



## Nutritional evaluation of selected underutilized edible fruit species of *Syzygium* R.Br. ex Gaertn. from Kerala, India

<sup>1</sup> AR Jisha Chand, <sup>2</sup> K Azeez

<sup>1</sup> Research and Development Centre, Bharathiar University, Coimbatore, Tamil Nadu, India

<sup>2</sup> Principal, PSMO College, Tirurangadi, Malappuram, Kerala, India

### Abstract

The underutilized, edible fruits of *Syzygium cumini* (L.) Skeels, *Syzygium gardneri* Thwaites and *Syzygium zeylanicum* (L.) DC. from Agasthyamala Biosphere Reserve, Kerala were investigated for their nutritional and antioxidant potential. The fruit of *Syzygium gardneri* Thwaites possessed the highest values of energy ( $97.35 \pm 1.70$  kcal  $100g^{-1}$ ), total carbohydrate ( $21.36 \pm 0.75\%$ ), total protein ( $2.56 \pm 0.40\%$ ), crude fiber ( $1.80 \pm 0.05\%$ ) and total ash ( $0.86 \pm 0.08\%$ ) but the lowest fat ( $0.19 \pm 0.04\%$ ) and moisture content ( $75.04 \pm 0.42\%$ ). *Syzygium cumini* (L.) Skeels fruit got the highest fat ( $0.39 \pm 0.02\%$ ) and moisture content ( $86.91 \pm 0.90\%$ ). Of all the investigated metals, the best represented in all the fruits were sodium, potassium, calcium and magnesium. The rest of the metals strontium, chromium, manganese, copper and zinc were identified in much smaller quantities. Cadmium and cobalt were not detected and lead content was not detected in *Syzygium gardneri* Thwaites but it was present in the other two species in very low concentrations ( $0.01$  mg  $100g^{-1}$ ), under the toxicity limits admitted by law. *Syzygium cumini* (L.) Skeels fruit contained the highest amount of potassium ( $590 \pm 0.07$  mg  $100g^{-1}$ ), calcium ( $250 \pm 0.56$  mg  $100g^{-1}$ ), chromium ( $0.11 \pm 0.01$  mg  $100g^{-1}$ ), iron ( $2.42 \pm 0.01$  mg  $100g^{-1}$ ), copper ( $0.15 \pm 0.01$  mg  $100g^{-1}$ ), manganese ( $1.43 \pm 0.02$  mg  $100g^{-1}$ ) and zinc ( $0.21 \pm 0.01$  mg  $100g^{-1}$ ) whereas *Syzygium zeylanicum* (L.) DC. fruit was rich in sodium ( $630 \pm 0.06$  mg  $100g^{-1}$ ). *Syzygium gardneri* Thwaites fruit contained high amount of magnesium ( $30.51 \pm 0.66$  mg  $100g^{-1}$ ), strontium ( $0.18 \pm 0.01$  mg  $100g^{-1}$ ) and showed remarkable antioxidant properties with highest total phenolic content ( $0.88 \pm 0.02\%$ ), total flavonoid content ( $0.30 \pm 0.01\%$ ), ascorbic acid ( $0.28 \pm 0.02\%$ ) and the strongest antioxidant activity ( $85.49 \pm 0.04\%$ ) at the concentration of  $100 \mu gml^{-1}$ . There was a significant difference at  $p < 0.05$  between all of the three species in antioxidant activity and the antioxidant potential of the studied fruits was in the following decreasing order: *S. gardneri* > *S. cumini* > *S. zeylanicum*. The composition of bio elements and active antioxidants revealed that these underutilized fruits could be explored as a viable source of natural antioxidants for the functional food and pharmaceutical applications.

**Keywords:** antioxidant, metals, nutritional, syzygium, underutilized

### 1. Introduction

The state of Kerala ( $8^{\circ}17'12''N$  and  $74^{\circ}51' - 77^{\circ}24' E$ ) situated in the southwest corner of Peninsular India is home to a great variety of tropical fruits. Many of these fruits, although locally abundant and of major cultural importance are rarely known in other parts of the country and there is little scientific knowledge about them and hence these fruits are often referred to as 'underutilized'.

Neglected and underutilized crop genetic resources are vital for sustainable agriculture. Underutilized fruits can be considered as nutraceutical as they provide a wide range of necessary supplement including a variety of antioxidant compounds apart from its nutritional value. They contain many natural antioxidant compounds such as carotenoids, vitamins, phenols, tannins, flavonoids, and many secondary metabolites which have been identified as a free radical or active oxygen scavengers. Therefore, underutilized fruits are important to be investigated from not only the point of view of its nutritional value but also as a potential therapeutic agent against a wide range of human disease [4].

