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ORIGINAL MANUSCRIPT

STAR FRUIT (*AVERRHOA CARAMBOLA*) JUICE: REDUCTION OF OXALIC ACID CONTENT BY OHMIC HEATING

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ABSTRACT

The study aimed to investigate the effect of ohmic heating on Oxalic acid content and antioxidant activity of Star fruit juice. The Star fruit was 6.31 cm in length and 3.48 cm in width. The moisture content of the Star fruit was 91%. Alternative current electricity (50 Hz) with 220 volt electric voltage was applied at different temperatures (60 ,80 ,90 ) at different time intervals (1 min.,3 min., 5min.). There was a noticeable reduction in the oxalic acid content of Star fruit juice. Presence of Oxalic acid leads to the formation of kidney stones due to formation of oxalates. So, it was important to reduce Oxalic acid content. Moreover, Ohmic heating is the best method in minimizing nutritional losses and reducing anti nutritional factor– Oxalic acid to a larger extent up to 66.70%. However there was also a significant decrease in the anti oxidant activity up to 40%.

Keywords: Star fruit juice, Ohmic heating, Oxalic acid content, Antioxidant activity

1. INTRODUCTION

*Averrhoa carambola* belongs to the Oxalidaceae family and is known as ‘Kamrakh’ or ‘Karmal’ in Hindi and ‘Star fruit’ in English because of its peculiar shape [1]. The word *carambola* hasoriginated from the Sanskrit word Karmaranga which means “Food appetizer”. Two varieties of this fruit are available: - smaller size variety with sour taste and larger one with sweet taste after ripening [2]. It also has medicinal uses such as antiscorbutic, febrifuge, laxative, appetite stimulant, treatment of mouth ulcer, cough, asthma, jaundice, malaria and heatstroke [1]. According to the USDA nutrient database Star fruit is a highly nutritive fruit and it also has medicinal values. But due to its tartness and mild astringency it is not gaining much popularity and is among one of the minor fruit crops grown in India. Most probably the main reason for the astringency flavor of the juice is oxalic acid and tannic acid. Oxalic acid is a dicarboxylic acid usually found in micro- organisms, plants and animals. Besides dietary intake, metabolic pathway of ascorbic acid and glyoxylate are responsible for increase in oxalate content in the human body [3]. According to (Sanz and Reig, 1992) consumption of a large amount of oxalate could be deadly to humans because of oxalosis or the formation of calcium oxalate deposits in vital tissues or organs of the body [4]. The patients with kidney stone problems should check dietary oxalate intake to less than 40–50 mg per day (recommended by the American Dietetic Association, 2005). Therefore, it’s very important to determine oxalate content in foods for patients with kidney stone problems. Star fruit contains a large amount of oxalic acid which causes kidney stones. (Neto *et al*., 2003) scrutinized the largest group of Star fruit intoxication where the neurological symptoms following Star fruit ingestion were exhibited by 32 uremic patients [5]. The neurotoxic effects of Star fruit were divided into mild, moderate and severe intoxication depending on the severity of symptoms and the onset of symptoms ranged from 30 minutes to 6 hours. It was revealed that all the patients who were promptly and properly treated with hemodialysis recovered but those with severe intoxication that were not treated or treated with peritoneal dialysis or by late dialysis, did not survive. (Hidaka *et al.,* 2004) stated that Star fruit juice inhibited the midazolam 1- hydroxylase activity and the juice was found to be the most potent inhibitor of human CYP3A activity [6]. *In vivo* evidence also implied that Star fruit juice inhibited the activity of CYP3A in rats as Star fruit juice contains oxalates which can cause acute inflammation in the urinary tract and finally acute oxalate nephropathy. Further, (Carolino *et al.,* 2005) carried out a study in chromatographic isolation of the convulsant fraction from the aqueous extract of the Star fruit [7]. The effects of the neurotoxin fraction AcTx given to experimental animals (rats and mice) resulted in behavioral changes acting on G-amino butyric acid (GABA) receptors. These excitatory neurotoxins, probably GABAergic antagonists, may be responsible for convulsions in renal patients and animal models. (Zhang *et al*., 2007) investigated the inhibitory effects of Star fruit (*Averrhoa carambola*) juice in human liver microsomes (HLMs) [8]. The study was conducted on the inhibitory effects of Star fruit towards seven CYP isoforms (CYP1A2, CYP2A6, CYP2D6, CYP2C8, CYP2C9, CYP2E1 and CYP3A4) and it was found that CYP2A6 was more strongly inhibited than other isoforms by Star fruit. Star fruit contains oxalate which causes acute renal failure, formation of oxalate crystals and neurotoxicity [9]. (Scaranello *et al*., 2014) studied that patients with normal renal function had acute kidney failure after drinking fresh fruit or its juice (30 carambola+ juice from 20 fruit) [10]. (W. Chai *et al*., 2005) stated that almost 75% of all kidney stones are composed of calcium oxalate [11]. Raw vegetables have a large proportion of water–soluble oxalates. Boiling of raw vegetables distinctly reduced the soluble oxalate content by 30-87% and was more effective than steaming (5-53%) and baking resulted in no oxalate loss in potatoes. Reduction of soluble oxalate was an effective strategy for reducing oxaluria in individuals susceptible to the development of kidney stones. (Shirsat *et al.,* 2004) stated that ohmic heating is a thermal process in which heat is internally generated by the passage of alternating electrical current (AC) through a body like a food system that serves as an electrical resistance [12]. The important benefit of ohmic processing is the rapid and relatively uniform heating achieved [13], ease of process control, high energy efficiency [14], lower degradation of vitamin [15], along with the lower capital cost compared to other electro heating methods such as microwave and radio frequency heating [16]. Therefore, efforts have been made to reduce the antinutritional factor present in the Star fruit.

