

## Effect of Cooking on the Vitamin C Content of Fresh Leaves and Wilted Leaves

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The vitamin C content of 12 edible leaves freshly harvested from a farm in Nigeria ranged from 109 to 421 mg per 100 g on a dry weight basis; these amounts were lowered by between 25 and 38% by the traditional method of cooking them. Wilting of fresh leaves for 2, 4, 6, 8, and 10 h lowered their ascorbate contents, on the average, by 11, 20, 36, 47, and 49%, respectively. Cooking of the wilted leaves significantly decreased their ascorbate contents.

Vitamin C, otherwise known as ascorbic acid, is required in greater amounts than all the other vitamins (Ezell and Wilcox, 1959), and its need has been reported to increase in some diseases, particularly tuberculosis (Williams and Deason, 1967).

Apart from its role in preventing scurvy (Reid, 1954), this vitamin also aids as well by increasing calcification of bones (Williams and Deason, 1967; Poal-Manresa et al., 1970), and it is a preventative and therapeutic remedy in both atherosclerosis (Ginter et al., 1969; Milenkov and Mitkov, 1969) and respiratory diseases (Cheraskin et al., 1973; Preshaw, 1972). Evidence has also been presented suggesting that vitamin C has a function in controlling mitotic activity of cells (Stern, 1956; Edgar, 1970).

It is also beneficial in the treatment of prickly heat (Hindson, 1968, 1970), and is thus required in the tropics in relatively larger quantities so as to ensure, among other things, the normal functioning of the hyperactive sweat glands (Wright and Mac Lenathen, 1939).

Leafy vegetables, as a class, are relatively rich in vitamin C and, together with fruits, furnish most of the vitamin C in the diet of urban families in most parts of the world (Oke, 1968; Cadwell, 1972).

In Nigeria, as in most parts of Africa, leafy vegetables are consumed daily in the staple diet after cooking and are grown in areas far removed from the population centers. Even those grown relatively near are in the process of wilting by the time they appear on the market stalls, where wilting continues until they are bought for food.

Some workers have reported losses in the vitamin C contents of various vegetables as a result of blanching (Hartzler and Guerrant, 1952; Oke, 1967) and of standing in various environmental temperatures (Ezell and Wilcox, 1959; Cadwell and Gim-Sai, 1973), but there are no records of losses due to cooking after various periods of wilting. This information seems necessary because of its possible nutritional significance. It could also be of importance in the evaluation of food consumption data of various nations.

### EXPERIMENTAL SECTION

**Edible Leaves.** Twelve common leaves were selected for study, and were plucked from 4-week-old plants grown on our experimental farm. They were quickly brought to the laboratory, washed with tap water to rid them of sand and other impurities, and their ascorbate contents were quickly determined on aliquots. They were then allowed to wilt, and, at 2-h intervals, ~40-g portions were taken from each type of leaf and then divided into two equal lots. One lot was subjected to ascorbate analysis, while the other was first cooked before it was analyzed.

Table I. Effect of Cooking on the Ascorbate Contents of Some Farm-Fresh Edible Leaves

Local name	Botanical name	% dry matter	Ascorbate content, mg/100 g dry wt	% loss of ascorbate by cooking
Soko	<i>Celocia argentea</i>	19	421	38
Tete	<i>Amaranthus hybridus</i>	15	405	35
Gbure	<i>Talinum triangulare</i>	11	280	30
Ewedu	<i>Corchorus olithorus</i>	21	165	33
Ewuro	<i>Vernonia amygdalina</i>	23	345	40
Ogunmo	<i>Solanum nodiflorum</i>	24	367	25
Ugu	<i>Telfairia occidentalis</i>	21	341	28
Uziza	<i>Piper guineense</i>	29	220	31
Ukazi	<i>Gnetum buchholzianum</i>	33	278	23
Ewe paki (cassava leaves)	<i>Manihot esculenta</i>	12	109	30
Ewe koko	<i>Xanthosoma sagittifolium</i>	16	198	30
Ilasa (okro leaves)	<i>Hibiscus esculentus</i>	20	180	36

Dry matter determinations were made on about 20-g portions drying at 100°C for 18 h.

**Wilting of Leaves.** Leaves were allowed to wilt on benches placed under a shady space outside the laboratory.

**Cooking of the Leaves.** About 20-g portions of fresh and wilted leaves were cut into smaller pieces and then cooked in water in a covered cooking pot as a housewife would normally do.

**Determination of Vitamin C.** Known weights (about 10 g) of leaves were ground with sand and 4% metaphosphoric acid in a large pestle and mortar. The macerate was kept covered by acid to extract the ascorbic acid and to prevent its oxidation. After this, the whole volume of extracted juice was measured, and the solids removed by centrifugation and filtration. Aliquots of this filtrate were then analyzed colorimetrically with 2,6-dichlorophenol-indophenol according to the methods of Hughes (1956) and of Twomey and Goodchild (1970). This was performed in duplicate on the raw and cooked samples of both the fresh and the wilted leaves.

