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Effect of Dehydration Temperature on Nutritional Quality and Antioxidant Activity of Roselle's (*Hibiscus sabdariffa* L.) Calyces

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ABSTRACT

The present study was carried out to standardize the dehydration of fresh Roselle's (*Hibiscus sabdariffa* L.) calyces. Procured fresh roselle calyces were subjected to drying in tray drier at different temperature of 40°C, 50°C, 60°C and 70°C, respectively. Physico-chemical characteristics, proximate composition, antioxidant activity were assessed for calyces dried at different temperatures. The colour of roselle calyces were found to be higher in the sample dried at 50°C temperature. Protein, fat, crude fibre and carbohydrate were found to be in the range of 8.81 - 6.96 g, 1.60 - 1.23 g, 7.25-5.76 g and 65.74 - 69.90 g, respectively. There was a decrease in nutritional values with an increase in drying temperature. Energy content was in the range of 312.24-323.46 Kcal. The pH ranged between1.96-1.83. Total soluble solids (TSS) content ranged between 4.50 - 2.400 Brix. Total titratable acidity (TTA) was found in the range of 4.48-3.87 per cent. The difference was also statistically significant. Dried roselle calyces at 50°C were found to have the highest radical scavenging activity percentage (79.71-82.71 %). Hence, 50°C at 25 hrs of duration was regarded as the best temperature for drying roselle's calyces as it showed good colour retention and increased radical scavenging activity when compared to other temperatures.

Keywords : Roselle, *Hibiscus sabdariffa* L., Antioxidant activity, Soluble solids, Titratable acidity

HIBISCUS sabdariffa L. commonly named as 'Red sorrel' or 'Roselle' is an annual or biannual semi-ligneous shrubby that belongs to the Malvaceae family. This plant is native to some parts of India, Malaysia, Indonesia, Thailand, Philippines, Vietnam, Sudan, Egypt and Mexico. It is mostly used extensively in the production of bast fibre, natural food colourants and infusion.

Beside their attractive colour, Roselle's flower calyces are potent source of vitamins, minerals and bioactive compounds like organic acids which includes citric acid, malic acid and tartaric acid and antioxidants like anthocyanin and polyphenols. Antioxidants play an important role in human health and disease prevention. It is used extensively in folk medicines for the treatment of hypertension and inflammatory diseases. They are also used in reducing low-density lipoprotein oxidation and hyperlipidemia (Borras-Linares *et al*., 2015). The research in plant extract is in increasing trend globally as they can be an immense source of phytochemicals which can help in improving human health.

The fleshy calyces of roselle have a pleasant acid taste and a very attractive red colour. The red colour of the calyces is due to the presence of the anthocyanins and the acidic taste is due to the presence of organic acid *viz.,* citric acid, malic acid and tartaric acid. The calyces are used in food industries as natural food colourants and also in preparation of jam, jellies and beverages.

As fresh roselle's calyces have high moisture content (85%, w.b.), they are highly perishable in nature. Drying is one of the oldest methods for preserving food. Drying the calyces can be one of the methods of post-harvest treatment to increase the shelf life and for preservation. Study conducted on best drying method by Deepa and Revanna (2019) revealed that tray drying method was observed suitable for dehydration of drumstick leaves. Similarly, hot air tray drying at three different temperatures (40°C, 50°C and 60°C) were carried out for drying of stevia leaves (Sadvatha *et al.*, 2011). Therefore, the present study was undertaken with the objective to standardise temperature and duration of drying of roselle calyces

for maintaining the stability of the phytochemical properties of the roselle calyces.

Material and Methods

Procurement of Sample : The fresh, mature roselle (*Hibiscus sabdariffa* L.) calyces were procured from Imphal-West district of Manipur (24°46'10.48.2'' N and 93°55'35.496'' E), India.

Flowchart for Sample preparation :

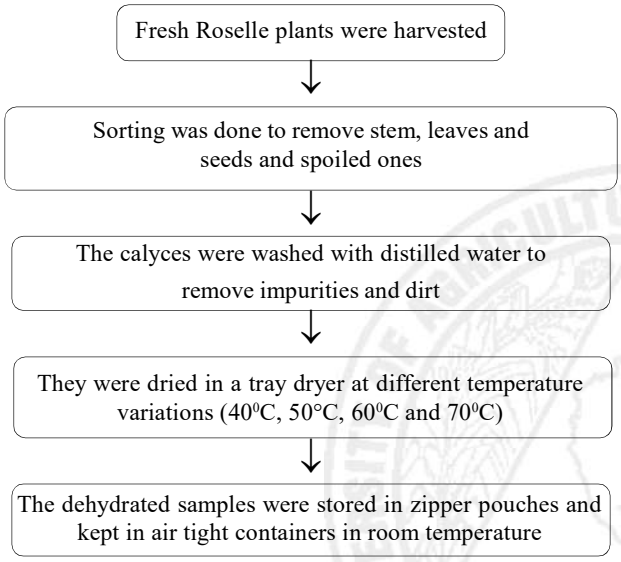

Fig. 1 : Flowchart for preparing Roselle's calyces sample for further analysis

Drying of reselle's calyces at different temperature is mentioned in Table 1 and the same is followed with suitable modification in the research.

