Food Sci. Preserv., 32(4), 579-594 (2025)
pISSN: 3022-5477, eISSN: 3022-5485

Food Science and Preservation
https://doi.org/10.11002/fsp.2025.32.4.579

Review

Solanum macrocarpon L.: Nutritional value, bioactive compounds, and applications in food and medicine

Tran Thi Mai Anh[1], Le Pham Tan Quoc[1]*, Lam Bach Bao Phuong[1], Pham Thi Quyen[1], Vuong Bao Thy[2]

[1]*Institute of Biotechnology and Food Technology, Industrial University of Ho Chi Minh City, Ho Chi Minh City 700000, Vietnam*
[2]*Faculty of Health Sciences, University of Cuu Long, Vinh Long 85000, Vietnam*

Abstract *Solanum macrocarpon* L., a prominent Solanaceae plant from tropical and subtropical regions, holds significant ecological and medicinal value. This review systematically synthesizes current scientific understanding of its chemical composition, biological activities, and potential applications. *S. macrocarpon* is rich in nutrients such as carbohydrates, proteins, and minerals. This plant also contains diverse bioactive compounds, including tannins, alkaloids, saponins, polyphenols, flavonoids, quinones, and steroids, with many beneficial phytochemicals showing higher concentrations in the leaves. These compounds underpin its antibacterial, anti-inflammatory, antioxidant, and stress-relieving properties, alongside promising roles in diabetes, obesity, blood pressure regulation, and potential against cancer and cardiovascular disorders. Crucially, the presence of glycoalkaloids poses toxicity concerns, necessitating further research into safe levels and effective detoxification. Future directions emphasize rigorous research into glycoalkaloid management (levels and detoxification methods) and expanding applications beyond traditional uses for sustainable development in food and pharmaceutical industries, ultimately enhancing public health.

Keywords antibacterial activity, antioxidant activity, *Solanum macrocarpon* L.

Citation: Anh TTM, Quoc LPT, Phuong LBB, Quyen PT, Thy VB. *Solanum macrocarpon* L.: Nutritional value, bioactive compounds, and applications in food and medicine. Food Sci. Preserv., 32(4), 579-594 (2025)

Received: May 11, 2025
Revised: June 15, 2025
Accepted: June 18, 2025

***Corresponding author**
Le Pham Tan Quoc
Tel: +84-28-38940 390-666/555/891
E-mail: lephamtanquoc@iuh.edu.vn

1. Introduction

Solanum macrocarpon L. is a tropical perennial plant from the Solanaceae family. Known in Vietnamese as “cà pháo” and in English as the “Vietnamese white eggplant,”. This species is notable for its rich nutritional profile and pharmacological properties, making it an important component of traditional medicine and diets in many tropical regions, particularly in West Africa (Chinedu et al., 2011). With beneficial phytochemical compounds, such as tannins, alkaloids, phytates, phenols, saponins, flavonoids, and steroids (Edeoga et al., 2005; Sood et al., 2012), *S. macrocarpon* is a potent natural antioxidant with diverse biological activities, protecting the body from the harmful effects of free radicals and diseases related to inflammation, cardiovascular issues, and cancer.

In West Africa, *S. macrocarpon* is cultivated as a fruit-bearing plant and serves as a significant food source in the form of leafy vegetables, contributing to the daily diet of local populations. The leaves are considered a valuable nutritional source, rich in protein, fats, fiber, calcium, and zinc (Oboh et al., 2005). These leaves are commonly prepared in dishes, such as soups and stews, providing essential nutrients for the body. Additionally, other parts of the plant, including flowers, fruits, and seeds, have valuable applications in agriculture and pharmaceuticals.

The morphological characteristics of *S. macrocarpon* are diverse, spanning from its leaves to flowers, fruits, and seeds, creating a rich and valuable ecosystem (Fig. 1). The leaves range from 10 to 30 cm in length and 4 to 15 cm in width, with an oval shape and undulating margins, growing alternately along the stem. The flowers are clustered in small inflorescences containing 2-7 flowers, with a diameter of about 3-8 cm. The flowers in the lower part of the inflorescence are typically hermaphroditic, while those in the upper part tend to be male. The fruit is round, with a flattened, grooved surface at the top and bottom, measuring 5-7 cm in length and 7-8 cm in width. The seeds have an asymmetrical structure with a smooth surface and intricate patterns that enhance the distinctiveness and identification of this plant species (Wahua and Sam, 2016).

These physiological characteristics not only make *S. macrocarpon* easily recognizable but also contribute to its wide applications in the agriculture and food industries. For example, in addition to direct consumption, various parts of the plant can be utilized in the food processing and pharmaceutical industries. *S. macrocarpon* leaves are widely used in cooking and traditional medicine, especially in tropical African regions, such as Nigeria, where the plant is cultivated and integrated into daily meals. In addition to their nutritional value, leaves are known for their strong pharmacological effects. They are used to treat a range of conditions in traditional medicine, including asthma, allergic rhinitis, rhinitis, and skin diseases, such as infections and ulcers (Bello et al., 2005). The plant is regarded as an important medicinal herb in many indigenous medical practices across Africa and other tropical regions.

Fig. 1. Morphological characteristics of *Solanum macrocarpon* L. with leaves, flows, and fruits.

Thus, advancing and expanding research on *S. macrocarpon* is crucial. Beyond its traditional uses, improving the cultivation of this plant through advanced agricultural techniques can help increase its yield, quality, and commercial value. Novel studies on its bioactive compounds may open opportunities for the development of health-promoting and therapeutic products derived from nature, contributing to the growth of sustainable agriculture and economic development in regions where the plant is grown. Therefore, this comprehensive review aims to systematically compile and analyze current scientific literature on the phytochemical composition, nutritional value, and diverse biological activities of *S. macrocarpon*. Specifically, we seek to highlight its potential applications in both the food and pharmaceutical industries, identify existing knowledge gaps regarding its safe consumption and full utilization, and propose future research directions to optimize its sustainable development and maximize its benefits for public health.

2. Chemical composition of *S. macrocarpon*

S. macrocarpon is not only an important food plant but also possesses remarkable nutritional and pharmacological value, as highlighted in numerous studies. This plant contains a high concentration of essential minerals, including calcium, iron, potassium, and magnesium, which offer various health benefits. Jaeger and Hepper (1986) found that *S. macrocarpon* was a nutritious food source that could support important bodily functions, such as maintaining bone health, improving neurological functions, and maintaining the electrolyte balance.

According to the data presented in Table 1, the calcium and potassium content in *S. macrocarpon* leaves and fruit are particularly impressive. Specifically, the calcium and potassium levels in the fruit are 23.30-37.70 and 374.10 mg/100 g, respectively, indicating a moderate concentration of these essential minerals. However, in the leaves, the levels of both calcium and potassium are significantly higher, with concentrations reaching 1,704-1,965 mg/100 g for calcium and 2,289-4,596 mg/100 g for potassium (Ojo et al., 2015;

https://doi.org/10.11002/fsp.2025.32.4.579

Table 1. **Mineral composition of *Solanum macrocarpon* (mg/100 g, d.b.)**

Mineral	Leaves[1)]	Fruits[2)]
Calcium	1,704-1,965	23.23-37.70
Potassium	2,289-4,596	374.10
Magnesium	596-637.1	23.23-24.30
Phosphorus	275.90-430	47.34-51.00
Iron	9.40-25.1	0.30-20.30
Manganese	8.5	NT[3)]
Zinc	5.4-22.0	0.46-15.60
Copper	4.0-4.70	34.00

[1)]Data from Ojo et al. (2015), Sereno et al. (2018).
[2)]Data from Dougnon et al. (2012), Gbeyonron and Ortswen (2023).
[3)]NT, not tested.

