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Processing of roselle (*Hibiscus sabdariffa*) calyces for value addition

S.V. GHODKE AND K.A. MANE

Roselle (*Hibiscus sabdariffa*) belongs to the family Malvaceae. The different part of roselle are the seeds, leave and calyces and these have been used for different uses. Roselle or *Hibiscus sabdariffa* plant is also reported to be antiseptic, aphrodisiac, astringent, demulcent, digestive, purgative and resolvent. It is used as a folk remedy in the treatment of abscesses, bilious conditions, cancer, cough, debility, dyspepsia, fever, hangover, heart ailments, hypertension, neurosis, scurvy and strangury. The fresh calyces consist of saponins, tannins, cyanogenic glycoside and other phytocochemical such as protocatechuric acid. It also contains antioxidants including flavonoids, gossypetine, hibiscetine and sadderetine. Some of the anthocyanins of roselle identified by chromatographic process include delphinidin –3- sambubioside, cyaniding –3- sambubioside and delphinidin –3- glucose. The aqueous extract and the colouring matter of the calyces are lethal to *Mycobacterium tuberculosis*. Fresh calyces are rich in pectin and citric acid. Aonla is known for its nutritional qualities being rich in vitamin C and tannins. Guava is a seasonal fruit and is high in pectin and vitamin A.So present investigationis undertaken to prepare jam using fresh roselle (*Hibiscus sabdariffa*) calyces, aonla and guava.Three samples of jam are prepared. One is prepared by using only roselle pulp. Other two are prepared by replacingroselle pulp withaonla and guava each at 50%. Overall acceptability of these sample ranges from 7.2 to 7.55.

Key Words : Roselle, *Hibiscus sabdariffa*, Jam, Aonla, Guava

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INTRODUCTION

Roselle (*Hibiscus sabdariffa*) belongs to the family Malvaceae. It is a species of Hibiscus native from India to Malaysia and introduced to other parts of the world such as central America, West Indies and even Africa (Bruke, 1975). Infusions of the leaves or calyces are regarded as diuretic, cholerectic, febrifugal and hypotensive, decreasing the viscosity of the blood and stimulating intestinal peristalsis. Pharmacognosists in Senegal recommended roselle extract for lowering blood pressure. The aqueous extract and the colouring matter of the calyces are lethal to Mycobacterium Tuberculosis. (Morton *et al.*, 1987). Roselle or *Hibiscus sabdariffa* plant is also reported to be antiseptic, aphrodisiac, astringent, demulcent, digestive, purgative and resolvent. It is used as a folk remedy in the treatment of abscesses, bilious conditions, cancer, cough, dyspepsia, fever, hangover, heart ailments, hypertension, neurosis, scurvy and strangury (Duke, 1985). It is an aromatic, astringent, cooling herb that is much used in the tropics. It is said to have diuretic effects, help to lower fevers and is antiscorbutic (Komarov, 1968 and Bown, 1995). Roselle extract decreased the rate of absorption of alcohol and so lessened the effect on the system. The fresh calyx

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per 100g, it contained 49 calories, 84.5% H_2O, 1.9 g protein, 0.1 g fat, 12.3 g total carbohydrate, 2.3 g fibre, 1.2 gash, 1.72 mg Ca, 57mg P, 2.9mg Fe, 300µg β carotene equivalent and 14mg ascorbic acid (Duke and Atchley, 1984). The presence of saponins, tannins, cyanogenic glycoside had been reported (Akanya *et al.*, 1997). Other phytoco-chemicals are protocatechuric acid a phenol (Lin *et al.*, 2003). It also contains antioxidants including flavonoids, gossypetine, hibiscetine and sadderetine. Some of the anthocyanins of roselle identified by chromatographic process include delphinidin –3- sambubioside, cyaniding –3- sambubioside and delphinidin –3- glucose (Hong and Wrostlad, 1990). The calyces are rich in acid 3.74% (calculated as citric acid) and pectin 3.19%.

