SCIENTIFIC NOTE

Changes in the quality characteristics of carrot juice preserved with *Aframomum danielli* seed extract

Abiodun Aderonke Amanyunose[1], Olufunmilola Adunni Abiodun[2*], Gabriel Olaniyi Adegoke[3], Adegbola Oladele Dauda[2]

[1] *Department of Food Science and Technology, Iree, Osun State, Nigeria*
[2] *Department of Home Economics and Food Science, University of Ilorin, Kwara State, Nigeria*
[3] *Department of Food Technology, University of Ibadan, Oyo State, Nigeria*

[*] *Corresponding author: funmiabiodun2003@yahoo.com, abiodun.oa@unilorin.edu.ng*

Abstract

Effect of using different concentrations of Aframomum danielli on the physicochemical, microbiological and sensory characteristics of carrot juice stored under refrigerated and ambient temperatures were examined. This was done to ascertain the concentration and storage conditions that will enhance the quality of the juice. Carrot juice was produced and treated with different concentrations of Aframomum danielli extract (5, 10 and 15 %). The juice was pasteurized and stored at 4 °C and 27 °C. Control sample was prepared for each group and the quality attributes of the samples were monitored for five days. Sensory properties of the juice were conducted on the first day of production. A decrease in pH was observed during the five days storage with the control samples showing lower pH when compared to the treated samples. The pH of treated samples (10 and 15 %) was slightly maintained at 4 °C. Titratable acidity increased while the total soluble solids decreased with days of storage. Vitamin A loss was more pronounced in the control samples than the treated samples which showed more vitamin A retention at higher concentration of Aframomum danielli at 4 °C. The microbial population was higher in the control juice stored at ambient temperature but was retarded by low temperature coupled with higher concentrations of A. danielli extract. Sensory evaluation showed that the control and up to 10% inclusion of A. danielli extract were acceptable

Keywords: *Aframomum danielli, carrot juice, physicochemical properties, spices, temperature*

Introduction

Carrots (*Daucus carota*) are an excellent source of antioxidant compounds and the richestvegetable sources of the provitamin A (carotene) which can be used in our daily diet (Bao and Chang, 1994). They are of good nutritional quality and could be used to make carrot juice and fiber products which can be supplied all year round (Bao and Chang, 1994). Fresh carrot juice has a short shelf life, which makes centralized industrial production and distribution difficult, and there is also high degree of spoilage in the retail outlet (Alkint, 2003). Reiter et al. (2003) observed that enzymatic mash maceration, acidification and thermal treatment of carrot juices prior to juice extraction was found to be an important step in the production of cloud stable juices. Reiter et al. (2003) and Demir et al. (2004) produced carrot juices using different methods and additives but, however, thermal processing had been reported to alter food qualities. Thus suitable procedure for maintaining quality of carrot juice is important (Huang and Bourne, 1983). The use of artificial additives on food had been reported to cause harmful effect on human health (Al-Shammari et al., 2014; Inetianbor et al., 2015). According to Kennedy *et al.* (1992), additives have been found to reduce the quality loss usually associated with juice processing. Synthetic antioxidants are very effective with high stability and low cost but their use in food has been reduced due to their suspected contribution to the growth of carcinogenic tissues in humans (Ho, 1997, Anbudhasan et al., 2014). This invariably led to general rejection of synthetic food additives, thus increasing the trend among consumers toward natural ingredients. Several compounds with antioxidant properties have been isolated from spices, herbs, oil seeds, fermented foods and vegetables (Taghvaei and Jafari, 2015).

Aframomum danielli, an aromatic spice belonging to the *Zingiberaceae* family is an effective spice that has been of commercial value and of wide application in the country. Both the seeds and leaf extracts do not cause tissue damage and it lowers significantly the effect of some enzymes that lead to liver toxicity (Adegoke *et al*., 2002). It possesses broad-spectrum antimicrobial properties as it has been found to inhibit the growth of some microorganisms such as *Salmonella enteriditis, Streptococcus aureus*, *Aspergillus niger* and *Pseudomonas fragii* (Adegoke and Skura, 1994, Ashaye *et al.*, 2006). With the existing information on the application of *Aframomum danielli* (Adegoke *et al*., 2002), this spice could be used as a preservative on the carrot juice. However, the objective of this work was to ascertain the changes in the quality characteristics of carrot juice preserved with *Aframomum danielli* extract.