Sereno et al., 2018). This stark difference highlights the leaves as a much richer source of these vital nutrients, which are crucial for various physiological functions, including bone health, muscle function, and maintaining fluid balance. The higher mineral content in the leaves suggests that they could be a valuable part of the plant, not only for their potential medicinal uses but also as a dietary supplement to enhance nutrient intake. These figures highlight the plant's superior nutritional profile compared to many other foods, particularly in providing essential nutrients that support bone health, the nervous system, and the normal functioning of bodily organs.

Compared to sesame seeds and bananas, which are common foods with lower calcium and potassium contents, *S. macrocarpon* offers superior nutritional value. Sesame seeds and bananas contain only 1,450 mg of calcium/100 g and 261.66-546.66 mg of potassium/100 g, respectively (Athira et al., 2019; Siji and Nandini, 2017). In contrast, *S. macrocarpon* provides significantly higher levels of these essential minerals in its leaves (Table 1), making it especially valuable for individuals who need to supplement their daily calcium and potassium intake.

Beyond these general comparisons, when examining *Solanum* species like *S. torvum*, *S. melongena* L., *S. incanum*, and *S. sessiliflorum* D., *S. macrocarpon* generally demonstrates a superior or at least comparable mineral content. For instance, *S. macrocarpon* fruit shows remarkably higher calcium levels compared to *S. torvum* (22.15 mg/100 g; Akoto et al., 2015), *S. incanum* (15.00 mg/100 g; Sambo et al., 2016), and *S. sessiliflorum* D. (1.82 mg/100 g; Sereno et al., 2018), which only contain trace or very low amounts of calcium (Table 2). Similarly, *S. macrocarpon*'s potassium content in its fruit far surpasses that found in *S. torvum* (9.153 mg/100 g; Asante et al., 2024), *S. incanum* (215.45 mg/100 g; Sambo et al., 2016), and *S. sessiliflorum* D. (0.55 mg/100 g; Sereno et al., 2018), and even the reported ranges for *S. melongena* L. (159-274.48 mg/100 g; Arivalagan et al., 2013). This trend extends to iron (e.g., *S. macrocarpon* fruit with high values vs. *S. torvum* 7.68 mg/100 g, *S. melongena* L. 0.170-0.846 mg/100 g, *S. sessiliflorum* D. 0.18 mg/100 g) and copper

Table 2. **Mineral composition in fruits of other *Solanum* species (mg/100 g, d.b.)**

Mineral	*S. torvum*[1)]	*S. melongena* L.[2)]	*S. incanum*[3)]	*S. sessiliflorum* D.[4)]
Calcium	22.15	NT[5)]	15.00	1.82
Potassium	9.153	159-274.48	215.45	0.55
Magnesium	NT	5.15-20.4	38.99	2.53
Phosphorus	NT	NT	1,082.50	0.90
Iron	7.68	0.170-0.846	325.75	0.18
Manganese	1.94	NT	147.00	0.04
Zinc	2.14	0.073-0.270	NT	0.08
Copper	0.26	0.024-0.178	256.05	40

[1)]Data from Akoto et al. (2015), Asante et al. (2024).
[2)]Data from Arivalagan et al. (2012), Arivalagan et al. (2013).
[3)]Data from Sambo et al. (2016).
[4)]Data from Sereno et al. (2018).
[5)]NT, not tested.

(e.g., *S. macrocarpon* fruit vs. *S. torvum* 0.26 mg/100 g, *S. melongena* L. 0.024-0.178 mg/100 g, *S. sessiliflorum* D. 40 mg/100 g), where *S. macrocarpon* (specifically its fruit) also exhibits substantially higher concentrations when compared to most of the *Solanum* species listed. While some *Solanum* species, like *S. incanum*, show high levels of certain minerals (e.g., phosphorus 1,082.50 mg/100 g and magnesium 38.99 mg/100 g), *S. macrocarpon* stands out for its consistently high concentrations of multiple key minerals, especially calcium and potassium in its fruit. This comparative analysis further underscores *S. macrocarpon*'s potential as a highly valuable source of essential dietary minerals within the *Solanum* species.

Additionally, in Nigeria, during the rainy season, *S. macrocarpon* thrives and becomes an important vegetable source in the local diet. However, in the dry season, the availability of this vegetable decreases, making preservation methods crucial to ensure its availability year-round. Traditional preservation techniques, such as sun-drying fresh or processed leaves, have been developed to extend the shelf life of vegetables. While these methods help preserve food for extended periods, the drying and cooking processes can result in nutrient losses, particularly in essential minerals and vitamins. Studies have noted nutrient degradation during vegetable processing, especially when they are dried or cooked for extended periods (Khachik et al., 1992; Yadav and Salgel, 2007). This can affect the nutritional value of the food, reducing the bioavailability of minerals, such as calcium, potassium, and magnesium, which are crucial for health.

Oboh et al. (2005) showed that *S. macrocarpon* leaves are rich in nutritional value, particularly in protein, fat, and carbohydrate content (Table 3). Regarding moisture content, the data indicate a broad range across the plant's parts, with the fruit exhibiting the highest levels, typically between 90.54 and 92.50 g/100 g. Leaves also contain a substantial amount of moisture (85.87-88.6 g/100 g), while roots show the lowest moisture content at 62.62 g/100 g (Chinedu et al., 2011; Gbeyonron and Ortswen, 2023; Ilodibia et al., 2016).

When compared to *Solanum* species, *S. macrocarpon*'s moisture content falls within a similar range to *S. torvum* (86.23-95.79%; Akoto et al., 2015), *S. melongena* L. (90.86-94.08%; Khan et al., 2015), *S. incanum* (91.40%; Sambo et al., 2016), and *S. sessiliflorum* D. (91.42-91.94%; Andrade-Júnior and Andrade, 2012), indicating that high moisture content is a common characteristic across many members of this species, suggesting their potential as fresh food sources.

The protein content in *S. macrocarpon* shows a clear trend, with leaves being the richest source. Specifically, the protein content in the leaves is 4.78-27.16 g/100 g, suggesting that the leaves of this plant serve as a significant source of plant-based protein. Notably, the protein concentration in the leaves is approximately four times higher than that found in the fruit (1.33-1.52 g/100 g) and considerably higher than in the roots (2.89 g/100 g), making leaves particularly useful for vegetarians or those needing to supplement their protein intake from plant sources. In comparison, the protein content of brown rice and black beans is 7.23% and 10.56 g/100 g, respectively (Anjum, 2007; Mary et al., 2021). Furthermore, *S. macrocarpon* fruit exhibit a comparable protein content when compared to *Solanum* species (Table 4), for example, *S. melongena* L. (1.30-1.51 g/100 g; Arivalagan et al., 2013) and *S. sessiliflorum* D. fruit (1.09-2.72 g/100 g; Vargas-Arana et al., 2024); while protein content of *S. torvum* (5.08 g/100 g) and *S. incanum* fruit (7.80 g/100 g) is

Table 3. Chemical composition of *Solanum macrocarpon* (g/100 g, f.w.)

