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*Research Article*

# Nutritional evaluation of *Chrysophyllum oliviforme* L. (Sapotaceae) an underutilized exotic fruit

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## Abstract
Diet and nutrition are important factors in promoting and maintaining good health. Fruits are important sources of protective foods that are highly beneficial for maintaining good health and preventing diseases.The present study aimed to assess the nutritional profiling (carbohydrates, proteins, lipids, moisture, ash, solids and vitamins content), anti-nutritional (oxalate, saponin and tannin) and physico-chemical (shape, colour, size and weight) parameters of *Chrysophyllum oliviforme* fruits. The nutritional contents were determined by Biuret, dry ash, and oven dry method for protein, ash and moisture content, respectively. The nutritional values of this fruit were: carbohydrates (5.30±0.21 mg/g), protein (6.30±0.19), lipids (14.00 %), thiamine (0.04 mg/g), calcium (3.29 mg/kg), potassium (348-370 mg/100 g). The results revealed that this plant *C. oliviforme* has a high nutritious value and suggested that its underutilized edible fruits could be a source of protein, vitamins, and minerals.The study on underutilized edible fruit plant *C.oliviforme* L.appears to be the first report on its nutritional evaluation.This data may also helpimprove the nutritional and health status of rural populations nationwide by utilizing underutilized and neglected specialities.

**Keywords:** *Chrysophyllum oliviforme,* Nutritional profiling, Underutilized, Star apple

## INTRODUCTION

Global food security and economic growth depend on declining plant species. Today it has been a big challenge to provide safe, healthy, and nutritious sources of food for poor income groups and undernourished inthe developing world. Food is an essential requirement for the sustenance of human life and directly or indirectly depends on plants. A human being cultivates and conserves plants according to his needs throughout his life (Magbagbeola *et al.*, 2010). Many plants and plant parts are eaten as food and around 2000 plant species with several distinct cultivars are cultivated as food crops. Food safety and food security are monitored by International Food Information Council (IFIC) and Food and Agriculture Organization (FAO) (2021). They address issues such as their sustainability, biological diversity, climatic change, nutritional economics, population growth, water supply and access to food.

Edible fruits are a well-known and significant source of nutrients and food supplements in a society with concerns aboutscarcity. It is one of the best sources of dietary fiber, with lots of minerals and vitamins and also contains carbohydrates in the form of soluble sugars, cellulose, and starch (Williams *et al.*, 2019). Frequent consumption of fruits and vegetables has been associated with a lowered risk of diabetes, hypertension, cancer and stroke (Wang *et al.*, 2021).In addition to serving as a significant supply of micronutrients for rural populations, wild fruits have the potential to be a good source of antioxidants, vitamins, and minerals. Therefore, it is crucial to understand the makeup of these neglected fruits and their nutritional potential (McMullin *et al.*, 2019).

Underutilized plants are neither widely traded nor extensively produced for commercial purposes. These plants are traded, either cultivated or wild and eaten locally. It contributes immensely to family food security and serves as a means of survival during drought, famine, shocks and risks (Assefa and Abebe, 2012). With the alarming increase in human population and depletion of natural resources. Many neglected and underutilized species are nutritionally rich and adapted to low-input agriculture. A diverse and balanced diet and the prevention of micronutrients and other nutritional deficiencies, particularly among the rural poor and vulnerable social groups in developing countries, can be achieved by focusing on neglected and underutilized species(Li *et al*., 2020). Recently, in most developing nations, numerous edible wild plants have been exploited as a source of food to provide supplementary nutrition to the inhabitants (Ding *et al*., 2021). In the recent past, growing interest has emerged in evaluating various underutilized species for nutritional properties (Hunter *et al*., 2019).
Sapotaceae is a tropical family of evergreen trees and shrubs. The genus *Chrysophyllum* is one of the important genus of Sapotaceae. It includes 80 speciesnative to tropical regions worldwide, with the greatest number of species in Northern South America. One such species is *Chrysophyllum oliviforme*. It is commonly known as Satin leaf, a medium-sized tree which forms the distinctive colors of leaves and fruits. Once mature, they turn a dark purplish colour with several black seeds per fruit. In folk medicine, *Chrysophyllum* species are commonly used for the treatment of inflammation and diabetes (Ajayi *et al*., 2021). Fruits are generally acceptable as a good source of nutrients and supplement for food in a world facing food scarcity problems. They are known to be excellent sources of nutrients such as minerals, vitamins, micronutrients and carbohydrates (Morris and Mohiuddin, 2022).
*C. oliviforme* (satin leaf), the underutilized plant,is commonly called wild star apple. It is closely related to *C. cainito* and is edible and sweet (Swenson *et al*., 2008; Gann *et al*., 2012). Thus, there is a limited study on the nutritional value of *C. oliviforme* fruit. The present study aimed to assess the nutritional profiling,anti-nutritional and physico-chemical parameters of the fruits of underutilized plant, *C. oliviforme.*

