African Journal of Biotechnology Vol. 12(2), pp. 186-191, 9 January, 2013
Available online at http://www.academicjournals.org/AJB
DOI: 10.5897/AJB10.501

Full Length Research Paper

Vitamin C stability in pineapple, guava and baobab juices under different storage conditions using different levels of sodium benzoate and metabisulphite

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Accepted 17 December, 2012

Vitamin C is one of the most important vitamins in fruit based products and its stability is very critical to guarantee its availability. Stability of vitamin C in baobab, guava and pineapple juices stored at room (22.4°C±1.3), chilling (-1.2°C±0.1) and freezing (-17.3°C±0.2) temperatures and using 0.05% sodium benzoate, 0.005% sodium metabisulphite and combined use of sodium benzoate and metabisulphite at 0.04 and 0.005% respectively was investigated. Results from the study revealed that both storage conditions and levels of the preservatives used significantly affected vitamin C stability in all the three types of juices used. Vitamin C contents were 74.4, 52.4 and 34.7 mg/100 mL for baobab, guava and pineapple juices on the first day of processing. Furthermore, vitamin C was found to be more stable in freezing storage conditions and the combined use of sodium benzoate and sodium metabisulphite at 0.04 and 0.005%, respectively was more effective in stabilizing vitamin C in the fruit juices than the other preservative levels used. It can be concluded that vitamin C stability in the three types of juices was influenced by storage temperature conditions, storage time and levels and types of preservatives used.

Key words: Stability, baobab, guava, pineapple, vitamin C, sodium benzoate.

INTRODUCTION

Vitamin C is a water soluble vitamin and its nutritional importance to mankind is well established. It is associated with many health benefits such as promoting health cell development, healing injuries and helps in absorption of minerals such as calcium. Many food products contain vitamin C but fruits and vegetables contain significantly higher amounts.

The stability of vitamin C in food products such as fruit juices is influenced by a number of factors such as type of fruit, maturity state and production factors. The environment in which juice is stored can significantly affect its vitamin C content and loss of vitamin C with time differs from one fruit to another under similar storage environments (Ajibola, 2009).

Fruits are highly perishable and fruit based products such as juices are processed to ensure availability even when they are not in season. Preservatives such as sodium benzoate have been used in food products such as fruit juices to extend the shelf life. The use of preservatives such as citric acid (0.3%), sodium benzoate (0.015%), potassium sorbate (0.025%) and sucrose (10%) helped in extending the shelf life of sugar cane juice for 15 days at ambient temperature (26±2°C) and 35 days at 10°C (Mishra, 2011).

Fruit juices are now processed in rural communities in many different developing countries where in certain instances refrigeration or other essential basic processing requirements are not available. It is inevitable that deterioration of essential nutrients such as vitamin C in processed stored products like juices do occur and this

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study was carried out to determine the stability of vitamin C in baobab, guava and pineapple juices stored at room, chilling and freezing temperatures using different levels and combinations of sodium benzoate and metabisulphite.

MATERIALS AND METHODS

Sample collection

All the fruit samples namely baobab, guava and pineapples used in the study were purchased from the local markets in Lilongwe district in central Malawi. Wildly produced guava fruits were used and the indigenously grown pineapples were produced from the southern district of Mulanje in Malawi while the baobab fruits were produced from lakeshore district of Salima in central Malawi.

Fruit juice making

Fully ripe guava fruits were thoroughly washed to remove any adhering contaminants. The outer layer was thinly removed using a knife and fruits were neatly sliced and subsequently crushed using a food blender to produce pulp. Hot water was added to pulp in the ratio 1:2 (w/v), sieved and warmed to a temperature of 45°C. Sugar was added when the temperature reached 45°C at the rate of 12% (w/v) and the mixture was continuously stirred until the temperature reached 70°C where it was held for 3 to 5 min. Four treatments were made from the guava juice using different levels of sodium benzoate and metabisulphite after the juice was heated at 70°C for 3 to 5 min. The treatments were as follows: (i) No preservatives used, (ii) 0.05% sodium benzoate, (iii) 0.005% sodium metabisulphite, and (iv) 0.04% sodium benzoate and 0.005% sodium metabisulphite. The four treatments of juices were filled in pre-sterilised bottles, left to cool in basins containing cold water and then stored at room, chilling and freezing temperatures and observed for two months where stability of vitamin C was determined at weekly and two week intervals for room, chilling and freezing storage conditions respectively.