A bibliographic survey was carried out on the drying conditions and it was found that the usual temperatures for drying in an oven with forced air circulation were within the range from 40°C to 70°C.

Physico-chemical Characteristics : The dried roselle's calyces were analyzed in triplicate for the physicochemical characteristics.

The colour of the dried roselle's calyces was estimate using reflecting colorimeter (Chroma meter CR-300). The samples were kept in colorimeter cuvettes and readings were taken in triplicates. It was calibrated using a white reference standard tile (Ranganna, 2002). The *L*,* value is a measure of lightness / brightness, ranging from 0 (black) to 100 (white). The *a** value is a measure of greenness / redness, ranging from –60 (green) to +60 (red) and the *b** values is a measure of bluishness / yellowness, ranging from –60 (blue) to +60 (yellow).

pH was analysed using pH meter which was standardised with standard buffer solution 4.0 and 7.0 according to AOAC, 2005.

The Total soluble solids (TSS) was measured by using a digital hand refractometer and expressed as degree Brix (^{0}Brix). Erma hand refractometer was used in the range of 0 to 32 ^{0}Brix. Distilled water was used to standardize the refractometer. A drop of the sample was placed on the prism and reading was recorded in Brix at 20°C (Ranganna, 2002).

Total titratable acidity (TTA) was determined as per cent citric acid by the visual titration method standard protocol (Ranganna, 2002) using 0.1 N NaOH and phenolphthalein as an indicator.

Proximate Composition Characteristics : The dehydrated calyces were analysed for the ash, moisture, crude fibre, fat, protein and carbohydrate using standard protocols (A.O.A.C, 2005) in triplicates.

Table 1

Drying of fresh roselle's calyces at different temperature

Type of drying	Temperature and duration	References
Oven drying	Drying carried out at 60^{0}C for 24 hrs	Ashaye, 2013 and Amoasah, 2019
Oven drying	Drying carried out at 55°C for 24 hours	Zaman *et al.,* 2017
	Drying carried out at 60°C for 36 hrs	Hinojosa-Gomez *et al.,* 2018
Hot air drying	Drying carried out at 60°C.	Langova *et al.,* 2013
Tray drier	Drying carried out at temperatures 40, 50 and 60°C	Suherman *et al.,* 2012

Antioxidant Activity : The dried roselle calyces were analysed for antioxidant activity using DPPH antioxidant activity assay (Vani *et al*., 1997) in triplicates using Trolox as the standard.

Statistical Analysis : Mean and standard deviation was calculated using the SPSS 16.0 software. One way ANOVA was used to test the significance of the data.

Results and Discussion

The colour analysis of dried roselle calyces are presented in Fig. 2. The colour analysis of the dried roselle calyces was found to be highest in sample dried at 40^{0}C (43.47) and 50^{0}C (43.23). The value for *a** was found to be higher in sample dried at 50^{0}C (20.03) and followed by sample dried at 70^{0}C (19.54) which means that redness was more in these two

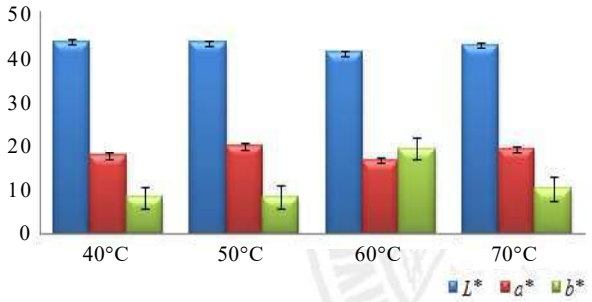

Fig. 2: Colour of the roselle's calyces dried at different temperature; *Significant at p<0.001

temperatures. The higher *L** value indicates lightness and the value varies between the range of 43.47 to 42.73. The *a** value indicates more redness which varies between 16.75 to 20.03 whereas, b* value which signifies between 10.41 to 8.33. There was significant difference among calyces samples dried at different temperature. The present results are on par with study conducted by Zaman *et al*. (2017).

Influence of temperature on the physico-chemical properties of dried roselle calyces are shown in Table 2. With an increase in temperature, the pH value of the dried roselle calyces decreased whereas total titratable acidity (TTA) value was found to increase. The mean pH was found to be highest in roselle's calyces dried at 40°C (1.96 %). The mean TTA was found to be highest in roselle's calyces dried at 70°C (4.48 %). The mean total soluble solids (TSS) value decreased with increase in temperature which was in the range between 4.50-2.40 ^{0}Brix. The present TSS value was also decreased with increase in temperature and similar result was also observed by Satheesh *et al*. (2017) with dried tomato samples. Further, pH and TTA results are on par with study conducted by Zaman *et al*. (2017).

