XX. AN INVESTIGATION OF THE METHODS EMPLOYED FOR COOKING VEGETABLES, WITH SPECIAL REFERENCE TO THE LOSSES INCURRED. PART I. DRIED LEGUMES.

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THE value of dried legumes as articles of diet has long been known, but the present necessity for economising other foodstuffs has led to far more general recognition of the use and importance of these vegetables.

At the request of the Foods Committee of the Ministry of Munitions this investigation was undertaken with a view to obtaining some data as to the losses incurred and the time required for cooking dried vegetables under various conditions.

It was thought that from the information thus gained it would be possible to devise a convenient method of cooking dried legumes on a large scale which, whilst satisfactory in other respects, would minimise as far as possible the waste of food material due to losses in cooking and also reduce the time of cooking, thus effecting a saving in the consumption of fuel.

Some information on the subject of dried legumes is to be found in the bulletins issued by the United States Department of Agriculture [Abel, 1900; *Farmers' Bulletin*, 1903; Wait, 1907].

These publications discuss briefly the cooking of dried legumes but deal chiefly with their nutritive value and digestibility; their scope is therefore somewhat different from that of the present enquiry.

The varieties of dried legumes most commonly used in this country appear to be butter beans, haricot beans, and peas. As the butter beans were found to be rather more uniform in size and shape than the other varieties, most of the experiments were made with these and a few experiments were then made with haricot beans (white and brown) in order to see if similar results were obtained.

A study of the methods usually advocated for cooking dried legumes

seemed to indicate that the subject could be dealt with best in the following sections:

- I. The use of tap and distilled water for cooking beans and the effect of soaking previous to cooking.
- II. The use of sodium bicarbonate in cooking beans.
- III. The use of salt in cooking beans.
- IV. The possibility of cooking beans by steaming.
- V. Note on haricot beans and peas.
- VI. Suggested methods of cooking dried vegetables.

I. THE EFFECT OF SOAKING BEANS PREVIOUS TO COOKING AND OF SOAKING AND COOKING IN DISTILLED AND TAP WATER.

Dried beans are usually soaked in water for at least eight hours previous to cooking. The beans so treated take up water, swell considerably and are generally supposed to cook more rapidly than those which have not been soaked previous to cooking.

The use of soft water in preference to hard water for soaking and cooking beans is also usually advocated since the presence of calcium salts in the water is stated to retard the softening of the beans and prolong the time of cooking¹.

A series of experiments was therefore made in order to compare the time of cooking and the loss in solid matter during cooking of beans both dry and previously soaked and to find how far these results were modified by using distilled water as compared with ordinary London tap water. (Temporary hardness = 12 parts per 100,000. Permanent hardness = 5 parts per 100,000.)

The dry beans were heated in a steam oven to constant weight and were found to contain 12 % of moisture which has to be allowed for in relation to losses incurred in cooking.

The experiments were carried out under conditions which reproduced as far as possible those of the ordinary kitchen. The method adopted for cooking the beans was as follows:

A. Beans cooked without previous soaking.

100 g. of beans were placed in a strainer and washed with cold water in order to remove any adhering particles of dirt. The beans were then placed in an enamel saucepan, 500 cc. of cold water were added, the saucepan was covered with a lid and the temperature of the water was raised to the boiling point and kept at this temperature until the beans were cooked. The time required for cooking was then recorded.

¹ See Robert Hutchison, *Food and the Principles of Dietetics*, also general statements in cookery books.

B. Beans soaked in water previous to cooking.

The beans (100 g.) were washed with cold water as in *A* and were then covered with 250 cc. water and allowed to stand overnight (i.e. about 16 hours). The soaking water was strained off, measured and evaporated to dryness and the residue weighed in order to determine the loss in solid matter due to soaking. The beans were then placed in an enamel saucepan and covered with 500 cc. water less the volume of water taken up by the beans in soaking; this was found to be in each case about 100 cc. so that the volume added was about 400 cc. The cooking was then carried out as in *A*.