For baobab juice, the dried baobab fruits were broken and the powder and seeds were scrapped off in the container and weighed. The contents were soaked in boiled water in the ratio of 1:2 (w/v). The contents were stirred and left for 1 to 2 h. The pulp was weighed and diluted with boiled water in the ratio of 1:1(v/v) and then sieved and the contents were weighed again and sugar was added at the rate of 10% (w/v) when the temperature reached 45°C. The same procedure as in guava juice was followed in making the juices and the four treatments. Pineapple juice was made by removing the outer layer and crushing the sliced pieces using a blender to produce the pulp. The pulp was weighed and 30% (w/v) of boiled water was added and then the mixture was sieved and the contents were weighed again. The mixture was warmed and 2% of sugar was added based on weight when the temperature reached 45°C. The same procedure as in guava juice was followed in making the juices and the four treatments.

Vitamin C determination

Vitamin C was determined by using the procedure as outlined by Nielsen (2003). 2 mL of the muslin filtered juice was used in the titration using the indophenol dye solution until a light rose pink persisted for 5 s. The indophenol dye solution was prepared by placing 50 ml deionised water into a 150 ml beaker and 42 mg of sodium bicarbonate was stirred to dissolve. 50 mg of 2,6-dichlorophenol (2,6-DCP) sodium was added and stirred to dissolve and the mixture was diluted to 200 ml with deionised water, filtered with fluted paper and store refrigerated.

The amount of dye used in the titration was determined and used in the calculation of vitamin C content. Determination of vitamin C in all the three types of juices was done on the same day of preparation before they were stored under different storage conditions. Determinations of vitamin C was done at weekly intervals for samples stored at chilling and room temperatures and at two week interval for samples stored at freezing temperatures.

Sample storage conditions

The four different treatments of the three fruit juices were stored at room temperature, chilling and freezing temperatures for the two months periods. Temperature measurements were taken daily in all three storage conditions for the entire period of the study. At the end of the study, temperature recordings were computed to obtain the average temperatures for three storage conditions. The temperature readings for the refrigeration storage used in the study was found to be less than -1°C and it was conveniently referred to as chilling storage conditions to correctly reflect the reality of the storage condition. During the storage period, parameters like pH were recorded and visual observations on the colour of the juices were also made.

Data analysis

All the data collected from the study were analysed using GenStat Discovery Edition 3 computer package (2010). Differences among treatments were evaluated by least significance difference test at 5% level of significance.

RESULTS AND DISCUSSION

Results on the stability of vitamin C in pineapple, guava and baobab juices as reflected by the level of its degradation at different storage conditions and different levels of sodium benzoate and metabisulphite are presented in Tables 1, 2 and 3. Furthermore, the summary of the average losses of vitamin C in all the three types of juices for the entire storage period of two months is presented in Table 4. Stability of vitamin C in all the three types of juices were significantly ($p<0.05$) affected by storage conditions (Tables 1, 2 and 3). The results show that vitamin C was highly retained in freezing storage conditions and least retained in room storage conditions. Vitamin C losses in foods such as juices have been attributed to many factors such as temperature and these results are in agreement with what was reported by Ribero et al. (2011) who stated that the observed degradation of vitamin C in the formulation could be due to other interfering factors such as presence of oxygen, storage temperature and presence of oligo elements. These findings are also supported by the results of Steskova et al. (2006) who reported that stability of vitamin C in foods and beverages is affected by temperature, form of vitamin and matrix and lower storage temperature brings about higher retention of vitamin C. On the other hand, the use of preservatives

Table 1. Vitamin C degradation in pineapple juice during the two month storage period under different storage conditions (mg/100 mL)

Storage condition (Temperature in °C)	Treatment	Storage time (weeks)				
		0	2	4	6	8
Freezing	Control	34.7±0.62	29.5±0.66	25.7±0.56	23.8±0.62	21.3±0.36
	0.05%SB	34.7±0.62	27.8±0.95	27.3±0.36	24.6±0.96	24.1±0.36
	0.005% SMB	34.7±0.62	29.3±0.20	28.6±0.15	26.0±0.26	25.4±0.44
	0.04%SB +0.005%SMB	34.7±0.62	30.5±0.72	28.6±0.36	26.9±0.26	25.7±0.76
Chilling	Control	34.7±0.62	25.5±0.70	13.4±0.79	10.0±0.46	7.1±0.36
	0.05%SB	34.7±0.62	24.6±1.10	17.6±0.62	12.3±0.30	9.1±0.36
	0.005% SMB	34.7±0.62	23.5±0.78	21.4±0.62	15.4±0.30	10.3±0.20
	0.04%SB +0.005%SMB	34.7±0.62	27.7±0.53	21.7±0.53	16.4±0.31	11.3±0.36
Room	Control	34.7±0.62	15.7±0.36	9.2±0.40	8.0±0.36	3.5±0.36
	0.05%SB	34.7±0.62	19.7±0.26	9.4±0.26	8.3±0.20	4.0±0.26
	0.005% SMB	34.7±0.62	22.9±0.30	11.9±0.19	10.3±0.20	5.3±0.26
	0.04%SB +0.005%SMB	34.7±0.62	23.6±0.23	19.0±0.10	11.9±0.12	6.1±0.21

Control: No preservative used, SB: Sodium benzoate, SMB: Sodium metabisulphite.

