

QUALITY CHARACTERISTICS AND SENSORY EVALUATION OF CABBAGE (*Brassica oleracea* L. var. *capitata*) AND LIME (*Citrus aurantiifolia*) READY TO SERVE TS BEVERAGE

J. INTHUJA¹, T. MAHENDRAN² AND M. B. F. JEMZIYA³

Abstract

The experiment was conducted to formulate the low calorie cabbage-lime blend Ready-to-Serve (RTS) functional beverage. Considering the results of preliminary studies, six formulations of the low calorie functional RTS beverage were prepared by blending different ratios of cabbage and lime juice (27:3, 24:6, 21:9, 18:12 and 15:15) including control, where only cabbage juice was added. The prepared formulations were subjected to nutritional and sensory evaluation after the formulations were done. Nutritional parameters including titrable acidity, pH, vitamin C, total sugar and total soluble solids were analysed. Sensory attributes of color, aroma, taste, appearance (cloudiness) and overall acceptability were evaluated using a seven point hedonic scale. The nutritional analysis of the fresh low calorie RTS beverage showed the increasing trend in titrable acidity (from 0.32% to 1.3% as citric acid), vitamin C (from 8.35 mg/100 ml to 17.75 mg/100 ml), total sugar (from 2.75% to 4.99%), and total soluble solids (from 4.64 ° Brix to 5.17 °Brix) with the increase of lime juice from 3% to 15%. The pH was reduced when the lime juice concentration increased. The sensory assessment of fresh low calorie RTS beverage revealed that there were significant ($p < 0.05$) differences among the sensory attributes. The highest overall acceptability was observed in the formulation with 18% cabbage juice and 12% lime juice with ideal functional qualities.

Keywords: RTS beverage, cabbage juice, lime juice, nutritional analysis and sensory attributes

Introduction

Consumer demands for healthy and nutritious food products with a fresh-like appearance have undergone a continuous rise during recent years. Fruits and vegetables have always of an elite status among the healthy foods. At present, beverages are by far the most active functional food category because of convenience and possibility to meet consumer demands for container contents, size, shape, and appearance, as well as ease of distribution and storage for refrigerated and shelf-stable products. Healthy beverages, particularly those that offer functional ingredients such as botanicals, minerals, and antioxidants, are increasing in demand. Moreover, they are an excellent delivering means for nutrients and bioactive compounds ω -3 fatty acids, plant extracts, fiber, prebiotics and probiotics (Sanguansri and Augustin, 2009).

^{1&2}Department of Agricultural Chemistry, Faculty of Agriculture, Eastern University, Sri Lanka, ³Department of Biosystems Technology, Faculty of Technology, South Eastern University of Sri Lanka.

Cabbage (*Brassica oleracea* L. var. *capitata*) is one of the most popular vegetable crops of the family Brassicaceae grown around the world. It is nutrient rich and economically important vegetable crop with higher amount of vitamins A, C, K, folic acid, fiber, flavonoids, proteins, minerals and are connected with secondary metabolites called glucosinolates contributed to anti-carcinogenic properties (Sarikamis *et al.*, 2009).

Lime (*Citrus aurantifolia*) belonging to the family Rutaceae, is a fruit crop which is an excellent source of vitamin C, and are often used to accent the flavors of foods and beverages. Citrus is likely the most widely established fruit for direct human consumption in the world due to its pleasant flavor, sour taste and attractive color. Further, lime juice contains saponins, alkaloids, tannins, phenolics, flavonoids and terpenoids (Robinson, 2006).

A combination of cabbage and lime could lead to the production of delightful and delicious beverages with improved organoleptic quality and high nutritive value. With the above facts in view, in the present study, a low calorie cabbage-lime blend ready RTS functional beverage was developed and its physicochemical characteristics, microbial quality and sensory acceptability were evaluated.

Materials and Methods

Procurement of materials

Healthy fresh and firm white cabbage heads dense with shiny, crisp and brightens leaves, free of cracks, bruises and blemishes were purchased from the wholesale market in Batticaloa, Sri Lanka. Matured healthy key limes were acquired from local market in Batticaloa, Sri Lanka. Artificial sweetener (aspartame) and permitted color (E142) were purchased from United Pharmacy, Colombo and Cargill, Batticaloa, Sri Lanka, respectively.