Nutrients	Fruits[1)]	Roots[2)]	Leaves[3)]
Moisture	90.54-92.50	62.62	85.87-88.6
Protein	1.33-1.52	2.89	4.78-27.16
Fat	0.11-0.17	0.38	0.77-2.16
Ash	0.47-1.36	0.93	1.77
Carbohydrates	3.92-4.42	NT[4)]	NT

[1)]Data from Chinedu et al. (2011), Gbeyonron and Ortswen (2023).
[2)]Data from Ilodibia et al. (2016).
[3)]Data from Dougnon et al. (2012).
[4)]NT, not tested.

https://doi.org/10.11002/fsp.2025.32.4.579

Table 4. Chemical composition in fruits of other *Solanum species* (g/100 g, f.w.)

Nutrients	*S. torvum*[1)]	*S. melongena* L.[2)]	*S. incanum*[3)]	*S. sessiliflorum* D.[4)]
Moisture	86.23-95.79	90.86-94.08	91.40	91.42-91.94
Protein	5.08	1.30-1.51	7.80	1.09-2.72
Fat	10.50	0.28-0.31	12.50	1.08-2.72
Ash	6.51	5.4-6.4	21.20	0.71-094
Carbohydrates	7.033	NT[5)]	51.74	3.10-4.28

[1)]Data from Akoto et al. (2015), Asante et al. (2024).
[2)]Data from Arivalagan et al. (2012), Arivalagan et al. (2013), Khan et al. (2015).
[3)]Data from Sambo et al. (2016).
[4)]Data from Andrade-Júnior and Andrade (2012), Vargas-Arana et al. (2024).
[5)]NT, not tested.

significantly higher (Asante et al., 2024; Sambo et al., 2016).

In addition to protein, the leaves of *S. macrocarpon* also contain notable amounts of fat and carbohydrates, providing energy for the body and supporting its physiological functions. These components are essential in maintaining stable energy levels and supporting metabolic processes.

The fat content in different parts of *S. macrocarpon* has been studied, showing clear differences between the fruit, roots, and leaves. There is a discernible trend of increasing fat content from the fruit to the roots, and then to the leaves. Specifically, the fat content is in the range of 0.11-0.17 g/100 g in fruit, 0.38 g/100 g in the roots, and is highest at 0.77-2.16 g/100 g in the leaves (Chinedu et al., 2011; Gbeyonron and Ortswen, 2023; Ilodibia et al., 2016). The increasing fat content from fruit to leaves is similar to the trend observed for ash content, which also increases from fruit (0.47-1.36 g/100 g) to roots (0.93 g/100 g) and leaves (1.77 g/100 g) (Chinedu et al., 2011; Gbeyonron and Ortswen, 2023; Ilodibia et al., 2016). When compared with *Solanum* species, *S. macrocarpon*'s fat content in fruit (up to 2.16 g/100 g) is generally higher than that of *S. melongena* L. (0.28-0.31 g/100 g; Khan et al., 2015) and comparable to *S. sessiliflorum* D. (1.08-2.72 g/100 g; Vargas-Arana et al., 2024). However, it is notably lower than the high fat content reported for *S. torvum* (10.50 g/100 g; Asante et al., 2024) and *S. incanum* (12.50 g/100 g; Sambo et al., 2016). Regarding ash content, *S. macrocarpon* fruit (1.77 g/100 g) appears to have a lower ash content than *S. torvum* (6.51%; Asante et al., 2024) and *S. incanum* (21.20%; Sambo et al., 2016), though it is comparable to or slightly higher than *S. sessiliflorum* D. (0.71-0.94%; Vargas-Arana et al., 2024). Although the fat levels in these parts are not particularly high, they still play a significant role in the plant's biological effects. Scientific studies have demonstrated that *Solanum* species can regulate blood lipoprotein levels, specifically reducing low-density lipoprotein (LDL) - the "bad" cholesterol - while increasing high-density lipoprotein (HDL), the "good" cholesterol, thereby protecting the cardiovascular system. This effect has been clearly demonstrated in rabbits with hypercholesterolemia (Igwe et al., 2003; Odetola et al., 2004), suggesting that *S. macrocarpon* may reduce the risk of cardiovascular disease.

Regarding carbohydrates, current research primarily focuses on the fruit, showing a range of 3.92-4.42 g/100 g. However, there is a notable lack of detailed studies on carbohydrate content in the leaves and roots of *S. macrocarpon* (Chinedu et al., 2011; Gbeyonron and Ortswen, 2023), indicating a gap in current knowledge.

Reported nutritional values for *S. macrocarpon* can vary due to environmental factors (soil, climate, light), plant variety, and post-harvest processing (drying, cooking). Consequently, these elements directly influence nutrient content and can explain conflicting research findings. Recognizing these variables is key for a more accurate understanding of the plant's true nutritional profile and for standardizing future research.

In general, *S. macrocarpon* is a versatile plant that provides rich nutrition and has numerous important medical applications for treating common diseases. Research and development related to appropriate preservation methods to maintain the plant's nutritional and pharmacological value are essential to maximizing the benefits of this plant in the community. Furthermore, studies on the biological effects of *S. macrocarpon* will provide opportunities for the development of additional natural health products, particularly in the context of the increasing demand for natural medicinal therapies.

3. Phytochemicals in *S. macrocarpon*

Table 5 shows that the fruit and leaves of *S. macrocarpon* are rich in bioactive compounds, including tannins, alkaloids, saponins, polyphenols, flavonoids, phytosterols, and triterpenoids (Chinedu et al., 2011; Oyessola et al., 2022). The potential of these bioactive compounds suggests that *S. macrocarpon* may offer new beneficial properties for the fields of medicine and pharmacology.

Table 5 highlights the significant differences in the biological activities between the leaves and fruit of *S. macrocarpon*. Specifically, the leaves contain compounds such as alkaloids, pyrogallic tannins, mucilage, saponins, and reducing compounds. Although *S. macrocarpon* is widely consumed, particularly in regions such as Nigeria, no comprehensive studies have yet confirmed the long-term safety of consuming the leaves, especially regarding the impact of the compounds found in the leaves on human health.

On the other hand, tannins, particularly hydrolysable pyrogallic tannins, have been identified as potentially having negative effects at high doses, such as reducing growth and inhibiting protein digestion in experimental animals. Additionally, research has shown that certain cancers, such as esophageal cancer, may be linked to the consumption of foods rich in tannins, as tannins negatively affect cells and, in some cases, contribute to carcinogenesis (Ross et al., 2020). Therefore, excessive consumption of this vegetable, particularly the leaves, should be carefully controlled to avoid potential health risks.

Emebu and Anyika (2011) noted the presence of tannins in *S. macrocarpon*, showing that tannins are found in both the leaves and fruit but in different concentrations. *S. macrocarpon* fruit contains a moderate number of hydrolysable tannins, while the leaves have a higher concentration, which explains the more common consumption of the leaves than the fruit in many African countries. Sodipo et al. (2008) clarified the astringent properties of tannins and highlighted their role in traditional medicine as a treatment for wounds. However, the strong presence of tannins in the leaves can have an opposite effect if consumed excessively. Chinedu et al. (2011) also confirmed the presence of tannins in *S. macrocarpon* fruit but in more moderate amounts compared to the leaves.