The edible fruit tissue of aonla (*Emblica officinalis* Geartn.) contains about 3 times as much protein and 160 times as much vitamin C as apple (Bharathkar and Arnold, 1991). The fruit contains a chemical substance called leucanthocyanin which retards the oxidation of ascorbic acid. Antioxidant effect of gallic acid, present in aonla fruit is being well aknowledged. Dahiya and Dhawan (2001) reported that the fresh fruit of aonla are very rich source of ascorbic acid (454.40 mg/100g) and appreciable source of total sugar (7.53mg/ 100g), calcium (14.91 mg/ 100g), iron (0.62 mg/100g) and phosphorus (11.81 mg/ 100g) and also has great potential for processing. Singh *et al.* (1996) noted that vitamin 'C' content was in no way lower than that of barbados cherry. A number of the products like jam, squash, candy, dried shreds, powder, tablets, chutney, murabba and preserve may be prepared with ease from aonla fruit. Fresh fruits are highly acidic and astringent make unsuitable for the direct consumption. Therefore, fruits are essentially forced to process into palatable products.Guava is a fair source of vitamins like vitamin A (about 250 IU per 100g of pulp), ascorbic acid (75-265 mg per 100g of pulp), thiamin, riboflavin and niacin and phosphorus (17.8–30 mg per 100g of pulp) (Ghosh and Chattopadhyay, 1996 and Das *et al.*, 1995).

Hence the present investigation was undertaken to standardize the recipe and processing technology for jam by use of roselle, aonla and guava.

METHODOLOGY

Ingredients:

Calyces were brought to laboratory of food science and technology and used for processing. Aonla, guava and sugar are obtained from local market.

Packaging material:

Packaging material required *i.e.* glass bottles were obtained from local market.

Instruments:

All the instruments required like physical and analytical balance, tintometer, refractometer, hot air oven, soxlhet apparatus, distillation unit, pH meter were used.

Methods:

Preparation of rosell jam :

Freshly harvested, wine red colouredroselle calyces were washed with plenty of water. They were crushed using water through grinder to obtain pulp. Then sugar was added to pulp and boiling was carried out till the end point was obtained which was judged when product obtained 68.5°Bx TSS. The finished product was immediately filled into sterilized glass bottle of 500 ml capacity. The product was allowed to cool and bottles were sealed air tight. As the calyces contain 3.74% acid and 3.19% pectin which is adequate for jam preparation (Chem. Abst. 1936, 1941) no pectin and acid was added during preparation of jam.Three jam sample S_0, S_1 and S_2 were prepared with the recipe as shown in Table A.

Table A : Recipe for preparation of jam samples

Commodity	S_0	S_1	S_2
Roselle pulp(g)	100	50	50
Aonla pulp(g)	-	50	-
Guava pulp(g)	-	-	50
Sugar(g)	120	120	120

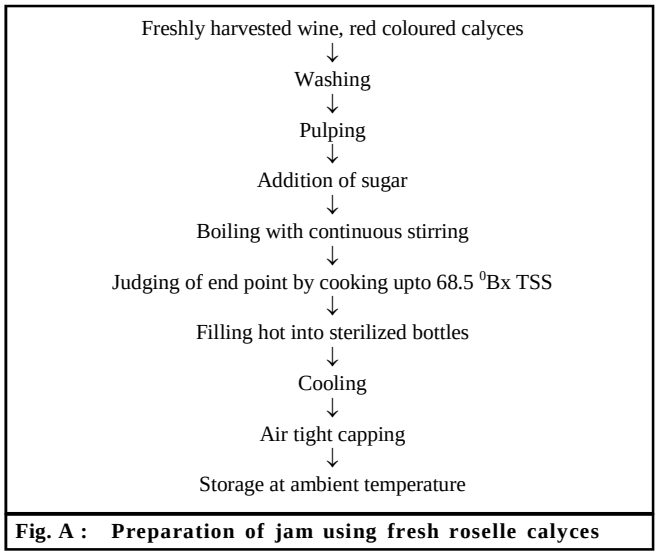

Fig. A : Preparation of jam using fresh roselle calyces

Preparation of jam using blend of roselle (*Hibiscus sabdariffa*) calyces and aonla pulp :

