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The Effect of Pre-process Handling Conditions on the Ascorbic Acid Content of Green Leafy Vegetables

O. O. P. Faboya

Chemistry Department, University of Ibadan, Nigeria

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ABSTRACT

*Five green leafy vegetables (*Talinum triangulare, Amaranthus hybridus, Celosia argentea, Corchorus olitorius *and* Vernonia amygdalina*) were analysed for their ascorbic acid contents. The intersite variation in the values was rather high when compared with both the intrasite and the between-sample variations. For a particular site,* Celosia argentea *had the lowest ascorbic acid content (181 mg/100 g dry wt) while* Talinum triangulare *had the highest (354 mg/100 g dry wt). In direct sunlight, an average of 64·0% of the initial ascorbic acid content was lost in 8 h. An open laboratory did not, however, appreciably reduce the loss. On the other hand, in darkness, only about 16·0% loss occurred within the same period. In a household refrigerator, the decrease in the vitamin was almost arrested, as an average of only 0·5% loss occurred after 8 h. The patterns of ascorbic acid change in both vegetables were similar despite the different initial levels.*

INTRODUCTION

Green leafy vegetables have long been recognized as an important source of vitamin C. In Nigeria these vegetables are, however, most often consumed cooked (Oke, 1968), a process which leads to losses in the vitamin C (Oke, 1967). Decrease of this vitamin from vegetables during cooking is important, as between 63 and 76% losses have been reported in some cases (Fafunso & Bassir, 1976). Apart from this, illumination of vegetable leaves has also been shown to lead to rapid oxidation of ascorbic acid (Mapson, 1961). This implies that handling conditions prior to the cooking could also be important for the ultimate level of the vitamin in the cooked vegetables.

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Among Nigerian communities, the green leafy vegetables are handled in various ways. Some of these handling conditions include:

(i) cooking immediately after harvest;
(ii) cooking after leaving on the kitchen table for some time;
(iii) cooking after leaving in a closed cupboard for some time;
(iv) cooking after leaving in a refrigerator for some time;
(v) purchasing from the market, where the vegetables must have been exposed to direct sunlight for some time, and cooking immediately or some time thereafter.

In this report, the effect of a number of these handling conditions on the ascorbic acid levels in some green leafy vegetables was investigated.

MATERIALS AND METHODS

Samples and sampling

The vegetables were collected fresh from the farms, in sealed polythene bags. In the laboratory, the samples were rinsed under running water to remove any adhering soil and then allowed to drain for about 10 min. Ten-gram units were then weighed out and used for subsequent ascorbic acid determinations.

Moisture determination

The moisture contents of the samples were determined by drying weighed portions in an oven set at 105°C, until a constant weight was attained in each case.

Ascorbic acid determination

Ten grams of the fresh vegetables were crushed in a mortar with a minimum volume of 0·5% oxalic acid solution to form a fine paste. The paste was transferred into a beaker and the mortar and pestle rinsed several times with the oxalic acid solution, into the beaker. The mixture was thoroughly stirred and then filtered through thick glass wool into a 100 cm^3 volumetric flask and the filtrate made up to the mark with more oxalic acid solution.

Ascorbic acid extract (10 cm^3) was pipetted into a 100 cm^3 conical flask and 5 cm^3 of 4% (wt/vol.) potassium iodide solution added. The mixture was titrated against 0·01% *N*-bromosuccinimide solution, using starch solution

TABLE 1
The Percentage Moisture Content of Leafy Vegetables Harvested from Three Different Locations

Sample	*Chemistry Department farm*	*Queen's Hall farm*	*Agriculture Faculty farm*
Corchorus olitorius	81·8	78·1	82·2
Talinum triangulare	93·6	92·1	91·9
Celosia argentea	90·8	90·2	89·6
Amaranthus hybridus	84·7	84·3	83·8
Vernonia amygdalina	81·9	82·1	79·1

as indicator. The ascorbic acid content was then calculated using the Barakat *et al.* (1955) formula.

Each vegetable was sampled twice and each sample analysed in duplicate.

RESULTS AND DISCUSSION

Moisture contents

The vegetables were each sampled from three different farms and their moisture contents determined (Table 1). The values varied from about 80 to 94% with only slight intersite variations. In all cases, however, *Talinum triangulare* had the highest moisture content.