Materials and methods

Materials

Fresh carrots and *Aframomum danielli* seeds were purchased from a local market in Ibadan, Oyo State, Nigeria.

MethodsProduction of carrot juice

Matured carrot (500 g) were sorted, washed, trimmed and sliced with a stainless steel knife. The carrot slices were weighed and blended with distilled water (125mL) in a warring blender (Howard *et al.*, 1996). The blended carrots roots were filtered using a muslin cloth to obtain the juice.

Preparation of *Aframomum danielli* extract

Aframomum danielli seeds were obtained and cleaned to remove extraneous matter and adhering particles, the seeds were then sorted, dried and milled in a hammer mill to separate the endosperm from the seed coat. The powder (89 % dry matter) obtained was packed in polyethylene bag to prevent moisture absorption. Fifty grams of *Aframomum danielli* powder was dissolved in 1000 mL of distilled water. The suspension was kept in the refrigerator at 4 °C for 5 days followed by centrifuging at 1000 rpm to obtain supernatant solution and was then stored at 4 °C until required (Adegoke *et al*., 2000).

Treatment of carrot juice with *Aframomum danielli* extract

Different concentrations of *Aframomum danielli* extracts (5, 10 and 15 mL) were added to 95, 90 and 85 mL of the carrot juice respectively. The juice was sieved, filled into sterile bottles and then pasteurized at 71 °C for 15 s. After pasteurization the juice was allowed to cool before storage at both refrigeration temperature (4 °C) and ambient temperature (27 °C). The samples were then monitored for their physicochemical properties for a period of five days.

Physico-chemical composition of carrot juice

The pH of the samples was determined using a pH meter standardized with buffer solution of pH 7.0 and 4.0 respectively according to AOAC's method (1990). The pH of the juice was read directly after dipping the electrode into the juice. Titratable acidity was determined according to the method of AOAC (1990) and was expressed in citric acid equivalent. Soluble solids was expressed as ºBrix and determined by refractometer (Abbe refractometer).

Vitamin A determination

Carrot juice (2 mL) was added to 10 mL of chloroform and homogenized properly for 1 hour. The mixture was then filtered into a 30 mL test tube. Standard solution of β-carotene was prepared by dissolving 30 μg/mL β-carotene stock solutions in 100 mL of chloroform. Absorbance of sample and standards were read on the spectrophotometer (Jenway Analog Colorimeter) at a wavelength of 449 nm and absorption coefficients of 2592 (Cardoso *et al*., 2009). Conversion of β-carotene to vitamin A was done according to Barr (2003) as follows;

Retinol Equivalents (RE) and International Units (IU).

1 RE = 1 μg retinol or 6 μg beta-carotene

Sensory analysis

Sensory evaluation was carried out on the carrot juice immediately after processing using 20 panelists chosen from students of Food Technology Department, University of Ibadan. Evaluation was on the following sensory parameters: colour, taste, aroma and overall acceptability. Panelist evaluated the quality attributes using 9 point hedonic scale, with 9-liked extremely and 1-disliked extremely. The data obtained were subjected to analysis of Variance.

Statistical analysis

The analyses were carried out in triplicate. The mean and standard deviation of the data obtained were calculated. The data were evaluated for significant differences in their means using One-Way Analysis of Variance at $p \leq 0.05$. Differences between the means were separated using Tukey's test with SPSS (17.0).

Results and Discussion

pH of the control and *A. danielli* treated carrot juices ranged from 5.1-6.4. The pH value decreased in juices kept at 27±2 °C than at refrigeration temperature. The control samples had lower pH values than the treated samples. There was slight decrease in the control juice pH from 6.3 to 6.08 while at 27±2 ºC, the pH dropped drastically to 5.1 in the juice at day 5. The pH values of the juice samples dropped during the five days storage period. pH drop was pronounced in the control samples than in the samples treated with varying concentrations of *A. danielli* (Fig. 1). The pH drop was accompanied with cloud formation for the samples stored at room temperature similar to observations of Alkint (2003). Carrot juice stored at 27±2 ºC had the lowest range of pH values after five days and this could be as a result of the onset of fermentation process. The pH drop was inhibited by the addition of *A. danielli* extract above 10 % at 4 ºC. However, pH drop was suppressed in dose-dependent manner at 27±2 ºC. This drop in pH was more prevalent at 27±2 °C due to greater rate of fermentation at this temperature according to Ashaye *et al*. (2013). The *A. danielli* treated samples had higher pH values compared to the control samples at refrigerated temperature showing that the spice extract had a stabilizing effect on the juice.

