

## Substitution of commercial citric acid with hill lemon juice powder

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### ABSTRACT

An effort was made to substitute the commercially available citric acid, most commonly used in the preparation of almost all processed products, with foam mat dried hill lemon juice powder, during the preparation of Apple Jam, Apple Jelly and Brahmi Syrup. The results of the Triangle Difference Test for brahmi syrup, apple jam and apple jelly prepared by using citric acid and lemon juice powder as different acid sources do not show any significant differences. Only 8/18, 3/16 and 5/16 panelists could identify the samples correctly in brahmi syrup, apple jam and apple jelly, respectively. Most of the panelists preferred the product made by using lemon juice powder due to better mouth feel. The sale price of lemon juice powder including 20 per cent profit margin was computed to be Rs 185.14 per kg. The sale price of brahmi drink, apple jam and apple jelly prepared by using citric acid comes out to be Rs. 29.04, 43.39 and 51.55 per kg while the corresponding sale prices of products prepared from lemon juice powder were Rs. 29.08, 43.58 and 51.82 per kg of the product, respectively. Thus, the costs of production of products prepared by using citric acid and lemon juice powder were highly comparable. The technology if tested on pilot scales may open new avenues for the industry in the manufacture of various commercial products.

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**H**ill lemon (*Citrus pseudolimon* Tan.) also known as “Galgal” is well known among the indigenous commercial varieties of lemon and grown in plains and sub-mountainous regions of North-Western Himalayan ranges including Himachal Pradesh, Punjab and some parts of Uttaranchal. Hill lemon trees demand less and return more, as evident from the fact that it is prolific bearer and has very high productivity, despite minimum requirements for irrigation, fertilization and other inputs, easy and cheap growth habits and almost freeness from diseases and pest attack. The nutritional value of this fruit lies in its high contents of acidity, ascorbic acid, minerals, flavonoids and phenolics (Gopalan *et al.*, 1995; Swisher and Swisher, 1977). Lemon juice also possesses special dietetic and medicinal significance associated with its vitamins, minerals and phenolics and is used as a preventive medicine for cold, influenza and constipation and many other diseases and human ailments (Aman, 1980; Manica, 1988 and Rao, 1993). In spite of such high productivity, good nutritional and therapeutic value, the hill lemon fruits fetch a very low market price owing to its limited and seasonal utility.

Lemon juice can be successfully converted into juice powder by foam mat drying technique (Sharma *et al.*, 2002). The prepared powder from lemon juice is of very high acidity, besides having good nutritional, therapeutic and medicinal properties. The high acidity of lemon juice powders may substitute synthetic citric acid in the

preparation of some of the commercial products. This would not only substitute the synthetic citric acid but the prepared products shall also be supplemented in nutritional and other therapeutic constituents. These investigations were, therefore, undertaken to evaluate lemon juice powder as a substitute to commercially available synthetic citric acid in the preparation of various commercial products such as Brahmi syrup, apple jam and apple jelly.

### MATERIALS AND METHODS

The present investigations were carried out in the Department of Post harvest Technology, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh, during 2001-2002. The juice from hill lemon (*Citrus pseudolimon* Tan.) fruits, harvested at optimum maturity from local orchards in district Sirmour (Himachal Pradesh), was extracted using rosin machine, strained through muslin cloth and heat pasteurized at 90°C for 10 seconds followed by quick cooling to room temperature and preservation with 500 ppm SO<sub>2</sub> (Ting and Rouseff, 1986). Juice was clarified by using “Pectinase CCM” enzyme @ 0.2 per cent for 2 hours at 50 ± 2°C followed by filtration under suction and treated with an acidic cation exchange resin, Dowex-50W for the purpose of reduction of browning in the prepared concentrates (Sharma *et al.*, 2004). A 60° Brix concentrate was prepared from treated juice in a rotary

vacuum evaporator at  $50 \pm 2^{\circ}$  C and  $28 \pm 2^0$  Hg vacuum. The prepared concentrate of 60° Brix was converted into juice powders by the standardized technique of foam mat drying by making use of carboxymethyl cellulose as a foaming agent (Sharma *et al.*, 2002).