In addition to tannins, *S. macrocarpon* leaves and fruit contain several other bioactive compounds with pharmacological effects. The presence of alkaloids (which are found in low concentrations in the leaves and higher concentrations in the fruit) suggests potential analgesic, anti-inflammatory, and immunostimulant properties as well as stress-reducing effects (Gupta, 1994). The mucilage in leaves and fruits, which consists of polysaccharides, is known for its antioxidant properties (Lin et al., 2005), indicating the potential of *S. macrocarpon* as a food and medicinal plant capable of

Table 5. Phytochemicals in fruits, leaves, and roots of *Solanum macrocarpon*

Phytochemical	Fruits[1]	Leaves[2]	Roots[3]
Tannins	+[4]	+	+
Alkaloid	+	+	+
Saponin	+	+	+
Polyphenol	+	+	NT
Flavonoid	+	+	-
Quinone	NT	NT	NT
Steroid	-	+	NT
Triterpenoids	+	-	NT
Phytosterols	+	NT	NT

[1]Data from Chinedu et al. (2011).
[2]Data from Oyessola et al. (2022).
[3]Data from Ilodibia et al. (2016).
[4]+, present; -, absent; NT, not tested.

https://doi.org/10.11002/fsp.2025.32.4.579

protecting cells from free radical damage.

Furthermore, *S. macrocarpon* is a rich source of reducing compounds, including monosaccharides and disaccharides, which are found in the fruit (Otshudi et al., 2000). Saponins, a group of glycosidic compounds, are also present in leaves and are known for their expectorant properties, which are helpful in treating respiratory infections (Sodipo et al., 2008).

Notably, phytochemical analysis reveals that *S. macrocarpon* fruit is rich in key bioactive compounds such as tannins, alkaloids, saponins, polyphenols, flavonoids, triterpenoids, and phytosterols (Chinedu et al., 2011). The presence of tannins, alkaloids, and saponins is a notable commonality when compared to the fruits of *S. incanum*, *S. melongena* L., *S. torvum*, and *S. sessiliflorum* D., indicating these are widespread phytochemical groups within the *Solanum* species (Table 6). Similarly, polyphenols and flavonoids are also frequently found in these species, reinforcing their antioxidant roles. However, a distinction emerges with triterpenoids: while present in *S. macrocarpon* and some species like *S. torvum* (Kannan et al., 2012) and *S. sessiliflorum* D. (Mascato et al., 2015), they are notably absent in *S. melongena* L. (Contreras-Angulo et al., 2022; Solanke et al., 2019). Overall, the rich phytochemical profile of *S. macrocarpon* fruit, with significant similarities to *Solanum* species, underscores its potential as a valuable source of beneficial compounds for health and medicinal purposes. However, it's crucial to acknowledge that differences in cultivation region, climate, and soil composition can also influence the specific phytochemical concentrations reported across studies for these *Solanum* species.

Overall, the research findings suggest that while *S. macrocarpon* has significant nutritional and pharmacological value, its consumption should be carefully managed to avoid unwanted effects due to the presence of compounds, such as tannins, alkaloids, and coumarins. Moreover, the differences in chemical composition between the plant's leaves and fruit highlight the need for clear distinctions in their use, as excessive consumption of the leaves can have adverse effects. Further research is needed to better understand the long-term effects and safety of using *S. macrocarpon* in both dietary and medicinal contexts.

4. Antioxidant capacity, total polyphenol content (TPC), and tannin content of *S. macrocarpon*

The antioxidant concentration required to reduce the initial concentration of 2,2-diphenyl-1-picrylhydrazyl (DPPH) by 50% (IC_{50}) is an important and commonly used parameter to measure the antioxidant activity of plant extracts. A lower IC_{50} value indicates a higher antioxidant capacity, meaning the substance can neutralize free radicals more effectively

Table 6. Phytochemicals in fruits of other *Solanum* species

Phytochemical	*S. incanum*[1)]	*S. melongena* L.[2)]	*S. torvum*[3)]	*S. sessiliflorum* D.[4)]
Tannins	+[5)]	+	+	+
Alkaloid	+	+	+	+
Saponin	+	+	+	-
Polyphenol	NT	+	+	+
Flavonoid	+	+	+	+
Quinone	NT	NT	NT	NT
Steroid	+	NT	+	+
Triterpenoids	NT	-	+	+
Phytosterols	+	+	NT	+

1)Data from Sambo et al. (2016).
2)Data from Solanke at al. (2019), Contreras-Angulo et al. (2022).
3)Data from Kannan et al. (2012).
4)Data from Mascato et al. (2015).
5)+, present; -, absent; NT, not tested.

(Brighente et al., 2007). According to Ojo et al. (2015) and Eletta et al. (2017), the antioxidant capacity of various parts of *S. macrocarpon* varies significantly, with the lowest IC_{50} value found in the fruit (IC_{50}=3.9-33.56 μg/mL) and the highest in the leaves (IC_{50}=47.06 μg/mL) (Table 7). This suggests that fruit extracts are more potent in scavenging free radicals than leaf extracts, reflecting a higher concentration of antioxidant compounds in the fruit than in the leaves.

Beyond its antioxidant properties, *S. macrocarpon* is notably rich in its TPC, reflecting its significant contribution to human health. Studies have shown a clear trend in TPC distribution: it is most abundant in the leaves, reaching levels as high as 61.93, highlighting leaves as a prime source of natural antioxidants. Conversely, the fruit contains the lowest TPC, at 8.13. Interestingly, current literature does not extensively detail or report the presence of TPC in the roots of *S. macrocarpon*, indicating an area for future research. This plant also contains other important compounds, such as tannins, found in all parts of the plant (leaves, roots, and fruit). The concentration of tannins also exhibits a distinct trend across the plant's various parts: it is highest in the leaves with 6.39 mg/g, followed by the roots at 0.77 %, and lowest in the fruit at 0.65% (Eletta et al., 2017; Ilodibia et al., 2016; Ojo et al., 2015). Tannins are phenolic compounds with strong antioxidant properties that inhibit the development of free radicals and protect the body from oxidative damage. Furthermore, some studies have reported the presence of steroid compounds in these plants, particularly in their leaves, though other research may present differing results (Dougnon et al., 2012). These steroid compounds are closely related to sex hormones, such as testosterone and estrogen, and play a crucial role in the synthesis of these hormones in the body (Okwu, 2001). This explains why *S. macrocarpon* leaves are commonly used in Vietnam as a nutritious vegetable for pregnant or breastfeeding women to help balance hormones in the body and support fetal development.

In conclusion, the presence of tannins, flavonoids, polyphenols, and other compounds in various parts of *S. macrocarpon* is responsible for the plant's positive physiological effects and antioxidant properties. These compounds can help reduce free radical accumulation, thereby protecting the body from damage caused by oxidative stress. However, further detailed studies are needed to isolate and clearly identify the active components in each part of the plant to fully exploit the potential of *S. macrocarpon* in medicine and practical applications. These studies also help clarify the mechanisms of action of these compounds and expand their potential uses in the treatment and prevention of diseases related to oxidative stress and chronic inflammation.