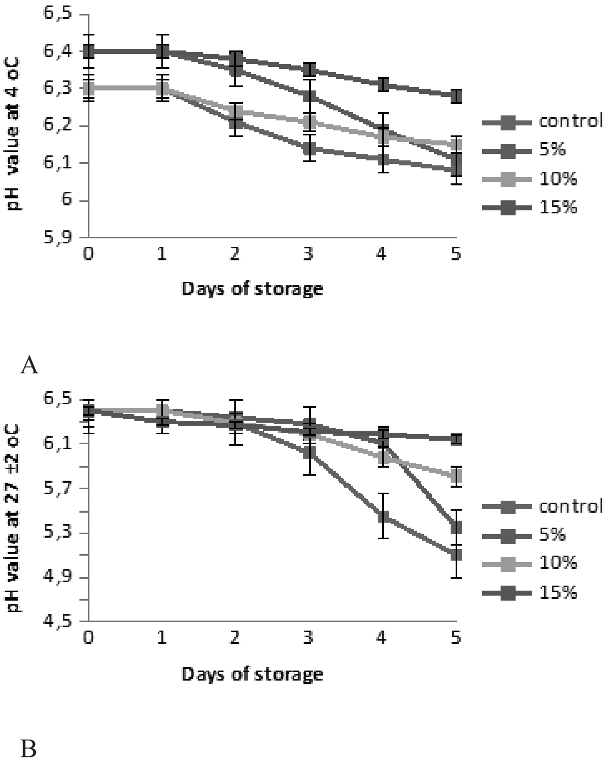


Fig. 1: *Effect of Aframomum danielli on the pH of carrot juice stored at 4 °C (A) and 29 °C (B)*

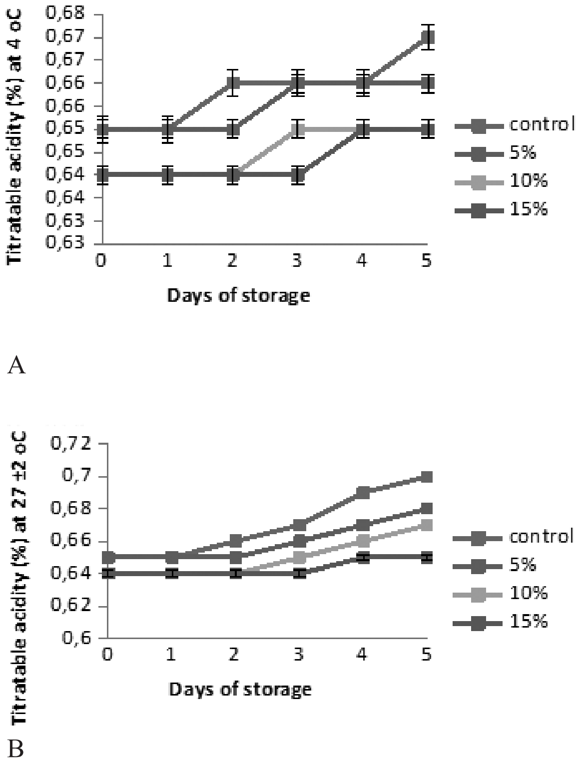
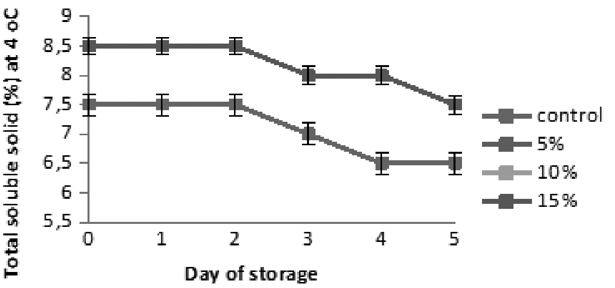