*Syzygium* R.Br ex Gaertner is the largest genus of the family Myrtaceae, comprises more than 1200 species, mainly

distributed in the Old World tropics from Africa to the West Pacific with major concentration in Malaysia [8]. Recent taxonomic enumeration in the genus revealed ca. 42 taxa to occur in Kerala state alone; of which 16 are endemic to the Western Ghats [10]. Despite its high species diversity, only a fraction of the *Syzygium* species is commercially cultivated for its fruit and several other little known species of *Syzygium* with great prospects for their cultivation for edible and medicinal uses. In this context, underutilized edible fruits of three *Syzygium* species were selected for the present study to estimate their nutritional value as to popularize these fruits.

*Syzygium cumini* (L.) Skeels, locally known as Njaval is an evergreen tree, 9-18 m tall, common in the evergreen and mixed deciduous forests upto 1340m. Bark grey brown. Leaves coriaceous, ovate or elliptic-lanceolate, base cuneate, tip obtusely acuminate, entire, glabrous, pellucid-dotted. Flowers creamy white, fragrant, in cymose panicles. Fruit a berry, 10 x 7 mm, oblong, succulent, smooth, purple to black when ripe. Seed single, oblong. Flowering and fruiting occurs from December to August. Ripe fruits are mostly eaten raw and also good for making jam, wine or pickles. Fruits are sold in local markets as well as on way sides in season. Although

the edible use of the fruit is widely accepted throughout the state, huge quantities are being wasted uncollected.

*Syzygium gardneri* Thwaites, locally known as Karinjaval is an evergreen tree attaining 30m high, common in the evergreen forests upto 1400m. Bark pale grey. Leaves simple, opposite, elliptic-ovate or ovate-lanceolate, apex caudate-acuminate, base acute, margin entire, glabrous, glossy, membranous. Flowers white, in axillary and terminal trichotomous cymes. Fruit a berry, 5-8 mm across, ovoid, rarely globose, purple. Seed single. Flowering and fruiting period occurs from December to June. Despite the edibility of the fruit is widely accepted by the tribal communities of Kerala, it is seldom subjected for nutritional evaluation.

*Syzygium zeylanicum* (L.) DC., locally known as Poochapazham is a medium sized tree, 5-12m tall, common on the banks of streams in evergreen forests and scrub jungles upto 1350m. Bark greyish brown. Branches slender. Leaves chartaceous, pellucid dotted, ovate lanceolate, base round, tip long acuminate, entire, glabrous. Flowers white, dense in short paniculate cymes. Fruit a berry, 6-12 mm long, white, gland-dotted, crowned with calyx segments, spongy, insipid to slightly sweet. Seed single, globose, green. Flowering and fruiting period occurs from January to September. Fruits are usually eaten raw and good for making pickles. Edible property of the fruit is widely accepted by the villagers and tribal communities throughout the state.

The aim of the present study was to evaluate and compare the nutritional status and antioxidant potential of three *Syzygium* species (*S. cumini* (L.) Skeels, *S. gardneri* Thwaites and *S. zeylanicum* (L.) DC.) that are most commonly consumed as edible fruit source among the tribal communities of Agasthyamala Biosphere Reserve, Kerala.

## 2. Materials and methods

Fresh and ripened fruits of selected species viz. *S. cumini* (L.) Skeels, *S. gardneri* Thwaites and *S. zeylanicum* (L.) DC. (Fig. 1) were collected from Agasthyamala Biosphere Reserve, Kerala during the month of April to June 2017. Fruits were botanically identified with the help of local flora [7, 9]. Proximate and metal element compositions were determined according to the standard methods of the Association of Official Analytical Chemists [2]. Moisture content was analyzed following oven dehydration at 105°C, ash by incineration at 525°C in a muffle furnace, protein using micro Kjeldhal method (Nx6.25 conversion factor), fat using petroleum ether extraction and measured by soxhlet apparatus and crude fiber was obtained by digesting the fat free sample with 1.25% sulfuric acid and 1.25% sodium hydroxide solutions and then incinerated in muffle furnace at 600°C. Total carbohydrate contents were obtained by subtracting the sum of moisture, ash, protein and fat from 100 and the energy value in kilocalorie was calculated by multiplying the percentage content of crude proteins, crude fats and carbohydrates by the recommended factors of 4, 9 and 4 respectively and then taken the sum of the values [3]. Proximate results obtained were recorded as g 100g<sup>-1</sup> fresh weight.