Roselle calyces were washed and crushed to obtain pulp. Aonlaand guava of good quality, mature, sound were selected. They were washed with plenty of water. They were given pretreatments. Aonla were boiled in water for 20 min. Then seeds from the softened fruits were removed by hand. Segments of aonla were crushed using water through grinder to obtain pulp. Guava were peeled and cut into pieces seeds were removed. Then pieces were crushed through grinder to obtain pulp. Then pulp of aonla/ guava and calyces were taken in 50:50 proportion. Then add sugar 120 % of pulp. Then boiling was carried out and end point was judged by cooking upto 68.5 ^{0}Bx TSS. The finished product was immediately filled hot into sterilized glass bottle of 500ml. Then bottle were cooled and sealed airtight. As the pectin and acid content of calyces is adequate, no pectin and acid was added during preparation of jam.

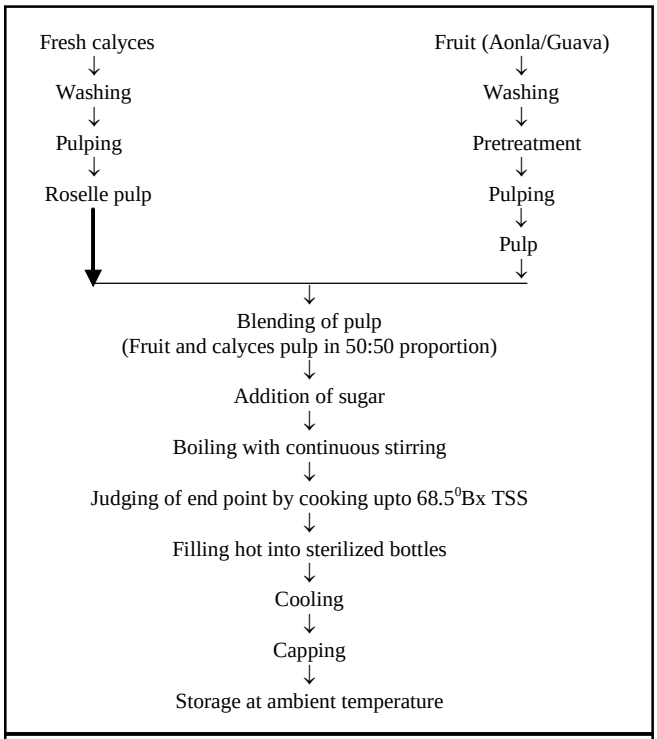

Fig. B : Preparation of jam using calyces and fruits (aonla/ guava)

Determination of physico- chemical properties:

Average weight of capsule:

The weight of ten randomly selected capsules from a sample lot was taken individually on electronic weighing balance. Then average weight of capsules were taken and expressed in gram.

Weight of seed :

10 capsules were selected seeds were removed and average weight of seed calculated, expressed in percentage.

Colour:

Colour is the visual property which gives idea about its required chemical constituent for processing. Colour of capsule, calyx and pulp was determined by visually and it was measured by tintometer in terms of R, Y,B.

Edible index :

It is ratio of edible part of capsule to total weight multiplied by 100. 10 capsules were separated and weight of each capsule was taken (W_1). Edible calyces is separated from capsule and weight (W_2) was taken. It was calculated by given formula and expressed in percentage.

$$\text{Edible index} = \frac{W_2}{W_1} \times 100$$

Waste index: :

It is ratio of waste part of capsule to total weight multiplied by 100. 10 capsules were separated and weight of each capsule was taken (W_1). Edible calyces is separated from capsules and weight (W_2) was taken. It was calculated by given formula and expressed in percentage. Waste index is the ratio of waste part (W_2) to total weight (W_1) multiplied by 100.

$$\text{Waste index} = \frac{W_2}{W_1} \times 100$$

Chemical analysis:

Determination of moisture:

The moisture content was determined by method given by Ranganna (1995). Calyces were comminuted in a blender and 5g of sample was taken in previously weighed moisture box and dried in hot air oven at 110^{o}C for three hours. The loss in weight was calculated and expressed in per cent. After cooling in the desiccators, the sample was weighed again. The loss in weight was recorded as moisture content.

$$\text{Moisture} = \frac{W_1 - W_2}{W_1} \times 100$$

where,
W_1 = Weight of wet sample
W_2 = Weight of dry sample

Determination of total ash :

Total ash content of calyces was determined by the method given by Ranganna (1995) calyces were comminuted in blender and ash content was determined by ashing the sample at 525^{0}C for 4 to 6 hrs in a muffle furnace.

$$\text{Ash (\%)} = \frac{\text{Weight before heating - Weight after heating}}{\text{Weight of sample}} \times 100$$

Determination of Acid insoluble ash :

Acid insoluble ash was determined by method given by Ranganna (1995). To the ash add 25 ml of dil. HCl (10%wt/wt) and filter. Washed the filter paper thoroughly ignited, cooled and weighed the insoluble ash.

Determination of protein :

Protein content of sample was determined by method given by Ranganna (1995). Protein was determined by Microkjeldal method which is based on the determination of the amount of reduced nitrogen present in sample.

$$\text{Nitrogen (\%)} = \frac{\text{(Sample titre - Blank titre) x normality of HCl x 14 x 100}}{\text{Weight of sample x 1000}}$$

$$\text{Protein (\%) = Nitrogen (\%) x 6.25}$$

Determination of fat :

Fat was extracted from an oven dried sample of calyces. Fat was estimated by using Soxhlet apparatus which is given by Ranganna (1995). Petroleum ether was used for the extraction of fat. Extraction was done for 16 hrs on heater. Solvent was evaporated on heater then cooled and weighed. The difference in weights give the quantity of fat extracted.

$$\text{Crude fat (\%)} = \frac{\text{Weight of ether soluble material}}{\text{Weight of sample}} \times 100$$

Determination of crude fibre :

Fat extracted sample of 2g of calyces was taken. Crude fibre was estimated by the method given by Ranganna (1995). Crude fibre was determined by following formula :

$$\text{Crude fibre (\%)} = \frac{\text{Loss in weight noted}}{\text{Weight of sample taken}} \times 100$$

Determination of ascorbic acid :

Calyces of 100g were taken and blended with 3 % HPO_3 and 100ml volume was made. Then it was filtered. Ascorbic acid in fresh calyces was determined by 2,6-dichlorophenol idophenol visual titration method, given by Ranganna (1995) and result was expressed in mg per 100g of sample.

$$\text{Ascorbic acid (mg/100 g)} = \frac{\text{Titre x dye factor x volume made}}{\text{Aliquote of extract x Weight or volume taken for estimation}} \times 100$$

Determination of titrable acidity :

Calyces of 5g were taken and pulp was prepared in blender and this sample was used for determination of titrable acidity. For jam and jelly 5g was sample of taken and dissolved in water and used for determination of titrable acid. It was determined by method of Ranganna (1995) using standard NaOH (0.1 N) with phenophthalein indicator to a faint pink colour.

$$\text{Total acid (\%)} = \frac{\text{Titre of alkali x Normality made up x volume x 64 x 100}}{\text{Volume of sample taken for estimation} \times \text{Weight or volume x 1000 of sample taken}}$$

Determination of pectin content :

Calyces of 50g of blended sample taken into 1000ml beaker and extracted with 400ml of 0.05N HCl for 2hrs at 80-90^{0}C. It was determined by method given by Ranganna (1995). Pectin is extracted from plant material and saponified. It is then precipitated as calcium pectate by adding calcium chloride. After removal of chloride ions, the precipitate is dried and weighed.

$$\text{Pectin content (as \% calciumpectate)} = \frac{\text{Weight of calcium pectate x 500 x 100}}{\text{ml of filter taken x weight of sample for estimation}}$$