Suitability of hill lemon juice powder as a substitute of citric acid in the manufacture of various commercial products *viz.*, brahmi syrup, apple jam and apple jelly, prepared by using recipes presented in Table 1, was determined. One set of above-mentioned products was prepared by using citric acid (laboratory grade, CDH (P) Ltd., Bombay) and the other by using lemon juice powder consisting of equivalent acidity. For sensory evaluation

**Table 1 : Recipes used for the preparation of different products**

Ingredients	Brahmi syrup	Apple jam	Apple jelly
Brahmi extract	100g	-	-
Apple pulp/ extract	-	800g	750g
Sugar	650g	978g	917g
Acid	14g	9.42g	12.25g
Pectin	-	8.62g	12.62g
Colour	20 mg	-	-
Flavour	30 mg	-	-

chilled samples of brahmi syrup after 5 times dilution were served to the taste panelists. However, apple jam and jelly were applied in between two bread slices in about 0.5 cm thick layers before serving to the taste panelists. Both types of products were compared for various sensory quality characteristics by using Triangle Difference Test (Ranganna, 1997).

Cost of production of different products prepared from hill lemon juice was calculated by taking into consideration various input costs such as cost of raw material, labour, processing cost, packaging and other charges. For calculating the sale price of the product, a profit margin of 20 per cent was added to the cost of production of each product.

## RESULTS AND DISCUSSION

The hill lemon juice powder contained 55.78 per cent titratable acidity, 5.05 per cent moisture besides the presence of 28.18 per cent total sugars, 242.61 and 32.55 mg per 100 g ascorbic acid and total phenols, respectively, 0.987 per cent ash (minerals) and 55.74, 49.56 and 23.43 mg per 100 g of naringin, hesperidin (flavonoids) and limonin, respectively.

According to tabulated data for Triangle Difference

Test (Table 2) of Brahmi syrup made both from citric acid and lemon juice powder, only 8 evaluators out of 18 could identify the odd sample correctly. The difference between the two drinks was statistically non-significant both at 1 per cent and 5 per cent levels of significance when calculated as per the standard method (Ranganna, 1997). Further, out of 8 evaluators who correctly chose the odd sample, 4 indicated only slight differences, 3 indicated moderate differences and only 1 indicated much difference between two types of beverages. However, out of 8 evaluators who correctly chose the odd sample, 7 panelists preferred the beverage prepared by using lemon juice powders. The better preference to the product prepared from juice powder might be due to the addition of juice solids along with acid, which was responsible for imparting better mouth feel. Thus, the lemon juice powder can successfully substitute citric acid in the preparation of Brahmi syrup.

The Triangle Difference Test of apple jam shows that only 3 out of 16 evaluators could identify the odd sample correctly (Table 3). The differences between the two jams were non-significant both at 1 per cent and 5 per cent levels of significance when calculated as per the standard method (Ranganna, 1997). Further, all the panelists who correctly chose the odd sample indicated only slight differences between the two jams. However, 2 out of these three evaluators preferred the jam prepared by using lemon juice powder and only one preferred the jam prepared by using citric acid.

During the evaluation of apple jelly prepared by using citric acid and lemon juice powder only 5 evaluators out of 16 could identify the odd sample correctly (Table 4). The differences between the two jellies were found non-significant both at 1 per cent and 5 per cent levels of significance when calculated as per the standard method (Ranganna, 1997). However, 3 out of these 5 evaluators preferred the jelly prepared by using lemon juice powder and only 2 preferred the jelly prepared by using citric acid.

Thus, the results of the Triangle Difference Test for brahmi syrup, apple jam and apple jelly prepared by using citric acid and lemon juice powder as different acid sources did not show any significant differences. Also, most of the panelists preferred the product made by using lemon juice powder which might be due to the presence of more nutrients, vitamins, minerals etc., ultimately giving better quality and mouth-feel. Therefore, lemon juice powder may successfully substitute citric acid in the preparation of such conventional fruit products.