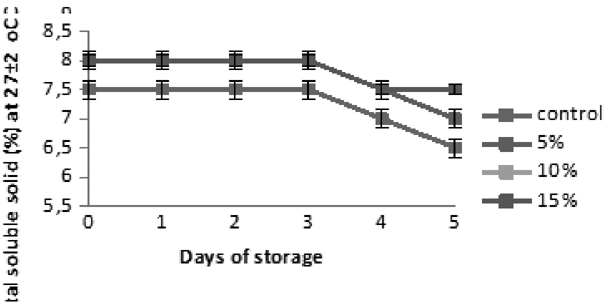
Fig. 2: *Effect of Aframomum danielli on the titratable acidity of carrot juice stored at 4 oC (A) and 27±2 oC (B)*

The total titratable acidity changes are shown in Fig. 2. Titratable acidity of control and *Aframomum danielli* treated carrot juices ranged from 0.63-0.70 %. Titratable acidity increased with days of storage (Fig. 2). These values were stabilized at higher concentration (15 %) till the third day but increased slightly at 4 and 5 days of storage at both refrigeration and ambient temperatures. Total titratable acidity of the samples increased with days of storage, with the sample stored at ambient temperature recording higher range of total titratable acidity. The control samples had higher values compared to the samples treated with *A. danielli* extract. *A. danielli* extract inhibited the increase in titratable acidity at 4 °C and 27±2 °C. Increase in titratable acidity of the carrot juice may possibly be due to reactions between the carrot juice components and *A. danielli* extracts at low temperature. The high pH value 6.4 in the juice treated with 15 % *Aframomum danielli* extract at first day result in low acidity and characterizes the carrot juice as a low-acid food. Rise in total titratable acidity and decrease in pH indicates increase in the acid concentrations of the carrot juice with increase in storage time. Jatto and Adegoke (2010) reported stabilized pH for cashew juice with *Aframomum danielli* for one week but addition of additives was observed to have differential effect on the pH of tomato juice with length of storage (Hossain *et al*., 2011).

Total soluble solid are shown in Fig. 3. The values of the control and *Aframomum danielli* treated carrot juice ranged from 6.5-8.5 °Brix and decreased with days of storage. At 4 °C, the values were constant at 0-2 days and the 4-5 days in the treated samples. Total soluble solids followed the same trend in the samples treated with different concentrations of *Aframomum danielli* at 4 and 27±2 °C. The total soluble solids of *A. danielli* treated carrot juices were higher than the control carrot juice and may be as a result of dissolved compounds in the *A. danielli* extract. Total soluble solid obtained was within the value (6.9 °Brix) reported by Sharma *et al*. (2006) for carrot juice. The values decreased at both temperatures with storage periods. This corroborates the report of Hossain *et al* (2011) that the soluble solids decreased rapidly in tomato juice with storage time. This could be due to fermentation process in which the components are broken down into alcohol, water and carbon dioxide. Sugars and acids can be considered as parameters of composition of the juices and hence indices of adulteration Maireva *et al*. (2013).



A



B

Fig. 3: *Effect of Aframomum danielli on the total soluble solid of carrot juice stored at 4 °C (A) and 27±2 °C (B)*

The control sample had the lowest vitamin A value 520.20 µg/100 g at 4 °C in the fifth day while the highest value was 3150.10 µg/100g in the control juice after production (Table 1). The values decreased with increased concentration of *Aframomum danielli* in the first day but later increased with increase in *Aframomum danielli* concentration in the fifth day. Storage at 4 °C retained appreciable level of vitamin A than storing at ambient temperature. The vitamin A content of the juice which was calculated as β-carotene equivalent decreased after the five days of storage for the samples stored 4 and 27±2 °C. The values for the carrot juices were higher after preparation but reduced greatly with storage days. There were no significant differences ($p>0.05$) in the vitamin A contents of control and carrot juices treated with *A. danielli* extract at day 1 in the samples kept at 4 °C. There were significant differences ($p<0.05$) in the juices stored at ambient temperature at all periods. The vitamin A contents of the juice decreased with increase in concentration of *A. danielli* extract. This may be due to the reduction in carrot juice with increased concentration of *A. danielli* extract. It has been stated that only about 25 % of total carrot β-carotene is extracted by juicing and retention during processing has been found to be reasonably high (Bates *et al*., 2001). Chen *et al*. (1995) observed highest destruction of carotenoids in carrot juice using convectional canning (121°C for 30min) processing method. Reduction in vitamin A in carrot juice was possibly due to degradation of carotenoids and was reported to vary according to preservation techniques and processing conditions (Bao and Chang, 1994). Carotenoids are generally stable in their natural environments but when food is heated or when they are extracted into solution, in oils or organic solvents, they become much more labile (Coultate, 2002).