Cooked beans. The cooked beans were in each case separated as completely as possible from the cooking water by straining, allowed to cool at the room temperature and weighed when cold. This weighing gives the weight of the cooked beans in the condition in which they are ordinarily served. The appearance and taste of the beans were then examined and reported on.

Cooking water. The cooking water was evaporated to dryness and the residue weighed. This residue gives the total solid matter extracted from the beans in cooking together with the residue, if any, from the water used. A correction was made where necessary for such residue.

Since the dry uncooked beans used for the experiments were found to contain 12 % of moisture the residue from the cooking water represents the loss of solid matter on 88 g. of solids, from which figure the percentage loss, i.e. the loss on 100 g. of solids, was calculated. The time of cooking, weight of cooked beans and percentage of loss of solid matter in cooking as observed in a number of experiments both with tap and distilled water are given below.

TABLE I. (Tap water.)

<i>A. 100 g. beans cooked in tap water without previous soaking</i>			<i>B. 100 g. beans soaked and cooked in tap water</i>				
Time of cooking	Weight of cooked beans	Percentage loss of solids in cook- ing	Time of cooking	Weight of cooked beans	Percentage loss of solids in cooking	Percentage loss of solids in soaking	Total percent- age loss of solids
2 h. 10 m.	244	12.5	2 h. 0 m.	231	13.6	1.8	15.4
2 15	223	12.8	2 0	235	8.4	2.2	10.6
2 0	230	—	2 0	—	11.5	1.7	13.2
2 15	—	11.6	1 50	210	8.2	1.5	9.7
2 15	229	12.9					
2 0	230	10.9					
2 15	235	8.5					
2 10	219	8.1					
2 15	237	11.1					
2 0	232	9.3					
2 0	214	9.6					
2 0	211	8.6					
Average							
2 h. 5 m.	220.5	10.5	2 h. 0 m.	228	10.4	1.8	12.2

TABLE II. (Distilled water.)

A. 100 g. beans cooked in distilled water without previous soaking			B. 100 g. beans soaked and cooked in distilled water				
Time of cooking	Weight of cooked beans	Percentage loss of solids in cooking	Time of cooking	Weight of cooked beans	Percentage loss of solids in cooking	Percentage loss of solids in cooking	Total percentage loss
1 h. 45 m.	242	—	1 h. 45 m.	231	12.8	2.2	15.0
1 45	218	13.7	1 45	235	9.4	2.2	11.6
1 45	213	11.6	1 45	—	10.7	1.7	12.4
1 45	229	10.7	1 55	208	8.6	—	—
2 0	205	8.6					
Average							
1 h. 45 m.	218	11.1	1 h. 45 m.	224	10.4	2.0	12.6

Discussion of results of Tables I and II.

Time of cooking. It will be seen from the results given above that soaking previous to cooking does not reduce the time required for cooking to any very marked extent, but that the time required with distilled water is less than in the case of tap water.

Cooked beans. Soaking beans previous to cooking has practically no effect on the weight of the beans when cooked, the weight of cooked beans being in each case rather more than double that of the raw beans. The soaked beans were a better colour, *i.e.* whiter, and had rather a less pronounced flavour than those which were cooked without previous soaking. The beans cooked in tap water had a better flavour than those cooked in distilled water, which were rather tasteless.

Loss in solid matter. As regards the loss in solid matter during cooking the mean results show that the loss with tap and distilled water is practically the same. Taking into consideration the solid matter extracted by soaking, the total loss in the case of the soaked beans is greater than in the case of those cooked without previous soaking. The individual experiments show considerable variation in the amount of solid matter extracted during cooking; this no doubt is due mainly to the difficulty of determining the exact stage at which the beans are cooked.

