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Optimization of Parameters for Ivy Gourd Juice based soft drink

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Abstract

Ivy gourd (*Coccinia grandis*) is highly effective in diabetes, keeping the sugars in check and curing skin infections like leprosy, psoriasis & scabies. A study was conducted to explore the possibility of using for the preparation of ivy gourd juice based soft drink. The ivy gourd juice was prepared and tested in various combinations according to experimental design of response surface methodology (CCRD) for optimization of ingredients. The carbohydrate content, protein content, vitamin C, total soluble solids, and pH of juice varied from 4.60-22.05g/100 ml, 0.43-1.44g/100ml, 0.382-0.55 mg/100ml, 7-18°Brix and 1.9-4.9 respectively. The compromised optimum condition obtained for maximum sensory score for product acceptability and maximum sensory score with minimum carbohydrate content for preparing low sugar juice were salt 1.40 g, sugar 9.15g and lemon 0.35ml in 100 ml juice, and salt 1.31 g, sugar 1.15g and lemon 0.90ml in 100 ml juice respectively.

Keywords: ***Ivy gourd, Juice based soft drink, Optimization***

1. Introduction

Juice is consumed as a soft drink and prepared from liquid extract of fruits and vegetables. Juice is obtained by mechanically squeezing or macerating fruit or vegetable flesh without the application of heat or solvents. Fruit and vegetable juices have become important in recent years due to overall increase in natural juice consumption as an alternative to the traditional caffeine containing beverages such as coffee, tea, or carbonated soft drinks (Kaur et al., 2009). Orange, citrus, apple juices are already in demand due to high nutritional values. Juice may also be prepared at home from fresh fruit and vegetables using a variety of hand or electric juicers.

The Indian food industry stood around Rs 247,680 crore in 2013 and is expected to grow at a rate of 11 per cent to touch Rs 408,040 crore by 2018 (India Brand Equity Foundation, 2014). The production of juice is increasing along with its consumption. The juices category was valued at INR18,949.2 million in 2008, representing a CAGR (Compound Annual Growth Rate) of 20% since 2003. The juices market was led by fruit drink (0-29% juice) (representing 72.2% of the total value) followed by nectar (30%-99% juice) and 100% fruit juice (from concentrate), with a 23.5% and 3.8% market share, respectively. Vegetable juice accounts for the remaining 0.5% share. Parle Agro Pvt. Ltd. is the market leader with a 33.6% share of the market (NIIR, 2014).

The ivy gourd (*Coccinia grandis*), also known as baby watermelon, little gourd, gentleman's toes or tindora. It is easily available in the local stores of middle Gujarat region as they are prevalent in the markets. It is being sold at comparatively lower price due to unavailability of any value addition technology present in the market. The leaves and juice of ivy gourd is highly effective in treating diabetes and keeping the sugars in check (Radhapriya and Lakshmi, 2012; Kurpad and Raj, 2008). It is an excellent cure for an array of skin infections like leprosy, psoriasis and scabies (Zakaria et al., 2011). They have also been used for treating tongue sores, diarrhea and jaundice. Anti-inflammatory, antioxidant, ant mutagenic, ant diabetic, antibacterial, antiprotozoal, antiulcer, hepatoprotective, expactorants, analgesis, anti-

inflammatory are the reported pharmacological activities of Ivy Gourd (Yadav & Mishra, 2014). Leaves and fruits of this plant are eaten as vegetables. There are a number of edible uses of this plant. In Thailand, it is eaten in boiled and fried form. Curries and soups are prepared using the green ivy gourds. It is quite popular in India and Africa. Ripe gourds are also eaten without cooking in many cultures. Its leaves are often used in preparing a kind of herbal tea after drying it. The unripe fruits can be made into pickles. Indian cuisine is rich and it uses Ivy Gourds in a number of dishes in which it is filled with spices before deep frying them. Indonesian cooking involves cooking these fruits in coconut milk.