The expenditure incurred in manufacturing lemon juice concentrate and lemon juice powder were calculated

**Table 2 : Sensory evaluation of brahmi syrup prepared by using citric acid and lemon juice powder (Triangle test)\***

Panelist number	Sampling sequence	Difference observed	Odd sample chosen <sup>a</sup>	Degree of difference <sup>b@</sup>	Preferred sample <sup>b</sup>
1	AAB	Yes	(B)	Slight	B
2	AAB	Yes	A		
3	ABA	Yes	(B)	Much	B
4	BAA	Yes	(B)	Moderate	B
5	ABA	Yes	(B)	Slight	B
6	BAB	Yes	B		
7	BBA	Yes	B		
8	ABA	Yes	A		
9	BAB	Yes	B		
10	ABB	Yes	B		
11	BAB	Yes	(A)	Moderate	A
12	AAB	Yes	A		
13	ABA	Yes	(B)	Slight	B
14	BAA	Yes	A		
15	ABA	Yes	(B)	Moderate	B
16	BAA	Yes	(B)	Slight	B
17	BAA	Yes	A		
18	BBA	Yes	B		

<sup>a</sup> Letters in the parenthesis indicate correct identification

<sup>b</sup> Difference and the preference rating of panelists not correctly identifying the odd sample are not considered

A Brahmi syrup prepared by using citric acid

B Brahmi syrup prepared by using lemon juice powder

@ differences statistically non significant both at 1 and 5 % level of significance

\* For sensory evaluation the brahmi syrup was served to the taste panelists after 5 times dilution

**Table 3 : Sensory evaluation of apple jam prepared by using citric acid and lemon juice powder (Triangle test)**

Panelist number	Sampling sequence	Difference observed	Odd sample chosen <sup>a</sup>	Degree of difference <sup>b@</sup>	Preferred sample <sup>b</sup>
1	AAB	Yes	A		
2	ABA	Yes	A		
3	ABA	Yes	A		
4	BAA	No			
5	BBA	Yes	(A)	Slight	B
6	BBA	Yes	B		
7	BAB	Yes	B		
8	BBA	Yes	B		
9	ABA	Yes	A		
10	ABB	Yes	(A)	Slight	A
11	ABB	No			
12	ABA	Yes	(B)	Slight	B
13	AAB	Yes	A		
14	ABB	Yes	B		
15	ABA	Yes	A		
16	AAB	Yes	A		

<sup>a</sup> Letters in the parenthesis indicate correct identification

<sup>b</sup> Difference and the preference rating of panelists not correctly identifying the odd sample are not considered

A Apple jam prepared by using citric acid, B Apple jam prepared by using lemon juice powder

@ differences statistically non significant both at 1 and 5 % level of significance

**Table 4 : Sensory evaluation of apple jelly prepared by using citric acid and lemon juice powder (Triangle test)**

Panelist number	Sampling sequence	Difference observed	Odd sample chosen <sup>a</sup>	Degree of difference <sup>b@</sup>	Preferred sample <sup>b</sup>
1	AAB	Yes	A		
2	ABA	Yes	A		
3	BAB	Yes	B		
4	ABB	Yes	B		
5	BAA	Yes	(B)	Slight	B
6	ABA	No			
7	BAB	Yes	(B)	Moderate	A
8	ABA	Yes	A		
9	AAB	Yes	A		
10	BAB	Yes	(A)	Slight	B
11	ABB	Yes	(A)	Slight	A
12	BAB	Yes	B		
13	BBA	Yes	B		
14	BAB	Yes	B		
15	ABB	Yes	(A)	Slight	B
16	AAB	Yes	A		

<sup>a</sup> Letters in the parenthesis indicate correct identification

<sup>b</sup> Difference and the preference rating of panelists not correctly identifying the odd sample are not considered

A Apple jelly prepared by using citric acid, B Apple jelly prepared by using lemon juice powder

@ differences statistically non significant both at 1 and 5 % level of significance

**Table 5 : Cost of production of hill lemon juice based products (concentrate and powder)**

Particulars	Concentrate 60 <sup>0</sup> Brix			Juice powder		
	Qty.	Rate (Rs./kg)	Amt. (Rs.)	Qty.	Rate (Rs./kg)	Amt. (Rs.)
Fruit (Hill lemon)	100 kg	2.35	235.00			
Labour charges			20.95			
Juice yield	41.40 kg					
KMS @1000ppm	41.40 g	180.00	7.45			
Pectinase @0.2%	82.80 g	740.00	61.27			
Clarification and filtration charges			3.09			
Juice yield (clarified)	31.88 kg					
Cost of clarified juice			327.76			
Cost of dowex-50W treatment @ 10%			32.78			
Processing cost for concentration @10%			36.05			
Yield of concentrate (60 <sup>0</sup> B)	4.18 kg					
Total cost of (concentrate 60 <sup>0</sup> B)			396.59	4.18 kg	94.88	396.59
CMC @ 2%				83.6 g	80.00	6.69
Processing charges for drying @10%						40.33
Yield of juice powder				2.93 kg		
Total cost of lemon juice powder						443.61
Packaging cost	7 (glass bottles 650 ml cap.)	3.00/ bottle	21.00	21 (AL pouches 200g cap.)	0.45/ pouch	9.45
Cost of production			417.59			452.06
Sale price (including 20% profit)			501.11			542.47
Sale price per kg			119.88			185.14