Table 1: *Effect of Aframomum danielli on vitamin A (µg/100g) content of carrot juice*

Sample		4 °C		27±2 °C	
		Days of storage			
	0	1	5	1	5
Control	3150±0.41a	2077±0.21a	520±0.15d	1931±0.23c	782±0.33d
5 %	3016±0.63b	2900±0.10a	1907±0.12c	1986±0.16a	989±0.19c
10 %	2961±0.38c	2742±0.19a	1927±0.24b	1966±0.10b	1012±0.09b
15 %	2827±0.22d	2689±0.27a	1934±0.11a	1902±0.12d	1361±0.18a

Value with *the same letter down the column are not significantly (p<0.05) different*

Microbial load was noticed in the control and 5 % *A danielli* at 4°C from 3 -5 days (Table 2a and b). The value increased in the control with days of storage but was constant at 5 % *A. danielli* concentration. There was increase in microbial load of the juice stored at 27±2 °C with higher value ($15.0x10^4$cfu/mLmL) in the control juice at the fifth day. The total viable bacterial count of the carrot juice increased rapidly with increase in storage periods in the samples kept at 27±2 °C. The carrot juice stored at ambient temperature had the highest number of microbial population which may be due to the favorable temperature with the higher levels of *A. danielli* concentration showing a reduction in growth of microorganisms when compared to the control. Retardation of growth was recorded for refrigerated samples at increasing *A. danielli* concentrations. According to Akhtar et al. (2012) spoilage can be controlled by keeping the juice in refrigerator and using preservatives. Quality changes in strawberry were also observed to be due to microbiological and physiological processes. This was in agreement with Adegoke and Skura (1994) that *A. danielli* possesses broad-spectrum antimicrobial activity and the results in study showed that the spice antimicrobial activity is enhanced with low-temperature storage. Moreover, it was concluded that beyond one week, the preservative potential of *Aframomum danielli* at 15% concentration becomes very low (Adegoke et al., 2000).

Table 2a: *Microbial counts (cfu/mL) of carrot juice at 4 °C*

Sample	Days		
	1	3	5
Control	Nil	1.8 x10^1	2.5 x 10^2
5% *A. danielli*	Nil	1.0 x10^2	1.0 x 10^2
10% *A. danielli*	Nil	Nil	Nil
15% *A. danielli*	Nil	Nil	Nil

Table 2b: *Microbial counts (cfu/mL) of carrot juice at 27±2 °C*

Sample	Days		
	1	3	5
Control	Nil	10.8 x10^2	15.0 x 10^4
5% *A. danielli*	Nil	6.6 x10^2	8.1 x 10^3
10% *A. danielli*	Nil	4.0 x 10^2	5.0 x 10^2
15% *A. danielli*	Nil	2.1 x 10^2	3.0 x 10^2