The method usually adopted in the kitchen is to prod the beans with a fork and to stop the cooking when the beans have reached what is considered to be the required degree of softness. Since the experiments were to be carried out as far as possible under conditions similar to those of an ordinary kitchen the same method was adopted in the laboratory though it is obviously open to objection.

When the beans are tested the skin is pierced and this will tend to increase the amount of solid matter removed. This is especially the case when the cooking of the beans is nearing completion. The results are given in the order

in which the experiments were carried out and it will be noted that the earlier experiments showed, on the whole, greater losses than the later ones.

This would be accounted for by the fact that at first some difficulty was experienced in deciding when the beans were cooked; they had to be tested several times and there was probably also a tendency towards overcooking; whereas in the later experiments more experience had been gained in judging the end point, the beans were not tested so frequently and the cooking was stopped before the beans began to disintegrate.

It might be thought that the time of cooking would indicate whether the beans had been overcooked or not, but this is not a sufficiently reliable check as owing to the difficulty of exactly regulating the gas supply the time required for cooking was found to vary slightly from day to day and it was noticed that if the cooking was not stopped when a certain stage was reached the beans began to break up rather rapidly and that in the case of peas this tendency was even more marked than in the case of beans.

In order to show the effect of overcooking on the loss in solid matter the beans in one experiment were purposely overcooked, the time allowed being 2 hrs. 25 mins.; the loss in solid matter was then found to be 16.6 % of the total solids.

It would of course be possible to employ a more uniform source of heat and it is hoped to make some experiments under such conditions later.

For the purpose of the present enquiry however it was thought best to adopt such methods as would ordinarily be employed in the kitchen. In dealing with other methods of cooking it was therefore decided that several experiments should be made in each case and an average then taken, and a control experiment with tap water made from time to time. It was hoped that in this way the errors dealt with above might be to some extent eliminated.

Nature of residue. The residues obtained from the soaking and cooking waters have not yet been fully examined and the discussion of their exact nature must be left until some further investigations of the subject have been made.

Residue from soaking water. The residue from the soaking water is dark brown in colour, difficult to dry and if exposed to the air rapidly takes up water and becomes syrupy. The odour and taste is somewhat similar to that of a meat extract. The residue from dry beans soaked in tap water was found to contain 2.3 % of nitrogen probably in the form of extractives and the mineral matter extracted by soaking was 1.54 % of the total mineral matter present in the beans.

Residue from cooking water. The residue from the cooking water is lighter in colour than that from the soaking water and is less deliquescent. The taste and odour are similar but less pronounced.

The residue from dry beans cooked in tap water contains 2.4 % nitrogen corresponding to a loss of 7.5 % of the total protein matter present in the beans and the mineral matter extracted by the cooking is 36.8 % of the total mineral matter present in the beans.

A few experiments were also made to see if there was any advantage to be gained by (1) cooking the beans in the water in which they had been soaked, (2) cooking the beans by the addition of boiling instead of cold water. The results obtained however were very similar to those given above.

In (1) the residue from the cooking water was equal to the combined residue obtained from the soaking and cooking waters in the previous experiments.

In (2) allowing for the time required for bringing the water to the boil the time required for cooking was the same as in the above experiments and the solid matter extracted by cooking was about the same.

II. THE USE OF SODIUM BICARBONATE IN COOKING DRIED BEANS.

Sodium bicarbonate and also washing soda are sometimes added in small quantities to the water in which dried legumes are to be cooked or if they are soaked previous to cooking it may be added to the soaking water.

It is usually stated that this treatment softens the water and so tends to reduce the time of cooking¹.

Although the degree of hardness of the water used for cooking must be taken into account in determining the amount of sodium bicarbonate which should be added it would appear from the experiments now to be described that the alkali has a more specific action than can be accounted for by the above explanation.

