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Effect of different pre-drying operations on some nutritionally valuable minerals, ascorbic acid and rehydration index of *Capsicum* species

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ABSTRACT

Some nutritionally important minerals, ascorbic acid and rehydration index of three capsicum species, namely sweet pepper (*Capsicum annum var. grossum L. Sendt*), Tobasco pepper (*Capsicum annum var. acumination Fingerh*) and Chilli pepper (*Capsicum frutescens var. baccatum L.*) were determined in the laboratory, with samples subjected to blanching and soaking in 30% sodium chloride solution, 1% potassium metabisulphite solution using standard methods. The mineral composition (ppm) of samples varied significantly for different treatment groups, with highest losses being recorded for water-blanched samples. Samples soaked in sodium chloride and potassium metabisulphite gave better mineral retention values than blanched samples. The different pre-treatment operations employed had no significant effect on ascorbic acid content of the peppers. Highest values for rehydration index was obtained for samples soaked and blanched in potassium metabisulphite.

Key words: Capsicum spp, Pre-drying operations. Mineral retention, Rehydration index, ascorbic acid, blanching.

INTRODUCTION

Peppers (*Capsicum spp*) commonly cultivated as vegetable or spice in almost all tropical and warm climates, belong to the family *Solanaceae* and *Capsicum,* Linn. The fruit vary greatly in shape, size, pungency and colours depending on the species (Hugues and Deleener 1989). All pepper varieties contain an alkaloid called capsaicin as well as carotene and vitamin C (Pamplona-Roger, 1999). The largest fraction of peppers are used in sauces or added to meat dishes. Peppers (especially hot pepper) increase the production of gastric and intestinal juices, thus activating all digestive organs. Sweet pepper (*Capsicum annum* L) has anti-flatulent and laxative properties when eaten raw or roasted. Due to their low content of carbohydrates and fats, they are especially recommended for diabetic and obese people and those suffering from bloated stomach, slow digestion, gastric ptosis and lack of appetite (Pamplona-Roger, 1999).

Peppers are preserved traditionally by sundrying, the only pre-drying operation being boiling. The boiling process results in the loss of mineral contents, inhibit ripening of many fruits and vegetables and alleviates storage disorders (Paull, 1990; Klein & Lurie, 1991). Olorunda *et al.* (1990) reported remarkable improvement in the rehydration characteristics of dried tomatoes immersed in potassium metabisulphite (PMS) solutions prior to drying. Blanching is a widely accepted practice of heat pre-treatment of most vegetables prior to storage or other subsequent processing. It inactivates spoilage enzymes but increases nutrient losses, especially water-soluble minerals. However, the type and conditions of blanching determine the rate of loss of their constituents (Badifu, 1991). A study by Carbonell *et al.* (1986) demonstrated that drying conditions substantially influenced the quality attributes of peppers and that higher the drying temperature, the greater will be the quality impairment of fresh or stored ground pepper.

Vitamin C is often considered equivalent to ascorbic acid (AA) although its oxidation product, dehydroascorbic acid (DHAA), also has vitamin C activity, whose utilisation in the human body is almost the same (Sabry *et al* 1958). Fresh fruits and vegetables hardly contain any DHAA, as all vitamin C present is AA. However, during processing, AA content decreases as a result of oxidation and DHAA content increases. Therefore, Klein (1987) suggested that measurement of vitamin C in fruits and vegetables in relation to their nutritional value should include both AA and DHAA.

Although several works have been published on peppers (Nwakiti 1976; Fagbemi & Oshodi 1993; Falusi & Morakinyo 1994; Chang *et al.* 1995; Fallik *et al.* 1996; Kumar *et al.* 1996; Peusch *et al.* 1997) not much has been published on the relationship between pre-drying operations, mineral retention, AA and rehydration index (RI) in peppers.