The sensory properties carried out on the freshly prepared carrot juice were shown in Table 3. There were significant difference ($p<0.05$) in the color, taste, aroma and overall acceptability of all the juice produced. The sensory properties revealed no significant differences ($p>0.05$) in the colour and aroma of carrot juice with 10 and 15 % *A. danielli* extract. The control carrot juice was significantly different ($p<0.05$) from *A. danielli* treated carrot juices in the taste and overall acceptability. The taste and acceptability of the carrot juices were affected by increased concentration of *A. danielli* extract in the carrot juice. The taste of the carrot juice was acceptable at 5 % *A. danielli extract* concentration but at 10 % concentration, slight change in the taste of the carrot juice was observed. There was an objectionable taste at 15 % *A. danielli extract* concentration. The control carrot juice was more acceptable than the *A. danielli* treated juices. Addition of up to 10 % *A. danielli* concentration to carrot juice is desirable as higher concentrations (15%) of *A. danielli* impact undesirable effect on the taste of the product. Ashaye *et al*. (2013) reported acceptability of roselle grape juice preserved with *A. danielli* at zero and one week of storage. Likewise, Ishola et al. (2015) preserved zobo drink with *Aframomum danielli* and black pepper extracts. But it was observed that 12% and 4% *Aframomum danielli* and black pepper extracts were the most preferred in the zobo drink. Adegoke et al. (2013) reported acceptability of yoghurt with *A.danielli*, strawberry and vanilla. Therefore, addition of *A. danielli* to food had impact on the taste and aroma of the product.

Table 3: *Sensory characteristics of carrot juice treated with A. danielli*

Sample	Colour	Taste	Aroma	Overall Acceptability
Control	6.2±0.16c	6.6±0.12a	6.5±0.10a	7.1±0.15a
5% *A. danielli*	6.4±0.20b	6.4±0.15b	6.4±0.08b	6.7±0.14b
10% *A. danielli*	6.5±0.11a	6.0±0.09c	6.0±0.17c	6.5±0.11c
15% *A. danielli*	6.5±0.19a	5.2±0.14d	6.0±0.13c	6.4±0.07d

Value with *the same letter down the column are not significantly (p<0.05) different*

Conclusions

The results of this study showed that *A. danielli* can be used effectively as a preservative for carrot juice. This was reflected in the total soluble solids, acidity and vitamin A retention of the juice when compared to the control samples. Although there were significant differences in the taste and overall acceptability of the control and carrot juice treated with *A. danielli* but the sensory analysis conducted on the fresh juice revealed that incorporation of up to 10 % *A. danielli* extract into carrot juice were desirable.

References

Adegoke, G.O., Gbadamosi, R., Ewoerhurhoma, F., Uzo-Peters, P.I., Falade, K.O., Itiola, O., Moody, O., Skura, B.J. (2002). Protection of maize (*Zea mays*) and soybeans (*Glycine max*) using *A. danielli. European food Resource Technology,* 214: 404-411.

Adegoke, G.O. and Skura, B.J. (1994). Nutritional profile and antimicrobial spectrum of the *A. danielli. Plant Food for Human Nutrition.* 45:175-182

Adegoke, G.O., Fasoyiro, S.B. and Skura, B.J. (2000). Control of microbial growth, browning and lipid oxidation by the spice *A. danielli. European food Resource Technology,* 211: 342-345

Adegoke, G.O., Musenbi, S., Wachira, S., Muigai, C., Muigai, F., Ngumba,E., Karanja, P., Onyango, C., Adoko, G.M. (2013). Production of Probiotic Yoghurt Flavored with the Spice, Aframomum danielli, Strawberry and Vanilla. *Food and Public Health*, 3(2): 92-96

Alkint, C. (2003). Carrot juice processing-Effects on various quality aspects. Presented in the Faculty of Technology, Lund University.

Al-Shammari, E., Bano, R., Khan, S. Shankity, I. (2014). The Effect of Preservatives and Flavour Additive on the Production of Oxygen-Free Radicals by Isolated Human Neutrophils. International Journal of Nutrition and Food Sciences. 3 (3): 210-215.

AOAC (1990). Association of Official Analytical Chemists Official methods of Analysis 15th edition. Washington, DC, USA.

Anbudhasan, P., Surendraraj, A., Karkuzhali, S. and Sathishkumaran, P. (2014). Natural antioxidants and its benefits. *International Journal of Food and Nutritional Sciences*, 3(6): 225-232

Ashaye, O.A., Taiwo, O.O. and Adegoke, G.O. (2006). Effect of local preservative (*Aframomum danielli*) on the chemical and sensory properties of stored warakanshi. *African Journal of Agricultural Research,* 1 (1): 010-016

Ashaye, O.A., Olanipekun, O.T., Ige, E.A., Farinde, E.O. and Akinkunmi, S.O. (2013). Changes in quality attributes of mixed roselle, water melon and grape juice using *Aframomum danielli* as a preservative. *African Journal of Food Science*, 7 (6): 216-221

Bao, B. and Chang, K.C. (1994). Carrot juice colour, carotenoids and monostarchy polysaccharide as affected by processing condition. *Journal of Food Science*, 59: 2-5.Barr, S.I. (2003). Dietary reference intakes: Vitamins. The Whitehall-Robins Report, vol 12 no 2

Bates. R.P., Morris, J.R. and Crandall, P.G. (2001). Principles and practices of small and medium scale fruit juice processing. Chapman & Hall publishers, London.