The ash obtained after combustion in the muffle furnace was used to prepare the ash solution, which was used for the estimation of selected metals. Sodium, potassium and calcium

were estimated flame photometrically, while the remaining metals viz. magnesium, strontium, chromium, manganese, iron, cobalt, copper, zinc, cadmium and lead by inductively coupled plasma mass spectrometry. Results obtained were recorded as mg 100g<sup>-1</sup> fresh weight.

Total phenolic content was determined by Folin-Ciocalteu method and the results were expressed as gallic acid equivalents GAE, g 100 g<sup>-1</sup> fresh weight, total flavonoid content by aluminium chloride colorimetric method and expressed as quercetin equivalents, QE, g 100 g<sup>-1</sup> fresh weight [6]. Titrimetric method was followed to determine ascorbic acid [5] and antioxidant potential was determined by using DPPH radical scavenging assay which was expressed as the percent inhibition of DPPH radical and calculated as [(absorbance of control – absorbance of samples) / absorbance of control] × 100 [11].

All the analyses were carried out in triplicate and the mean calculated. The data was analysed using Analysis of Variance (ANOVA). Duncan's Multiple Range Test was used to compare mean values. Significance was accepted at  $p \leq 0.05$  level.

## 3. Results and discussion

Significant variation was observed among the three species in proximate composition (Table 1). Moisture content was generally very high ranged from 75.04 ± 0.42% to 86.91 ± 0.90% with a significant difference between *S. gardneri* Thwaites and the other two species at  $p < 0.05$ . The high content of moisture in the fruits suggested that they have high perishability. Total ash content ranged from 0.64 ± 0.02% to 0.86 ± 0.08% with a significant difference only between *S. gardneri* Thwaites and *S. zeylanicum* (L.) DC. at  $p < 0.05$ . Total protein ranged from 1.94 ± 0.02% to 2.56 ± 0.40% with a significant difference only between *S. cumini* (L.) Skeels and *S. gardneri* Thwaites at  $p < 0.05$ . Total fat content was very low ranged from 0.19 ± 0.04% to 0.39 ± 0.02% with a significant difference at  $p < 0.05$  between *S. gardneri* Thwaites and the other two species. There was a significant difference at  $p < 0.05$  in the crude fiber content between the three species ranged from 0.46 ± 0.05% to 1.80 ± 0.05%. Total carbohydrate and energy ranged from 10.00 ± 1.01% to 21.36 ± 0.75% and 51.25 ± 3.79 kcal 100g<sup>-1</sup> to 97.35 ± 1.70 kcal 100g<sup>-1</sup> respectively with significant difference at  $p < 0.05$  between *S. gardneri* Thwaites and the other two species.

The fruits of the three species contained relatively high quantities of sodium, potassium, calcium and magnesium and considerable amounts of many other nutritionally essential elements (Table 2). There was a significant difference at  $p < 0.05$  between all of the three species in the content of sodium with values ranging from 340.00 ± 0.44 mg 100g<sup>-1</sup> to 630.00 ± 0.06 mg 100g<sup>-1</sup>, potassium from 310.00 ± 0.04 mg 100g<sup>-1</sup> to 590.00 ± 0.07 mg 100g<sup>-1</sup>, magnesium from 17.40 ± 0.01 mg 100g<sup>-1</sup> to 30.51 ± 0.66 mg 100g<sup>-1</sup>, strontium from 0.06 ± 0.01 mg 100g<sup>-1</sup> to 0.18 ± 0.01 mg 100g<sup>-1</sup>, chromium from 0.04 ± 0.01 mg 100g<sup>-1</sup> to 0.11 ± 0.01 mg 100g<sup>-1</sup>, iron from 0.56 ± 0.01 mg 100g<sup>-1</sup> to 2.42 ± 0.01 mg 100g<sup>-1</sup>, copper from 0.08 ± 0.01 mg 100g<sup>-1</sup> to 0.15 ± 0.01 mg 100g<sup>-1</sup> and zinc from 0.05 ± 0.01 mg 100g<sup>-1</sup> to 0.21 ± 0.01 mg 100g<sup>-1</sup>. As for calcium, there was a significant difference between *S. gardneri* Thwaites and the other two species at  $p < 0.05$  with values

ranging from  $220.00 \pm 0.31$  mg  $100g^{-1}$  to  $250.00 \pm 0.56$  mg  $100g^{-1}$ . Cadmium and cobalt were not detected in all the three species, this indicate that these metals were not present in a detectable amount in these fruits. Lead content was not detected in *Syzygium gardneri* Thwaites but it was present in the other two species in very low concentrations ( $0.01$  mg  $100g^{-1}$ ), under the toxicity limits admitted by law.