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The objective of this study was to examine the effect of blanching and soaking in PMS and sodium chloride solutions on the mineral retention, AA and RI of sweet pepper (*Capsicum annum var grossum L Sendt*), Tobasco pepper (*Capsicum annum var. accuminatum Fingerh*) and chilli pepper (*Capsicum frutescence var. baccatum L)*

MATERIALS AND METHODS

Raw Material Preparation

Fresh wholesome sweet pepper (*Capsicum annum var grossum L Sendt)*, Tobasco pepper *(Capsicum annum var. accuminatum Fingerh)* and chilli pepper *(Capsicum frutescens var. baccatum L)* used in this work were obtained from local farms in Ilaro, Ogun State, Nigeria. About 500g of each species were cut into pieces of about 1cm^2 (seeds removed) and subjected to the following pre-drying treatments:

(a) Blanching in de-mineralised water (BDW) at 90 - 95° C for 5 minutes
(b) Blanching in 30% sodium chloride solution (BSC) at 90 - 95° C for 5 minutes
(c) Blanching in 1% potassium metabisulphite solution (BPMS) at 90 - 95° C for 5 minutes
(d) Soaking in 30% sodium chloride solution (SSC) at 25 ± 2° C for 20 minutes
(e) Soaking in 1% potassium metabisulphite solution (SPMS) at 25 ± 2° C for 20 minutes
(f) Control (untreated)

The samples (18) were drained, dried in a laboratory forced air oven set at 50° C to a moisture content of 10%, milled to pass through a sieve size of 0.5mm mesh and packaged in 0.15mm thick dark air-tight cellophane pack (7 x 7 cm) till when it is used for analyses.

Mineral Analysis

A mixture (ratio 1:2) of concentrated perchloric acid and nitric acid (15 cm^3) was added to 0.5g of each sample and heated. The resulting digest was cooled, transferred into 50 cm^3 standard flask and made up to the mark with demineralised water. The calcium, magnesium, potassium, sodium and iron contents of the samples were measured using atomic absorption spectrophotometer (Perkin - Elmer 1973). Phosphorus was determined colometrically (AOAC, 1990).

Ascorbic Acid Determination

AA was analysed by titration with 2,6 - dichlorophenol-indophenol (DCPIP) as described by AOAC (1990). Aqueous oxalic acid solution (0.1%) was used instead of metaphosphoric acid-acetic acid extracting solution. The total content of ascorbic acid (TAA) was analysed using the same method, after reducing the DHAA to AA with homocystein. The amount of DHAA was calculated by difference as TAA - AA.

About 100g of pepper samples were mixed with 1L or oxalic acid (0.1%) The mixture was blended for 1.5 minutes. Approximately 50 ml of the solution was centrifuged and 10 ml of the supernatant used for titration. Before titration, 5 ml of buffer and 3 ml of oxalic acid (1%) was added.

For determination of TAA, 3 ml distilled water followed by 2 ml K_2HPO_4 solution (50%) and 1 ml homocystein solution (0.5%) was added to 5.0 ml of the supernatant. After standing for 30 minutes at ambient temperature, 1 ml ethylmaleimide solution (1%) was added, and after 5 minutes, 2 ml citrate buffer were added. Finally the solution was titrated with DCPIP solution.

Rehydration Index

Ten (10)g of each dried sample were transferred into a 250 ml conical flask containing 90 ml of boiling water, stirred and placed on a mechanical shaker for 90 seconds. The resulting mixture was poured in a 100 ml measuring cylinder and allowed to settle for 10 minutes. The volume of the sediment was recorded as the RI (Olorunda *et al.* 1990).

Statistical Analysis

The measurements were carried out in triplicates and data analysed by ANOVA and Duncan's multiple range test (mean comparison) using the Statistical Package for Social Scientists, SPSS 9.0 for windows computer program (SPSS Inc. 1998).

RESULTS AND DISCUSSION

Results in Table 1 showed significant differences in the mineral composition of pre-treated and untreated samples for the three species. Mineral losses in sweet pepper were higher for samples blanched in demineralised water (BDW): 34% Ca, 33% Mg, 57.6%, Na, 43% Fe, 72% P and 48% K compared with the control. However, there is no significant difference in the Mg losses between samples BDW, BSC and SSC ($P = 0.05$). For all minerals measured in sweet pepper, SSC and SPMS gave the best retention values with the following percent losses: 3.3 Ca (SSC), 7.5 Mg (SPMS), 10 Na (SPMS), 21.4 Fe (SSC), 54 P (SSC) and 0.8 K (SPMS),

Table 1: Mineral contents (mg/kg) of pre-treated dry-milled sweet pepper, tobasco pepper and Chilli pepper