Extraction of Cabbage juice

Fresh cabbage outer covers were removed and the remained cabbage head were washed under running distilled water. The thick outer leaves were collected, sliced into 2 cm thick pieces. Then the cabbage slices were steam blanched at 80 ± 2 °C for 2-3 minutes as stated by Burtness in 2014. Two hundred gram of blanched cabbage pieces and 200 ml of distilled water were blended with a blender (Model Smeeth) and filtered using a cheesecloth to obtain the juice. The juice was kept in a refrigerator at 4 °C.

Extraction of Lime juice

Limes were washed and cleaned thoroughly. Then the fruits were washed again with distilled water. The limes were cut and squeezed to extract the juice. A cheese cloth was used to filter the juice from the pulp. Juice was then kept in a refrigerator at a temperature of 4 °C.

Treatments of the study

The experiment consisted of six treatments which namely C: 30% Cabbage juice only, F₁: 27% Cabbage juice and 3% Lime juice, F₂: 24% Cabbage juice and 6% Lime juice, F₃: 21% Cabbage juice and 9% Lime juice, F₄: 18% Cabbage juice and 12% Lime juice and F₅: 15% Cabbage juice and 15% Lime juice

Preparation of cabbage-lime juice blend

For having 100 ml of RTS beverage, 70 ml of water was added to 30 ml juice and 0.032 g of aspartame and 3 drops of permitted color (E142) were added equally to all of the treatments and was heated at 60 °C for 10 minutes. Then it was allowed to cool for 30 minutes. After that sodium metabisulfite was added at the rate of 70 ppm to the formulations.

Microbial, physico-chemical and sensory evaluation

After the preparation, microbial analysis, sensory evaluation and chemical analysis were completed by agar method, seven point hedonic scale and standard AOAC 2016 techniques to all of the formulations respectively to determine the quality of RTS beverages.

Sensory evaluation

The sensory attributes including color, taste, aroma, cloudiness and overall acceptability were evaluated by a trained 30 member's panel. Ranking test was used to evaluate the perceptible differences in intensity of an attribute among samples. They were asked to rank the coded samples for the intensity of a specific characteristic, by ordering the samples from the most intense to the least intense.

Chemical analysis

The chemical quality parameters such as pH, titrable acidity, total sugars, total soluble solids and vitamin C content were analyzed after the preparation of the RTS beverage using the recommended standard AOAC (2016) methods. Analysis was carried out for three replicates of each formulation.

Statistical Analysis

The treatments were designed in Completely Randomized Design (CRD). Data on sensory attributes were analyzed using Friedman's test (Rayner and Best, 1990) and chemical properties were performed using ANOVA at 95% significant level. Duncan's Multiple Range Test (DMRT) was used to determine the significance of the differences between the means of the measured parameters.

Results and Discussion

Physico-chemical analysis of cabbage juice and lime juice

The chemical properties of juice have direct effect on ultimate quality of Ready-To-Serve (RTS) beverages (Table 1). The value of TSS, pH, titrable acidity, vitamin C and total sugar were remained in close agreements with the results of Champa *et al.* (2007), Frederick *et al.* (2016) and Gyorene and Varga (2006) in cabbage and Carolina *et al.* (2011), Jamil *et al.* (2015) and Hariharan and Mahendran (2016) in lime.

Table 1. Chemical analysis of cabbage juice and lime juice

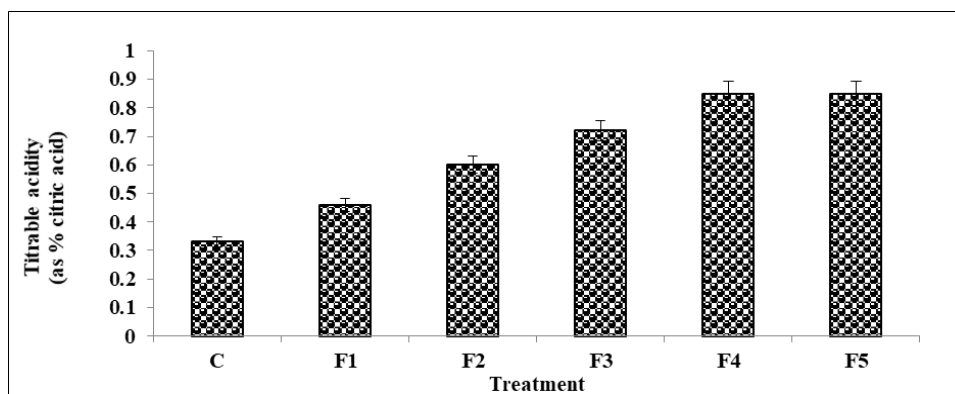
Chemical parameters	Cabbage	Lime
Total Soluble solids (TSS)	5.20 ± 0.01	6.80 ± 0.02
pH	5.73 ± 0.02	2.68 ± 0.01
Titrable Acidity (as % of citric acid)	0.61 ± 0.01	5.48 ± 0.02
Vitamin C content (mg/100 ml)	26.26 ± 0.12	37.82 ± 0.15
Total sugar (%)	4.10 ± 0.11	1.56 ± 0.12

