of variance procedures, and statements of significance were based on odds of 19 to 1.

The vegetables were cooked in each piece of equipment according to the recommendations furnished by the manufacturers of the equipment. When cooking times were not available, they were established by preliminary tests. Preparation and cooking procedures used in the study are given in Table 1.

The steam jacketed kettle was a Groen[5] Model TDC-20 unit, and all cooking done in this kettle was without the cover. The low-pressure steamer was a Market Forge[6] Model 1W-S unit, and the pressure for this unit was set for 5 pounds of pressure per square inch. The high-pressure steamer was a Vischer[7] Model 75

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[5]Groen Manufacturing Company, Elk Grove Village, Illinois.

[6]Market Forge Company, Everett, Massachusetts.

[7]Vischer Products Company, Chicago, Illinois.

TABLE 1

PREPARATION AND COOKING PROCEDURES FOR FROZEN VEGETABLES COOKED IN THREE TYPES OF FOOD SERVICE EQUIPMENT

Procedure	Food Service Equipment: Steam Jacketed Kettle	Low-Pressure Steamer	High-Pressure Steamer
<u>Okra</u>			
Thawing time	None	Overnight in air-conditioned room[a]	Overnight in refrigerator
Cooking time (minutes)	8	8	1½
Amount of water[b] added (cups)	8	None	None
<u>Spinach</u>			
Thawing time	Overnight in refrigerator	Overnight in air-conditioned room[a]	Overnight in refrigerator
Cooking time (minutes)	3	4	½
Amount of water[b] added (cups)	7	None	None

[a]Temperature maintained at 76° F.

[b]Distilled water.

which was set to operate with 15 pounds of pressure per square inch.

CHAPTER IV

RESULTS AND DISCUSSION

Detailed data obtained in this study are presented in Appendix B. Mean levels of calcium and of phosphorus found in the cooked and the uncooked okra and spinach are presented in Tables 2 and 3.

Although the amounts of calcium and of phosphorus found in okra cooked in the steam jacketed kettle were lower than those found in the uncooked vegetable (Table 2), statistical analysis of the data (Appendix C) revealed that these differences were not significant. There are approximately a 35 per cent loss of calcium and a 13 per cent loss of phosphorus from okra cooked in the steam jacketed kettle. There was no appreciable loss of these minerals when okra was cooked by either of the steaming methods.

The amounts of calcium and of phosphorus found in spinach cooked in the low-pressure steamer were lower than the levels of these minerals found in the uncooked spinach (Table 3). Approximately 24 per cent of the calcium and 16 per cent of the phosphorus was lost when the spinach was cooked by the low-pressure steamer. Statistical analysis of the data (Appendix C), however, revealed that the differences in calcium and phosphorus levels of the uncooked spinach and the spinach cooked in the low-pressure

TABLE 2

MEAN CALCIUM AND PHOSPHORUS VALUES OF OKRA COOKED IN A STEAM JACKETED KETTLE, A LOW-PRESSURE STEAMER, AND A HIGH-PRESSURE STEAMER

Method of Cooking	Calcium[a]	Phosphorus[a]
	mg./100 gm. of wet weight	
Uncooked	34	30
Steam jacketed kettle	22	26
Low-pressure steamer	45	33
High-pressure steamer	34	36

[a] Each value is the mean of 9 determinations.

TABLE 3

MEAN CALCIUM AND PHOSPHORUS VALUES OF SPINACH COOKED IN A STEAM JACKETED KETTLE, A LOW-PRESSURE STEAMER, AND A HIGH-PRESSURE STEAMER

Method of Cooking	Calcium[a]	Phosphorus[a]
	mg./100 gm. of wet weight	
Uncooked	82	43
Steam jacketed kettle	108	42
Low-pressure steamer	62	36
High-pressure steamer	114	42

[a] Each value is the mean of 9 determinations.

steamer were not significant. There was no appreciable loss in either mineral when the spinach was cooked in the steam jacketed kettle or in the high-pressure steamer.

The overall results of this study indicate that okra and spinach could be cooked in a steam jacketed kettle, low-pressure steamer, or a high-pressure steamer with the resulting levels of calcium and of phosphorus retained quite similar. Thus, it would appear that adequate retention of calcium and of phosphorus in these vegetables can be maintained, regardless of the method of steam cooking.

The results of this study do not agree with the information[8] published by Market Forge on spinach cooked by boiling and by steaming. That information indicated greater losses in calcium and phosphorus when spinach was cooked by boiling than there were when the vegetable was cooked by steaming. In the present study no losses in calcium and phosphorus were found when spinach was cooked in the steam jacketed kettle. Some losses in these minerals did occur, however, when spinach was cooked in the low-pressure steamer.