Cardoso, P.C., Della-Lucia, C.M., Stringheta, P.C., Chaves, J.B.P. and Pinheiro-Sant'Ana, H.M. (2009). Carotene and provitamin A content of vegetables sold in Viçosa, MG, Brazil, during spring and winter. *Brazilian Journal of Pharmaceutical Sciences*, 45 (3): 527-537

Chen, B.H., Peng, H.Y. and Chen, H.E. (1995). Changes in carotenoids, color and vitamin A contents during processing of carrot juice. *Journal of Agricultural and Food Chemistry*, 43:1912-1918

Coultate, T.P. (2002). Food: The chemistry of its component. 4th edition. Royal Society of Chemistry. Pp 175-217.

Demir, N., Acar, J. & Bahçeci, K.S. (2004).Effects of storage on quality of carrot juices produced with lactofermentation and acidification. *European Food Research and Technology,* 218: 465–468 https://doi.org/10.1007/s00217-004-0883-

Ho, C.T. (1997). Antioxidant properties of plant flavonoids. Food factors for cancer prevention. Chigashi, H., Osawa, T., Terao, J., Watanabe, S., Yoshikawa, T. (eds). Pp 593-595. Springer publisher, Tokyo, Japan.

Hossain, M.N., Fakruddin, M., Islam, M.N. (2011). Effect of chemical additives on the shelf life of tomato juice. *American Journal of Food Technology*, 6: 914-923

Howard, L.R., Braswell, D., Aselage, J. (1996). Chemical composition and colour of strained carrots as affected by processing. *Journal of Food Science*, 61: 327-330

Huang, Y.T. and Bourne, M.C. (1983). Kinetics of thermal softening of vegetables. *Journal of Texture Studies*, 14: 1-9.

Inetianbor, J. E., Yakubu, J. M. and Ezeonu, S. C. (2015). Effects of food additives and preservatives on man- A Review. *Asian Journal of Science and Technology*, 6(2):1118-1135

Ishola, A.I., Okorie, S.U., Nwokeke, B.C. and Ike, E.A. (2015). Comparative Study on the Effect of Spices Bioactive Extract on the Stability of Physico-chemical and Sensory Attributes of Zobo Drink under Storage. *Asian Journal of Agriculture and Food Sciences*, 3 (2): 120-127

Jatto, W.G. and Adegoke, G.O. (2010). Storage studies on cashew juice preserved with water extracted *Aframomum danielli*. *Electronic Journal of Environmental Agricultural and Food Chemistry*, 9: 1351-1359.

Kennedy, J.F., Riverazis, J., Lioyd, L.L. (1992). Enzyme browning in orange juice using a model system based on freshly squeezed orange juice. *Journal of Science of Food and Agriculture*, 52: 85-95.

Maireva, S., Usai T. and Manhokwe, S. (2013). The determination of adulteration in orange based Fruit Juices. *International Journal of Science and Technology*, 2 (5): 365- 372.

Reiter, M., Stuparic, M., Neidhart, S. and Carle, R. (2003). The role of process technology in carrot juice cloud stability. Lebensm.-Wiss. U.-Technol. 36: 165–172

Sharma, H.K., Kaur, J., Sarkar, B.C., Singh, C., Singh, B. and Shitandi, A.A. (2006). Optimization of pretreatment conditions of carrots to maximize juice recovery by response surface methodology. *Journal of Engineering Science and Technology*, 1: 158- 165

Taghvaei, M. and Jafari, S.M. (2015). Application and stability of natural antioxidants in edible oils in order to substitute synthetic additives. *Journal of Food Science and Technology*, 52 (3): 1272-1282