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Fresh vegetables commonly eaten in the South, and of relatively high iron content were cooked by five different methods. Three of these methods were based upon methods of cooking vegetables most frequently used by Southern housewives. The losses of iron were determined by analysis of the fresh vegetable, the cooked vegetable, and the cooking water.

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INTRODUCTION

Dietary studies made in 1925 and 1927 on 75 rural white families (1) and 80 rural negro families (2) in Mississippi revealed that over 60 per cent of the dietaries were deficient in iron. A similar study (3) made on 200 rural white families in Georgia during the same period showed that 77 per cent of the dietaries were deficient in iron. These studies, therefore, confirm the statement made by Sherman (4) based on estimates of the amounts of iron contained in 150 American dietaries that "the typical American dietary does not contain any such surplus of iron as would justify the practice of leaving the supply of this element entirely to chance." Moreover, the deficiency of iron in the Mississippi and Georgia diets was greater than that in the 150 American dietaries described by Sherman.

Fresh green vegetables were one of the most important sources of iron in these Southern dietaries, but those commonly eaten, namely, turnip greens, mustard greens, collards, and cabbage are, with the exception of cabbage, always cooked. Cabbage is generally cooked. Estimates of their iron content were necessarily based on that of the uncooked vegetable. This means that, unless all the water in which the vegetables were cooked was consumed the deficiency of iron in the Mississippi and Georgia diets would be even greater than the studies indicated.

A survey* was made among rural housewives in Mississippi to determine their favorite methods of preparing and cooking vegetables. The vegetables of relatively high iron content which were most frequently cooked were turnip tops, mustard, collards, butter beans, string beans, cow peas (field peas) and garden peas (English peas). From 112 to 124 records were obtained for each vegetable. In preparing the leafy vegetables for cooking the majority of the housewives discarded the stems and part of the ribs of the leaf since these parts are apt to be tough and unpalatable when cooked.

*Survey made under the direction of Miss Dickins, by Home Economics seniors of Mississippi State College for Women. Unpublished work.

The usual method of cooking was boiling in at least enough water to cover the vegetables. From 64 to 90 per cent of the women interviewed cooked the above vegetables, with the exception of mustard, in this way. 60 per cent cooked mustard in less than enough water to cover it. The time of cooking depended upon the vegetable. 60 per cent of the housewives cooked garden peas and mustard one hour or more; about 80 per cent cooked cow peas, and butter beans 1½ hours or more, and string beans 2 hours or more. Turnip tops and collards were cooked 2 hours or more by 50 and 63 per cent of the women. From 23 to 52 per cent of the women did not use the cooking water in which the above vegetables were cooked. 30 to 37 per cent of the women discarded the water in which butter beans, mustard, and turnip tops were cooked. About 24 per cent did not use the cooking water from garden peas, cow peas, and string beans. 52 per cent discarded the water from collards.

In view of the results obtained by the Mississippi studies, a project was undertaken on losses of iron in the preparation and cooking of vegetables. Its objects were: (1) To determine what losses of iron occurred when vegetables were cooked by the most usual methods; (2) To determine what methods of cooking were best from the standpoint of conservation of iron.

Review of Literature

A number of papers have been published on losses of iron in cooking vegetables but a review of this literature reveals that with the exception of one paper the data given is incomplete. In most instances not more than one or two vegetables have been studied for losses of iron. Moreover, details of the exact methods of cooking are frequently not stated.

Haensel (5) found as high as 70 per cent loss of iron in boiling spinach and lettuce.

Blunt and Otis (6) boiled 5 to 10 grams of spinach, string beans, navy beans, and peas in 25 to 75 cc of distilled water for 20 to 40 minutes (navy beans 2 hours), and determined the losses of iron. The loss varied from 32 to 50 per cent, spinach losing the most iron. Potatoes were peeled, grated, and boiled. They lost between 15 and 22 per cent of their iron. The raw vegetable, the cooked vegetable, and the cooking water were analyzed, but since such small quantities of vegetable were cooked, recoveries were poor.