Total phenolic content, flavonoids and ascorbic acid that are commonly found in fruits can act as antioxidants. Based on the analyses conducted, *S. gardneri* Thwaites had the highest total phenolic content, total flavonoid content and ascorbic acid than the other two species (Table 3). There was a significant difference at  $p < 0.05$  between all of the three species in total phenolic content with values ranging from  $0.11 \pm 0.01\%$  to  $0.88 \pm 0.02\%$ . Total flavonoid content and ascorbic acid ranged from  $0.11 \pm 0.01\%$  to  $0.30 \pm 0.01\%$  and  $0.13 \pm 0.02\%$  to  $0.28 \pm 0.02\%$  respectively with a significant difference between *S. gardneri* Thwaites and the other two species at  $p < 0.05$ . When the fruit extracts were tested for DPPH free radical scavenging capacity, the methanolic extract of *S. gardneri* at  $100\mu gml^{-1}$  showed the strongest free radical

scavenging activity ( $85.49 \pm 0.04\%$ ) whereas *S. cumini* and *S. zeylanicum* showed relatively poor free radical scavenging activity of  $5.64 \pm 0.06\%$  and  $2.36 \pm 0.05\%$  respectively. Antioxidant potential of the studied fruits was in the following decreasing order: *S. gardneri* > *S. cumini* > *S. zeylanicum*. There was a significant difference at  $p < 0.05$  between all of the three species in antioxidant activity that indicates each fruit had its own potential to reduce the free radicals and cannot be an alternative to each other.

#### 4. Conclusion

Food security becomes vulnerable when it depends on a few numbers of traditional crop plants. Exploitation of underutilized fruit crops can become a solution to the social problem of health and nutrition insecurity. The results of our present study revealed that underutilized fruits like *S. cumini* (L.) Skeels, *S. gardneri* Thwaites and *S. zeylanicum* (L.) DC. are enriched source of various bioactive constituents and are promising species for promotion as backyard planting especially farming systems suffering from crop loss, food shortage and chronic malnutrition.

**Table 1:** Proximate composition of selected *Syzygium* fruits (g  $100g^{-1}$  fresh weight)

Parameters (%)	<i>S. cumini</i>	<i>S. gardneri</i>	<i>S. zeylanicum</i>
Moisture	$86.91 \pm 0.90^b$	$75.04 \pm 0.42^a$	$86.00 \pm 0.04^b$
Total Ash	$0.76 \pm 0.07^{ab}$	$0.86 \pm 0.08^b$	$0.64 \pm 0.02^a$
Total Protein	$1.94 \pm 0.02^a$	$2.56 \pm 0.40^b$	$2.38 \pm 0.03^{ab}$
Total Fat	$0.39 \pm 0.02^b$	$0.19 \pm 0.04^a$	$0.36 \pm 0.03^b$
Crude Fiber	$0.46 \pm 0.05^a$	$1.80 \pm 0.05^c$	$1.53 \pm 0.03^b$
Total Carbohydrate	$10.00 \pm 1.01^a$	$21.36 \pm 0.75^b$	$10.62 \pm 0.10^a$
Energy (kcal $100g^{-1}$ )	$51.25 \pm 3.79^a$	$97.35 \pm 1.70^b$	$55.24 \pm 0.20^a$

a Values are means (n = 3)  $\pm$  SD.