5. Antibacterial activity of *S. macrocarpon*

Table 8 indicates that different *S. macrocarpon* parts, including the leaves, roots, and fruit, exhibit good antibacterial activity against various test bacteria. Specifically, the minimum inhibitory concentration (MIC) values of the ethanol extract from these plant parts against different bacteria are outlined in the table. Leaf extracts have shown strong antibacterial activity. For *S. macrocarpon* leaves, the aqueous extract demonstrated significant inhibition against *Staphylococcus aureus* with a zone of 23.56±0.46 mm at 200 mg/mL, and against *Escherichia coli* with 21.33±0.70 mm at 150 mg/mL. It was also effective against *Klebsiella pneumoniae*, showing 20.00±0.71 mm at 200 mg/mL (Enyinta et al., 2024). These results indicate strong efficacy, particularly against Gram-negative bacteria, based on the agar diffusion method. In contrast, the fruit extract exhibited activity against *E. coli* and *S. aureus* at concentrations ranging from 100 to 200 mg/mL. However, its antibacterial efficacy was generally lower compared to the leaves. For *S. macrocarpon* fruit aqueous extract, the highest recorded inhibition zone against *Salmonella* sp. was 21.67±0.20 mm at 200 mg/mL, against *E. coli* was

Table 7. Antioxidant capacity and total polyphenol content (TPC) in leaves, roots, and fruits of *Solanum macrocarpon*

Parts	Antioxidant (IC_{50}, μg/mL)	TPC (mg GAE/g)	Tannin content	References
Leaves	47.06	61.93	6.39 mg/g	Ojo et al. (2015), Oyessola et al. (2022)
Roots	NT	NT	0.77%	Ilodibia et al. (2016)
Fruits	3.9-33.56	8.13	0.65%	Eletta et al. (2017) Oaa et al. (2017)

NT, not tested.

https://doi.org/10.11002/fsp.2025.32.4.579

Table 8. Antibacterial ability of leaves, roots, and fruits of *Solanum macrocarpon*

Microorganism	Leaves[1)]	Roots[2)]	Fruits[1)]
Staphylococcus aureus	+[3)]	+	+
Escherichia coli	+	+	+
Candida albicans	+	+	+
Aspergillus niger	+	+	+
Klebsiella pneumonia	+	NT	+
Salmonella sp.	+	NT	+

1)Data from Ilodibia et al. (2016), Enyinta et al. (2024).
2)Data from Ilodibia et al. (2016).
3)+, present; NT, not tested.

18.97±0.43 mm at 200 mg/mL, and against *S. aureus* was 16.58±0.33 mm at 200 mg/mL (Enyinta et al., 2024).

Regarding the root extract, while it did not show a significant inhibition zone in agar diffusion assays (Ilodibia et al., 2016), further studies using different methods confirmed its antimicrobial potential. The root extract demonstrated activity against *E. coli* with a MIC of 50 mg/mL and a Minimum Bactericidal Concentration (MBC) of 100 mg/mL. Similarly, it was effective against *S. aureus* with an MIC of 50 mg/mL and an MBC of 100 mg/mL (Ilodibia et al., 2016). Compared to the leaf and fruit extracts, which exhibited clear inhibition zones, the root extract's efficacy, as measured by MIC/MBC, requires relatively higher concentrations for inhibition compared to the lower end of the active concentration ranges of leaf/fruit extracts in agar diffusion (e.g., leaf at 50 mg/mL in study of Enyinta et al. 2024). This difference may be related to the evaluation methods, distribution and concentration of bioactive compounds, such as alkaloids, flavonoids, saponins, and polyphenols, in each part of the plant (Hassan et al., 2009). These compounds are known for their strong antibacterial properties, particularly against common pathogenic bacteria, such as *E. coli* and *K. pneumoniae*. These findings suggest that the various parts of *S. macrocarpon* are valuable natural resources for developing antibacterial products that contribute to public health protection.

The previous results highlighted the similarity in antibacterial potential among species within the *Solanum* species. Ihodibia et al. (2016) demonstrated that leaf and fruit extracts from *S. aethiopicum* and *S. macrocarpon* exhibited bactericidal and fungicidal activities (minimum bactericidal/fungicidal concentration, MB/MFC) ranging from 25 to 100 mg/mL against the tested organisms, indicating strong antibacterial potential within *Solanum* species. This similarity may be attributed to the presence of bioactive compounds, such as alkaloids, flavonoids, and saponins, which are known for their ability to inhibit the growth of bacteria and fungi. Additionally, Tegegne et al. (2021) affirmed the antibacterial activity of *S. anguivi*, particularly against *E. coli* and *K. pneumoniae*. This further supports the hypothesis that *Solanum* species contain potent bioactive compounds that help protect the plant from pathogenic attacks while also providing opportunities for the development of natural antibacterial products. The similarities among these species emphasize the value of *Solanum* plants as a valuable resource in the research and production of plant-derived pharmaceutical products.

Thus, these findings not only highlight the diverse antibacterial potential of the various parts of *S. macrocarpon* but also contribute to expanding the scientific foundation for the use of natural plants in medicine. This provides a basis for further research into the biological activities and application potential of these extracts in developing therapeutic products, especially in the context of the growing issue of antibiotic-resistant bacterial and fungal infections today.

6. Pharmacological properties of *S. macrocarpon*

Table 9 indicates that *S. macrocarpon* fruit extracts inhibit tracheal contractions, suppress nitric oxide (NO) production, protect against air pollution-induced oxidative stress, and prevent obesity in mice at doses of 46.8 μg/mL, 200 μg/mL, 75 mg/kg, and 200 mg/kg, respectively (Akinwunmi and Ajibola, 2018; Bello et al., 2005; Ng et al., 2015; Olajire and Azeez, 2012). Excessive NO production can increase chronic

Table 9. Pharmacological properties of fruits and leaves of *Solanum macrocarpon*

Part	Subjects	Dosage	Effects	References
Fruits	Hartley guinea pigs	46.8 μg/mL	Brochial spasm inhibition	Bello et al. (2005)
	RAW 264.7	200 μg/mL	No inhibition	Ng et al. (2015)
	Adult male albino rats	75 mg/kg	Anti-stress due to air pollution	Olajire and Azeez (2012)
	Adult female Wistar	200 mg/kg	Obesity	Akinwunmi and Ajibola (2018)
Leaves	Adult Wistar rats	600 mg/kg	Treatment of acute renal toxicity due to acetaminophen	Sood et al. (2012)
	Male albino rats	500 mg/kg	Anti-stress	Elasoru et al. (2018)
	Spontaneously hypertensive rats	100 mg/kg	Antihypertensive	Oluwagunwa et al. (2019)
	Male Wistar rats	550 mg/kg	Reduce anxiety	Mary et al. (2020)
	Male Wistar rats	49.8 mg/kg	Reduce kidney disease	Ekakitie et al. (2021)
	Diabetic rats	100 mg/kg	Improve cardiomyopathy	Osukoya et al. (2022)
	Female albino rats	800 mg/kg	Enhance fertility	Ezechukwu et al. (2024)

inflammatory responses, contributing to the development of severe conditions (Ng et al., 2015). Therefore, inhibiting NO production is a key strategy in chronic inflammatory disease treatment.

Olajire and Azeez (2012) demonstrated that *S. macrocarpon* can mitigate toxicity caused by exposure to urban air pollution. Specifically, their study found that oral administration of a *S. macrocarpon* fruit extract at a dose of 75 mg/kg body weight in rats significantly reduced oxidative stress markers and improved histopathological changes in affected organs. This finding supports the broader understanding that urban air pollution can cause severe toxic effects on vital organs, such as the lungs, liver, and kidneys (Mary et al., 2020).