Courtney, Fales, and Bartlett (7) cooked spinach, New Zealand spinach, and a number of other vegetables by boiling and steaming, and determined the losses in cooking of eight ash

constituents including iron as iron oxide. Unfortunately they used a gravimetric method for iron analysis which was not sufficiently sensitive to determine the losses of iron in most instances. They give data only on spinach. They found that spinach boiled 10 minutes lost 23.4 per cent and spinach boiled 90 minutes lost 28.2 per cent of its iron as iron oxide. New Zealand spinach boiled 30 minutes lost 50.8 per cent of its iron. Spinach steamed 30 minutes in a double boiler without additional water lost 30.8 per cent of its iron, as iron oxide. The quantity of vegetable cooked and the quantity of water used is not stated.

Field, Peacock, Cox, and Earle (8) determined losses of iron in cooking mustard and turnip greens. They boiled 200 grams of vegetable in 500 cc and 1500 cc of distilled water for 45 minutes. The loss of iron for turnips was 3.3 per cent and for mustard 4.3 per cent when boiled in 500 cc water. When boiled in 1500 cc water the loss of iron was 16 per cent for turnips and 19 per cent for mustard. Turnip greens boiled in tap water lost more than twice as much iron as when boiled in distilled water.

Peterson and Hoppert (9) have conducted the most comprehensive investigations on losses of minerals, including iron, in the cooking of vegetables. The vegetables on which losses of iron were determined were asparagus, string beans, beet greens, cabbage, spinach, celery cabbage, carrots, kolhrabi, onions, parsnips, sweet potatoes, and rutabagas. From 400 to 600 grams of these vegetables were cooked in 4 different ways. Three samples were used for each cooking and the samples combined after cooking and before analyzing. Iron determinations were made on the uncooked and cooked vegetables but the cooking water was not analyzed. The greatest loss of iron occurred in the leafy vegetables in all four methods of cooking with one or two exceptions, celery cabbage losing 67.6 per cent of its iron when boiled. The average loss of iron for all vegetables was as follows: Boiled in enough water to cover, 40.1 per cent; boiled in twice that amount of water, 48.0 per cent; steamed, 21.3 per cent; and pressure cooked 17.4 per cent.

McLaughlin (10) determined the losses of iron in boiling and steaming New Zealand spinach for varying lengths of time. She used different quantities of tap water for the boiled spinach. The steamed spinach was cooked in the top of a double boiler without water except that which clung to the leaves after washing. Steamed spinach cooked 50 minutes lost from 13 to 28 per cent of its iron. Spinach boiled 10 minutes in nearly twice its weight of water lost from 40 to 47 per cent of its iron.

CONSERVATION OF IRON IN VEGETABLES

The work described in this bulletin was undertaken to obtain data on losses of iron when vegetables were cooked by methods most commonly used by Southern housewives, as well as to determine what methods of cooking were most desirable, if iron was to be conserved.

Methods of Preparation and Cooking

Vegetables were obtained in as fresh a condition as possible. They were thoroughly washed, trimmed, and dried at room temperature until the visible moisture had evaporated, but not until they were wilted. String beans were broken into pieces before cooking. The stems of the leafy vegetables (mustard, turnips, and collards) were separated from the leaves, and were not cooked. After the vegetable was prepared for cooking the whole quantity was thoroughly mixed. From 300 to 450 gram samples were then weighed out in duplicate for each method of cooking, and for moisture determinations and analysis of the uncooked vegetable.

All cooking was done on an electric stove. Vegetables were boiled in covered three-cornered aluminum vessels of the same size and shape. Duplicates were cooked on one hot plate at the same time, and were turned around during the cooking to insure a more uniform temperature. The vegetables were put on in boiling water and the time counted from the time they were first placed in the water.

The steamer and pressure cooker were also aluminum. Duplicates were cooked on the same hot plate at as nearly the same temperature as possible.

Five different methods of cooking were used; three methods of boiling and two methods of steaming. The former were based upon those commonly used by Mississippi housewives in boiling vegetables. The time of cooking and the quantity of water used varied with the vegetable as well as with the method of cooking. The methods were as follows:

1. Boiling in 400 to 1000 cc of water 1 to 2½ hours.
2. Boiling in 400 to 1000 cc of water ½ to 1¼ hours.
3. Boiling in 200 to 500 cc of water ½ to 1½ hours.
4. Steaming ½ to 1½ hours.
5. Cooking in a pressure cooker 8 to 15 minutes.