## MATERIALS AND METHODS

### Study area and plant collection

*Chrysophyllum oliviforme* L.,plant material was collected from the Coimbatore district, located in Western-Ghats(10.1667° N, 77.0667° E) mountain range to the west and the north, with a reserve forest and the Nilgiris biosphere reserve on the north side. It is also found on the banks of Noyyal River. Fresh fruits of these plants were collected from the PSGR Krishnammal College for Women campus, Coimbatore, Tamil Nadu, which lies between 11ºN altitude and 7º E longitude approximately. The fruits were washed in tap water to remove dirt and dust particles. The seeds were extracted from the fruit and collected fruits were stored and used for further analysis studies.

### Plant descriptions

The plant comes under Kingdom – Plantae, Order – Ericales, and Family – Sapotaceae. Individuals of the species typically range in height from 3 to 5 m (9.8 to 16.4 ft) and occasionally reach a height of 10 m (33 ft.). The alternating leaves have lustrous dark green tops and light brown bottoms. They have pinnate venation and are simple leaf kinds. The ovate leaves are between 3 and 11 cm long (1.2 to 4.3 in). The leaves are evergreen and range in width from 2 to 5 cm (0.79 to 1.97 in).
The fruit matures over a number of months and is often ripe by February. As they ripen, the fruit turns from green to roughly the size of an olive. When fully grown, they take on a dark purplish hue. There are typically a number of black seeds per fruit. The seeds exude a milky white liquid when cut. A rubbery, gum-like layer surrounds the white, fleshy centre of the seeds, which serves as protection.

### Analysis of physicochemical and nutritional Properties:

### Physico-chemical parameters:

### Physical parameters

The physical parameters of fruits were analyzed for their shape, colour (through visual perception), and weight (15 fruit weight). The size (length and diameter) of the fruits was measured with Verniercalliper.

### Chemical parameters:

### Estimation of carbohydrate

The 100 mg of fruit sample was hydrolyzed(3h) with 5.0 ml of 2.5 N HCl, cooled to room temperature, and later neutralized with solid Na2CO3 until the effervescence ceased.Then, it was made up100 ml and centrifuged, collected the supernatant and its 0.2 to 1.0 ml was for analysis and water served as a blank. Anthrone reagent was added, and the green to dark green colour was measured at 630 nm (Sadasivam and Manickam, 1996).

### Estimation of protein

For protein estimation, the Biuret method (Okon and Akpanyung, 2005) was adopted. One ml biuret reagent was added to 1 ml of test solutions in dry test tubes and 1 ml distilled water (control) and mixed well and it was analysedfor the development of blue colours.

**Estimation of moisture content**

This was determined by the Oven drying method and calculated using the formula,

$$\text{Moisture content \%} = \frac{w_2 - w_3}{w_2 - w_1} \times 100 \quad \text{(Eq.1)}$$

where, $w_1$ = Weight of the Petridish

$w_2$ = Weight of the petridish with sample before drying

$w_3$ = Weight of the petridish with sample after drying

**Estimation of ash content**

This was determined by the dryash method using Muffle furnace(550°C – 600°C). The residue remaining after destroying the organic matter sample was weighed as total ash (Sadasivam and Manickam,1996).

$$\text{Ash \%} = \frac{\text{Weight of ash}}{\text{Weight of original sample}} \times 100 \quad \text{(Eq.2)}$$

**Estimation of lipid**

Lipid was determined by Folich *et al.*(1957) and was carried out by pipetting outplant extracts, chloroform and methanol (1:2:1). It was heated (40°C) for 5-10 min. Then it was centrifuged, the supernatant was taken in a Petri dish, and the solvent was allowed to evaporate.

The % of the lipid present in the plant sample = (W1-W2) × 100 (Eq.3)

where,W1= Initial weight of the empty Petridish, W2=Final weight of the Petri dish.

