Int.J.Curr.Microbiol.App.Sci (2017) *6*(11): 2253-2259

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 6 Number 11 (2017) pp. 2253-2259**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2017.611.267

Development and Sensory Evaluation of Beverages having High Antioxidant Activity

Gopika Puri*, Balwinder Sadana and Neerja Singla

Department of Food and Nutrition, College of Home Science, PAU, Ludhiana, Punjab, India
**Corresponding author*

Keywords

Antioxidants, Astringency, Beverages, Citrus fruits, Phenols.

Article Info

Accepted:
17 September 2017
Available Online:
10 November 2017

A B S T R A C T

Citrus fruits and juices are valuable part of healthy and nutritious diet. Beverages from fruits are low cost and are very refreshing. Fruit beverage gives all the plant nutrients e.g. phenols, important vitamins, minerals and fiber. Low cost beverages with high nutritional values can be made from fruits which plays a significant role in human diet. Four beverages namely- amla beverage, grapefruit beverage, kinnow beverage and orange beverage were prepared and were subjected to sensory evaluation. Grapefruit due to its bitter taste is not palatable for direct consumption, same with amla fruit due to its astringency it is not consumed, hence processing is required. The fruit beverages were chemically analyzed and suitable formulation was made. The nutritional analysis revealed that the beverages are rich in vitamins and antioxidant content. Orange beverage got the highest moisture content i.e. 97.0 ±1.0 /100 ml, whereas grapefruit beverage had the highest content of crude protein 0.8 ± 0.05/100 ml and amla beverage got the highest vitamin C content 780.2 mg ± 1.3/100 ml than grapefruit, kinnow and orange beverage. The study evaluated the appearance, colour, texture, flavour, overall acceptability of fresh fruit beverages. The prepared beverages were sensory evaluated by a panel of judges using 9 point hedonic scale.

Introduction

Citrus fruits have high content of vitamin C, carotenoids and phenolic content that play important role in the nutritional and organoleptic properties contributing to color, astringency, flavor and bitterness (Xu *et al.*, 2008). Fruits are healthy foods as they are rich in antioxidants, vitamins, dietary fiber, minerals and do not contain any dairy allergens like casein and lactose (Lucknow and Delahunty, 2004). Beverages made from fruits and vegetables are important in our diet as they are pleasant, satisfying and having refreshing qualities. Carbonated beverages do not contain any nutrients and are expensive. So there is a plenty of scope for the development of low cost beverages of high nutritional value using locally available fruits and vegetables (Sundharani *et al.*, 2013). Using seasonal fruits low cost beverages of high nutritional value can be developed. Fruit juice also serves as a good medium for probiotics (Tuorila and Cardello, 2002). Approximately 65% of the citrus produced in United States is processed into juices, however 95-96% of Florida's orange crop is used for juice (USDA, 2006). The vitamin C and flavonoids level vary depending upon the species, place of growth, harvesting period,

storage and also on the processing technique (Franke *et al.,* 2003). Consumption of fruit juices is also recommended for prevention of cardiovascular diseases, liver diseases etc as natural juices provide a high percentage of vitamins and minerals. Flavonoids in fruits exhibit biological properties including antiallergic, antiviral, anti-atherogenic, anti-inflammatory, inhibition of blood clots, cardio protective and antitumor activity. Sensory evaluation is necessary to build a relationship between the product characteristics and the consumer. Appearance, taste, color and texture are the important sensory attributes (Escribano *et al.,* 2010).

Materials and Methods

Procurement

Commonly consumed fruits were taken namely- Amla, grapefruit, kinnow and orange were procured from the local market of Ludhiana city. Fruits were purchased and checked for any infestation or damage. They were then used for juice extraction.

Formulation and development of the beverages

Four antioxidant rich beverages namely amla, grapefruit, kinnow and orange beverages were developed. The standard procedures used for product development is mentioned in Table 1.