In some cases values for calcium and phosphorus in the cooked vegetables were higher than the values determined for the uncooked vegetables. Although there is the possibility that exogenous minerals could have been added to the vegetables by contamination from the water or steam during cooking, it is more

[8]Market Forge test kitchen bulletin No. 12, Everett, Massachusetts.

likely that the packages within a particular carton varied in their mineral content. There is also the possibility that within an individual package of each vegetable, a wide variation in mineral content existed.

CHAPTER V

SUMMARY AND RECOMMENDATIONS

Summary

The present study was conducted to determine the retention of calcium and phosphorus in frozen okra and spinach cooked in a steam jacketed kettle, a low-pressure steamer, and a high-pressure steamer.

Institutional packages, 3 pounds in weight, were used in the study. With the exception of the okra cooked in the steam jacketed kettle, all vegetables were thawed before cooking. The vegetables were cooked according to the times recommended by the equipment manufacturers. Representative samples of cooked and uncooked okra and spinach were taken from individual packages, ashed with nitric and perchloric acids on a hot plate, and diluted with distilled water. Appropriate aliquots of the diluted samples were used for subsequent calcium and phosphorus determinations.

Experimental results indicated some loss in calcium and in phosphorus from okra cooked in the steam jacketed kettle and from spinach cooked in the low-pressure steamer, respectively. The overall results, however, indicated that the retention of these minerals was quite similar, regardless of the method of cooking.

Recommendations for Further Investigations

Similar types of investigations should be conducted on other vegetables which are considered good sources of calcium and phosphorus so that complete information concerning the vegetable cooking capabilities of the types of equipment used in this study can be obtained. Some vegetables which would be appropriate for such investigations are broccoli, Brussels sprouts, cauliflower, and turnip greens.

Since the results of this study indicated the possibility of a wide variation in the mineral contents between and within vegetable packages, more samples and sub-samples of the vegetables should be analyzed in future studies of this type than were analyzed in this study.

While this study gave indications of the calcium and the phosphorus contents of two frozen vegetables cooked by three steam cooking methods, evaluations of color, texture, and flavor were not obtained. Cooking methods which result in satisfactory nutrient retention may or may not result in acceptable color or flavor. Since these factors, as well as the nutritive value of the final product should serve as criteria for the choice of a cooking method, valuable information could be obtained from a study designed to correlate and study all of these factors in vegetables cooked by the boiling and steaming methods used in this study.

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APPENDIX A

ANALYTICAL METHODS FOR CALCIUM AND PHOSPHORUS

ANALYTICAL METHOD FOR CALCIUM

Procedure

An appropriate aliquot of each sample was pipetted into a 15 ml. conical tip centrifuge tube, and sufficient distilled water was added to bring the total volume to 5 ml. One ml. of 20% sodium acetate, 0.25 ml. of brom cresol green, and 1 ml. of 4% ammonium oxalate were added to each sample and the mixture was stirred thoroughly with a Vortex mixer. An amount of 0.1 ml. of 1:3 ammonium hydroxide (1 volume of concentrated ammonium hydroxide and 3 volumes of distilled water) was added to each sample. The resulting mixture was stirred with a Vortex mixer, and the samples were allowed to stand overnight in the test tubes with cork stoppers in them.

The samples were centrifuged at 1800 to 2000 r.p.m. for 15 to 20 minutes. The liquid was poured off and discarded. The calcium tubes were allowed to drain upside down on a paper towel for about 5 minutes. The calcium precipitates were washed with approximately 3 ml. of ether-alcohol solution by stirring with a Vortex mixer. The samples were centrifuged 5 to 10 minutes, and the wash liquid was discarded. The calcium tubes were drained, and the washing was repeated. After the second washing, the samples were drained overnight.

The dried precipitate was dissolved in 2 ml. of 1N sulfuric acid. Simultaneously, 2 ml. of each sodium oxalate standard was pipetted into clean conical tip test tubes.

The samples and standards were heated in a boiling water bath for 5 minutes. Exactly 10 ml. of ceric sulfate working solution was added to each tube. The contents of each tube were mixed by stoppering and inverting repeatedly.

Using distilled water as a reference solution, the per cent transmittance of the samples and the standards were read in a Bausch and Lomb Spectronic 20 colorimeter with the wave length set at 370 m .

The milligrams of calcium in the samples were calculated from the regression equation of the calcium standards.