**Estimation of total solids**

The total percentage solid of each sample was determined using the equation;

Total solids (%) = 100 – moisture content (Eq.4)

**Estimaiton of thiamine (Vitamin $B_1$)**

One g of sample is added in 10ml ethanolic sodium hydroxide. Ten mlof filtrate was taken and added to 10ml $K_2Cr_2O_7$. The readings of sample were read on a fluorescent UV Spectrometer (Cecil A20 Model) at a wavelength of 360nm (Koche, 2010).

**Mineral Profiling (Macro and Micro elements)**

The powdered dried fruit sample was digested using a nitric acid-prechloric acid mixture (4:1) for 24 h. This was then filtered using Whatman no. 42 filter paper and the filtrate was used to determine the mineral content using Atomic Absorption Spectroscopy (AAS, USA). Four macro elements, Mg, Na, Ca, K and six microelements like Fe, Cu, Zn, Pb, Cd and Cr were quantified (Rivero-Huguet *et al.,* 2006).

**Anti-nutritional analysis**

**Determination of oxalate**

The oxalate content was then calculated by taking 1ml of 0.05N $KMnO_4$ as equivalent to 2.2mg oxalate (Chinma and Igyor, 2007). To 1g of sample, 75ml 3M $H_2SO_4$ was added and stirred for 1h with a magnetic stirrer. This was filtered using a Whatman No. 1 filter paper. Twenty-five ml of filtrate was then taken and titrated with 0.05N KMnO4 solution until a faint pink colour persisted for at least 30 sec.

**Determination of saponin**

Twenty g of crude100 $cm^3$ of 20% aqueous ethanol were added and heatedfor 4h with continuous stirring at 55ºC. Itwas filtered and residue-extracted with another 200 ml of 20% ethanol. The combined extracts were reduced to 40 ml (90ºC). Twenty ml of concentrated diethyl ether was added and shaken vigorously. The aqueous layer was recovered, while the ether layer was discarded. The purification process was repeated, and 60 ml of n-butanol was added. The combined n-butanol extracts were washed twice with 10 ml 5% aqueous sodium chloride. The remaining solution was heated in a water bath. After evaporation, the samples were dried in the oven to constant weight and the saponin content was calculated (El-Olemyet al., 1994).

**Determination of tannin**

Spectrophotometric estimation of tannin is based on the measurement of the blue colour formed by the reduction of phosphotungusto molybdic acid by tannin-like compounds in an alkaline solution. The % of tannin was calculated as follows;

Tannin % =mg of tannic acid × Dilution × 100 (Eq.5)

Tannin as Tannic acid /ml of the sample taken × wt. of the sample taken × 1000 for colour development.

**Statistical analysis**

Physico-chemical and nutritional parameters values were expressed as mean ± standard error. Procured data were analyzed with MS-Excel/MS Office 10 software package.

## RESULTS AND DISCUSSION

**Physical properties**

The physical characteristics of *C. oliviforme* are presented in Table 1. The physical characteristics of *C. oliviforme* wereaccordance with an earlier report of Ajayi and Ifedi (2015) they analyzed physical properties of *C. albidum* fruit. It showed differences mainly in taste and shape. The *C. oliviforme fruit* pulp had the lowest moisture content when compared with *Spondias pinnata* and *Elaeaglus pyriformis* (Khomdram*et al*., 2014). The pH of *C. oliviforme* fruit juice was 6.50, whereas *Morinda citrifolia* fruit juice had a pH of 4.76 (Anugweje, 2015).

*C. oliviforme* fruits turned purple after ripening, showing

**Table 1.** Physical properties of the fruit *C. oliviforme*

| Parameters | Observations[#] |
|---|---|
| Shape | Elongated / oval |
| Odour | Pleasant |
| Colour | Purplish black |
| Taste | Sweet |
| Size - length (cm) | 1.40 ± 0.03 |
| Size - breadth (cm) | 0.90 ± 0.03 |
| Weight (fruit pulpfor15fruits)(g) | 11.25 ± 0.41 |
| pH | 6.50 ± 0.29 |

[#]Each value is a mean of three replicates ± SE (Standard Error)

the variation in fruit skin colour and firmness as they ripened naturally. In accordance with an earlier study by Ajayi and Ifedi (2015) with *C. albidum* fruit, the results showed that the average length was 2.31 cm. Similarly, Sudhakaran and Nair (2016) analyzed the underutilized fruits of *Gynochthodes umbellata* and the size of the fruits ranged from an average length of 3.93 cm.