Sensory and organoleptic evaluation of prepared beverages

The beverages were prepared in the Food Laboratory of Department of Food and Nutrition, Punjab Agricultural University, Ludhiana. The four antioxidant rich beverages were first standardized at different levels. Each of the developed beverages for hyperlipidemic subjects was compared treatment wise by ten trained panelists including faculty of department of Food and Nutrition of Punjab Agricultural University using 9 point hedonic scale for different parameters such as appearance, color, texture, aroma, taste and overall acceptability (Larmond, 1970). The samples were then given to the panelists with an evaluation form.

They were asked to taste one sample at a time, and record their responses allowing time between samples so that the tasters can record their opinion. Two variations of each fruit beverage were made. The composition of the different beverages was subjected to sensory evaluation as presented in Table 1.

Nutritional analysis of the prepared beverages

The developed beverages were then subjected to nutritional analysis for proximate, vitamins and antioxidant content using standard procedures.

Proximate composition

Proximate composition like Moisture, Crude Protein, Crude Fat, Crude Fiber, Crude Ash and Carbohydrates were analyzed using standard procedures suggested by AOAC (2000).

Vitamins

Vitamins like Ascorbic Acid was analyzed using standard procedures given in AOVC (1996), β-carotene and Total carotene was estimated by column chromatography method as explained by Rangana (1995).

Antioxidant activity

DPPH activity by (Sreeramulu *et al.,* 2009), total flavonoid content by (Woisky and Salatino, 1998) and total phenolic content by Singleton and Rossi (1965).

Statistical analysis

The data generated from the performas of sensory scores were statistically analyzed using Tukey test and paired t-test was applied for the nutritional attributes. The values are expressed as Mean ± SD (Standard deviation).

Results and Discussion

Proximate content of the developed beverages

The result of the proximate composition of the four beverages is shown in Table 2. The four beverages showed a high content of moisture level ranging from 86.0±1.0 to 97.0±1.0 /100 ml which indicated that the beverages were good source for quenching thirst. The other nutrients like crude protein, crudefat and carbohydrates are reduced due to the high intake of moisture in it. The carbohydrate content in fruit beverages ranging from 2.1±0.7 to 8.1±1.7 /100 ml indicated that they are moderate sources of sugars. The low levels of crude protein and fat indicates that fruits are not good source of these nutrients (Nnam and Nojku, 2005). Ogbonna *et al.*, (2013) had also reported that orange juice, pineapple juice and paw juice had 85.85 ± 0.04, 83.99 ± 0.07, 82.74 ± 0.10 moisture, 0.74 ± 0.03, 0.62 ± 0.01, 0.43 ± 0.03 crude protein, 0.21 ± 0.01,0.12 ± 0.00, 0.35 ± 0.02 crude fat, 0.24± 0.01, 0.16 ± 0.03, 0.21 ± 0.01 crude fiber and 11.54 ± 0.03,12.67 ± 0.05, 14.87 ± 0.07 g/100 ml carbohydrates, respectively.

Vitamin content of the developed beverages

Among the developed fruit beverages high ascorbic acid was observed in amla beverage i.e.780.2 ± 1.3mg followed by orange beverage (40.4 ± 1.4mg), grapefruit beverage (36.5 ± 0.5mg) and kinnow beverage (30.3 ± 0.5mg/100 ml). The higher amount of ascorbic acid also indicates that beverages increases the iron absorption in the body as well as the formation of intracellular protein collagen. The β-carotene content was high in kinnow beverage i.e. 0.03 ± 0.01/100 ml whereas total carotenoid content was high in orange beverage i.e. 1.4 ± 0.1/100 ml and lowest in amla beverage i.e. 0.4 ± 0.5/100 ml (Table 3).

