

## A Comparison of the Vitamin C Content of Vegetable Stew when Prepared on a Large Scale in Open and Pressure Cookers

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In the large compound kitchens of the gold mines of the Witwatersrand, where food is prepared for over a quarter of a million Bantu workers, there is a present trend to replace open cooking by pressure cooking. Of the food consumed, the vegetable stew is the chief, and sometimes the sole, source of vitamin C; however, since scurvy occurs infrequently, the amount of the vitamin provided up to now must have been adequate for protection. All the same, it is desirable that any change in the cooking procedure shall not lower the vitamin C content of the stew. A few investigations of the comparison between retention of the vitamin by both methods of cooking have already been reported in the literature, but they were carried out with relatively small quantities of vegetables. In a stew, in which both vegetable and cooking water are consumed, only the total vitamin content is of importance. In this connexion Noble & Hanig (1948) showed that, during the cooking of the six vegetables examined, the total amount retained averaged about 80 %, though it depended more on the kind of vegetable than on the method of cooking. Chappell & Hamilton (1949), who used a popular type of household pressure cooker, found that for the ten vegetables studied the total retention averaged just under 80 %; the average for the open cooker was about 2 % higher than for the pressure cooker. In the compound kitchens the scale of cooking is very large, and the nutritional implications of the changeover to pressure cooking may be far reaching; the Chief Medical Officer of the Union Corporation group of mines therefore decided that a direct comparison should be made between the retention occurring (a) when the stew is cooked in the usual manner in the open container, and (b) when it is cooked under pressure in a container identical with those it is proposed to introduce in the future.

### EXPERIMENTAL

*General.* In the particular compound kitchen where our investigation was carried out, food is prepared for about 3000 Bantu. The vessels used in each method of cooking are made of steel; they are semi-cylindrical and hold about 170 gal. The usual charge is about 600 lb. vegetables, 160 lb. meat and 70 gal. water. The meat is cooked just before the mixed, minced vegetables are added, heat being supplied from steam led through openings in the base.

*Preparation of vegetables.* Thoroughly fresh vegetables are delivered to the kitchen

every other day and are stored in a cool dark room. The composition of the vegetable mixture is subject to seasonal variations, but the amounts of green leaf vegetables and of potatoes are kept fairly constant. During the present investigation the mixture used for each cooker was: sweet potatoes 343 lb., cabbage 130 lb., carrots 88 lb. and leeks 14 lb.

After being washed for about 10 min. in a rotating cylinder, two lots of such vegetables were roughly mixed on a cement floor, using a spade, and fed into a mincing machine, where they were quickly reduced to portions about 0.5–1.0 cm. in diameter. (Were the portions larger, certain tribes of Bantu who do not care for vegetables would try to pick out and discard them.) The mixed vegetables were discharged into eight wooden boxes, four alternate ones for the open cooker, and the remainder for the pressure cooker. The contents of each box, about 150 lb., were mixed by hand as thoroughly as possible. Several small handfuls were then taken from the four boxes for the open cooker and combined to make about a 0.5 lb. sample. This was repeated. The same procedure was undertaken with the pressure-cooker vegetables. Determinations of vitamin C were then carried out, in duplicate, on 50 g. from each 0.5 lb. sample.

After sampling, the boxes of vegetables were added to the respective cooking waters, which were kept at about 85° and contained the meat just previously cooked. (Water boils at about 94° on the Witwatersrand.) During these additions the temperature fell to about 80°. The time taken from the beginning of mincing to the complete addition of vegetables was about 2 min. Salt was available for the Bantu, but neither salt nor any other chemical was added to the stew.

*Cooking of the stew.* For open cooking the time taken was 20–25 min. With the pressure cooker, it took 9 min. from the time of putting on to removing the lid, although the stew was maintained at a pressure of 12.5 lb. for 5 min. only. Each stew mass was rapidly stirred with a large soup ladle and two 0.5 lb. samples were taken from each cooker and analysed in duplicate for vitamin C.

*Determination of vitamin C.* Vitamin C was determined by the dichlorophenol-indophenol method as described by the Association of Vitamin Chemists (1947).

#### RESULTS

The results are given in Table 1.

The 575 lb. vegetables are mixed with 70 gal. (i.e. 700 lb.) water, to yield a total weight of 1275 lb. Hence, to obtain the vitamin C content of the stew before cooking, the vitamin C content of the mixed vegetables is multiplied by 575/1275, i.e. 0.45.