The values are means of triplicates ± standard error

Nutritional analysis of low calorie cabbage-lime blend RTS functional beverage

Titrable acidity

The titrable acidity of fresh formulations of cabbage and lime juice blend RTS beverage increased gradually with the rate of increase of lime juice in the treatments (Fig.1). Maximum acidity was found in F₅, closely followed by F₄ and minimum value was recorded in control. According to the Sri Lanka Standard Institute Specifications, the limits of acidity for RTS preparation are 0.3-1 % as anhydrous citric acid (SLS 729:1985) (Sri Lanka Standard Institute, 2007).



Vertical bars indicate the standard error

Fig. 1. Titrable acidity of cabbage-lime blend RTS beverage.

pH

The pH of low calorie cabbage-lime blend RTS functional beverages is shown in Table 2. The highest pH value was recorded in control and the lowest pH value was recorded in F₅. The presence of free hydrogen ions and buffering capacity of the juices influence the pH value of the beverage (Shubhangi, 2002). Significant valuation ($p > 0.05$) was noted with the increasing concentration of lime juice. This might be due to increase in titrable acidity, as acidity and pH are inversely proportional to each other (Bhardwaj, 2005).

Total Soluble Solids (TSS)

Total soluble solids (TSS) increased significantly ($p > 0.05$) when the concentration of lime juice increased in RTS beverages. Maximum TSS was found in F₅ and its minimum value was recorded in F₁. Similar trend in TSS have been reported by Kausar *et al.* (2016) in ready to serve Aloe vera-lemon functional drink.

Table 2. The pH and Total Soluble Solids (TSS) of RTS functional beverages

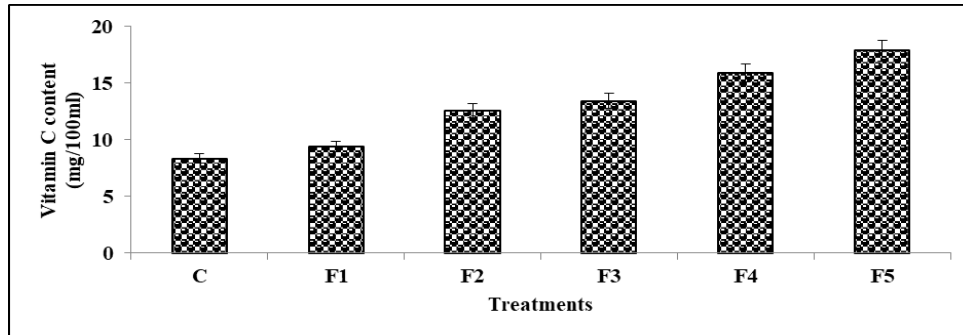
Formulations	pH	TSS (°Brix)
C	5.64 ± 0.01 ^a	4.64 ± 0.01 ^f
F ₁	3.98 ± 0.06 ^b	4.21 ± 0.01 ^e
F ₂	3.80 ± 0.03 ^c	4.51 ± 0.02 ^d
F ₃	3.64 ± 0.04 ^d	4.82 ± 0.01 ^c
F ₄	3.54 ± 0.02 ^e	4.91 ± 0.02 ^b
F ₅	3.17 ± 0.04 ^f	5.17 ± 0.01 ^a

The values are means of triplicates ± standard error

Figures with different letters in the same column are significantly different at $p < 0.05$ by DMRT (95% level).

Vitamin C

The vitamin C content significantly increased ($p > 0.05$) from 8.35 to 17.75 mg/100 ml with an increase in the concentration of lime juice from 0 to 15% in the RTS beverage formulations (Fig. 2). Maximum vitamin C content was found in F₅ treatment and minimum vitamin C found in the control. The reason of increasing vitamin C may be due to concentration of lime juice present in the treatments. Afreen *et al.* (2016) reported similar increasing trend in vitamin C content when the sour orange juice concentration were increased in RTS Beverage from carrot with sour-orange juices.