In this connection it may be mentioned that Snyder [*Minnesota Station Bulletin*] states as a matter of common observation that when beans are properly prepared with a small amount of soda and salt there is less formation of gas in the intestines during digestion. A series of experiments was therefore made in order to compare the times of cooking and the loss in solid matter when beans were cooked (A) with the addition of varying amounts of sodium bicarbonate to the cooking water, (B) after soaking in water to which varying amounts of sodium bicarbonate had been added.

¹ See Hutchison, *Food and the Principles of Dietetics*, also general statements in cookery books.

The quantities used, the method of cooking and the subsequent treatment of the cooked beans and cooking water were the same as in the previous experiments.

A. The addition of sodium bicarbonate to the cooking water.

Beans were cooked, without previous soaking, in tap water to which a weighed amount of sodium bicarbonate had been added. The quantity of alkali left in the cooking water at the end of the experiment was estimated and the residue corrected by a corresponding amount. The mean results of these experiments are given below:

TABLE III.

Beans (100 g.) cooked in tap water containing sodium bicarbonate.

(Average results.)

Parts of sodium bicarbonate per 100 parts water	Time of cooking	Weight of cooked beans	Percentage loss of solids in cooking
0.05	2 h. 0 m.	221	10.3
0.1	1 50	216	11.3
0.25	1 45	225	14.3
0.5	1 15	240	22.3
1.0	1 0	190	27.3

The results are also shown graphically below. The logarithms of the relative concentrations of sodium bicarbonate used have been plotted instead of the actual concentrations so that equal changes in the concentration may be represented by equal lengths of ordinate.

Graph showing the Loss of Solid Matter compared with the Concentration of Sodium Bicarbonate used.

Fig. 1.

Discussion of the results of Table III.

The effect of the addition of sodium bicarbonate both on the time of cooking and on the loss in solid matter is somewhat striking.

The high percentage loss of solids obtained when the sodium bicarbonate added is as high as 0.5–1.0 % is attributable to the fact that under these conditions the beans soften and disintegrate rapidly, hence a large proportion of solid matter passes into the cooking water, and the latter becomes very turbid. The beans become distinctly yellow in colour, are slimy to the touch, and practically uneatable.

Similar effects, though in a much less marked degree, were also observed when 0.25 % sodium bicarbonate was used.

The most satisfactory results (for the particular tap water used) were obtained when 0.1 % of sodium bicarbonate was used.

As shown in the above results, the time of cooking was then the same as the time required with distilled water. The loss of solid matter was only slightly greater than in the case of tap water (Table I), and was slightly less than the total loss observed when the beans were soaked and then cooked in tap water.

There is no advantage to be gained by adding quantities of sodium bicarbonate less than 0.1 %, since the time required with the addition of 0.05 % is the same as when untreated tap water is used (Table I).

More information is needed before any complete explanation of the action of sodium bicarbonate can be attempted, but the solubility of the legumin of the beans in alkali must play an important part, and it is interesting to note that Osborne [1909], in dealing with vegetable proteins, states that "the amount of protein extracted by alkalies is usually greater than that extracted by neutral saline solutions or by water, in fact in many cases it is very much greater. Sufficient attention has not yet been directed to the cause of this difference and for this reason our present knowledge of the character of the total protein constituents of the greater number of seeds which have been studied is incomplete."

B. The addition of sodium bicarbonate to the soaking water.

Beans were soaked overnight in tap water containing varying amounts of sodium bicarbonate. The soaking water was strained off, measured and evaporated to dryness, and the residue weighed. An estimation was made of the quantity of sodium bicarbonate left in the soaking water which was then deducted from the total residue obtained.

The amount of sodium bicarbonate absorbed by the beans during soaking was found, for each concentration of the alkali, to be proportional to the volume of water absorbed which was about 100 cc. in each case.

The average results obtained are shown in Table IV.

TABLE IV.

Beans (100 g.) soaked overnight (about 16 hours) in tap water containing sodium bicarbonate.

(Average results.)