Variation in the ascorbic acid contents of the vegetables with locations

The samples collected from the three farms were analysed for their ascorbic acid contents. Each of the vegetables was also sampled from more than one point on site B and also analysed. As shown in Table 2, for each vegetable

TABLE 2
The Ascorbic Acid Contents of Leafy Vegetables Harvested from Three Different Locations (mg/100 g dry wt)

Sample	*Chemistry Department farm*			*Queen's Hall farm*	*Agriculture Faculty farm*	*Mean (SD)*
	i	*ii*	*Mean (SD)*			
Corchorus olitorius	258 (0·8)[a]	236 (1·3)	247 (15·8)	218 (1·2)	342 (2·7)	264 (54·5)
Talinum triangulare	350 (3·3)	359 (2·1)	354 (6·2)	307 (2·9)	475 (3·4)	373 (72·0)
Celosia argentea	194 (1·6)	168 (0·9)	181 (18·5)	157 (0·8)	242 (2·0)	190 (37·8)
Amaranthus hybridus	239 (3·8)	247 (3·1)	243 (5·7)	209 (3·2)	320 (2·7)	254 (47·4)
Vernonia amygdalina	265 (4·2)	275 (2·5)	270 (7·0)	227 (2·2)	353 (3·9)	280 (52·9)

[a] Standard deviations are shown in parentheses.

sample, the ascorbic acid content was found to vary widely with locations (large standard deviations). Smaller variations were observed for different points on the same farm and the least for replicate readings. For all sites, however, *Talinum triangulare* had the highest ascorbic acid content while *Celosia argentea* had the lowest. This high value of the acid in *T. triangulare* could be attributed to the high moisture content of the vegetable and the water solubility of the vitamin. A comparison of the results in Tables 1 and 2, however, showed no such correlation.

The variations with locations could be due to the fact that the level of the vitamin in plants is affected by soil properties. Avdonin *et al.* (1964) reported that application of nitrogen, potassium and phosphorus fertilizers to the soil increased the vitamin C content of vegetables grown on such a soil. This could have been responsible for the high levels found in samples from the Faculty of Agriculture farm, on which fertilizers are regularly used.

As a result of these observed variations, subsequent samplings were confined to just one of the sites.

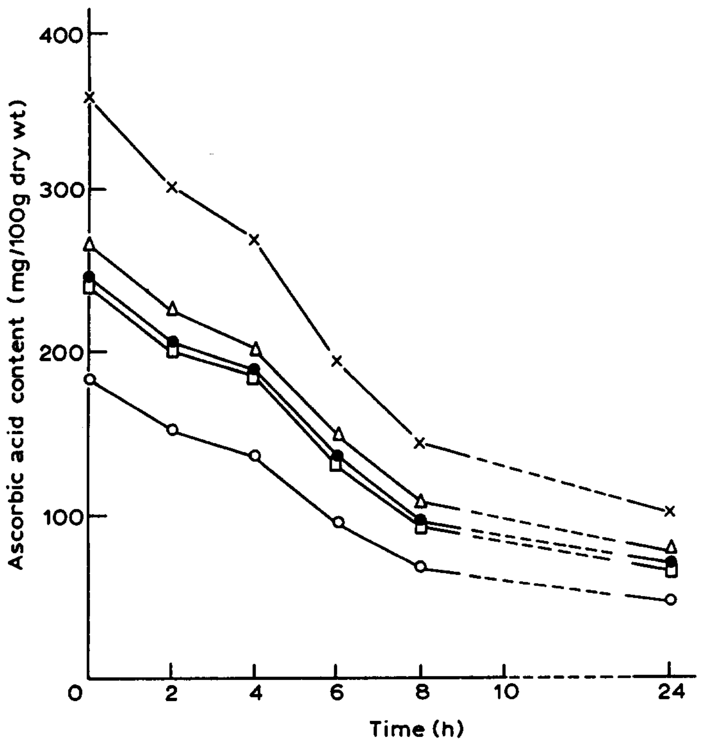

Fig. 1. Changes in ascorbic acid contents of leafy vegetables kept in an open laboratory for varying periods. ×, *Talinum triangulare*; ●, *Corchorus olitorius*; □, *Amaranthus hybridus*; ○, *Celosia argentea*; △, *Vernonia amygdalina*.

Effect of handling conditions on the ascorbic acid contents of the vegetables

Samples of the five vegetables were kept in the open laboratory, at an average room temperature of 26°C, and the ascorbic acid contents determined at 2-h intervals (Fig. 1).

The ascorbic acid contents of the different vegetables decreased rapidly with time. After only 2 h, between 14·4 and 17·4% of the initial ascorbic acid present in the samples had been lost. These losses increased to 58·7 and 62·1% after 8 h. When kept for longer periods, the rate of loss seemed to decrease, as samples kept overnight only had between 69·6 and 72·6% decrease. It was also noted that the patterns of ascorbic acid change in all the vegetable samples were similar. This could be due to the fact that reduction in the ascorbic acid levels was probably mostly due to the effect of light on the vegetables. As all the samples were exposed to the same amount of light, there were similar patterns of change.