The vegetable is still underutilized despite of above mentioned medicinal values. Costs of other popular fruits and vegetable have gone up due to adoption of technology by fruit and processing industries. Ivy gourd is available at a comparatively cheaper rate in the study area. Therefore, this study was planned to utilize the nutrient potential of ivy gourd to optimize process parameters for fresh ivy gourd juice based soft drink preparation.

2. Materials and methods

Ivy gourd, salt, sugar and lemon were procured from local market, Godhra, Panchmahal, Gujarat. The juice of ivy gourd was extracted and optimized to prepare juice. All the experiments were executed in the Department of Agri. Processing Engg., CAET, AAU, Godhra.

2.1 Extraction of juice

Ivy gourd samples were washed in running tap water to remove impurities. The juice was extracted using a Juice Mixer Grinder cum Food Processor (Khera Food Processor Pvt. Ltd., Delhi).

2.2 Experimental design

Response surface methodology (RSM) was adopted in the experimental design in number of studies (Kumar *et al.*, 2010a, 2010b) It emphasizes the modeling and analysis of the problem in which response of interest is influenced by several variables, and the objective is to optimize this response (Montgomery, 2001). The independent variables selected for the set of experiments were: Salt, x_1, 0, 0.75, 1.5, 2.25 and 3.0 g, Sugar, x_2, 0, 5, 10, 15 and 20 g, Lemon juice, x_3, 0, 5, 10, 15, and 20 ml. The variables and their levels were chosen based on sensory evaluation and preliminary studies. A five-level, three factor central composite rotatable design was employed.

The responses for different experimental combinations were related to the coded variables (x_i, i=1, 2 and 3) by a second degree polynomial equation

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_{11} x_1^2 + \beta_{22} x_2^2 + \beta_{33} x_3^2 + \beta_{12} x_1 . x_2 + \beta_{13} x_1 . x_3 + \beta_{23} x_2 . x_3 + \varepsilon$$

The coefficients of the polynomial were represented by β_0 (constant), β_1, β_2, β_3, (linear effects); β_{12}, β_{13}, β_{23} (interaction effects); β_{11} β_{22}, β_{33} (quadratic effects); and ε (random error).

Table 1: Experimental design in coded form for response surface analysis

Independent Variable	Levels in coded form					
	Code	-2	-1	0	+1	+2
Salt, g/100ml	X_1	0	0.75	1.5	2.25	3
Sugar, g/100ml	X_2	0	5	10	15	20
Lemon, ml/100ml	X_3	0	5	10	15	20

2.3 Preparation of sample

Ivy gourd juice (100g) was mixed with all other ingredients in a food processor (Khera Food Processor Pvt. Ltd., Delhi) for 2 min for proper mixing. Sensory evaluation were carried out for fresh juice samples, whereas, samples were kept at refrigeration temperatures till further chemical analysis.

2.4. Chemical Analysis

Carbohydrate content of the samples was measured using Anthrone method (Hedge et al., 1962), Protein content of the samples was analyzed using biuret assay test (Lowry, 1951), Vitamin C of the samples was determined using procedure reported by FSSAI (2012), Total Soluble Solids was measured using hand refractometer (ERMA, Tokyo, Japan, Range 0-32%) and pH was measured by digital pH meter.

3. Results and Discussion

3.1 Carbohydrate content

Carbohydrate content of ivy gourd juice ranged from 4.60 to 22.05 g/100ml with an average value of 12.19g/100ml. The maximum carbohydrate content at coded point (0, 1.68, 0) was about 4.79 times more than the minimum carbohydrate content at coded point of (0,-1.68, 0). The model F value of 8.16 implies that the model is significant (P<0.01). R^2 and *adjusted* R^2 values of the model are 0.88 and 0.77 respectively. The *adequate precision* value of 10.34 indicates that the model can be used to predict the response within the design space as it is greater than 4.0 (Montgomery, 2001). The coefficients of x_1 and x_2 are positive, but x_3 is negative. The variation was significant in case of x_2, which shows increase in carbohydrate with the addition of sugar (P<0.01) (Fig. 1). Sugar is the disaccharide sucrose ($C_{12}H_{22}O_{11}$), a carbohydrate found in every fruit and vegetable. Hence, increase in carbohydrate with addition of sugar is justified.