Parts of sodium bicarbonate per 100 parts water	Time of cooking	Weight of cooked beans	Percentage loss of solids in cooking	Percentage loss of solids in soaking	Total percentage loss
0.25	1 h. 15 m.	222	10.6	1.8	11.4
0.5	1 15	214	9.2	1.5	10.8
1.0	1 0	211	8.7	1.5	10.8
2.0	1 0	212	13.1	1.5	14.6

TABLE V.

Beans (100 g.) soaked for four hours in water containing sodium bicarbonate.

(Average results.)

Parts of sodium bicarbonate per 100 parts water	Time of cooking	Weight of cooked beans	Percentage loss of solids in cooking	Percentage loss of solids in soaking	Total percentage loss
1.0	1 h. 30 m.	222	10.8	0.2	11.0
2.0	1 30	234	12.0	0.2	12.2

Discussion of Tables IV and V.

The time required for cooking the beans after soaking in water containing sodium bicarbonate is considerably less than when either tap or distilled water is used (Tables I and II).

The reduction in time thus effected is fully as great as that observed when sodium bicarbonate up to 1 % is added to the cooking water and the reduction in the former case is not accompanied by the objectionable features noted in the case of the latter. Further experiments show that when 2 % of sodium bicarbonate is used the time of cooking is the same as in the case of 1 %, but the loss in solid matter is greater. The beans also were yellowish in colour and exhibited, though to a less degree, other objectionable features noticed in the case of beans cooked in water containing over 0.2 % of sodium bicarbonate (Table III).

The addition of sodium bicarbonate to the soaking water appears to diminish the amount of solid matter extracted from the beans by soaking, and it was also noted that these residues were lighter in colour than those obtained from tap water (see Section I).

This effect is somewhat curious, but the whole question of the action of sodium bicarbonate needs to be more fully investigated under more carefully controlled conditions and it is hoped that such an investigation may be made at a later date.

Table V shows the average results obtained when the beans are soaked for a shorter period, namely four hours, since it was thought that in some instances this might prove to be a more convenient method. The results show that the reduction in time of cooking thus effected is not so great as when the beans are soaked for a longer period, but the time required is appreciably less than that required with tap or distilled water (Tables I and II).

III. THE USE OF SALT IN COOKING DRIED LEGUMES.

Vegetables are usually cooked in water containing salt with a view to improving their flavour, but in the case of dried legumes the statement is frequently made in cookery books that salt should not be added to the cooking water, as it tends to harden the skins and prolong the time of cooking and that this difficulty may be avoided by delaying the addition of the salt until the cooking is nearing completion.

It therefore seemed advisable to make a few experiments in order to compare the time of cooking and loss in solid matter when beans were cooked in water containing varying amounts of salt.

The method of cooking and subsequent treatment of the cooked beans and cooking water were the same as in the previous experiments. An estimation was made of the quantity of salt left in the cooking water at the end of the experiment, which was then deducted from the total residue.

The average results obtained when unsoaked beans were cooked in tap water containing salt are given below:

TABLE VI.

Beans (100 g.) cooked in tap water containing salt.

(Average results.)

Parts of salt per 100 parts of water	Time of cooking	Weight of cooked beans	Percentage loss of solids in cooking
0.25	2 h. 0 m.	215	9.2
0.5	2 0	212	8.7
1.0	2 15	216	8.3

Discussion of results of Table VI.

These results show that contrary to the usually accepted statement, the addition of salt, in small quantities, to the cooking water, does not appreciably increase the time of cooking.

The loss in solid matter tends to decrease with the addition of salt (compare Table I), and the flavour is considerably improved.

The most satisfactory result was obtained when 0.25 % was added, the flavour of common salt being considered rather too pronounced when larger quantities were used.

In order to see how far these results were modified by the addition of salt when the beans were nearly cooked, some experiments were made in which beans were heated in boiling water for 15 minutes less than the average time required for cooking (*i.e.* 1 hr. 45 mins.), and 0.25 % of salt was then added and the heating continued until the beans were cooked. The results obtained confirmed those given in Table VI, since there was no appreciable difference in the times of cooking, whereas the loss in solids was on the average rather greater, being in fact practically the same as that observed in the case of untreated tap water.