**Chemical properties**

**Nutritional analysis**

The nutritional examination of fruit *C. oliviforme* is documented and presented in Table 2. The moisture content of *C. oliviforme* fruit was 61.30±1.60 % higher when compared to other fruits such as *Grewia tenax* (13.00 %) and *G. flavescens* (15%) reported by Elhassan and Yagi (2010). However, the moisture content of the fresh fruit was low when compared with other *Chrysophyllum* species described in the earlier work of Okwu *et al*. (2018) and it was higher than the fruit of *Gynochthodes umbellata* (Sudhakaran and Nair, 2016). Besides, the relatively high moisture content observed in the sweet pulp indicated its short shelf life reported by Edem *et al*. (2009) and Akpabio *et al*. (2012). Additionally, the low moisture content of fruit specified that the quantity of other nutrients might more (Nwamarah*et al*., 2015).

The ash content of the fruit was observed lower (0.90±0.06 %) than the *C. albidum* reported by Okwu *et al*. (2018). Consequently, the lower level of ash content in the *C. oliviforme* designates the lower level of mineral contents (Hassan *et al*., 2011). In this study, the total solids content of *C. oliviforme* fruit were 38.70±2.22 %. The variations of fruit's moisture content causes difference in the total solids contents. Current results were concurrence with earlier reports of Yadav and Singh (2014). Their study results displayed fruit's moisture content was implied by a rise in total solids, raising the fruit's nutritional composition.

Carbohydrates are one of the utmost essential constituents in many fruits. The total carbohydrate content in fresh fruits of *C. oliviforme* was 5.30±0.21 mg/g (Table 2). The earlier reports of Adeopoju*et al*. (2012) showed that carbohydrate content of *C. acreanum* (10.4 mg/g), *C. africanum* (10.3 mg/g) and *C. albidum* (4.9 mg/g). The present study indicates a lower level of carbohydrates in *C. oliviforme* fruit than the other *Chrysophyllum* species fruits.

Protein is another vital nutritional component. Additionally, the protein is a significant energy source with necessary amino acids and it is vital nutrition for human health. The protein content of *C. oliviforme* fruit was 6.30 ± 0.19 mg/g (Table 2), while other fruits such as *C. acreanum, C. africanum* and *C. albidum* comparatively had high protein in the fruit of C. oliviforme (Adepoju et al., 2012). A lipid detected in fruits of *C. oliviforme* was 14.00 %. The lipids content results of the current study were reported higher than that of the fruits of *G. tenax* (20.5%), *G. flavescens* (42.8%) and *G. villosa* (25.5%) by Elhassan and Yagi (2010).

Thiamine content was 0.04 mg/g in this fruit of *C. oliviforme* depicted in Table 2. The results corroboratewith the earlier results of *C. albidum* fruit (Ureigho and Ekeke, 2010). Table 2 displays that the total solid was higher than the moisture content of the fruit, but eventually, it was lower than that of the pulp. Furthermore, moisture, ash, carbohydrate, protein, and lipid contents decreased during processing of fruits reported by Sunila and Murugan(2017) in the fruit of *Pouteriacampechiana* and Adekanmi and Olowofoyeku (2020) in the fruit of *Chrysophyllumalbidum*.

**Mineral analysis**

The mineral composition of fruits plays an important role in human health and is crucial for providing exact nutritional information. In addition, minerals are necessary for cellular activity and body protection and serve as a second messenger in some biochemical pathways. The results of the mineral analysis of *C. oliviforme* are depicted in Table 2. The calcium (3.29 mg/kg dw) was the highest of the three macro elements quantified, followed by sodium (0.52 mg/kg dw) and potassium (0.21±0.02 mg/kg dw). The fruit also contains significant quantities of copper (0.53 mg/kg dw), zinc (0.04 mg/kg dw), iron (0.34 mg/kg dw), and magnesium (0.61 mg/kg dw). The lead (Pb), cadmium (Cd), and chromium (Cr) content of the *C. oliviforme* fruits are present in trace levels (Table 2). The calcium, sodium and potassium amounts of *C. oliviforme* were less compared to other underutilized exotic fruits like *Nepeta hindostana* (Koche, 2010), *Nauclealatifolia* (Eze and Emest, 2014) and *C. albidum* (Azor*et al*., 2017).