3.2 Protein content

Protein content of ivy gourd juice ranged from 0.43 to 1.44 g/100ml with an average value of 0.81 g/100ml. The maximum protein content at coded point (0, 0, 0) was about 3.35 times more than the minimum protein content at coded point of (1,-1,-1). The model F value of 16.90 implies that the model is significant (P<0.05). R^2 and *adjusted* R^2 values of the model are 0.94 and 0.88 respectively. The coefficients of x_1 and x_2 are positive, but x_3 is negative. The variation was significant in case of x_3 showing that the addition of lemon first increases the protein because of protein present in lemon but after adding more lemon juice the denaturation of protein decreases protein content (Fig. 1).

3.3 Vitamin C content

Vitamin C content ranged from 0.38 to 0.55 mg/100ml with an average value of 0.43 mg/100ml. The maximum vitamin c at coded point (0, 0, 1.68) was about 1.456 times more than the minimum vitamin at coded point of (-1,-1,-1). The model F value of 12.93 implies that the model is significant (P<0.05). R^2 and adjusted R^2 values of the model are 0.9209 and 0.8497 respectively. The variation was significant in case of x_2 & x_3 which shows that addition of sugar and lemon juice increases the level of vitamin-C. Lemon has the maximum vitamin-C content in fruits (Kumar et al., 2013). Hence, increase in vitamin C is justified (Fig.1).

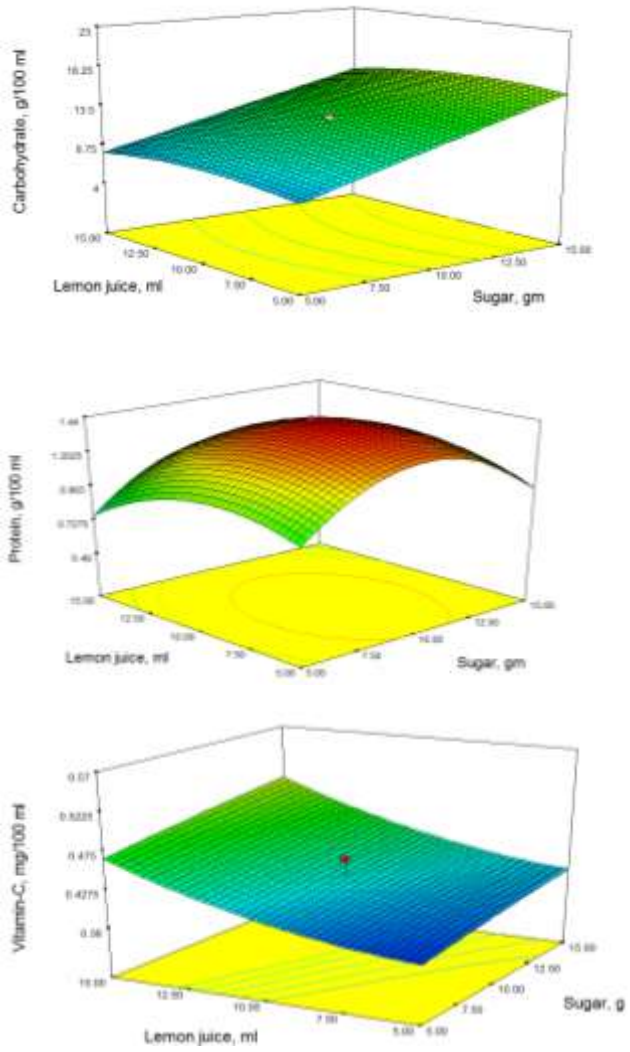

Figure 1: Variation of Carbohydrate, protein and vitamin C with respect to Lemon juice and sugar in juice