The larger amount of water was somewhat more than enough to cover the vegetable. The smaller amount of water was from ½ to ¼ enough water to cover the vegetable. The longer period of time was the longest time ordinarily used in

cooking that vegetable. The shorter period of time was the time required to cook the vegetable tender. After cooking, the vegetable was drained from 3 to 5 minutes, or until the water drained off a drop at a time.

Only distilled water was used in cooking, since tap water always contains some iron, and its reaction and mineral constituents effect the losses of iron as well as other nutrients of the vegetables cooked in it. Moreover, the composition of tap water shows wide variations in different localities. In order to determine the effect of the composition of the tap water on losses of nutrients in cooking, a thorough and prolonged study would be required which could not be undertaken as a part of this project. It was necessary in a study of this kind to eliminate as far as possible conditions which would lead to variations in results.

ANALYSIS OF VEGETABLES

Preparation of Samples and Materials Analyzed

Since it is customary to discard the stems and a portion of the ribs of the leaves of collards, mustard, and turnip tops before cooking these vegetables, the leafy portion of one or two samples of each vegetable was separated from the stems and ribs of the leaves and each part analyzed separately for iron. The roots of a number of samples of turnips were also analyzed separately from the leaves.

All samples of vegetables were dried at 100° C. in an electric oven, finely ground, and thoroughly mixed before analyzing for iron. Moisture determinations were made on the fresh uncooked vegetable, and on the dried ground samples before analysis. Four samples were usually taken both for moisture and analysis. The cooked vegetables were spread out on large watch glasses to dry.

Each cooking of vegetable was analyzed separately. The water from each cooking and the rinsings were poured into a Kjeldahl flask and evaporated to dryness. The residue was then wet ashed and analyzed.

Method of Analysis

The method of analysis was based upon that of Kennedy for the determination of iron in blood and tissue (11). The modified Kennedy Method was as follows: The weighed sample, usually two or three grams, was placed in a 300 cc Kjeldahl flask and from 5 to 12 cc of concentrated sulphuric acid added. An excess of acid was avoided but the flask was not allowed to

become entirely dry during digestion. The water from some of the cookings required much more than 12 cc of acid, small additions being made during the digestion. From 1½ to 3 cc of acid were left in the flask when digestion was complete. A 3 gram sample usually required about 12 cc of acid. Digestion was carried out over Argand burners, the flame being turned low until frothing ceased and the heat then increased until the acid began to wash down the sides of the flask. It was then cooled and from 1 to 5 cc of 60 per cent perchloric acid added. Heating was continued until the contents of the flask were clear and almost colorless. The flask was cooled, one drop of conc. nitric acid added and about 50 cc of distilled water. The flask was heated over the water bath for about an hour to insure complete solution of the iron. It was then cooled and the contents transferred to a 100 cc volumetric flask. This was made up to volume and the contents thoroughly mixed at about 20° C. 1 cc was pipetted out and titrated with standard alkali, N-4 being a convenient strength. 5 or 10 cc of the solution, depending upon the quantity of iron present, was measured into a 50 cc glass-stoppered cylinder and sufficient dilute sulphuric acid of known strength (1 part conc. acid to 9 parts distilled water) was added to make the acidity equivalent to 80 cc of N-4 alkali (0.78 grams sulphuric acid).

The volume was made up to 15 cc with distilled water, 10 cc of iso amyl alcohol and 5 cc of a 20 per cent solution of potassium thiocyanate added. The mixture was shaken thoroughly, and the colored layer of alcohol allowed to separate. It was then pipetted off into a test tube. The colored layers of alcohol from the standard and unknown were poured into the colorimeter cups and compared in the colorimeter.