TG	Calcium	Magnesium	Sodium	Iron	Phosphorous	Potassium
			SWEET PEPPER			
BW	561 ± 2.02[a]	466 ± 2.31[a]	515 ± 2.89[a]	235 ± 2.89c	1269 ± 2.89[a]	2470 ± 2.60[a]
BSC	33 ± 4.33[d]	482 ± 4.04[a]	585 ± 2.91[b]	195 ± 2.89[a]	1437 ± 3.53[b]	3102 ± 4.04[b]
BPMS	586 ± 3.48[b]	13 ± 4.67[b]	965 ± 2.89[d]	208 ± 3.76[b]	1646 ± 2.60[c]	3767 ± 4.33[d]
SSC	882 ± 4.36[e]	484 ± 2.91[a]	688 ± 2.60[c]	270 ± 2.91[d]	2078 ± 4.35[e]	3541 ± 5.49[c]
SPMS	670 ± 4.35[c]	640 ± 17.41[c]	1093 ± 29.56[e]	240 ± 2.91[c]	1682 ± 4.63[d]	4710 ± 15.78[e]
CONTROL	9 ± 2.33[f]	692 ± 4.35[d]	1215 ± 5.77[f]	343 ± 4.41[f]	4527 ± 4.67[f]	4749 ± 5.20[f]
			TOBASCO PEPPER			
BW	665 ± 2.89[a]	578 ± 2.08[a]	366 ± 5.86[a]	91 ± 3.79[a]	1660 ± 4.33[c]	2950 ± 5.77[a]
BSC	975 ± 2.89[c]	628 ± 4.33[c]	422 ± 4.33[b]	125 ± 2.91[c]	2065 ± 3.21[e]	3735 ± 2.89[e]
BPMS	855 ± 2.90[c]	615 ± 2.89[b]	686 ± 5.86[d]	102 ± 4.36[b]	1290 ± 5.49[a]	686 ± 3.48[b]
SSC	1217 ± 4.33[e]	628 ± 3.18[c]	582 ± 4.91[c]	133 ± 4.33[c]	1798 ± 4.33[d]	4830 ± 4.41[e]
SPMS	1028 ± 4.36[d]	634 ± 3.18[c]	928 ± 4.36[e]	148 ± 3.79[d]	1590 ± 2.90[b]	4602 ± 4.41[d]
			CHILLI PEPPER			
BW	704 ± 4.06[b]	525 ± 2.91[c]	441 ± 5.20[a]	98 ± 2.89[a]	1137 ± 3.76[a]	3562 ± 4.36[a]
BSC	671 ± 4.91[a]	596 ± 3.76[d]	754 ± 3.46[d]	123 ± 3.52[c]	1298 ± 4.35[b]	4150 ± 2.89[b]
BPMS	911 ± 6.21[c]	482 ± 4.33[a]	671 ± 4.91[b]	103 ± 4.06[b]	1460 ± 5.78[c]	4611 ± 5.21[d]
SSC	1318 ± 7.26[e]	618 ± 4.36[e]	821 ± 5.21[e]	171 ± 5.20[d]	2625 ± 4.06[e]	4549 ± 5.21[c]
SPMS	1033 ± 4.36[d]	497 ± 4.33[b]	718 ± 3.75[c]	111 ± 4.91[bc]	1732 ± 4.33[d]	5808 ± 4.41[f]
CONTROL	1443 ± 4.06[f]	676 ± 3.76[f]	726 ± 2.85[c]	173 ± 3.18[d]	3093 ± 3.52[f]	5446 ± 2.89[e]

Values are means of three replicates
Values in a column under each species denoted by different superscripts differ significantly at $P > 0.05$
TG: Treatment groups: BDW: Blanched in demineralised water; BSC: Blanched in 30% sodium chloride solution; BPMS: Blanched in 1% potassium metabisulphite solution SSC: Soaked in 30% sodium chloride solution; SPMS: Soaked in 1% potassium metabisulphite solution