Reagents

1. Sodium acetate, 20%. Two hundred grams of sodium acetate were dissolved in 400 - 500 ml. of distilled water. The solution was diluted to a total volume of 1 liter, mixed thoroughly, and a crystal of thymol was added to the reagent bottle to preserve the reagent.
2. Brom cresol green indicator. An amount of 0.0160 grams of brom cresol green was ground in a glass mortar with 2.3 ml. of 0.01N sodium hydroxide. When the indicator was dissolved, the solution was diluted to 100 ml. with distilled water.
3. Ammonium oxalate, 4%. Forty grams of ammonium oxalate were dissolved in about 400 ml. of distilled water. The solution was diluted to a total volume

of 1 liter. This solution was kept in the refrigerator.

4. Ether-alcoholwash solution. Five hundred ml. of ether, 500 ml. of 95% ethanol, 500 ml. of distilled water, and 30 ml. of concentrated ammonium hydroxide were mixed together.
5. Sulfuric acid, approximately 1N. Fifty-six ml. of concentrated sulfuric acid was added to about 500 ml. of distilled water in a 2 liter volumetric flask while agitating. The solution was cooled to a few degrees below room temperature and then diluted at room temperature to 2 liters. The solution was mixed well before using.
6. Cerous sulfate, 0.2%. Four grams of cerous sulfate (G. Frederick Smith Chemical Company, Columbus, Ohio) were dissolved in approximately 300 ml. of distilled water and 55.8 ml. of concentrated sulfuric acid with heat. The solution was cooled and diluted to 2 liters.
7. Ceric sulfate stock solution. An amount of 4.4901 grams of oven-dried ceric sulfate (G. Frederick Smith Chemical Company, Columbus, Ohio) was weighed and dissolved in and diluted to 1 liter with the 0.2% cerous sulfate-sulfuric

acid solution. This solution is approximately 0.0081N as standardized against sodium oxalate and is stable for at least 10 months. The solution was kept in the dark.

8. Ceric sulfate working solution. One volume of the ceric sulfate stock solution was diluted to ten volumes with the 0.2% cerous sulfate solution. This ceric sulfate solution is made fresh from the two solutions.

9. Primary standard sodium oxalate. Exactly 234 milligrams of oven-dried Bureau of Standards sodium oxalate is dissolved in 100 ml. of 1N sulfuric acid. Two, 3, 4, and 5 ml. portions of this solution were taken, and each was diluted to 50 ml. with 1N sulfuric acid. Two ml. of each of the four solutions are used for calcium standards. These are equivalent to 0.056 mg. Ca, 0.048 mg. Ca, 0.112 mg. Ca, and 0.140 mg. Ca, respectively.

ANALYTICAL METHOD FOR PHOSPHORUS

Procedure

An appropriate aliquot of each sample was pipetted into a test tube, and sufficient distilled water was added to bring the total volume to 5 ml. Five ml. of distilled water (blank solution) and 5 ml. of each phosphorus standard were pipetted into respective test tubes. One ml. of 0.25% ammonium vanadate solution was added to each test tube. One ml. of 5% ammonium molybdate solution was added to each test tube, and each determination was stirred in a Vortex mixer immediately after the addition of the molybdate reagent to fully develop the yellow color.

The per cent transmittance of the samples and the standards were read against the blank solution in a Bausch and Lomb Spectronic 20 colorimeter with the wave length set at 420 m .

The milligrams of phosphorus in the samples were calculated from the regression equation of the standards.

Reagents

1. Phosphorus standards.
   - (a) Stock phosphorus standard. Some highest purity potassium dihydrogenphosphate was ground finely with a mortar and pestle, dried in a vacuum oven overnight at 60

degrees, and held in a dessicator for two to three days. An amount of 0.3473 grams was weighed out accurately, dissolved in distilled water, and made to a volume of 1 liter.

(b) Working phosphorus standards.

(1) 0.004 mg./ml. 50 ml. of stock solution, 39.5 ml. of 10N sulfuric acid. Dilute to 1 liter with distilled water.

(2) 0.008 mg./ml. 100 ml. of stock solution, 39 ml. of 10N sulfuric acid. Dilute to 1 liter with distilled water.

(3) 0.012 mg./ml. 150 ml. of stock solution, 38.5 ml. of 10N sulfuric acid. Dilute to 1 liter with distilled water.

(4) 0.016 mg./ml. 200 ml. of stock solution, 38 ml. of 10N sulfuric acid. Dilute to 1 liter with distilled water.

2. Ammonium vanadate, 0.25% (in 1:2 nitric acid - 1 part HNO_3, 2 parts distilled water). An amount of 1.25 grams of ammonium vanadate was dissolved in approximately 200 ml. of 1:2 nitric acid and heated until solution was complete. The mixture was allowed to

cool to room temperature, made to a volume of 500 ml. with 1:2 nitric acid, and kept in a dark place.

3. Ammonium molybdate, 5%. Fifty grams of ammonium molybdate were dissolved in about 300 ml. of distilled water, and the solution was diluted to a volume of 1 liter.