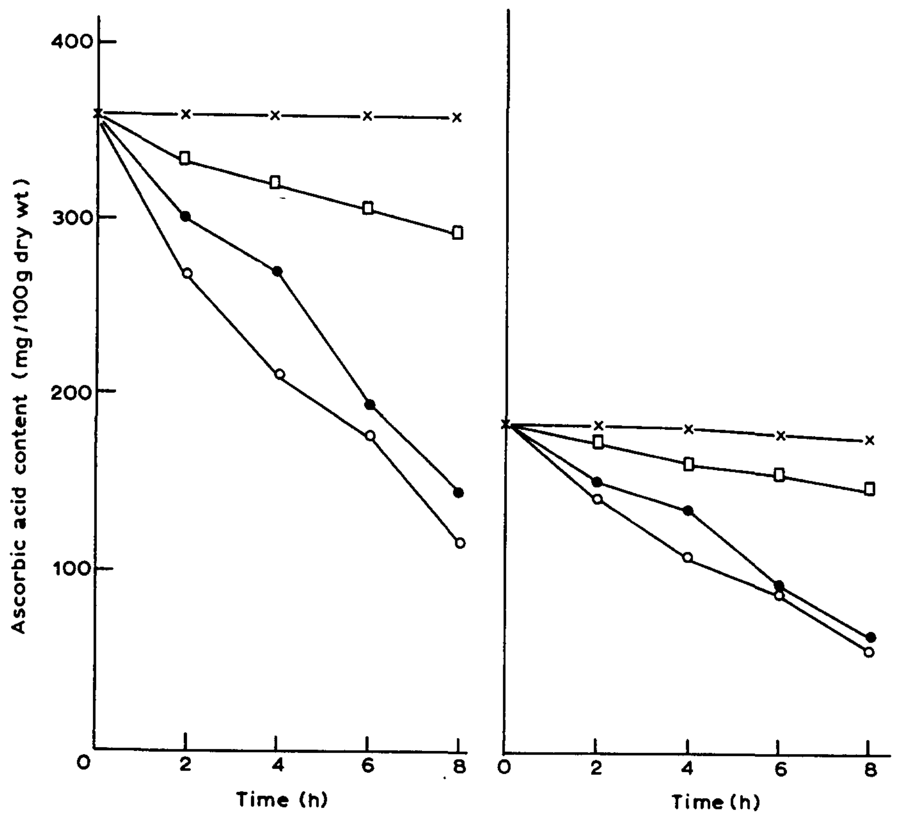

Fig. 2. Changes in ascorbic acid content of two leafy vegetables during different handling conditions. ×, Refrigerated; □, in a dark cupboard; ●, in an open laboratory; ○, in direct sunlight.

Talinum triangulare and *Celosia argentea* were then exposed to different handling conditions, as shown in Fig. 2, and changes in their ascorbic acid contents were examined. The highest rate of loss was recorded when the samples were exposed to direct sunlight, while keeping them in a household refrigerator almost eliminated any loss. After only 2 h, as much as 20% reduction had occurred when either vegetable sample was kept outside in direct sunlight. Less than 1% loss was recorded when the same samples were kept in a household refrigerator for 8 h. Keeping in a closed cupboard also greatly reduced the rate of ascorbic acid loss from the vegetables. Only about 5% loss was suffered after 2 h, as compared with about 17% loss when kept in an open laboratory for the same period. It is worth noting, however, that there was very little difference between the losses from samples kept in direct sunlight and those kept inside the open laboratory. After 8 h, 66·0 and 59·0% losses were recorded, respectively, for *Talinum triangulare* under both conditions, and 66·0% and 62·0% losses recorded, respectively, for *Celosia argentea.* This would imply that a greater proportion of the ascorbic acid must have been destroyed through photo-oxidation rather than through enzymic activity or heat effect. This suggestion was further confirmed by the results obtained when the vegetables were kept in either a dark cupboard or in a household refrigerator (Fig. 2). The negligibly small losses recorded for refrigerated samples were most probably due to a combination of reduced photo-oxidation and retardation of enzymic activities. Similar patterns of change were also obtained for both vegetables under similar conditions.

CONCLUSIONS

The ascorbic acid contents of leafy vegetables vary significantly with sampling sites. When exposed to sunlight, a high proportion of the vitamin is rapidly lost from the vegetables. The loss is drastically reduced by keeping in a dark compartment and almost arrested by keeping in a household refrigerator. To conserve the vitamin C in them, it is therefore recommended that leafy vegetables should be processed immediately after harvesting or purchasing. On the other hand, they should be stored in a refrigerator, or at least in a dark compartment, before processing.

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