Table 2. Vitamin C degradation in guava juice during the two month storage period under different storage conditions (mg/100 mL).

Storage condition (Temperature in °C)	Treatment	Storage time (weeks)				
		0	2	4	6	8
Freezing	Control	52.4±0.50	37.3±0.46	34.2±0.26	33.0±0.20	31.2±0.26
	0.05%SB	52.4±0.50	41.5±0.53	33.5±0.87	32.5±0.36	31.3±0.36
	0.005% SMB	52.4±0.50	42.4±0.40	34.4±0.53	32.5±0.56	31.3±0.36
	0.04%+0.005%SMB	52.4±0.50	43.9±0.20	36.6±0.26	33.8±0.36	32.4±0.46
Chilling	Control	52.4±0.50	28.3±0.44	23.7±0.20	20.0±0.10	10.7±0.71
	0.05%SB	52.4±0.50	37.7±0.36	25.7±0.26	23.7±0.20	16.0±0.36
	0.005% SMB	52.4±0.50	32.0±0.36	29.6±0.36	25.1±0.40	18.0±0.26
	0.04%SB+0.005%SMB	52.4±0.50	37.9±0.17	30.3±0.36	26.1±0.36	19.3±0.35
Room	Control	52.4±0.50	24.6±0.44	14.7±0.10	11.5±0.56	6.8±0.26
	0.05%SB	52.4±0.50	29.8±0.36	17.1±0.20	11.9±0.10	6.9±0.30
	0.005% SMB	52.4±0.50	30.6±0.26	15.3±0.17	10.1±0.20	4.4±0.36
	0.04%SB+0.005%SMB	52.4±0.50	32.9±0.26	21.4±0.56	12.5±0.36	7.1±0.46

Control: No preservative used, SB: Sodium benzoate, SMB: Sodium metabisulphite.

Table 3. Vitamin C degradation in baobab juice during the two month storage period under different storage conditions (mg/100 mL).

Storage condition (Temperature in °C)	Treatment	Storage time (week)				
		0	2	4	6	8
Freezing	Control	74.4±0.20	67.9±0.26	65.5±0.10	64.0±0.10	62.9±0.30
	0.05%SB	74.4±0.20	69.3±0.62	65.2±0.36	62.8±1.10	63.5±0.36
	0.005% SMB	74.4±0.20	69.5±0.44	66.9±0.20	65.1±0.20	64.8±0.36
	0.04%+0.005%SMB	74.4±0.20	69.9±0.40	67.1±0.61	66.9±0.20	66.5±0.26
Chilling	Control	74.4±0.20	58.8±0.26	42.5±0.72	37.2±0.46	28.4±0.70
	0.05%SB	74.4±0.20	58.3±0.62	56.7±0.72	47.7±0.53	36.8±0.46
	0.005% SMB	74.4±0.20	61.0±0.36	55.6±0.70	49.0±0.20	38.3±0.53
	0.04%SB+0.005%SMB	74.4±0.20	63.0±0.40	57.5±0.61	51.4±0.20	41.0±0.26
Room	Control	74.4±0.20	33.6±0.62	21.7±0.26	19.7±0.53	10.9±0.17
	0.05%SB	74.4±0.20	41.9±0.17	33.5±0.44	21.4±0.26	10.9±0.44
	0.005% SMB	74.4±0.20	47.4±0.17	35.3±0.17	27.1±0.35	17.5±0.20
	0.04%SB+0.005%SMB	74.4±0.20	56.7±0.26	44.0±0.30	33.2±0.36	19.5±0.20

Control, No preservative used; SB, sodium benzoate; SMB, sodium metabisulphite.

Table 4. Average loss (%) of vitamin C (mg/100 mL) at different storage conditions (°C) at the end of the two month storage period using different levels of preservatives.