respectively. Similarly, samples BSC and BPMS had better mineral retention values than sample BDW. Samples blanched in brine and PMS generally had significantly higher ($P = 0.05$) values than those blanched in water. The same trend was observed in Tobasco pepper which also had higher mineral losses for BDW: 61.8% Ca, 17.5% Mg, 64% Na, 48.6% Fe, 30% P and 43.2% K respectively. Samples SSC and SPMS also gave significantly higher retention values with the following percent losses: 30 Ca (SSC), 9.6 Mg (SPMS), 8.8% Na (SPMS), 16.4 Fe (SSC), 12.9 P (SSC) and 7.0 K (SSC) respectively. Samples BSC and BPMS of Tobasco pepper had better mineral retention values than sample BDW. For chilli pepper, the highest mineral losses were recorded in sample BDW for all minerals measured except for Mg with high losses in samples BPMS and SMS: 53.5% Ca, 28.6% Mg, 39% Na, 43.5% Fe, 63.2% P and 34.6% K. The lowest percent mineral losses were recorded with SSC: 8.7 Ca, 8.5 Mg, 1.34 Fe and 15.1 P respectively.

These results showed that higher losses were obtained for blanched samples than soaking in brine and PMS. The low retention values obtained for blanched samples could be attributed to losses arising mainly from leaching of soluble minerals into the blanching medium. This observation is consistent with earlier reports by Keshinro and Ketiku (1979), Ajayi *et al.* (1980) and Poulsen (1986) that blanching is associated with nutrient losses in Nigerian fruits and leafy vegetables. Furthermore, the boiling process led to loss of firmness due largely to the de-esterification of pectin molecules and subsequent conversion and formation of calcium bridges between free carboxyl groups of adjacent pectin molecules (Hoogzand & Doesburg, 1961; Lee *et al.* 1979; Van Buren, 1979). This loss of firmness further facilitates migration of minerals. However, samples blanched in salt solutions had better retention values than those blanched in de-mineralised water. This observation could be attributed to osmotic pressure created by the presence of salts in water.

The significantly higher mineral retention values obtained for samples soaked in brine and PMS may be attributed to mineral retention due to osmotic pressure, created by the presence of dissolved salts in water. In this case, the cell wall behaves as a semi-permeable membrane, which however, cannot serve as a perfect barrier to these minerals, hence the observation of mineral migration into the salt solution. The amount lost is however lower than those in blanched samples.

Results in Table 2 on TAA showed that there was no significant difference ($P \leq 0.05$) in the ascorbic acid content of chilli and tobasco pepper blanched in water and salt solutions. However, sweet pepper showed significant difference only

Table 2: Ascorbic acid (AA) and dehydroascorbic acid (DHAA) content (mg/g) DM of pre-treated dry-milled sweet pepper, tobasco pepper and chilli pepper

TG	Sweet Pepper		Tobasco Pepper		Chilli Pepper	
	AA	DHAA	AA	DHAA	AA	DHAA
BW	8.82 ± 0.08^{bc}	1.74 ± 0.09^{a}	8.40 ± 0.07^{b}	1.54 ± 0.07^{a}	8.61 ± 0.14^{a}	1.64 ± 0.06^{a}
BSC	8.77 ± 0.15^{bc}	1.69 ± 0.06^{a}	8.21 ± 0.07^{a}	1.59 ± 0.04^{a}	8.38 ± 0.07^{a}	1.59 ± 0.03^{a}
BPMS	8.41 ± 0.10^{ab}	1.59 ± 0.08^{a}	8.25 ± 0.05^{a}	1.69 ± 0.06^{abc}	8.54 ± 0.09^{a}	1.51 ± 0.09^{a}
SSC	8.43 ± 0.13^{ab}	1.63 ± 0.04^{a}	8.16 ± 0.14^{a}	1.52 ± 0.05^{a}	8.58 ± 0.11^{a}	1.62 ± 0.01^{a}
SPMS	8.06 ± 0.26^{a}	1.68 ± 0.07^{a}	8.30 ± 0.12^{b}	1.62 ± 0.06^{ab}	8.44 ± 0.06^{a}	1.68 ± 0.06^{ab}
CONTROL	9.38 ± 0.34^{c}	1.98 ± 0.04^{b}	9.26 ± 0.08^{c}	1.71 ± 0.04^{c}	9.58 ± 0.09^{b}	1.73 ± 0.05^{b}