Moreover, beyond its protective effects against pollution, *S. macrocarpon* leaf extracts have also been studied for their potential to treat acute nephrotoxicity induced by acetaminophen (also known as paracetamol) at a dose of 550 mg/kg, a widely used pain reliever and antipyretic agent. Although paracetamol is very effective in treating pain and fever, it can also cause acute tubular necrosis, one of the leading causes of acute kidney failure (Cobden et al., 1982). *S. macrocarpon* leaf extracts can reduce kidney damage and aid in the recovery of kidney function, highlighting their potential application in treating kidney toxicity-related issues.

Furthermore, *S. macrocarpon* leaf extracts have been reported to have various therapeutic effects, including reducing stress (Elasoru et al., 2018), alleviating diabetic nephropathy (Ekakitie et al., 2021), improving diabetic cardiomyopathy (Osukoya et al., 2022), and enhancing fertility (Ezechukwu et al., 2024). These effects reflect the broad range of biological activities of *S. macrocarpon*.

The research findings suggest that *S. macrocarpon* has significant anti-inflammatory and health-protective potential. However, all these studies were conducted in animal models, primarily in mice, and no clinical evaluations in humans have been reported. This presents a major challenge in translating these findings into practical applications. Therefore, to better understand the effectiveness and safety of *S. macrocarpon* for human health, more detailed clinical studies are required. Further research and human trials will help clarify the plant's potential in health protection, particularly in the context of increasing air pollution-related diseases and drug toxicity.

7. Applications of *S. macrocarpon* fruit in food in Vietnam

S. macrocarpon, commonly known as "cà pháo" or eggplant, is a plant of significant culinary and medicinal value in Vietnamese culture, particularly in traditional dishes. Not only is *S. macrocarpon* an essential ingredient in various foods, but it also contains numerous nutrients that have health benefits. One of the most popular traditional dishes made from *S. macrocarpon* is pickled eggplant. Each preparation method highlights the vegetable's natural sweetness, which, when combined with simple spices, enhances the flavor of the dish.

In recent years, several processed products made from *S. macrocarpon* have been commercialized, offering convenience

 https://doi.org/10.11002/fsp.2025.32.4.579

to consumers. Products such as pickled eggplant (Fig. 2), sour and spicy eggplant (Fig. 3), and traditional fermented shrimp sauce-based eggplant preparation (Fig. 4) are now available on the market, catering to the growing consumer demand. The prices of these products range from USD 1.08 to 1.50 for 400 g, depending on the type and quality. This indicates a promising market, reflecting the widespread popularity of *S. macrocarpon* in Vietnamese cuisine and the increasing demand for its consumption. These products are easy to make and can be produced on a small or industrial scale. Some processing processes of Vietnamese white eggplant fruit are described as follows:

Fig. 2. Commercially available pickled *Solanum macrocarpon* (Vietnamese white eggplant) product.

Fig. 3. Commercially available sour and spicy *Solanum macrocarpon* (Vietnamese white eggplant) product.

Fig. 4. Eggplant prepared with fermented shrimp sauce, a traditional Vietnamese dish.

7.1. Pickled eggplant

Ingredients: Soak the eggplants in a diluted salt solution (1 tablespoon of salt per 500 mL of water) for 10-15 minutes. Mix 1,000 mL of water with 3-4 tablespoons of salt, 1-2 tablespoons of sugar, and 2-3 tablespoons of vinegar (or lemon juice), and stir well. Remove 1 kg of eggplant, rinse it under clean water, and place it in a glass jar. Pour the pickling liquid over the eggplant until it is fully submerged. Seal the jar and leave it in a cool place for 2-3 days. Once the eggplants absorb the flavors and become crisp, they are ready to be eaten with white rice, braised meat, or other dishes.

7.2. Sour and spicy eggplant

Clean the eggplant, remove the stem, and make small cuts on each fruit. Soak the eggplant in a diluted salt solution for 10-15 minutes, then drain it and let it cool. Boil water with vinegar, fish sauce, sugar, and salt, stirring until the ingredients dissolve completely, and then let it cool. Chop garlic and slice chili. Place the eggplants in a jar, add garlic and chili, and pour the prepared pickling liquid over them to fully submerge the eggplant. Seal the jar and let it sit at room temperature for 1-2 days. The eggplants have a tangy, spicy flavor and crisp texture.

7.3. Traditional fermented shrimp sauce-based eggplant preparation

Cut the eggplant into halves or quarters, and soak it in a lemon salt solution for 30 min. Rinse the eggplant several times. Mix 200 g of fermented shrimp paste, 100 g of water, and 100 g of sugar in a pot, and heat while stirring until the shrimp paste boils. Remove the mixture from the heat and let it cool. Add the eggplant, mix well, and place it in a glass jar to allow it to absorb the flavors overnight.

Depending on the culinary characteristics of the different regions, preparation methods vary significantly. However, most products made from these ingredients are still primarily produced on a small scale. Therefore, it is essential to promote and introduce these unique dishes globally.

With immense potential in both culinary and medicinal applications, *S. macrocarpon* could become a key product in the agricultural economy if developed sustainably with a strategic approach. As the demand for organic and healthy food continues to rise, *S. macrocarpon* has the opportunity to expand both domestically and internationally.

8. Toxicity of *S. macrocarpon* and potential solutions in the future

While *S. macrocarpon* offers several benefits, such as fast growth and high nutritional value, it also contains glycoalkaloids – a group of compounds that can be harmful to health if consumed in high quantities. According to Moreau et al. (2002), *S. macrocarpon* fruit and leaves contain glycoalkaloids, which protect the plant from pests and fungi. However, if these compounds accumulate in food, they can have negative health effects. Despite this, there is still limited research on the levels of glycoalkaloids in *S. macrocarpon* fruit, and detailed studies on their concentrations are necessary.

Indeed, alkaloids have been reported in both the leaves (Ezechukwu et al., 2016) and fruit (Sánchez-Mata et al., 2010) of *S. macrocarpon*. Notably, the levels of these compounds in *S. macrocarpon* fruits were found to be much higher than those reported for the common eggplant (*S. melongena*) and scarlet eggplant (*S. aethiopicum*), reaching values of 1.4-2.2 mg/g fresh weight, which is far beyond the safety level (Sánchez-Mata et al., 2010). However, it is also acknowledged that other reports suggest a much lower content, indicating that this plant characteristic can vary intraspecifically (Sánchez-Mata et al., 2010). A study on the toxicity of fresh leaves of tropical vegetables demonstrated the relatively low toxicity of *S. macrocarpon* leaves when compared to other plant species (Oboh, 2005). The presence of cholesterol in plants from the Solanaceae family is typically linked to the biosynthesis of glycoalkaloids (Hartmann, 1998). Therefore, the analysis of glycoalkaloid content in the leaves is crucial for a proper evaluation of the potential toxicity of *S. macrocarpon* leaves, as well as edible parts of other underutilized *Solanum* species (Haliński et al., 2012).