The iron content of *C. oliviforme* was 0.335 mg/g (Table 2). The iron content was high for other fruits such as *Cucumis melo* (0.45 mg/g), *Psidium guajava* (0.61 mg/g) and *Carica papaya* (0.6mg/g) reported by Haque *et al*. (2009). In general, the *Chrysophyllum* species fruits iron content was low, according to the report of Deka *et*

**Table 2.** Nutritional characteristics of the fruit *C. oliviforme*

| **Nutritional compounds** | **Concentration#** |
|---|---|
| Carbohydrate (mg/g) | 5.30 ± 0.21 |
| Protein (mg/g) | 6.30 ± 0.19 |
| Thiamine (mg/g) | 0.04 ± 0.02 |
| Lipid (%) | 14.00 ± 0.33 |
| Moisture content (%) | 61.30 ± 1.60 |
| Ash (%) | 0.90 ± 0.06 |
| Total solids (%) | 38.70 ± 2.22 |
| **Anti-nutritional compounds** | |
| Oxalate (mg/g) | 0.74 ± 0.06 |
| Saponin (mg/g) | 0.80 ± 0.02 |
| Tannin (%) | 12.90 ± 1.60 |
| **Minerals - macro elements** | **Concentration (mg/kg)#** |
| Sodium (Na) | 0.52±0.06 |
| Calcium (Ca) | 3.29±0.33 |
| Potassium (K) | 0.21±0.02 |
| Trace elements | |
| Iron (Fe) | 0.34±0.03 |
| Copper (Cu) | 0.53±0.02 |
| Magnesium (Mg) | 0.61±0.02 |
| Zinc (Zn) | 0.04±0.01 |
| Chromium (Cr) | 0.02±0.01 |
| Lead (Pb) | Trace amount |
| Cadmium (Cd) | Trace amount |

#Each value is a mean of three replicates ± SE (Standard Error)

*al*. (2021). While comparing this *C. oliviforme* fruit with other *Chrysophyllum* species represents less quantities of copper, magnesium, zinc, and lead. Cadmium content present in *C. oliviforme* fruit showed the lowest amount with the fruit of *Gynochthodes umbellata* (Sudhakaranand Nair, 2016) and in the fruit of *Nepeta hindstana* (Koche, 2010).

**Anti-nutritional analysis**

Fruits are significant sources of vitamins, minerals, and fiber, which give vital nutritional elements to human health. However, it is well recognized that some fruits include 'anti-nutritional' elements that reduce nutrient bioavailability, particularly if they are present in large concentrations. The high content of these anti-nutrients negatively impacts the bioavailability of various minerals.

Fruit *C. oliviforme*oxalate content was 0.74 mg/g (Table 2), whereas saponin level was 0.08 mg/g. In contrast, the oxalate amount was lower than in the fruit of *Gynochthodes umbellata* (Sudhakaran and Nair, 2016) and saponin (1.15) higher in *C. albidum* fruit (Okwu*et al*., 2018). The tannin content in fruit *C. oliviforme* was 12.90% (Table 2), whereas lower in *Chrysophyllum albidum*(8.06%) (Okwu et al., 2018). Tannin is a complex polyphenolic substance known to reduce palatability in fruits. It explains the low value of tannin in the fruit pulp, which accelerate the healing of wounds and inflamed mucus membrane (Okwu and Okwu, 2004). Low values of saponin in the pulp reduce health risks in humans.

The present study results revealed that protein and calcium contents were high among all the examined nutritional quantities tested compared to other fruits. Furthermore, the low carbohydrate content can underscore its low value of simple sugar so that the fruit can be recommended for diabetic patients for consumption. Additionally, its low calorie and sugar may make the fruit suitable for the obese, while its sodium content qualifies for hypersensitive. Finally, the present study explored the significant nutritional value of the fruit *C. oliviforme*. Also, it will recommend the general public to popularize this underutilized exotic edible fruit from a nutraceutical point of view.

## Conclusion

The present studies dealt with the physico-chemical properties, such as nutritional and anti-nutritional profiling of *C. oliviforme* fruits. The results showed nutritional values of this fruit as follows; carbohydrates (5.30mg/g), protein (6.30 mg/g), lipids (14.00 %), thiamine (0.04 mg/g), calcium (3.29 mg/kg), potassium (0.21±0.02 mg/g).The fruit *C. oliviforme* was highly nutritious and suggested that underutilized fruits could be employed as a source of protein, vitamins, and minerals. Hence, it is low-cost fruit with high nutritional and health value.The study also recommended exploring for their regular consumption and commercial nutraceutical aspects on health.This information is also necessary to improve the nutritional and health status of rural populations nationwide by utilizing underutilized and neglected specialities.

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**Authors contributions**

Concept, planning, supervision, manuscript draft and statistical analysis were done by UE. Experimental work was completed by YS. The manuscript review and editing were done by the PK. All the authors have read, review and final approval for the completed manuscript.

**Conflict of interest**

The authors declare that they have no conflict of interest.

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