The use of sodium bicarbonate and salt.

The results given in Sections II and III above show that the addition of sodium bicarbonate to the cooking water or preferably to the soaking water tends to decrease the time of cooking, but that the beans so cooked are somewhat insipid in flavour. The addition of salt, on the other hand, does not increase the time of cooking, improves the flavour and tends to reduce the loss of solid matter in cooking.

It therefore seemed probable that a judicious combination of the two methods would yield more satisfactory results than could be obtained by either method alone.

For this reason most of the experiments described in Section II (*A* and *B*) were repeated, the only variation made being the addition of 0.25 % of salt to the cooking water.

These experiments gave the anticipated results, and it is therefore hardly necessary to deal with them in detail.

The results as compared with those in Tables III–VI showed that the time of cooking was unaltered, the loss in solid matter on the average was slightly less and the flavour was improved.

IV. COOKING OF DRIED LEGUMES BY STEAMING.

Cooking by the action of steam instead of by boiling water is a method frequently adopted on the large scale. This method has much to recommend it from the practical point of view, but its greatest advantage lies in the fact that the loss in solid matter during cooking must necessarily be less than when the food is exposed to the action of boiling water.

The possibility of cooking dried legumes by steaming was therefore investigated.

In the first experiments made, dry beans, and also beans which had previously been soaked in water, were placed in a steamer, closed with a tightly fitting lid. This method proved to be unsatisfactory both with dry and soaked beans, as even after steaming for about four hours the beans did not swell properly and presented a dried and unappetising appearance.

It appeared, therefore, that satisfactory results could probably only be obtained when the beans were covered with water during the process of cooking. The method was therefore modified, and a series of experiments was made in which the beans were covered with boiling water and then exposed to the action of steam. The method adopted was as follows:

Method of steaming beans. 100 g. of beans were placed in a basin covered with 250 cc. of boiling water, and the basin then placed quickly in a steamer, and closed with a tightly fitting lid. The cooked beans were separated from the water by straining and weighed.

TABLE VII.

Beans cooked by steaming.

Beans (100 g.) covered with boiling tap water and cooked by steaming.

(Average results.)

Treatment of beans	Time of cooking	Weight of cooked beans	Percentage loss of solids in cooking	Percentage loss of solids in soaking	Total percentage loss
I. Beans cooked without previous soaking	2 h. 10 m.	215	8.9	—	8.9
II. Beans cooked, without previous soaking, in water containing 0.25 % salt	2 10	217	8.4	—	8.4
III. Beans cooked, without previous soaking, in water containing 0.1 % sodium bicarbonate and 0.25 % salt	1 40	220	7.8	—	7.8
IV. Beans soaked overnight in tap water	2 5	214	8.6	1.8	10.4
V. Beans soaked overnight in water containing 1 % sodium bicarbonate and cooked in water containing 0.25 % salt	1 10	215	6.6	1.5	8.1

The water in the basin was evaporated to dryness and weighed, any necessary corrections being made as in the previous experiments.

The water below the steamer was evaporated to dryness and when allowance had been made for the solids present in the tap water, this residue was found to contain about 0.1 % of solid matter from the beans.

The results obtained in these experiments were such that it appeared worth while to pursue the matter further. In order to obtain a comparison with the results given in Tables III-VI, the experiments were repeated, using bicarbonate and also salt in the proportions previously found to be the most satisfactory. A summary of the results obtained is given in Table VII.

Discussion of results of Table VII.

These results show that although the beans were in contact with water during cooking, the loss in solid matter is less than when the beans are cooked in boiling water.