Determination of calcium :

For the determination of minerals calyces were ashed first at 450^{0}C for 5 to 7 hrs. It was determined by method given by Ranganna (1995). Calcium was precipitated as calcium oxalate. The precipitate was dissolved in hot dilute H_2SO_4 and titrated with standard potassium permagnate.

$$\text{Calcium (mg/100 g)} = \frac{\text{Titre x Normality of } KMNO_4 \text{ of ash solution} \times 20 \times \text{total volume} \times 100}{\text{ml of ash solution taken for estimation} \times \text{Weight or sample taken for ashing}}$$

Determination of phosphorus :

It was determined by method given by Ranganna (1995). Phosphorus react with molybdic acid to form a phosphomolybdate complex. It was then reduced with amino phtholsulphonic acid to the complex molybdenum blue which was measured calorimetrically.

$$\text{Phosphorus mg/100 g} = \frac{\text{mg of p in the aliquot of ash solution taken for estimation} \times \text{total volume of ash solution} \times 100}{\text{ml of ash solution taken for estimation} \times \text{Weight or sample taken for ashing}}$$

Determination of total soluble solid (TSS) :

Total soluble solid of jam was measured by using hand refractometer in terms of degree Brix.

Determination of pH :

Sample of 5g was taken and equal quantity of water mixed and pH of prepared sample was measured by laboratory pH meter.

Determination of carbohydrate :

For determination of carbohydrate Anthrone method was used (Ranganna, 2005).

Organoleptic evaluation:

The organoleptic evaluation in respect of colour, flavour, texture, taste and overall acceptability was evaluated by semi-trained judges using nine point hedonic scale (Amerine *et al.*, 1965).

OBSERVATIONS AND ASSESSMENT

The experimental findings as influenced by different parameters are discussed below :

Physico-chemical characteristic of capsul of roselle (*Hibiscus sabdariffa*) :

The fresh capsules were collected and studied for physical characteristic of capsules. The data (Table 1) showed that colour of fresh capsule was wine red and colour by tintometer was 14.9R + 3.9Y + 1.9B. The colour of pulp was pinkish red and pulp colour by tintometer was 14R + 4Y + 2B.The weight of individual capsule was 5.45 g and weight of calyces from individual capsule was 2.45g. The weight of waste from individual capsule was 3 g and waste index was 54.78% whereas edible index was 45.22%.

Table 1 : Physico-chemical characteristic of capsule of roselle (*Hibiscus sabdariffa*)

Sr. No.	Parameter	Observations
1.	Colour of capsule	
	Visually	Wine red
	By tintometer	15 R+4Y+2B
2.	Colour of pulp	
	Visually	Pinkish red
	By tintometer	14R+4Y+2B
3.	Weight of capsule (g)	5.45
4.	Weight of calyces from one capsule (g)	2.45
5.	Weight of waste from capsule (g)	3
6.	Weight of seed (g)	0.9
7.	Edible index (%)	45.22
8.	Waste index (%)	54.78

Proximate chemical composition of fresh roselle calyces :

It was felt necessary to study the chemical composition of fresh roselle calyces with respect to moisture, ash, protein, fat, carbohydrate, crude fibre, ascorbic acid, sodium, calcium. The results are reported in Table 2.

It is revealed from Table 2 that the fresh calyces

Table 2 : Chemical composition of fresh roselle calyces (*Hibiscus sabdariffa*)

Sr. No.	Parameter	Observations
1.	Moisture (%) (Wb)	88.21
2.	Ash (%)	0.89
3.	Crude protein (%)	1.50
4.	Fat (%)	1.91
5.	Carbohydrate (%)	5.80
6.	Crude fibre (%)	1.60
7.	Ascorbic acid (mg/100g)	16.63
8.	Calcium (mg/100g)	12.62
9.	Phosphorus (mg/100g)	36.32
10.	Pectin	2.9
11.	pH	3.20
12.	Titrable acidity (%)	3.10
13.	Total soluble solid (^oBx)	4.00

Each value represents the average of three determinations

contain 88.21% moisture, 0.89% ash, 1.5% protein, 1.91% fat, 5.80% carbohydrate, 1.6% crude fibre, 16.63 mg/ 100 g ascorbic acid, 96.00 g sodium, 12.62mg/100g calcium, 36.32mg/100g phosphorus. Pectin content was found to be 2.9 %. Titrable acidity was found to be 3.5%, pH and total soluble solid was found to be 3.2 and 4^0Bx respectively. It is clear that calyces rich in acid and pectin.