3.4 Total soluble solids

Total soluble solid ranged from 7.00 to 18.00 with an average value of 13.16 °Bx. The maximum total soluble solid at coded point (0, 0, 0) was about 2.25

times more than the minimum total soluble solid at coded point of (0,-1.68, 0). The model F value of 11.65 implies that the model is significant ($P<0.05$). R^2 and adjusted R^2 values of the model are 0.9129 and 0.8345 respectively. The coefficients of x_1 and x_2 are positive but x_3 is negative. The variation was significant in case of x_1 and $x_2$which shows that addition of sugar increases the level of degree of brix. The variation in x_2^2 is also significant as compared to other sources. Brix is a measure of the percent solids (TSS%) in given weight of plant juice. It is equal to the percent of sucrose (Harrill, 1998). Hence, increase in total soluble solid with increase in sugar is also justified (Fig. 2).

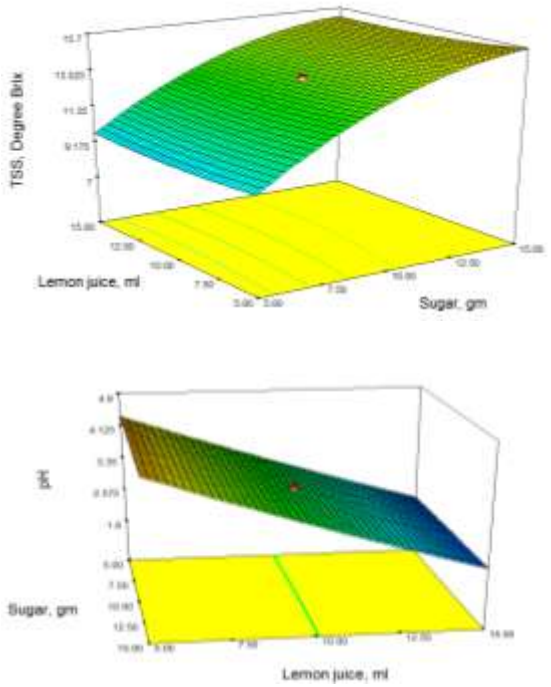

Figure 2: Variation of TSS and pH with respect to Lemon juice and sugar in juice

3.5 Variation in pH

The pH ranged from 1.9 to 4.9 with an average value of 3.25. The maximum pH at coded point (0, 0,-1.68) was about 2.57 times more than the minimum pH at coded point of (0, 0, 1.68). The model F value of 40.67 implies that the model is significant ($P<0.05$). R^2 and adjusted R^2 values of the model are 0.9699 and 0.9643 respectively. Lemon juice is acidic, which means it has low pH. pH of lemon juice ranges from 2 to 2.60 (FDA, 2007). Hence, increase in pH with lemon juice addition is evident (Fig. 2).

3.6 Optimum condition for ivy gourd juice

The compromised optimum condition for ivy gourd was determined using Design expert Software (Statease, DE 7). Therefore, compromised optimum condition criteria applied for numerical technique optimization were as follows-(1) maximum sensory score for product acceptability, (2) maximum sensory score with minimum carbohydrate content for preparing low sugar juice. The compromised optimum condition obtained for the preparation of juice were juice were salt 1.40 g, sugar 9.15g and lemon 0.35ml in 100 ml juice, and salt 1.31 g, sugar 1.15g and lemon 0.90ml in 100 ml juice respectively.

4.0 Conclusion

The carbohydrate content, protein content, vitamin C, total soluble solids and pH of juice varied from 4.60-22.05g/100 ml, 0.43-1.44g/100ml, 0.382-0.55 mg/100ml, 7-18°Brix and 1.9-4.9 respectively. F values of quadratic models for carbohydrate content, protein content, vitamin C, total soluble solids, pH and solid content were 8.16, 16.90, 12.93, 11.65, 40.67 and 6.85 respectively, indicate models are significant and can be used for the prediction of data with the studied range ($P<0.01$). The compromised optimum condition obtained for maximum sensory score for product acceptability and maximum sensory score with minimum carbohydrate content for preparing low sugar juice salt 1.40 g, sugar 9.15g and lemon 0.35ml in 100 ml juice, and salt 1.31 g, sugar 1.15g and lemon 0.90ml in 100 ml juice respectively.

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