This is probably due to the fact that the water is not actually in a state of ebullition, and therefore the beans tend to break up less during the cooking process. In this connection it should be noted that the loss in solid matter observed in the individual experiments showed much less variation than in the case of boiling water (Table I). The actual values obtained in experiments (II) and (V) were as follows:

Percentage loss of solids in cooking.

	(II)	(V)
	8.5	6.6
	8.0	6.7
	8.6	6.4
Average	8.4	6.6

The time required for cooking is only very slightly greater than when boiling water is used.

The appearance and taste of the beans were considered to be superior to those cooked in boiling water, whilst as regards the action of sodium bicarbonate and of salt the results confirm the observations already made in the case of boiling water.

V. NOTE ON HARICOT BEANS AND DRIED PEAS.

Haricot beans. In order to compare the behaviour of other varieties of beans with that of butter beans, some of the experiments described in the foregoing sections were repeated using ordinary white haricot beans, and also

some brown beans which appeared to be fairly similar to the haricot beans but darker in colour.

The results were very similar to those obtained with butter beans. The time required for cooking was, however, slightly greater, being about 2 hrs. 15 mins.-2 hrs. 30 mins. when boiling water was used. The loss in solid matter was slightly less, namely 6-8 % of the total solids present in the beans.

Both these variations may be due to the fact that the haricot beans (white and brown) appear to have rather a thicker skin than butter beans.

Dried peas. Before discussing the behaviour of dried peas it is necessary to point out that the varieties of dried peas sold differ considerably in character. The peas sold in packets are usually smaller, have a better colour, and cook more rapidly than those sold by the pound. It is therefore difficult to make any general statement as regards the time required for cooking, and the loss in solid matter during cooking, though the latter shows an average from 6-8 % of the total solids in the peas. The experiments made show that soaking previous to cooking has a more marked effect in the case of peas than in the case of beans.

If the peas are cooked in tap water without previous soaking, the time required is, in most cases, greater than that required in the case of butter beans, the average time required with boiling water being about 2 hrs. 30 mins. Experiments carried out using the same sample of peas throughout, show, however, that the time of cooking can be reduced by about half-an-hour if the peas are soaked overnight in tap water previous to cooking.

The effect is still more marked if the peas are soaked in water containing sodium bicarbonate, since peas which required cooking for 2 hrs. 30 mins., if not previously soaked, cooked in 30 mins. after having been soaked overnight in tap water containing 1 % of sodium bicarbonate.

It is interesting to note in this connection that the effect of adding sodium bicarbonate to the soaking water appears to be much more generally recognised in the case of peas than in the case of beans, peas sold in packets sometimes containing a soaking powder or tablet. Those examined were found to consist chiefly of sodium bicarbonate, though the quantity supplied was usually rather in excess of that required. The use of sodium bicarbonate also tends to improve the colour of the peas, and it seems probable, from some experiments made with green vegetables which need not be dealt with here, that the colour is less affected by the cooking process if the peas are cooked in an open vessel, i.e. in a saucepan without the lid¹.

¹ This, however, increases the time required for cooking.

As regards the action of salt and the method of cooking described in Section IV the results obtained were similar to those observed in the case of the butter beans.

VI. SUGGESTED METHODS OF COOKING DRIED LEGUMES.

In carrying out this investigation it has been assumed that the dried legumes are to be served in the whole condition. Before considering how the results obtained in the foregoing experiments can be applied to the cooking of dried legumes on a large scale, some mention should be made of other possible methods of cooking.

It is clear that, if so desired, the cooking may be prolonged until complete disintegration takes place, and the beans, together with the cooking water, may then be served as a mash. In this case there can be practically no loss in solid matter during cooking. This method, however, is not satisfactory unless the skins are removed by some process, such as passing through a sieve. The removal of the skins entails a loss in solid matter of about 6.5 %, but to what extent this loss represents a loss of food material is a matter which lies outside the scope of this enquiry.