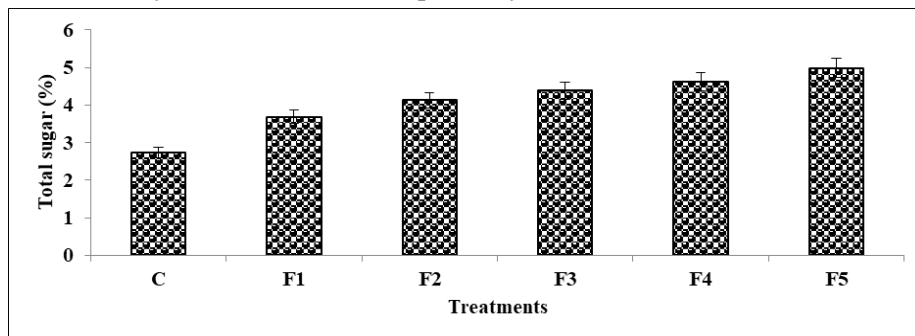


Vertical bars indicate the standard error

Fig. 2. Vitamin C content of low calorie cabbage-lime blend RTS beverages.

Total Sugars

Fig. 3 indicates the total sugars of fresh low calorie cabbage juice and lime juice blend RTS beverage. Maximum total sugar content (as sucrose) for RTS preparation is 5 % (SLS 729:1985). The total sugar content increased significantly ($p < 0.05$) from 2.75 % to 4.99 % with an increase in the concentration of lime juice from 0 to 15 % in the RTS beverage formulations. This may be because of the acid hydrolysis of polysaccharides, which resulted in increase in soluble sugars content. Similar increasing trend in total sugar content was reported in ginger-lime RTS functional beverage, sweetened by Palmyra sugar candy, blended beverage of pummel, sapota blended with jackfruit and avocado and Jamun based blended beverages by Hariharan and Mahendran (2015), Pooja *et al.*, (2012), Totad *et al.*, (2014) and Priyanka *et al.*, (2015) respectively.



Vertical bars indicate the standard error

Fig. 3. Total sugar (%) of low calorie cabbage-lime blend RTS beverages

Sensory analysis of fresh low calorie cabbage-lime blend RTS functional beverage

The sensory evaluation of the fresh cabbage-lime blend RTS functional beverage revealed that, there were significant differences among the properties including

color, taste, aroma and overall acceptability with an exception of overall acceptability of the formulations as the increase in lime juice from 3 % to 15 %. Mean scores of formulations according to Friedman's test are shown in Table 3. The treatment F₄ (RTS beverage with 18% cabbage juice and 12 % lime juice) had the highest mean value score of (6.1) overall acceptability and had the higher scores in color, aroma, taste, cloudiness compared to other formulations. Along with, the treatment F₃ also reflects the properties of the treatment F₄.

Table 3. Sensory analysis of low calorie cabbage-lime blend RTS functional beverage

Treatments	Color	Taste	Aroma	Appearance (Cloudiness)	Overall acceptability
C	5.1±0.17 ^b	3.6±0.03 ^b	3.1±0.09 ^c	3.6±0.11 ^b	3.8±0.02 ^c
F ₁	5.5±0.18 ^{ab}	3.7±0.02 ^b	5.5±0.01 ^{ab}	3.7±0.05 ^b	5.1±0.03 ^{ab}
F ₂	5.6±0.06 ^{ab}	4.4±0.19 ^b	5.6±0.11 ^{ab}	4.4±0.02 ^b	5.3±0.01 ^{ab}
F ₃	4.9±0.18 ^b	5.6±0.16 ^a	6.2±0.03 ^b	5.9±0.13 ^a	5.9±0.05 ^a
F ₄	6.2 ±0.01 ^a	6.1±0.06 ^a	6.3±0.16 ^a	6.1±0.01 ^a	6.1±0.01 ^a
F ₅	4.6±0.19 ^b	4.4±0.17 ^b	6.4±0.01 ^a	5.8±0.12 ^b	4.8±0.01 ^{ab}

The values are means of 30 replicates ± standard error

The means with the same letters in the same column are not significantly different from each other at 95 % level based on Friedman's test of significant. Sensory attributes were measured using seven point hedonic scale

Conclusion

The chemical and sensory evaluation of fresh low calorie cabbage-lime blend RTS beverage showed that RTS functional beverage prepared with 18 % cabbage juice and 12 % lime juice was the most preferred formulation. The formulation of low calorie cabbage-lime blend RTS functional beverage is a way of new product development strategy which simplifies the market penetration.

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