Values are means of three replicates
Values in a column under each species denoted by different superscripts differ significantly at $P > 0.05$
TG: Treatment groups; BDW: Blanched in demineralised water; BSC: Blanched in 30% sodium chloride solution; BPMS: Blanched in 1% potassium metabisulphite solution; SSC: Soaked in 30% sodium chloride solution; SPMS: Soaked in 1% potassium metabisulphite solution

with BPMS. Similar result were also observed for samples SSC and SPMS. Furthermore, no significant difference was recorded for values obtained from blanched and untreated samples in sweet pepper, while significant difference was recorded in tobasco and chilli pepper. While the observation with sweet pepper is consistent with other findings, tobasco and chilli pepper differ. For example, Mathew and Hall (1978) found no effect of steam blanching of green peppers for 2.5 minutes on the content of TAA. In addition, they reported that blanching had no effect on the DHAA level in green pepper. Al-Diliami et al (1986) found that heating of green pepper in water at 80° C for 20 minutes gave no loss of AA. The high retention during steam blanching is presumably because steam replaces the atmosphere around the vegetable thus preventing oxidation. The variation in results obtained for chilli and tobasco peppers may be attributed to varietal differences. The DHAA content in the control is significantly higher than values obtained for pre-treated samples. This suggests that the pre-treatments significantly reduced the rate of oxidation of AA to DHAA in *Capsicum* species. The variations observed in mineral and TAA results obtained for samples may be attributed to varietal, environmental and agricultural factors. Peppers contain AA, minerals and micronutrients capable of reducing the incidence of cancer and cardiovascular diseases (Roche 1997, Simon 1992, Moon & Micozzi 1998).

Table 3: Rehydration index (ml/10g) of pre-treated dry milled sweet pepper, tobasco pepper and chilli pepper.

TG	Sweet Pepper	Tobasco Pepper	Chilli Pepper
BW	31.7 ± 0.14^{b}	29.0 ± 0.14^{b}	31.3 ± 0.74^{ab}
BSC	30.4 ± 0.10^{a}	32.2 ± 0.13^{c}	32.0 ± 0.31^{bc}
BPMS	39.0 ± 0.14^{c}	$37.1 \pm 0.09e$	33.0 ± 0.31^{c}
SSC	31.0 ± 0.31^{a}	32.18 ± 0.09^{c}	32.05 ± 0.29^{bc}
SPMS	39.93 ± 0.19^{d}	35.32 ± 0.13^{d}	36.05 ± 0.29^{d}
CONTROL	31.07 ± 0.97^{ab}	27.11 ± 0.07^{a}	30.48 ± 0.13^{a}

Values are means of three replicates
Values in a column under each species denoted by different subscripts differ significantly at $P > 0.05$
TG: Treatment groups: BDW: Blanched in demineralised water; BSC: Blanched in 30% sodium chloride solution; BPMS: Blanched in 1% potassium metabisulphite solution SSC: Soaked in 30% sodium chloride solution; SPMS: Soaked in 1% potassium metabisulphite solution

The rehydration indices for *Capsicum* species are presented in Table 3. RI is a measure of the swelling capacity (i.e. water absorption capacity) of the samples. The higher the RI, better the reconstitution properties of dry milled product. Results in Table 3 showed that significant differences ($P > 0.05$) exist in the RI of the blanched samples (BDW, BSC and BPMS) with the best result obtained for BPMS. Similarly, samples soaked in salt solutions (SSC and SPMS) gave better results than both the control and BDW. SPMS gave the highest RI for sweet and chilli pepper, while BPMS gave the best rehydration values for tobasco pepper. These results further showed that samples SPMS and BPMS had the highest RI values in three samples. Improvements were also recorded in BSC and SSC in tobasco and chilli pepper respectively. This observation is consistent with the report of Olorunda (1990) on tomatoes treated with 30% PMS. This could be due to the fact that PMS solution reduces the rate of disruption of molecular cell structure during blanching and soaking, thereby ensuring that cells are in position to absorb maximum possible water during rehydration. Furthermore, being an antioxidant and a preservative (i.e. PMS), it may equally protect the samples against oxidation and microbial attack

CONCLUSION

The results have shown that mineral losses were significantly higher in samples blanched in

demineralised water compared to other pre-treatment operations. Furthermore, blanching in water at 90 - 95° C for 5 minutes had no significant effect on the AA of sweet pepper while, tobasco and chilli pepper had significantly lower values. Significantly higher mineral and RI values were obtained for samples soaked in brine and PMS. Thus, soaking in PMS may be useful as pre-treatment operation in terms of better mineral retention, vitamin C and RI.

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