#### DISCUSSION

Considering the scale of the experiment, the high vitamin C content of the stew observed with both methods is satisfactory, though not surprising, for practical conditions are such as to favour a high retention of the vitamin. These are (a) the very fresh state of the vegetables; (b) the quick washing of the vegetables; (c) the rapid mincing and the short time elapsing before the vegetables are put into the cooking water; (d) the high initial temperature of the cooking water, 80–85°, resulting in the

Table 1. Vitamin C content of vegetables, raw and cooked on a large scale in open cookers and in pressure cookers

	1st day		2nd day		3rd day		4th day	
	Open cooker	Pressure cooker	Open cooker	Pressure cooker	Open cooker	Pressure cooker	Open cooker	Pressure cooker
Raw vegetables (mg./100 g.)	31.5	27.0	20.5	35.4	24.0	25.8	21.6	23.6
	32.5	28.0	21.5	37.0	24.4	24.2	22.8	24.6
	19.8	25.7	29.0	23.5	25.3	27.2	19.0	18.6
	20.6	26.3	29.6	23.1	23.1	26.8	19.6	19.4
	30.1	—	23.2	20.0	—	—	—	21.9
	31.1	—	23.0	20.4	—	—	—	22.5
Mean*	27.6	26.7	24.5	26.6	24.2	26.0	20.8	21.8
Mean of stew before cooking†	12.4	12.0	11.0	12.1	10.9	11.7	9.4	9.8
Stew after cooking (mg./100 g.)	11.7	10.0	9.1	7.7	9.7	9.6	8.2	8.1
	12.1	10.0	9.1	8.1	9.0	9.6	8.4	8.1
	11.1	10.1	8.6	8.2	9.8	9.2	8.5	8.2
	11.3	10.3	9.0	8.4	9.8	10.0	8.5	8.4
Mean	11.6	10.1	9.0	8.1	9.8	9.6	8.4	8.2
Retention of vitamin C (%)	94	84	82	67	90	82	90	84

\* On two occasions determinations in duplicate were carried out on the individual vegetables minced separately. The values for sweet potatoes were 18.0, 18.8; 19.8, 20.6; mean 19.3 mg.; cabbage, 65.0, 67.2; 73.2, 70.0; mean 68.9 mg.; carrots, 4.8, 4.4; 5.4, 5.0; mean 4.9 mg.; leeks 25.5, 26.7; 26.6, 26.8; mean 26.4 mg./100 g. From these figures, calculation of the vitamin C in the vegetable mixture gives 28.4 mg./100 g., a value slightly higher than the mean of the eight values for mixed vegetables found above, i.e. 24.8 mg./100 g.

† In the present investigation the vitamin C content of the meat was not taken into account; moreover, meat was not included in the stew on which the vitamin determinations were carried out: the error thus introduced is very small.

immediate destruction of the relevant oxidases; and finally (*e*) the quick serving of the stew and its almost immediate consumption.

Ladles of about 500 g. capacity are used to serve the stew. Additional helpings are allowed, but they are not usually asked for because of the large helpings of other foods available. For each person, therefore, the stew provides 45–50 mg. vitamin C daily, well in excess of the 20–30 mg. recommended by the British Medical Association (1950).

The conclusion from this investigation is that for vitamin C retention there is no objection to the replacement of open cooking by pressure cooking. The main practical advantage is that there is an 80 % economy of steam. It might also be added, however, that the stew is, in the opinion of the consumers, more palatable when cooked by this method.

#### SUMMARY

1. There is a trend, in the compound kitchens of the gold mines of the Witwatersrand, to replace open by pressure cooking.

2. Since the vegetable stew is the chief, and sometimes the sole, source of vitamin C for the Bantu workers, among whom incidentally scurvy is very seldom observed, a comparison has been made between the vitamin C content of stew cooked on a very large scale by both methods.

3. Experiments have shown good retention of the vitamin with either method and a slightly better retention with open cooking, the mean values for tests carried out on four separate days being 89 and 79 % respectively.

4. The usual helping of stew, prepared by either method, provides daily 45–50 mg. vitamin C, an amount that may be considered adequate.

5. The conclusion reached is that for vitamin C retention there is no reason why pressure cooking should not be adopted.

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