Table 3 depicts the proximate composition of dried roselle's calyces. With the increase in temperature the moisture, protein, fat, crude fibre and carbohydrates values were decreased.The difference in the proximate composition among the samples dried at different temperature was also found to be statistically significant. Protein content ranged between 8.81-6.96g, fat content ranged between 1.60 - 1.23g, ash between 5.36 - 6.74g, crude fibre between 7.25 - 5.76g

Table 2

Physico-chemical analysis of dried roselle's calyces at different temperature

Temperatures	Duration	Values (Mean ± SD)		
		pH	TSS	TTA
40°C	28 hrs	1.96 ±0.02	4.50±0.17	3.87±0.12
50°C	25 hrs	1.94 ±0.01	3.6 ± 0.4	4.13±0.01
60°C	20 hrs	1.88 ±0.02	2.63±0.15	4.26±0.02
70°C	14 hrs	1.83 ±0.03	2.4 ± 0.2	4.48±0.11
F value		**	**	**
SEm±		0.011	0.145	0.046
CD @1%		0.038	0.481	0.152

*Significant at p<0.01 ; *Values are given in Mean ± SD

TABLE 3

Proximate composition of dried roselle's calyces at different temperature

Temperature	Duration	Moisture (g)	Protein (g)	Fat (g)	Ash (g)	Crude fibre (g)	CHO (g)	Energy (Kcal)
40^{0}C	28 hrs	11.33±0.29	8.81±0.05	1.60±0.163	5.36±0.06	7.25±0.06	65.74±0.04	312±0.06
50^{0}C	25 hrs	11.08±0.05	7.87±0.04	1.79±0.29	5.27±0.07	6.72±0.06	66.50±0.41	316±0.32
60^{0}C	20 hrs	10.67±0.28	7.12±0.09	1.10±0.26	6.90±0.13	6.23±0.02	66.88±0.02	310±0.05
70^{0}C	14 hrs	8.17±0.29	6.96±0.14	1.23±0.26	6.74±0.05	5.76±0.04	69.90±0.04	323±0.04
F value		*	*	*	*	*	*	*
SEm±		0.153	0.207	0.058	0.204	1.374	1.376	1.430
CD @5%		0.539	0.730	0.205	0.719	4.846	0.415	4.736

*Significant at p<0.05 ; *Values are given in Mean ± SD

TABLE 4

Antioxidant activity of dried roselle's calyces by DPPH assay

Conc.(µl/ml)	% Radical scavenging activity (RSA)			
	40^{0}C (28 hrs)	50^{0}C (25 hrs)	60^{0}C (20 hrs)	70^{0}C (14 hrs)
200	68.66±0.04	74.71±0.23	55.18±0.05	22.98±0.23
400	72.37±0.02	76.94±0.01	57.68±0.26	28.14±0.08
600	73.23±0.22	78.45±0.22	58.92±0.34	30.06±0.06
800	74.74±0.01	81.33±0.13	59.77±0.03	32.41±0.46
1000	79.78±0.06	82.71±0.02	60.75±0.21	32.77±0.03

and carbohydrate between 65.74 - 69.90g. Energy content was in the range of 312.24 - 323.46 KCal. The higher protein, fat, moisture and crude fibre values were observed for the sample dried at 40°C for 28 hrs however the carbohydrate and energy content were observed to be higher at 70°C for 14 hrs. The present study values for moisture, protein and ash were on par with the results shown in Puro *et al*. (2017). The trend in change in the proximate composition of moisture and fat was found to be similar with Zaman *et al.* (2017).

The radical scavenging activity of dried roselle calyces at different temperature is presented in Table 4. Highest radical scavenging activity of dried roselle calyces was observed for sample dried at 50°C. The increase in antioxidant activity at 50°C compared to 40°C may be attributed to the degradation of heat sensitive phenolic which is reported to be the major contributors to antioxidant capacity. Moreover, the duration was also more for the sample dried at 40°C. However, as the temperature increased beyond 50°C, the reduction in the antioxidant activity was observed. The results were in line with the study conducted by Zaman *et al.* (2017). However, in the study conducted by Chang *et al*. (2020) on different infusion temperature for black tea was noted to have a higher DPPH scavenging activity at higher temperature.

Roselle (*Hibiscus sabdariffa* L.) is a species of *Hibiscus* native to Africa and it is also grown in India which is an annual or biannual semi-ligneous shrub. Roselles' flower calyces are a potent source of vitamins, minerals and bioactive compounds. The optimization for drying temperature has been carried out in this study. At 50°C for 25 hrs duration showed

good colour retention, better proximate composition and highest radical scavenging activity when compared to other temperature variations. Hence, it can be concluded that drying of roselle calyces at temperature of 50°C is optimum and can be recommended to increase shelf life as well as to retain its antioxidant capacity and colour as well.

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