AL = Aluminium laminated

**Table 6 : Cost comparison of citric acid and lemon juice powder for the production of brahmi syrup, apple jam and apple jelly**

Particulars	Brahmi syrup			Apple jam			Apple jelly		
	Qty	Rate (Rs./kg)	Amt. (Rs)	Qty.	Rate (Rs./kg)	Amt. (Rs)	Qty	Rate (Rs/kg)	Amt. (Rs)
Brahmi extract	1.00 kg	80.00	20.00						
Apple fruit				1.00 kg	15.00	15.00	1.00 kg	15.00	15.00
Apple pulp/extract				800 g			750 g		
Sugar	6.50 kg	15.00	97.50	978 g	15.00	14.67	917 g	15.00	13.77
Pectin				8.62 g	1300.00	11.20	12.62 g	1300.00	16.41
Acid									
(i) Citric acid	14.00 g	308.00	4.31	9.42 g	308.00	2.90	12.25 g	308.00	3.77
(ii) Lemon juice powder	25.10 g	185.14	4.65	16.87 g	185.14	3.13	21.96 g	185.14	4.07
Processing charges @10%			18.20			4.39			4.91
Yield of product	10.00 kg			1.47 kg			1.37 kg		
Total cost of product									
(i) Citric acid			202.01			48.16			53.86
(ii) Lemon juice powder			202.35			48.39			54.16
Packaging cost	10 bottles (1 lg cap.)	4.00/ bottle	40.00	2 glass jars (1 kg cap)	2.50/ jar	5.00	2 glass jars (1 kg cap)	2.50/ jar	5.00
Cost of production									
(i) Citric acid			242.01			53.16			58.86
(ii) Lemon juice powder			242.35			53.39			59.16
Sale price (including 20% profit)									
(i) Citric acid			290.41			63.79			70.63
(ii) Lemon juice powder			290.82			64.07			70.99
Sale price per kg									
(i) Citric acid			29.04			43.39			51.55
(ii) Lemon juice powder			29.08			43.58			51.82

by taking into consideration the costs of juice extraction, enzymatic clarification, and cation exchange resin treatment (Table 5). The electricity, labour and other expenses including depreciation were added to the total expenditure. The sale price of the product was calculated after adding 20 per cent profit margin. The data pertaining to the cost of production of various products are presented in Tables 5 and 6. A perusal of the data indicates that cost of production per kg of concentrate (60°Brix) and juice powder were Rs. 99.90 and 154.29, respectively. Thus, the sales prices per kg after adding 20 per cent profit margin were calculated to be Rs. 119.88 and 185.14, respectively.

The comparison of costs of production of various products *viz.* brahmi syrup, apple jam and apple jelly prepared by using citric acid and lemon juice powder as acidulents, have been presented in Table 6. During preparation of these products the citric acid was substituted by lemon juice powder having equivalent acidity. The sale price (excluding taxes) of brahmi drink, apple jam and apple jelly prepared by using citric acid comes out to be Rs. 29.04, 43.39 and 51.55 per kg while

the corresponding sale prices of products prepared from lemon juice powder were Rs. 29.08, 43.58 and 51.82 per kg of the product, respectively. Thus, the costs of production of products prepared by using citric acid and lemon juice powder were highly comparable. However, the production of juice powder on larger scale may further reduce its cost.

Conclusively it emerges that lemon juice can be successfully be converted into juice powder by foam mat drying technique and the prepared lemon juice powder may substitute citric acid in the production of brahmi drink, apple jam, apple jelly and similar products, since it is a good source of ascorbic acid, phenolics and flavonoids besides the presence of high acidity. However, the pilot scale testing of the technology is required before its adoption by the industry.

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