Another method which appears to be specially favoured in the United States [Wait, 1907] is to parboil the beans in water containing sodium bicarbonate, then to remove the skins by rubbing and finally to bake the beans in an oven with the addition of fat.

This method, apart from the question of the doubtful advisability of removing the skins appears to involve too many processes to be satisfactory on a large scale, and has therefore not been dealt with in detail.

From a consideration of the results obtained in Sections I-V the following methods are suggested for cooking dried legumes on a large scale.

Method I. Soak the beans overnight or for a period of not less than four hours in water containing 1 % of sodium bicarbonate ($1\frac{1}{2}$ –2 oz. sodium bicarbonate per gallon of water)¹ using about half a gallon of water to 2 lb. of beans. Strain off the soaking water and cook by one of the following methods:

(A) Place the beans in a dish or basin and cover with boiling water (about $\frac{1}{2}$ gallon to 2 lb. beans) containing 0.25 % of salt ($\frac{1}{4}$ to $\frac{1}{2}$ oz. salt per gallon)² and cook in a steamer.

The time required for cooking by this process is about $1\frac{1}{4}$ hours.

¹ The exact figure is 1.6 oz. per gallon, but the above directions are probably sufficiently accurate for working on a large scale in the kitchen. Quantities much in excess of this amount should not be added (see Section II B).

² The exact figure is 0.4 oz. salt per gallon; quantities much in excess of this amount should not be added (see Section IV).

(B) Place the beans in a saucepan, add tap water (1 gallon to 2 lb. of beans) containing 0.25 % of salt, and cover with a lid and cook by bringing the water to the boil.

The time required for cooking by this process is about 1 hour.

Where possible, method (A) should be employed since it is more economical as regards loss of solid matter in cooking besides giving more satisfactory results in other respects. Under some circumstances soaking previous to cooking may prove to be inconvenient; in such cases the beans may be cooked without previous soaking, but a longer time is then required for cooking.

Attention must, however, again be drawn to the fact that unless sodium bicarbonate is added to the soaking water there is little to be gained (except as regards colour—see Section I) by soaking the beans previous to cooking. If it is inconvenient to soak the beans previous to cooking, Method II described below may be used, but it is not satisfactory in the case of peas (see Section IV), and it should be understood that even in the case of beans Method I (A or B) is distinctly preferable.

Method II. (A) Place the beans in a basin or dish, cover with boiling tap water ($\frac{1}{2}$ gallon to 2 lb. beans) containing 0.1 % of sodium bicarbonate ($\frac{1}{4}$ – $\frac{1}{2}$ oz. per 2 gallons of water)¹ and 0.25 % of salt and cook in steamer.

The time required for cooking by this process is about 2 hours.

(B) Place in a saucepan, add tap water (1 gallon to 2 lb. beans) containing salt and sodium bicarbonate in the proportions given in (A), cover with a lid and cook by bringing the water to the boil.

The time required for cooking by this process is about $1\frac{1}{2}$ hours.

For the reasons stated above (A) should be used where possible in preference to (B).

The directions given above are based on experiments which have necessarily been made on a small scale, and it is possible that in carrying out the processes on a large scale it will be found necessary to introduce certain modifications.

The quantity of sodium bicarbonate used in Method II will, as already pointed out, need adjusting according to the type of water used for cooking.

On a large scale the proportion of water to beans and the time of cooking may also work out rather differently, and the above directions should be looked upon as a general guide, which by means of a few experiments made in the kitchen can be modified in accordance with the scale required and the equipment available.

¹ The exact quantity is 0.16 oz. per gallon; quantities much in excess of this amount should not be added (see Section III A).

In conclusion it is desired to emphasise the fact that in carrying out this investigation primary importance has been attached to the practical aspects of the question, and it is realised that there are several factors which need to be dealt with more fully. In particular information is needed as to the composition of the residues obtained from the different cooking waters, and the nature of the action of sodium bicarbonate and salt on the dried legumes, and it is hoped to make such work the subject of further enquiry.

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