Beyond glycoalkaloids, another aspect of potential toxicity relates to the plant's cuticular waxes. While plant long-chain hydrocarbons found in these waxes are generally believed to be non-toxic for mammals (Kolattukudy and Hankin, 1966), there have been past reports of massive deposits of plant n-alkanes in the livers and lungs of animals (Halse et al., 1993) and humans (Salvayre et al., 1988). The hydrocarbon content in *S. macrocarpon* leaf waxes is relatively low, being 6-13 times lower than in the closely related eggplant (*S. melongena*). Specifically, the alkane content in *Solanum* species can vary, with reported values for *S. macrocarpon* ranging from 3.4 mg to 4.0 mg per 100 g fresh weight, while in eggplant leaves, it ranged from 23 to almost 45 mg per 100 g (Haliński et al., 2012). Despite these relatively low levels in *S. macrocarpon*, the potential risk associated with consuming large amounts of long-chain hydrocarbons of plant origin necessitates further complex studies involving *Solanum* species.

To ensure consumer safety, international organizations have established guidelines for total glycoalkaloid (TGA) content in food, primarily based on extensively studied crops like potatoes. The World Health Organization (WHO) considers TGA levels below 100 mg/kg fresh weight (FW) in potatoes as not concerning (WHO, 2023). Some broader assessments also suggest an acceptable upper safety limit of up to 200 mg/kg FW for TGA in products (Knuthsen et al., 2009).

To address the issue of glycoalkaloid toxicity in edible forms, various strategies can be considered, focusing on processing methods.

Processing Methods: Glycoalkaloids are generally considered quite heat-stable, with significant degradation typically occurring only at very high temperatures (e.g., above 200°C) (Friedman, 2006). However, standard food processing techniques

https://doi.org/10.11002/fsp.2025.32.4.579

can still effectively reduce their levels. Peeling is highly effective as glycoalkaloids are primarily concentrated in the skin or outer layers (Friedman, 2006). While not destroyed by typical boiling temperatures, glycoalkaloids are somewhat water-soluble; thus, boiling can reduce their concentration by leaching them into the cooking water, especially from peeled plant parts. Therefore, discarding the cooking water after boiling is recommended (Ojo et al., 2024). Deep-frying at high temperatures (e.g., above 170°C) can also lead to partial decomposition of glycoalkaloids, contributing to their reduction in the final product (Elżbieta, 2012). Furthermore, fermentation or prolonged soaking (with subsequent discarding of soaking water) may also contribute to glycoalkaloid reduction through enzymatic degradation or leaching. However, their specific efficacy for *S. macrocarpon* requires further investigation (Friedman, 2006). Implementing appropriate processing methods during food preparation is a practical approach to enhance the safety of *S. macrocarpon* for consumption. This would benefit both human health and increase the economic value of *S. macrocarpon*, especially in markets with stringent food safety standards.

Currently, despite initial insights into the chemical composition and potential toxicity of *S. macrocarpon* based on *in vitro* models (such as brine shrimp larvae) and data on the content of harmful compounds (glycoalkaloids) as well as heavy metals, there remains a critical lack of in-depth toxicity studies specifically on human subjects. Therefore, future research should focus on determining safe dosages, evaluating long-term health impacts, and exploring cultivation and processing methods to minimize toxins, thereby ensuring maximum consumer safety.

9. Conclusions

S. macrocarpon provides numerous benefits to human life, both economically and medicinally, through its various parts. Scientific studies have shown that the plant contains valuable nutrients, such as carbohydrates, proteins, minerals, and bioactive compounds, including phenolics, saponins, tannins, and steroids. These compounds exhibit anti- inflammatory, antimicrobial, antioxidant, blood pressure- regulating, blood sugar-stabilizing, and potential anticancer properties. While *S. macrocarpon* is widely used in cooking and traditional medicine, its medicinal potential extends to pharmaceuticals and health products, utilizing not only the fruit and leaves but also other parts like flowers and roots. However, it is important to acknowledge that *S. macrocarpon* contains glycoalkaloids, which can be toxic if consumed in excessive amounts. These compounds may cause adverse effects such as gastrointestinal disturbances and, in severe cases, neurological symptoms. Therefore, future research should focus on determining safe consumption levels and developing effective detoxification methods to minimize health risks. Additionally, further studies should explore innovative applications of *S. macrocarpon* in functional foods and nutraceuticals while ensuring safety and efficacy. By addressing these challenges, *S. macrocarpon* can contribute more effectively to sustainable development in the food and pharmaceutical industries, ultimately improving public health and quality of life.

Funding

None.

Acknowledgements

The authors would like to express their gratitude to the Institute of Biotechnology and Food Technology, Industrial University of Ho Chi Minh City for supporting this research.

Conflict of interests

The authors declare no potential conflicts of interest.

Author contributions

Conceptualization: Anh TTM, Quoc LPT. Methodology: Anh TTM, Quoc LPT, Phuong LBB, Quyen PT. Formal analysis: Anh TTM, Quyen PT, Thy VB. Validation: Anh TTM, Quoc LPT, Thy VB. Writing - original draft: Phuong LBB. Writing - review & editing: Quoc LPT.

Ethics approval

This article does not require IRB/IACUC approval because there are no human and animal participants.

ORCID

Tran Thi Mai Anh (First author)
https://orcid.org/0000-0003-4161-3455
Le Pham Tan Quoc (Corresponding author)
https://orcid.org/0000-0002-2309-5423
Lam Bach Bao Phuong
https://orcid.org/0009-0004-4152-609X
Pham Thi Quyen

https://orcid.org/0000-0003-3695-3703
Vuong Bao Thy
https://orcid.org/0009-0005-1753-4433

References

Akinwunmi KF, Ajibola IO. Evaluation of anti-obesity potentials of phenolic-rich fraction of *Solanum aethiopicum* L. and *Solanum macrocarpon* on diet-induced obesity in Wistar rats. Eur J Med Plants, 26, 1-10 (2018)

Akoto O, Borquaye LS, Howard AS, Konwuruk N. Nutritional and mineral composition of the fruits of *Solanum torvum* from Ghana. Int J Chem Biomol Sci, 4, 222-226 (2015)

Andrade-Júnior MCD, Andrade JS. Physicochemical changes in cubiu fruits (*Solanum sessiliflorum* Dunal) at different ripening stages. Food Sci Technol, 32, 250-254 (2012)

Anjum FM, Pasha I, Bugti MA, Butt MS. Mineral composition of different rice varieties and their milling fractions. Pak J Agric Sci, 44, 332-336 (2007)

Arivalagan M, Bhardwaj R, Gangopadhyay KK, Prasad TV, Sarkar SK. Mineral composition and their genetic variability analysis in eggplant (*Solanum melongena* L.) germplasm. J Appl Bot Food Qual, 86, 99-103 (2013)

Arivalagan M, Gangopadhyay KK, Kumar G, Bhardwaj R, Prasad TV, Sarkar SK, Roy A. Variability in mineral composition of Indian eggplant (*Solanum melongena* L.) genotypes. J Food Compos Anal, 26, 173-176 (2012)

Asante JO, Oduro I, Wireko-Manu F, Larbie C. Assessment of the antioxidant and nutritive profile of the leaves and berries of *Solanum nigrum* and *Solanum torvum* Swart. Appl Food Res, 4, 100438 (2024)

Athira KS, Tripathy TB, Sharma S, Harisankar MS. Shimbi Dhanya (pulses) as ayurvedic food supplement for calcium deficiency. J Ayurveda Integr Med Sci, 4, 47-50 (2019)

Bello SO, Muhammad BY, Gammaniel KS, Abdu-Aguye I, Ahmed H, Njoku CH, Pindiga UH, Salka AM. Preliminary evaluation of the toxicity and some pharmacological properties of the aqueous crude extract of *Solanum melongena*. Res J Agric Biol Sci, 1, 1-9 (2005)