Preparation of Standard—Analytical iron wire was used as a standard. It was first analyzed to determine its purity by passing a solution through the Jones reductor and titrating with a standard permanganate solution. Iron wire equivalent to 0.2 grams of pure iron was weighed out and dissolved in 40 cc of 10 per cent sulphuric acid. 1.5 cc of conc. nitric acid was added and the whole made up to 1000 cc. 25 cc of this stock solution was diluted to 200 cc and used for a standard. 1 cc, 1.5 cc, and 2 cc of this solution containing .025, .0375, and .05 mgs. of iron respectively were used as standards. The required amount of standard, as determined by a preliminary test on the unknown, was measured into a 50 cc cylinder, made up to the same volume and acidity as the unknown, and treated in the same way.

Precautions—It was found necessary to keep the volume

and acidity approximately the same in all determinations in order to obtain comparable results, since both affect the formation of the ferric thiocyanate. It was also necessary to cool the solution during warm weather to 20° C or below and to carry out the last part of the analysis as quickly as possible since increased temperature leads to more rapid reduction of the iron to the ferrous state.

Great care was taken throughout the process of preparing, drying, and analyzing the vegetables to avoid iron contamination. Only the purest reagents were used in analysis. They were tested for their iron content. It was found that the C. P. acids contained so little iron that with the quantities used their iron content could not be determined. The purest samples of potassium thiocyanate obtainable contained a small amount of iron, but this did not lead to error since the same quantity was added both to the unknown and the standard.

Results

The iron content of the leafy portion of mustard, turnips, and collards as compared with that of the stalks and ribs of the leaf, and also the iron content of the leaves of turnips as compared with the roots are given in Table 1. The results show that compared on the dry basis the leafy portion contains from 3 to 5 times as much iron as the stems and ribs of the leaves, and that the leaves of turnips contain more than five times as much iron as the roots. The leaves of mustard including the ribs were also analyzed separately from the stems of the leaf. The stems contained about half as much iron as the leaf. The results on the stems and leaves of mustard are in accordance with those reported by Holliday and Noble* on spinach.

The methods of cooking the seven vegetables and the losses of iron resulting from the different methods of cooking appear in Table 2. A comparison of these losses expressed as per cent is given in Table 3. The greatest loss of iron occurred in all seven vegetables when they were boiled the longest period of time in the largest quantity of water. Collards, string beans, and field peas lost from 25 to 29 per cent of their iron when cooked in this way. The loss varied in different vegetables from 9 to 29 per cent, mustard losing the least iron. The average loss of iron for the seven vegetables was 20.5 per cent. In every instance the vegetables lost less iron when boiled in the same quantity of water as that used in method 1, but a shorter time; though with five of the vegetables the difference was not more than 4 per cent. The average loss of iron for the

*Holliday and Noble, Hows and Whys of Cooking, page 6. Work done by Margaret Abt.

second method of cooking was 16.6 per cent. The difference between the losses of iron when vegetables were boiled in a small quantity of water the shortest time and the losses by the first two methods of boiling was more striking. The average loss was 9.8 per cent or less than half that which resulted when vegetables were boiled by the first method. The smallest losses of iron occurred when the vegetables were steamed or when they were cooked in the pressure cooker. With one exception all the vegetables lost less iron when steamed than when boiled in any of the three ways. Only five vegetables were cooked in the pressure cooker, but all of them lost less iron than when boiled. The average loss of iron for steaming was 6.9 per cent or one-third of that lost when the vegetables were boiled by the first method. The average loss of iron for cooking in the pressure cooker was 5 per cent or one-fourth that lost when boiled by the first method. Two of the five vegetables cooked in the pressure cooker lost decidedly less iron, and three of them slightly more iron than when steamed.

Discussion

The practice of discarding the stalks and ribs of the leaves of turnips, mustard, and collards, before they are cooked would seem justifiable from the standpoint of palatability and increased iron content of the cooked product. The decrease in the time required for cooking would also be a decided advantage.