Antioxidant activity of the developed beverages

Among various citrus fruits analyzed the total phenolic content of orange beverage was highest i.e. 77.6 mg ± 0.2 and lowest in grapefruit beverage 50.0 mg ± 1.0/100 ml. The total flavonoid content was very high in amla beverage i.e. 179.0 ± 1.3 mg/100ml, whereas the total flavonoid content among the citrus beverages ranged between 22.6 ± 0.2 to 78.5 ± 0.5 mg/100ml. A study on citrus fruit juices indicated the flavonoid content for grapefruit juice was 97.31 ± 5.49 mg/100 ml (Guimaraes *et al.*, 2010). The DPPH scavenging activity was highest in amla beverage i.e. 84.78 % followed by citrus fruit beverages i.e. grapefruit beverage having 81.3, orange beverage with 78.1 and kinnow beverage with 66.3%, respectively (Table 4).

Sensory evaluation of the antioxidant rich beverages

The sensory scores for the antioxidant rich beverages are presented in Table 5. The appearance of the beverage T2 got the highest score which was blend of amla juice, ginger and cumin seeds. Beverage prepared using grapefruit and kinnow in the ratio of 1:2 (T2) got the highest score in appearance i.e.7.4±0.01. The colour of grapefruit beverage T3 got the highest score which is a blend with kinnow juice in the ratio 2:1. In kinnow beverage C and T1 got the same score for color whereas in orange beverage T1 and T2 got the same score i.e. 8.3±0.1.

Table.1 Development of the beverages

S. No.	Name of the beverage	Ingredients	Method
1.	Amla beverage	Amla (after destonning)-150g, Mint leaves-3gms, Sugar-30g,Water-100 ml	Amla and mint leaves were washed thoroughly. Then amla was destoned and mint leaves were chopped. Both the ingredients were then blend together by adding water in the grinder. Then the juice was filtered and sugar syrup was added.
2.	Grapefruit beverage	Grapefruit (after peel)- 200 g, Kinnow (after peel)- 200 g, Sugar -30g.	Grapefruit was sliced and juice was extracted with the help of juicer. Kinnow was also peeled and white covering of the kinnow pieces was removed and the pulp was used for extracting the juice. The grapefruit juice was taken in a bowl and mixed with kinnow juice in a ratio 1:1. Then the sugar syrup was added to it.
3.	Kinnow beverage	Kinnow (after peel)-350 g, Sugar-30g, Black salt-pinch	Kinnow was peeled, the outer covering and the seeds were removed. The pulp was used for extracting the juice. Sugar was added and mixed well till the sugar dissolved.
4.	Orange beverage	Orange (after peel)-350 g, Ginger – 3g, Sugar- 30g	Orange was peeled, the outer covering and the seeds were removed. A slice of ginger was added with the pulp for extracting the juice. Sugar was added and mixed well till the sugar dissolved.

Table.2 Proximate composition of the developed fruit beverages (g/ 100ml fresh weight basis)

Fruits	Moisture	Crude Protein	Crude Fat	Crude Fiber	Ash	Available Carbohydrates
Amla	86.0±1.0	0.6±0.2	0.01±0.005	4.5 ± 0.4	0.8±0.2	8.1±1.7
Grapefruit	95.3±0.6	0.8±0.05	0.2 ± 0.1	1.2±0.1	0.4±0.2	2.1±0.7
Kinnow	90.3±2.5	0.7±0.2	0.1 ± 0.09	0.4 ± 1.0	0.2±0.3	6.2±0.5
Orange	97.0±1.0	0.1±0.05	0.1 ± 0.05	0.13±0.05	0.4±0.02	2.3±1.1

Values are expressed as mean ± SD

Table.3 Vitamin content of the developed fruit beverages (per 100ml fresh weight basis)

Fruits	Ascorbic Acid (mg)	β-carotene (µg)	Total Carotenoids (µg)
Amla	780.2 ± 1.3	0.02 ± 0.01	0.4 ± 0.5
Grapefruit	36.5 ± 0.5	0.02 ± 0.01	0.1 ± 0.01
Kinnow	30.3 ± 1.5	0.03 ± 0.01	1.3 ± 0.05
Orange	40.4 ± 1.4	0.1 ± 0.01	1.4 ± 0.1

Values are expressed as mean ± SD

Table.4 Antioxidant activity of the developed beverages (per 100ml fresh weight basis)