APPENDIX B

DETAILED CALCIUM AND PHOSPHORUS DATA

OF OKRA AND SPINACH

TABLE 1

CALCIUM CONTENT OF OKRA

Method of Cooking	Package 1	Package 2	Package 3
	mg./gm. of wet weight		
Uncooked	0.29	0.26	0.27
	0.26	0.24	0.83
	0.30	0.29	0.32
Total	0.85	0.79	1.42
Mean	0.28	0.26	0.47
Steam jacketed kettle	0.24	0.24	0.26
	0.20	0.27	0.15
	0.18	0.20	0.24
Total	0.62	0.71	0.65
Mean	0.21	0.24	0.22
Low-pressure steamer	0.27	0.20	0.83
	0.22	0.27	0.83
	0.22	0.39	0.83
Total	0.71	0.86	2.49
Mean	0.24	0.29	0.83
High-pressure steamer	0.30	0.41	0.30
	0.28	0.31	0.31
	0.29	0.46	0.39
Total	0.87	1.18	1.00
Mean	0.29	0.39	0.33

TABLE 2

PHOSPHORUS CONTENT OF OKRA

Method of Cooking	Package 1	Package 2	Package 3
		mg./gm. of wet weight	
Uncooked	0.19	0.39	0.21
	0.33	0.29	0.32
	0.32	0.40	0.29
Total	0.84	1.08	0.82
Mean	0.28	0.36	0.27
Steam jacketed kettle	0.18	0.26	0.31
	0.30	0.30	0.12
	0.30	0.24	0.28
Total	0.78	0.80	0.71
Mean	0.26	0.27	0.24
Low-pressure steamer	0.34	0.32	0.50
	0.14	0.32	0.51
	0.16	0.35	0.30
Total	0.64	0.99	1.31
Mean	0.21	0.33	0.44
High-pressure steamer	0.38	0.36	0.42
	0.41	0.40	0.16
	0.30	0.36	0.47
Total	1.09	1.12	1.05
Mean	0.36	0.37	0.35

TABLE 3

CALCIUM CONTENT OF SPINACH

Method of Cooking	Package 1	Package 2	Package 3
	mg./gm. of wet weight		
Uncooked	0.97	0.92	1.01
	0.85	0.23	0.81
	0.93	0.80	0.82
Total	2.75	1.95	2.64
Mean	0.92	0.65	0.88
Steam jacketed kettle	1.05	1.23	1.05
	0.99	1.17	0.99
	1.05	0.95	1.23
Total	3.09	3.35	3.27
Mean	1.03	1.12	1.09
Low-pressure steamer	0.85	0.21	0.63
	0.85	0.26	0.85
	0.85	0.24	0.85
Total	2.25	0.71	2.33
Mean	0.85	0.24	0.78
High-pressure steamer	1.27	1.29	1.20
	1.14	1.06	0.80
	1.10	1.27	1.11
Total	3.51	3.62	3.11
Mean	1.17	1.21	1.04

TABLE 4

PHOSPHORUS CONTENT OF SPINACH

Method of Cooking	Package 1	Package 2	Package 3
		mg./gm. of wet weight	
Uncooked	0.45	0.45	0.47
	0.38	0.32	0.52
	0.50	0.48	0.32
Total	1.33	1.25	1.31
Mean	0.44	0.42	0.44
Steam jacketed kettle	0.44	0.38	0.42
	0.43	0.44	0.44
	0.40	0.40	0.45
Total	1.27	1.22	1.31
Mean	0.42	0.41	0.44
Low-pressure steamer	0.52	0.30	0.52
	0.30	0.15	0.62
	0.26	0.15	0.46
Total	1.08	0.60	1.60
Mean	0.36	0.20	0.53
High-pressure steamer	0.41	0.27	0.45
	0.52	0.25	0.27
	0.57	0.55	0.47
Total	1.50	1.07	1.19
Mean	0.50	0.36	0.39

APPENDIX C

ANALYSES OF VARIANCE DATA

TABLE 1

ANALYSES OF VARIANCE OF CALCIUM DATA

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square
	Okra		
Total	35	1.230	
Between methods	3	0.24	0.080
Within methods	32	0.990	0.031
	Spinach		
Total	35	2.967	
Between methods	3	1.555	0.518**
Within methods	32	1.412	0.044

**Highly significant (P 0.01)

TABLE 2

ANALYSES OF VARIANCE OF PHOSPHORUS DATA

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square
	Okra		
Total	35	0.321	
Between methods	3	0.055	0.018
Within methods	32	0.266	0.008
	Spinach		
Total	35	0.440	
Between methods	3	0.025	0.008
Within methods	32	0.415	0.013