In general the results obtained on the losses of iron in cooking vegetables are in accord with those reported by other investigators. Both the quantity of water used and the length of time the vegetable is cooked are important factors in the losses of iron as well as other nutrients. In boiling vegetables, Peterson and Hoppert found that doubling the quantity of water used increased the losses of iron 20 per cent. Holliday and Noble (12) show the effect of time on losses of nutrients in boiled vegetables. Results obtained in their laboratory* were compared with those reported by Peterson and Hoppert. The former boiled cabbage and cauliflower eight and nine minutes respectively, while the latter boiled them thirty minutes. These vegetables when they were boiled eight minutes lost from one-third to two-thirds as much dry matter, and one-fifth to two-fifths as much protein as when they were boiled thirty minutes. This occurred in spite of the fact that the Chicago investigators used more water in cooking the same quantity of vegetable.

Our results as well as those of Peterson and Hoppert indicate that the smallest losses of iron take place when vegetables

*Experiments done by Fannie Jackson.

are steamed by either of the two methods. However, the losses of nutrients by steaming may be greatly increased under certain conditions. Denton (13) found that "if conditions within the steamer are such that water washes down over the vegetable mass steaming may cause very large losses. Particularly is this true with pressure steamers." The losses to which she referred applied to all soluble nutrients including total ash.

Holliday and Noble found that if carrots were "surrounded by water" when cooked in a pressure cooker the losses in soluble carbohydrates was considerably greater than as if they were boiled in an open kettle. It is to be expected that losses of iron and other soluble nutrients would be large when vegetables are surrounded by water and cooked in a pressure cooker, since at a high temperature disintegration of the vegetable occurs to a greater extent. It would seem that if nutrients are to be conserved in steaming by either method it is necessary that the vegetable come in contact with as little water as possible during the cooking process.

Although the results obtained by various investigators on the comparative losses of iron by different methods of cooking agree in a general way, there are wide variations in the percentages of loss reported for any one method of cooking or any one vegetable. The losses reported by us are considerably less than those reported by the Wisconsin investigators for the same general methods of cooking. A number of factors are doubtless responsible for this lack of agreement. The composition of the sample of vegetable cooked, the state in which it is cooked i. e. whether it is left whole or cut into pieces, the composition and reaction of the water used in cooking, the temperature at which the vegetable was cooked, the kind of cooking utensils used. are all factors which would affect the results.

Summary

The leafy portion of mustard, turnip, and collard leaves was separated from the stems and ribs, and each analyzed separately for iron. The leafy portion contained from three to five times as much iron as the stems and ribs compared on the dry basis. The leaves (including the ribs) and the stems of mustard were analyzed for iron. The stems contained about one-half as much iron as the leaves. The roots and leaves of six samples of turnips were also analyzed separately for iron. The leaves contained five times as much iron as the roots.

Seven fresh vegetables, namely, mustard, turnip greens, collards, cow peas, garden peas, butter beans, and string beans were cooked by four or five different methods to determine

losses of iron. The methods of cooking used were (1) boiling in more than enough water to cover the vegetables from 1 to 2½ hours; (2) boiling in the same quantity of water as method 1, ½ to 1¼ hours; (3) boiling in ½ to ¼ enough water to cover the vegetable ½ to 1¼ hours; (4) steaming, and (5) cooking in the pressure cooker.

The greatest loss of iron resulted in every instance when the vegetable was boiled by the first method. The average loss for the seven vegetables was 20.5 per cent. Boiling by the second method led to a smaller loss of iron in every instance, the average loss being 16.6 per cent. A much smaller loss of iron occurred in every vegetable except one, when they were boiled by the third method, the average loss being 9.8 per cent. The smallest losses of iron occurred when the vegetables were steamed or were cooked in the pressure cooker. The average loss of iron for the seven vegetables cooked in the steamer was 6.9 per cent, and for the five vegetables cooked in the pressure cooker was 5.0 per cent.