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Table II. Variations in the Percent Ascorbate Loss by Fresh Leaves which Have Been Allowed to Wilt for Different Periods

Wilting time, h	Range of ascorbate loss, %
2	5 and 18
4	10-30
6	28-44
8	34-60
10	38-66

## RESULTS AND DISCUSSION

Table I shows that the ascorbate contents of the 12 fresh leaves, when expressed as mg/100 g dry weight, ranged from 109 mg in cassava leaves (*Manihot esculenta*) to 421 mg in *Celocia argentea*. These are much higher than values reported by Oke (1967) for nine leaves, some of which were also investigated in this study. Various reasons could be used to account for this, such as differences in leaf maturity, and the fact that quite different ascorbic acid assay methods were employed (Oke, 1968; Stepanova et al., 1973).

They, however, fall within the wide range of 29-643 mg reported for the ascorbate contents of several Malaysian leaf vegetables purchased over a period of several months (Cadwell, 1972).

The traditional method of cooking these leaves led to a loss of 25 to 40% of their ascorbate (Table I) against an average of 55% reported for some Malaysian edible leaves (Cadwell and Gim-Sai, 1973).

The effects of wilting and of cooking of wilting leaves on the ascorbate loss are shown graphically in Figure 1. Loss of vitamin C increased with wilting time up to 10 h after harvest. Between 5 and 18% loss was observed after 2 h of wilting, and the corresponding figures for 4, 6, 8, and 10 h wilting times were 10 to 30%, 28 to 44%, 34 to 60%, and 38 to 66%, respectively (Table II).

Most of these leaves usually keep their lush appearance on the open market stalls up to about 10 h after harvest from various farms, after which physical and visible wilting occurs. At this time, they no longer entice the housewives and other buyers and are thus discarded. Exceptions to this are *Talinum triangulare*, *Telfairia occidentalis*, and *Piper guineense* which wilt more slowly, as they still retain their fresh appearance up to 24 h after harvest, at which time they had lost only about 50% of their vitamin C. The other nine leaves were found to lose between 70 and 89% of their ascorbate after 24 h wilting. This observation seems to support earlier findings by Ezell and Wilcox (1959) that wilting generally hastens the loss of ascorbic acid in leaves.

No significant correlation ( $P > 0.05$ ) was found between the moisture content of leaves and their loss of vitamin C.

Figure 1 shows that the loss of ascorbate by the leaves continued as they were wilting, and that the percentage loss per hour of wilting varied with different leaves. The rate of ascorbate loss was also found to increase generally within the first 4 h after harvest. It also shows that cooking the wilted leaves considerably increased loss of ascorbic acid for the first few hours, after which the rate of loss decreased. An interesting phenomenon was found in *Manihot esculenta*, *Gnetum buchholzianum*, and *Xanthosoma sagittifolium* where cooking did not seem to have any appreciable effect on the ascorbate content of leaves

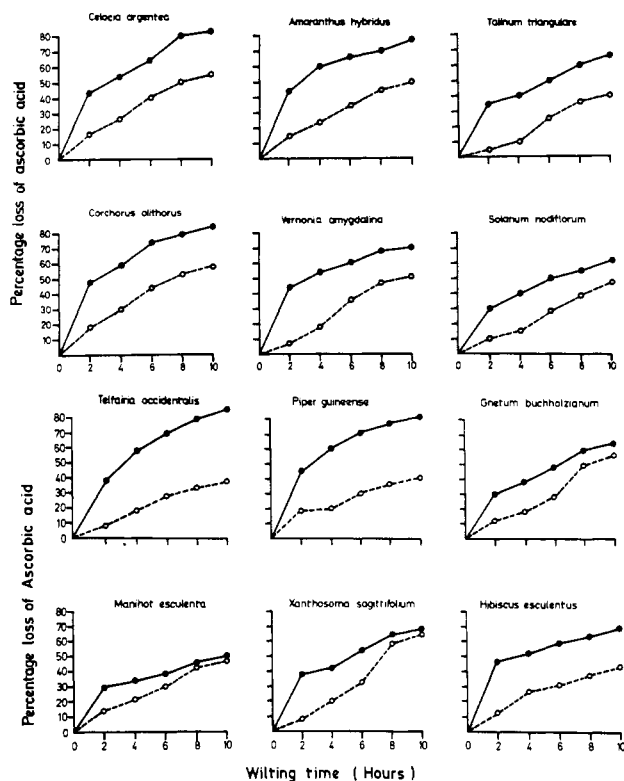


Figure 1. Loss of ascorbic acid of fresh leaves as related to wilting and to the cooking of wilted leaves: (●—●) cooked leaves; (○- -○) raw leaves.

which had wilted for 8 to 10 h (Figure 1).

Comparison of Table I with Figure 1 reveals that the effect of cooking of fresh leaves on their ascorbic acid content was the same as that of allowing leaves to wilt for about 6 h in an open space.

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