Storage condition	Type of juice	Treatment			
		Control	0.05% SB	0.005% SMB	0.04%SB+0.005%SMB
Freezing (-17.4°C±0.3)	Pineapple	38.6	30.5	26.8	25.9
	Guava	40.5	40.3	40.3	38.2
	Baobab	15.5	14.7	12.9	10.6
Chilling (-1.2°C±0.1)	Pineapple	79.5	73.8	70.3	67.4
	Guava	79.6	69.5	65.6	63.2
	Baobab	61.8	50.5	48.5	44.9
Room (22.4°C±1.3)	Pineapple	89.9	88.5	84.7	82.4
	Guava	87.1	86.8	86.6	86.3
	Baobab	85.3	85.3	76.5	73.8

Control, No preservative used; SB, sodium benzoate; SMB, sodium metabisulphite.

namely sodium benzoate and sodium metabisulphite at different levels significantly($p<0.05$) stabilized vitamin C with the exception of room temperature storage condition where there was no significant differences for guava and baobab juices in week eight for 0.05% sodium benzoate and the control treatments. It is evident from the results (Tables 1, 2 and 3) that where the preservatives were used, there were reductions in vitamin C losses as compared to where preservatives were not used and these findings are supported by the results of Vashista et al. (2003) who found out that the loss of vitamin C in tomato soup after storage for two months was 55% where preservative was not used and 36% where sodium benzoate was used at the rate of 750 ppm under ambient temperature (30±2°C). Degradation rate of vitamin C was also found to be influenced by the type of preservatives used and the results showed that sodium metabisulphite had a better stabilizing effect on vitamin C and these findings are in consistent with what was reported by Mathooko and Kiniiya (2002) who reported that although sodium metabisulphite and sodium benzoate are both equally effective as antimicrobial agents, the stabilizing effect of sodium metabisulphite on vitamin C was much better than that of sodium benzoate. The results also demonstrated that there would still be loss of vitamin C in foods such as juices even if preservatives are used and the findings are consistent with those of Hussain et al. (2011) who reported that there was negligible change in chemical constituents in tomato juice except for vitamin C throughout the 60 days storage period and further stated that considering all parameters, sodium benzoate tended to be better additive than potassium metabisulphite and sorbic acid for preservation of tomato juice.

The results on the use of preservatives have also shown that preservatives can still be effective in maintaiining food product quality and stability with respect to vitamin C stability even if used in amounts lower than the ones stipulated in codex general standard on food additive(www.codexalimentarius.net/gsfaonline/docs/cxs.192e.pdf). It was interesting to note that some preservative levels used in this study were in some instances below 50% of the maximum acceptable levels (1000mg/kg) but were able to stabilize vitamin C and the findings of this study are in agreement with those of Ndabikunze et al. (2010) who found out that sodium benzoate and sodium metabisulphite used at 175 ppm each increased the shelf life of juices to 90 days at ambient temperature (25-32°C). Stability of vitamin C was also found to be significantly ($p<0.05$) affected by time of storage.

The results show that regardless of storage conditions and level and type of preservatives used, vitamin C losses were higher in week eight of storage and these findings are supported by the findings as reported by Hussain et al. (2011) who found out that parameters such as ascorbic acid content of apple and apricot blend juice preserved with sodium benzoate decrease with time during the three months storage period. In all the juices treated with different types and levels of preservatives and stored at different conditions, it was found out that degradation of vitamin C was much lower in baobab juices than the other two juices which implies that vitamin C is naturally more stable in baobab fruits than in pineapple and guava fruits and other scientific reasons will be required to be investigated.

Conclusions

The results obtained in this study show that stability of vitamin C in pineapple, guava and baobab juices is influenced by storage conditions, type and levels of preservatives and storage time. Furthermore, vitamin C retention as a reflection of stability was found to be higher in freezing storage conditions compared to chilling and room storage conditions. The results have also shown that the use of sodium benzoate and metabisulphite at the levels of 0.04 and 0.005% respectively was more effective in stabilizing vitamin C in the three types of juices as compared to when the two preservatives were used individually at 0.05 and 0.005% respectively. The revelation from the study that product stability with respect to vitamin C can still be achieved using low levels of preservatives than those prescribed by food regulating agencies or bodies like codex alimentarius calls for more research to establish how far the current preservative levels can still be reduced without compromising their efficiency so that consumers are subjected to the lowest levels of food additives including preservatives.

ACKNOWLEDGEMENTS

The authors wish to extend their thanks to the management of the faculty of agriculture at Bunda College of Agriculture for providing funding for the work. We are deeply grateful to Mr. Emmanuel Chidiwa Mbewe for his assistance in statistical analysis. Lastly, we are also indebted to the technical assistance provided by laboratory staff from the departments of Food Science and Technology and Basic Sciences.

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