PRACTICAL APPLICATIONS

There would seem to be no doubt that, if we are to conserve iron as well as other nutrients in cooking vegetables, the best methods are boiling or steaming in a small quantity of water the shortest period of time required to get them tender. Unfortunately, we cannot cook all vegetables by these methods and produce a palatable sightly product. Steaming in a pressure cooker causes destruction of the color of green vegetables. If the strong flavored vegetables as onions, cabbage, and collards, are cooked in this way or boiled in a small quantity of water, they develop an undesirable flavor and odor. Therefore, the method generally recommended for such vegetables, namely, boiling in a large quantity of water in an uncovered vessel is preferable. It is neither desirable nor practical to cook delicately flavored vegetables such as fresh English peas and butter beans which require cooking only a short period of time, in a pressure cooker. The high temperature destroys their flavor and is apt to produce a mushy product. They should be steamed in a steamer or boiled in a small quantity of water. This applies also to very tender green vegetables such as spinach. Mustard and turnip greens (not the roots) may be cooked to advantage in a pressure cooker provided they come in contact with very little water, and one does not object to their loss of color. Both the flavor and appearance of the turnip roots are objectionable if cooked in a pressure cooker.

All vegetables whether they are steamed or boiled should

be cooked a minimum time if their nutrients, especially iron which is readily lost, are to be conserved, as well as their flavor and color preserved.

This is not in accord with methods of cooking commonly in use by many housewives. Unfortunately most of us prefer our food prepared as we have been accustomed to eating it, and we are not apt to be open to conviction as to new and foreign ways of cooking. Seasoning, however, is a most important factor in producing the flavor which we may prefer. In so far as this applies to the Southern housewife more desirable methods of cooking may perhaps be introduced, and found acceptable, if cabbage, collards, turnip greens, mustard, string beans, and field peas are seasoned in the customary Southern fashion with salt pork or bacon.

Applying then, the results of our investigations as well as those of other workers in the cooking of vegetables, to general methods of cooking, we would make the following recommendations:

1. Cook **all** vegetables only long enough to produce a tender product.

2. Steam in a steamer or boil in a small quantity of water (¼ to ½ enough water to cover them) all young tender delicately flavored vegetables which require a short period of time to cook. Such vegetables would include: garden peas, butter beans, spinach, young tender string beans, and roots of vegetables, as young carrots and turnip roots.

3. Boil in more than enough water to cover them, all strongly flavored vegetables such as cabbage, onions, collards, and kale.

4. Boil in just enough water to cover them, or less; or steam in a pressure cooker those vegetables which require longer cooking such as mustard, turnip greens, field peas, mature carrots, beets, and turnip roots. The latter, as well as any other vegetable the flavor of which is injured by high temperature should be boiled.

Table I—Comparison of the Iron Content of the Leafy Portion, the Stalks, and Ribs of the Leaves of Turnips, Mustard, and Collards, and a Comparison of the Iron Content of Turnip Roots and Leaves.

Vegetable	Part of Vegetable Analyzed	No. Samples	Moisture Per Cent	Iron Per Cent	Gms. Iron Per 1 Gm. Dry Veg.
			average	average	average
Turnips	Leafy Portion*	2	86.66	.004464	.000331
	Stems & Ribs of Leaf	2	92.59	.000891	.000116
	Whole Leaves**	6	89.51	.004144	.000392
	Roots	6	92.76	.000521	.000072
Mustard	Leafy Portion	1	90.66	.003545	.000379
	Stems & Ribs of Leaf	1	95.32	.000447	.000095
	Whole Leaves	5	91.56	.003571	.000423
	Stems of Leaf	5	93.70	.001583	.000251
Collards	Leafy Portion	2	84.99	.001766	.000111
	Stems & Ribs of Leaf	2	88.46	.000300	.000026

*The leafy portion of each vegetable was carefully separated from the stalk and from all but the smaller ribs of the leaf.