2. MATERIALS AND METHODS

The present investigation entitled “Star fruit (*Averrhoa carambola)* juice: Reduction of Oxalic acid content by ohmic heating” was conducted in the Department of Food Science and Technology, GJUS&T, Hisar, Haryana.

2.1 Sample procurement

Star fruit (*Averrhoa carambola)* was obtained from the field of Samalkha, Haryana, India. Star fruits were stored in refrigerated conditions for preparation of fresh juice. Washing, cleaning, drying, sorting and grading of Star fruit was done by hand picking method. Selection of Star fruits was done using physical parameters like size, shape, color and weight by visual method. Juice was extracted by cutting fruit into small pieces by basket press method. Storage of Star fruit juice was done at refrigerated conditions in sterilized stored bottles. Oxalic acid content was determined by KMN titration using Baker (1952) modified method of (Charles *et al.*, 1982) [17]. Total antioxidant activity of Star fruit juice was determined by using DPPH method.

2.2 Ohmic heating of Star fruit juice

The Star fruit juice was treated at 220 volt voltage and 50Hz frequency, at different temperature ranges (60°C, 80°C and 90°C). The juice was held at these temperatures for 1 min, 3 min and 5 min at fixed voltage gradient. The ohmic heated juice was then stored in sterilized bottles for further analysis.

2.3 Statistical Analysis

All the experiments were done in triplicate, and the results were expressed as mean SD (Standard deviation). The data was subjected to statistical analysis using two-way ANOVA (Analysis of Variance) using software SPSS version 16. Duncan‘s multiple-range test was used to measure the difference between means. A confidence level of 95% was chosen. Pearson‘s correlation test was used to assess correlations between means. A significant difference was considered at the level of p < 0.05.

3. RESULTS

Table 1: Effect of ohmic heating on oxalic acid content and antioxidant activity of Star fruit juice at varied temperatures

|  |  |  |
| --- | --- | --- |
| Temperature (º C) | Oxalic acid (mg/100g) | Antioxidant activity |
| Unheated Star fruit juice sample | 0.0 | 55.6 |
| 60º C | 0.0 | 38.9 |
| 80º C | 0.0 | 35.6 |
| 90º C | 0.0 | 29.8 |

Different letters in each column refers to significant difference at p < 0.05.

Table 2: Effect of ohmic heating on oxalic acid content and antioxidant activity of Star fruit juice at different time periods

|  |  |  |
| --- | --- | --- |
| Time ( in minutes) | Oxalic acid (mg/100g) | Antioxidant activity |
| Unheated Star fruit juice sample | 0.0 | 55.6 |
| 1 | 0.0 | 37.5 |
| 3 | 0.0 | 34.8 |
| 5 | 0.0 | 32.0 |

Different letters in each column refers to significant difference at p < 0.05.

4. DISCUSSION

Oxalic acid content in unheated Star fruit juice was 0.09 mg /100 g. After ohmic heating, concentration of oxalic acid decreased with increase in time and temperature. At 60 there was a decrease of ½ fold with increase in time, one fold decrease in oxalic acid content was observed at 80 and 3 fold decrease in oxalic acid content was observed at 90 with increase in temperature. This was in line with (Charles *et al.*, 1982) [17]. It was found that that antioxidant activity of Star fruit juice was 55.68 % before ohmic heating. At 60ºC antioxidant activity was analyzed as 38.93%, 35.66% antioxidant activity was noted at 80ºC and at 90ºC it was 29.83%. Antioxidant activity reduced with increase in temperature and time. But the decrease in antioxidant was less in comparison with other conventional heating methods. It is in line with the (Narain *et al.,* 2001) findings [18]. They reported that 66.37 ± 2.44% value of DPPH assay for *Averrhoa carambola* L. extracts. Higher phenolic content could be the main reason for its higher antioxidant activity of DPPH, therefore reduction in polyphenol content due to heating would result in decrease in antioxidant activity. (Iker *et al.,* 2015) reported that flavonoid accumulates after slight heat treatment in plant in many different species [19].

5. CONCLUSION

Oxalic acid content in unheated Star fruit juice was 0.09 mg /100 g. After ohmic heating, the concentration of oxalic acid decreased with increase in time and temperature. At 60 there was a decrease of ½ fold with increase in time, one fold decrease in oxalic acid content was observed at 80 and 3 fold decrease in oxalic acid content was observed at 90 with increase in temperature. It was found that that antioxidant activity of Star fruit juice was 55.68 % before ohmic heating. At 60ºC antioxidant activity was analyzed as 38.93%, 35.66% antioxidant activity was noted at 80ºC and at 90ºC it was 29.83%. Antioxidant activity reduced with increase in temperature and time. It was analyzed that heating of Star fruit at 80-90 was effective in reducing the oxalic acid content up to 3 fold level and antioxidant activity was reduced to lesser extent up to 35%.

6. LIMITATION(S) OF THE STUDY

There was limitation of resources. If the analysis of oxalic acid content would have been done with the help of HPLC (High Performance Liquid Chromatography), there would have been more accuracy in readings.

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