Fruits	Total Phenolic Content (mg)	Total Flavonoid Content (mg)	DPPH Radical Scavenging Activity (% Inhibition)
Amla	96.0 ± 1.3	179.0 ± 1.3	84.78 ± 0.9
Grapefruit	50.0 ± 1.0	78.5 ± 0.5	81.3 ± 0.1
Kinnow	74.1 ± 1.0	20.2 ± 0.9	66.3 ± 1.5
Orange	77.6 ± 0.2	22.6 ± 0.2	78.1 ± 0.1

Values are expressed as mean ± SD

Table.5 Sensory evaluation of the developed beverages

Treatments	Appearance	Color	Texture	Flavor	Overall acceptability
Amla beverage					
Control (C)	7.0.±0.05^{a}	6.5±0.1^{b}	7.3±0.01^{a}	6.4±0.01^{c}	6.8±0.005^{b}
T1	7.6±0.3^{b}	7.4±0.1^{a}	7.3±0.01^{a}	7.2±0.005^{a}	7.3±0.005^{a}
T2	8.0±0.1^{a}	7.2±0.06^{a}	7.2±0.005^{a}	6.7±0.005^{b}	7.3±0.005^{a}
Grapefruit beverage					
Control (C)	7.0±0.1^{a}	7.0±0.1^{a}	7.0±0.1^{a}	6.3±0.05^{b}	6.8±0.1^{b}
T1	7.2±0.1^{a}	7.1±0.05^{a}	7.0±0.1^{a}	6.9±0.05^{a}	7.2±0.1^{a}
T2	7.4±0.01^{a}	7.3±0.1^{a}	7.0±0.1^{a}	7.2±0.1^{a}	7.0±0.01^{a}
Kinnow beverage					
Control (C)	8.0±0.1^{a}	8.5±0.01^{a}	8.5±0.01^{a}	8.4±0.005^{a}	8.5±0.01^{a}
T1	8.6±0.01^{ab}	8.5±0.01^{a}	8.4±0.006^{a}	8.2±0.1^{a}	8.4±0.005^{ab}
T2	8.4±0.01^{b}	8.0±0.1^{a}	7.8±0.006^{c}	7.4±0.005^{b}	8.1±0.005^{b}
Orange beverage					
Control (C)	8.2±0.01^{a}	8.2±0.01^{a}	8.0±0.1^{a}	8.4±0.005^{a}	8.2±0.05^{a}
T1	8.0±0.1^{a}	8.3±0.1^{a}	8.1±0.1^{a}	7.7±0.01^{ab}	8.0±0.005^{a}
T2	8.0±0.1^{a}	8.3±0.1^{a}	8.1±0.1^{a}	7.4±0.01^{b}	7.9±0.05^{b}

Values are expressed as means ± SD, Significant at 5%,$^{a-c}$ Means within each row with different superscripts are significantly ($p \leq 0.05$) different

C: Amla juice; T1: Amla juice + mint leaves + sugar; T2: Amla juice+ ginger+ cumin seeds.