**The whole leaves of turnips and mustard including the ribs were analyzed.

Table II—Losses of Iron by Different Methods of Cooking

Vegetable	Meth. of Cooking	Quantity Vegetable Cooked	Moisture Uncooked Vegetable	Gms. Fe. In Uncooked Veg.	Gms. Fe. in Cooked Vegetable	Gms. Fe. in Cooking Water	Tot. No. Gms. Fe. in water & Vegetable Cooked	Av. Error
		gms.	per cent					Per cent
	1 Boiled in 600 cc water 2 hrs. 30 min.	400	*90.17	.008646	1. .007043 2. .007132 Av. .007087	1. .000811 2. .000961 Av. .000886	1. .007854 2. .008093 Av. .007973	—7.8
Turnip Tops	2 Boiled in 600 cc water 1 hr. 15 min,	400	*89.90	.009016	1. .007516 2. .007615 Av. .007565	1. .000882 2. .000789 Av. .000835	1. .008398 2. .008404 Av. .008401	—6.8
	3. Boiled in 250 cc water 1 hr. 15 min.	400	89.90	.009016	1. .008444 2. .008265 Av. .008354	1. .000361 2. .000446 Av. .000402	1. .008805 2. .008711 Av. .008758	—2.9
	4. Steamed using 600 cc water 1 hr. 20 min.	400	90.17	.008616	1. .007897 2. .008063 Av. .007980	1. .000441 2. .000459 Av. .000450	1. .008338 2. .008522 Av. .008430	—2.5
	5. Pressure cooker in 50 cc water 15 min. at 15 lbs. pressure	400	90.17	.008646	.008220	.000245	.008465	—2.1
	1. Boiled in 600 cc water 2 hrs. 30 min.	400	91.03	.012999	1. .011934 2. .011637 Av. .011784	1. .000887 2. .000882 Av. .000884	1. .012818 2. .012519 Av. .012668	—2.5
	2. Boiled in 600 cc water 1 hr. 5 min.	400			1. .011821 2. .011893 Av. .011857	1. .000817 2. .000822 Av. .000819	1. .012638 2. .012715 Av. .012676	—2.5
Mustard	3 Boiled in 200 cc water 1 hr. 5 min.	400			1. .011867 2. .012322 Av. .012094	1. .000399 2. .000284 Av. .000341	1. .012266 2. .012603 Av. .012433	—4.3
	4. Steamed using 500 cc water 1 hr. 5 min.	400			1. .012119 2. .012125 Av. .012122	1. .000341 2. .000327 Av. .000334	1. .012460 2. .012452 Av. .012456	—4.2
	5. Cooked in pressure cooker in 25 cc water at 15 lbs. pressure for 15 min.	400			.012845	.000253	.013098	+0.7
Collards	1. Boiled in 1000 cc water 2 hrs. 15 min.	350	89.53	.006841	1. .004853 2. .004832 Av. .004842	1. .001531 2. .001525 Av. .001528	1. .006384 2. .006357 Av. .006370	—6.9
	2. Boiled in 1000 cc water 1 hr.	350			1. .004777 2. .005314 Av. .005045	1. .001321 2. .001357 Av. .001339	1. .006098 2. .006671 Av. .006384	—6.7
	3. Boiled in 500 cc water 1 hr.	350			1. .005554 2. .005808 Av. .005681	1. .001060 2. .001056 Av. .001058	1. .006614 2. .006864 Av. .006739	—1.4
	4. Steamed using 500 cc water, 1 hr. 5 min.	350			1. .006134 2. .006115 Av. .006124	1. .000447 2. .000553 Av. .000501	1. .006583 2. .006668 Av. .006625	—3.1
	1. Boiled in 400 cc water 1 hr. 30 min.	300	66.15	.007031	1. .005255 2. .005316 Av. .005285	1. .001345 2. .001402 Av. .001373	1. .006600 2. .006618 Av. .006609	—4.1
Field Peas	2. Boiled in 400 cc water 1 hr.	300			1. .005619 2. .005415 Av. .005512	1. .001255 2. .001210 Av. .001232	1. .006865 2. .006647 Av. .006756	—3.9
	3. Boiled in 200 cc water 1 hr.	300			1. .006044 2. .006478 Av. .006261	1. .000605 2. .000555 Av. .000580	1. .006649 2. .007033 Av. .006841	—2.7
	4. Steamed 1 hr.	300			1. .006637 2. .006388 Av. .006512	1. .000318 2. .000432 Av. .000375	1. .006955 2. .006810 Av. .006887	—2.1