b Values with different superscript are significantly different at  $p < 0.05$

**Table 2:** Metal composition of selected *Syzygium* fruits (mg  $100g^{-1}$  fresh weight)

Metals (mg $100g^{-1}$ )	<i>S. cumini</i>	<i>S. gardneri</i>	<i>S. zeylanicum</i>
Sodium	$340.00 \pm 0.44^a$	$500.00 \pm 0.16^b$	$630.00 \pm 0.06^c$
Potassium	$590.00 \pm 0.07^c$	$510.00 \pm 0.43^b$	$310.00 \pm 0.04^a$
Magnesium	$22.41 \pm 0.49^b$	$30.51 \pm 0.66^c$	$17.40 \pm 0.01^a$
Calcium	$250.00 \pm 0.56^b$	$220.00 \pm 0.31^a$	$250.00 \pm 0.12^b$
Strontium	$0.08 \pm 0.01^b$	$0.18 \pm 0.01^c$	$0.06 \pm 0.01^a$
Chromium	$0.11 \pm 0.01^c$	$0.04 \pm 0.01^a$	$0.09 \pm 0.01^b$
Manganese	$1.43 \pm 0.02^c$	$1.35 \pm 0.03^b$	$1.10 \pm 0.01^a$
Iron	$2.42 \pm 0.01^c$	$0.56 \pm 0.01^a$	$1.63 \pm 0.01^b$
Cobalt	N.D.	N.D.	N.D.
Copper	$0.15 \pm 0.01^c$	$0.08 \pm 0.01^a$	$0.12 \pm 0.01^b$
Zinc	$0.21 \pm 0.01^c$	$0.05 \pm 0.01^a$	$0.10 \pm 0.01^b$
Cadmium	N.D.	N.D.	N.D.
Lead	$0.01 \pm 0.00$	N.D.	$0.01 \pm 0.00$

a Values are means (n = 3)  $\pm$  SD.

b Values with different superscript are significantly different at  $p < 0.05$

c N.D= Not detected

**Table 3:** Antioxidant properties of selected *Syzygium* fruits

Parameters (%)	<i>S. cumini</i>	<i>S. gardneri</i>	<i>S. zeylanicum</i>
Total phenolic content	$0.29 \pm 0.02^b$	$0.88 \pm 0.02^c$	$0.11 \pm 0.01^a$
Total flavonoid content	$0.11 \pm 0.01^a$	$0.30 \pm 0.01^b$	$0.12 \pm 0.01^a$
Ascorbic acid	$0.14 \pm 0.02^a$	$0.28 \pm 0.02^b$	$0.13 \pm 0.02^a$
Antioxidant activity (% DPPH)	$5.64 \pm 0.06^b$	$85.49 \pm 0.04^c$	$2.36 \pm 0.05^a$

a Values are means (n = 3)  $\pm$  SD.

b Values with different superscript are significantly different at  $p < 0.05$



**Fig 1:** A. *Syzygium cumini* (L.) Skeels B. *Syzygium gardneri* Thwaites C. *Syzygium zeylanicum* (L.) DC.

## 5. Acknowledgement

The authors are grateful to Dr. Tenson Antony, Lab Manager, CaRe KERALAM for the technical support and Sri. B Jayalal Kumar, Gardener, JNTBGRI for the support and encouragement provided during the survey.

## 6. References

1. Akomolafe SF, Ajayi OB. A comparative study on antioxidant properties, proximate and mineral compositions of the peel and pulp of ripe *Annona muricata* (L.) fruit. *International Food Research Journal*. 2015; 22(6):2381-2388.
2. AOAC. Official Methods of Analysis of AOAC international 20th edition. AOAC International, Gaithersburg, Maryland, USA, 2016.
3. FAO. Food energy – methods of analysis and conversion factors, Report of a technical workshop, Rome, 3–6 December 2002. Food and Agriculture Organization of the United Nations, Rome, 2003.
4. Hegazy AK, Al-Rowaily SL, Faisal M, Alatar AA, El-Bana MI, Assaeed AM. Nutritive value and antioxidant activity of some edible wild fruits in the Middle East. *Journal of Medicinal Plant Research*. 2013; 7(15):938-946.
5. IP. Indian Pharmacopoeia 7<sup>th</sup> edition, Indian Pharmacopoeia Commission, Ghaziabad, 2014.
6. Khadabadi SS, Deore SL, Baviskar BA. Experimental Phytopharmacognosy A Comprehensive Guide. Nirali Prakashan, Pune, Maharashtra, 2013.
7. Nayar TS, Rasiya Beegam A, Mohanan N, Rajkumar G. Flowering plants of Kerala, TBGRI, Trivandrum, 2006.
8. Parnell JAN, Craven LA, Biffin E. Matters of Scale: Dealing with one of the largest genera of angiosperms. In: Hodkinson TR and Parnell JAN (ed.), *Reconstructing the Tree of Life: Taxonomy and Systematics of Species Rich Taxa*, The Systematics Association Special Volume Series 72. CRC Press, Boca Raton, Florida. 2007, 251-273.
9. Sasidharan N. KFRI Handbook, No. 17; Biodiversity documentation for Kerala. Part 6: Flowering plants, 2004.
10. Shareef SM, Santhosh Kumar ES, Roy PE. A new species of *Syzygium* (Myrtaceae) from Kerala, India. *Phytotaxa*. 2013; 129(1):34-38.