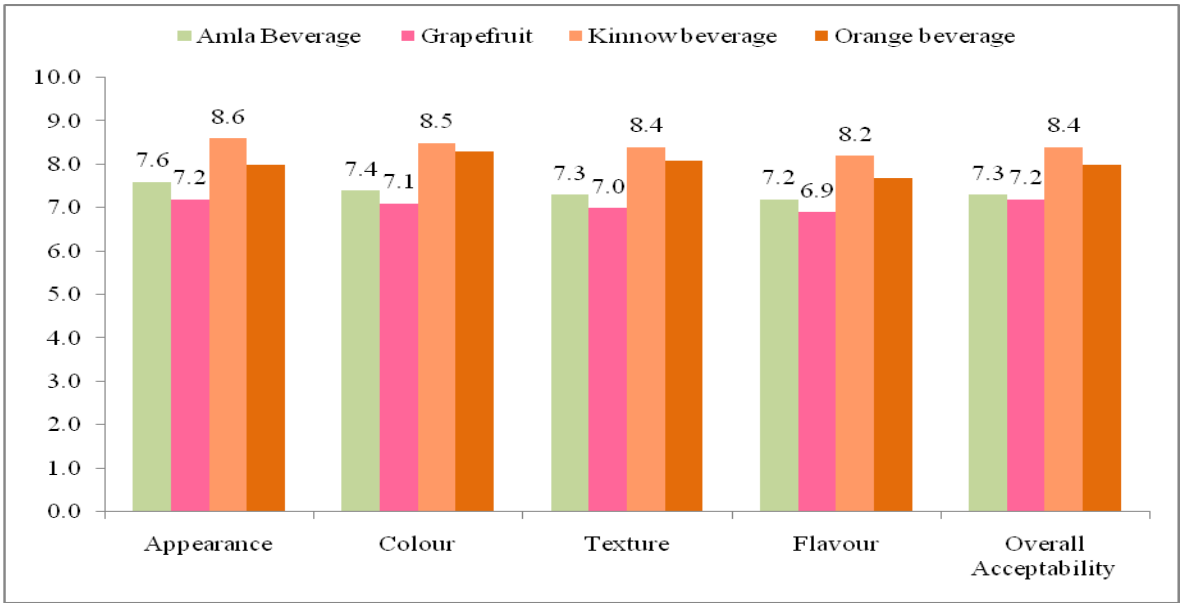
C: Grapefruit juice; T1: Grapefruit juice + kinnow juice (1:1) + sugar; T2: Grapefruit juice+ kinnow juice (1:2) + sugar

C: Kinnow juice; T1: Kinnow juice+ cumin seeds+ black salt; T2: Kinnow juice + honey + lemon

C: Orange juice; T1: Orange juice+ ginger +sugar; T2: Orange juice + lemon + sugar

Scores (Nine point hedonic scale, 9- Excellent, 8- Extremely good, 7- Very good, 6- Moderately good, 5- Good, 4- Fair, 3- Very fair, 2- Poor, 1- Very poor)

Fig.1 Sensory evaluation of the developed beverages



In case of texture of the beverages amla beverage, grapefruit and orange beverages scored almost the same. For the parameter flavour in kinnow and orange beverage C got the highest score as it is the 100 % fruit juice and in amla beverage the C got the lowest score of 6.4±0.01 (Fig. 1). Amla due to its astringent taste, was not palatable for direct consumption, so processing is required (Mishra *et al.,* 2010). Hundred percent of kinnow beverage (C) and orange beverage (C) scored the highest in overall acceptability i.e. 8.5±0.01 and 8.2±0.05 whereas amla beverage (C) and grapefruit (C) got the lowest score i.e. 6.8±0.005 and 6.8±0.1 respectively. Blending of fruit juices is practiced to overcome the high cost of some exotic fruits, scarcity or seasonal availability, balancing of strong flavors, astringency, high acidity, bitterness and stabilizing colour (Bates *et al.,* 2001).

The study concluded that, the four beverages were prepared namely amla beverage, grapefruit beverage, kinnow beverage and orange beverage which are rich sources of vitamins, minerals, antioxidants and fibers and are well relished by everyone. T1 was acceptable for supplementation among all the four prepared beverages. Amla beverage had the highest antioxidant activity i.e. 84.78% and among the citrus beverages grapefruit had the highest antioxidant activity i.e. 81.3%.

The blending of fruit juices are done to increase their acceptability and nutritional quality of fruits which cannot be eaten raw like amla due to its astringent property need to get processed and grapefruit due to its sour flavour need to be blended with other juices. The fresh made seasonal beverages provide more cost-effective alternative to meet daily recommended values.

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How to cite this article:

Gopika Puri, Balwinder Sadana and Neerja Singla. 2017. Development and Sensory Evaluation of Beverages having High Antioxidant Activity. *Int.J.Curr.Microbiol.App.Sci.* 6(11): 2253-2259. doi: https://doi.org/10.20546/ijcmas.2017.611.267