Table II (Continued) Losses of Iron by Different Methods of Cooking

Vegetable	Meth. of Cooking	Quantity Vegetable Cooked gms.	Moisture Uncooked Vegetable per cent	Gms. Fe. In Uncooked Veg.	Gms. Fe. in Cooked Vegetable	Gms. Fe. in Cooking Water	Tot. No. Gms. Fe. in water & Vegetable Cooked	Av Erro
English Peas	1. Boiled in 400 cc water 1 hr.	350	*78.48	.005844	1. .004688 2. .005466 Av. .005081	1. .001676 2. .001071 Av. .001373	1. .006364 2. .006537 Av. .006450	+10
	2. Boiled in 400 cc water 30 min.	350			1. .005256 2. .005164 Av. .005210	1. .000493 2. .000625 Av. .000559	1. .005749 2. .005789 Av. .005769	−1
	3. Boiled in 200 cc water 30 min.	350			1. .005078 2. .005674 Av. .005376	1. .000706 2. water lost	1. .005784	−1.
	4. Steamed 40 min.	350			1. .005750 2. .005351 Av. .005550	1. .000127 2. .000146 Av. .000136	1. .005877 2. .005497 Av. .005687	−2.
	5. Cooked in pressure cooker without water 8 min. 10 lb. pressure	350	*74.44	.006507	.006033	.000268	.006301	−3.
Butter Beans	1. Boiled in 500 cc water 1 hr. 30 min	375	*64.99	.011093	1. .009034 2. .008896 Av. .008965	1. .002597 water lost	1. .011632	+4.0
	2. Boiled in 500 cc water 30 min.	375			1. .009655 2. .009936 Av. .009795	1. .001734 2. .001818 Av. .001776	1. .011389 2. .011754 Av. .011571	+4.3
	3. Boiled in 200 cc water 30 min.	375			1. .010288 2. .010527 Av. .010407	1. .001086 2. .001103 Av. .001094	1. .011374 2. .011630 Av. .011502	+3.7
	4. Steamed in teamer 30 min. using 500 cc water	450	*65.7	.013027	1. .012541 2. .012408 Av. .012474	1. .000293 2. .000279 Av. .000281	1. .012834 2. .012678 Av. .012756	−2.1
	5. Cooked in pressure cooker in 25 cc water at 10 lbs. pressure 12 min.	450	65.7	.013027	.012390	.000213	.012603	−3.3
String Beans	1. Boiled in 600 cc water 2 hrs. 30 min.	400	91.78	.003250	1. .002363 2. .002252 Av. .002307	1. .000933 2. .000904 Av. .000918	1. .003296 2. .003156 Av. .003226	−0.7
	2. Boiled in 600 cc water 1 hr.	400			1. .002690 2. .002427 Av. .002558	1. .000572 2. .000625 Av. .000598	1. .003262 2. .003052 Av. .003157	−2.9
	3. Boiled in 200 cc water 1 hr.	400			1. .002773 2. .002931 Av. .002852	1. .000351 2. .000344 Av. .000347	1. .003124 2. .003275 Av. .003199	−1.3
	4. Steamed using 600 cc water 1 hr.	400			1. .003030 2. .003046 Av. .003033	1. .000181 2. .000186 Av. .000183	1. .003231 2. .003202 Av. .003216	−1.0
	5. Pres. cooker no water added. cooked 10 min. 15 lbs. pressure	400			.003030	.000135	.003165	−2.6

*Two different samples of turnip tops, English peas and butter beans were used.

Table III—Comparison of the Losses of Iron by Different Methods of Cooking*

Vegetable	Boiling in 400 to 1000 cc water 1 to 2½ Hrs.	Boiling in 400 to 1000 cc water ½ to 1¼ Hrs.	Boiling in 200 to 400 cc water ½ to 1¼ Hrs.	Steaming	Pressure Cooker
	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent
Turnip Tops	18.0	16.1	7.3	7.7	4.9
Mustard	9.3	8.8	7.0	6.7	1.2
Collards	29.2	26.2	17.0	10.5	. .
Field Peas	25.5	21.6	10.9	7.4	. .
English Peas	13.1	10.8	8.0	5.0	7.3
Butter Beans	19.2	11.7	6.2	4.2	4.9
String Beans	29.0	21.3	12.2	6.7	6.8
Average	20.5	16.6	9.8	6.9	5.0

*The percentage of loss was calculated from the difference between the iron content of the total quantity of fresh vegetable cooked, and that of the cooked vegetable.

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