The chemical composition of fresh calyces was reported by some scientists, results are quite similar to that of the chemical composition given by Singh and Dutt (1941). The results are also comparable with results reported by Duke and Atchley (1984).

Physico-chemical constituent of prepared jam sample :

Prepared jam sample were analyzed for physico-chemical constituent. The result obtained were present in Table 3.

It has been observed from Table 3 that total soluble solid of jam was 68.9 ^{0}Bx to 70 ^{0}Bx, acidity was found to be 0.61% to 0.65%. Brix to acid ratio of jam was ranges between 107.6-112.9, pH value was 3.1 to 3.25. It is observed that R value of jam using roselle alone was higher *i.e.* 40, Y value was higher for jam using 50% guava *i.e.* 40.

Effect of blending rosellecalyces pulp with aonla and guava pulp on sensory quality of jam

Effect of blending rosellecalyces pulp with aonla and guava pulp on sensory quality of jam is given in Table 4.

It has been observed from Table 4 that jam prepared using 50% guava pulp shown higher scores for sensory quality except colour and appearance. This was due to that guava pulp help to impart better mouthfeelflavour, taste and acceptability. Colour and appearance of jam prepared using 50% aonla pulp shown higher scores *i.e.* 7.9 and 7.65, respectively. Jam prepared using only roselle shown high flavour, overall acceptability score. It clearly indicates that jam prepared using 50% guava pulp was found to be optimum in sensory quality followed by jam using 50% aonla which was followed by jam using roselle pulp alone.

Table 3 : Physico-chemical constituent of prepared jam sample

Sr. No.	Parameter	Jam		
		S_1	S_2	S_3
1.	TSS (^{o}Bx)	70	69.6	68.9
2.	Acidity	0.65	0.63	0.64
3.	Brix : Acid	107.6	110.4	112.9
4.	pH	3.25	3.23	3.1
5.	Colour			
	R	40	30	30
	Y	11	0.6	40
	B	0.5	0.3	10

Each value represent average of three determination
where,
S_1 = 100% roselle pulp
S_2 =Blend of roselle pulp and aonla pulp (50:50)
S_3 =Blend of roselle pulp and guava pulp (50:50)

Table 4 : Effect of blending roselle pulp with aonla and guava pulp on sensory quality of jam

Jam	Colour	Mouth feel	Taste	Flavour	Appearance	Overall acceptability
S_1	7.65	6.95	7.15	6.8	7.45	7.2
S_2	7.8	7.35	7.15	7.2	7.65	7.35
S_3	7.35	7.55	7.5	7.6	7.55	7.55
S.E.$\pm$	0.13	0.14	0.15	0.15	0.15	0.14
C.D. (P=0.05)	0.40	0.41	0.45	0.45	0.48	0.40

where,
S_1 = 100% roselle pulp
S_2 =Blend of roselle pulp and aonla pulp (50:50)
S_3 =Blend of roselle pulp and guava pulp (50:50)

Conclusion :

The present investigation was undertaken for exploitation of roselle (*Hibiscus sabdariffa*) calyces for preparation and standardization of jam. Organoleptic evaluation of jam prepared using roselle pulp blended with aonla and guava pulp showed that jam prepared using 50% guava pulp scored higher values of sensory quality than jam prepared using roselle alone and blend of roselle with aonla. Overall acceptability of these jam were 7.2, 7.35 and 7.55. It is concluded that roselle pulp can be utilized for preparation of jam successfully.

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