Chinedu SN, Olasumbo AC, Eboji OK, Emiloju OC, Arinola OK, Dania DI. Proximate and phytochemical analyses of *Solanum aethiopicum* L. and *Solanum macrocarpon* L. fruits. Res J Chem Sci, 1, 63-71 (2011)

Cobden I, Record CO, Ward MK, Kerr DN. Paracetamol-induced acute renal failure in the absence of fulminant liver damage. Br Med J, 284, 21-22 (1982)

Contreras-Angulo LA, Moreno-Ulloa A, Carballo-Castañeda RA, León-Felix J, Romero-Quintana JG, Aguilar-Medina M, Ramos-Pyán R, Heredia JB. Metabolomic analysis of phytochemical compounds from agricultural residues of eggplant (*Solanum melongena* L.). Molecules, 27, 7013 (2022)

Dougnon TV, Bankolé HS, Johnson RC, Klotoé JR, Dougnon G, Gbaguidi F, Assogba F, Gbénou J, Sahidou S, Atègbo JM, Rihn BH, Loko F, Boko M, Edorh AP. Phytochemical screening, nutritional and toxicological analyses of leaves and fruits of *Solanum macrocarpon* Linn (Solanaceae) in Cotonou (Benin). Food Nutr Sci, 3, 1595-1603 (2012)

Edeoga HO, Okwu DE, Mbaebie BO. Phytochemical constituents of some Nigerian medicinal plants. Afr J Biotechnol, 4, 685-688 (2005)

Ekakitie L, Ajiboye BO, Oyinloye BE, Owero-Ozeze OS, Onikanni SA, Ojo OA. Attenuation of diabetic nephropathy in alloxan-induced diabetic rats by *Solanum macrocarpon* Linn aqueous leaves extract. Comp Clin Pathol, 30, 173-179 (2021)

Elasoru SE, Adedosu OT, Fatoki JO, Kehinde BD. Flavonoid-rich extract of *Solanum macrocarpon* leaves shows tissue protective and ameliorate certain inflammatory and oxidative indices associated with d-galactose exposed rats. World J Pharm Sci, 7, 278-302 (2017)

Eletta OAA, Orimolade BO, Oluwaniyi OO, Dosumu OO. Evaluation of proximate and antioxidant activities of Ethiopian eggplant (*Solanum aethiopicum* L) and Gboma eggplant (*Solanum macrocarpo*n L). J Appl Sci Environ Manage, 21, 967-972 (2017)

Elżbieta R. The effect of industrial potato processing on the concentrations of glycoalkaloids and nitrates in potato granules. Food Control, 28, 380-384 (2012)

Emebu PK, Anyika JU. Vitamin and antinutrient composition of Kale (*Brassica oleracea*) grown in Delta State, Nigeria. Pak J Nutr, 10, 76-79 (2011)

Enyinta MC, Bello-Hassan M, Dike OK, Nnadi EC, Odili CW, Itaman VO. Antimicrobial and phytochemical screening of garden eggs (*Solanum macrocarpon*) and (*Solanum aethiopicum*) leaves and fruit. Int J Microbiol, 7, 42-64 (2024)

Ezechukwu CS, Ejere VC, Mbegbu EC, Ugwu GC, Nnamonu EI. Effects of methanolic fruit extract of *Solanum macrocarpum* L. (*Solanaceae*) on biochemical profile of albino rats (*Rattus norvegicus*). Comp Clin Pathol, 25, 67-73 (2016)

Ezechukwu CS, Mbegbu EC, Mgbenka BO, Nwani CD, Nnamonu EI, Orji EA. Pro-fertility effects of gboma eggplant (*Solanum macrocarpon*) leaf extract in female albino rats. Trop J Nat Prod Res, 8, 8418-8423 (2024)

Friedman M. Potato glycoalkaloids and metabolites: roles in the plant and in the diet. J Agric Food Chem, 54, 8655-8681 (2006)

Gbeyonron FM, Ortswen JF. Chemical composition of processed fresh and dried garden egg (*Solanum macrocarpon* L.)

https://doi.org/10.11002/fsp.2025.32.4.579

and unripe pawpaw (*Carica papaya* L.) fruits chips. Agro-Science, 22, 72-76 (2023)
Gupta SS. Prospects and perspectives of natural plants products in medicine. Indian J Pharmacol, 26, 1-12 (1994)
Haliński ŁP, Paszkiewicz M, Gołębiowski M, Stepnowski P. The chemical composition of cuticular waxes from leaves of the gboma eggplant (*Solanum macrocarpon* L.). J Food Comp Anal, 25, 74-78 (2012)
Hassan HS, Sule MI, Usman MA, Ibrahim A. Preliminary phytochemical and antimicrobial screening of the stem bark extracts of *Bauhinia rufescence* Lam using some selected pathogens. Bayero J Pure Appl Sci, 2, 53-55 (2009)
Igwe SA, Akunyili DN, Ogbogu C. Effects of *Solanum melongena* (garden egg) on some visual functions of visually active Igbos of Nigeria. J Ethnopharmacol, 86, 135-138 (2003)
Ilodibia CV, Akachukwu E, Chukwuma M, Igboabuchi N, Adimonyemma R, Okeke N. Proximate, phytochemical and antimicrobial studies on *Solanum macrocarpon* L. J Adv Biol Biotechnol, 9, 1-7 (2016)
Jaeger P, Hepper F. A review of the genus *Solanum* in Africa. In: Solanaceae Biology and Systematics, Columbia University Press, New York, USA, p 41-55 (1986)
Kannan M, Dheeba B, Gurudevi S, Ranjit Singh AJA. Phytochemical, antibacterial and antioxident studies on medicinal plant *Solanum torvum*. J Pharm Res, 5, 2418-2421 (2012)
Khachik F, Goli MB, Beecher GR, Holden J, Lusby WR, Tenorio MD, Barrera MR. Effect of food preparation on qualitative and quantitative distribution of major carotenoid constituents of tomatoes and several green vegetables. J Agric Food Chem, 40, 390-398 (1992)
Khan IA, Habib K, Rasheed Akbar AK, Saeed M, Farid A, Ali I, Alam M. Proximate chemical composition of brinjal, *Solanum melongena* L. (Solanales: Solanaceae), genotypes and its correlation with the natural enemies in Peshawar. J Entomol Zool Stud, 3, 7-11 (2015)
Knuthsen P, Jensen U, Schmidt B, Larsen IK. Glycoalkaloids in potatoes: Content of glycoalkaloids in potatoes for consumption. J Food Comp Anal, 22, 577-581 (2009)
Lin SY, Liu HY, Lu YL, Hou WC. Antioxidant activities of mucilages from different Taiwanese yam cultivars. Bot Bull Acad Sin, 46, 183- 188 (2005)
Mary OO, Sebastine OU, Ejuiwa MC, Ikemefuna OI, Dominic E. Anxiolytic and curative effect of *Solanum macrocarpon* leaves extract on acetaminophen induced brain injury in adult Wistar rats. J Pharmacogn Phytochem, 9, 205-212 (2020)
Mascato DRDLH, Monteiro JB, Passarinho MM, Galeno DML, Cruz RJ, Ortiz C, Morales L, Lima ES, Carvalho RP. Evaluation of antioxidant capacity of *Solanum sessiliflorum* (Cubiu) extract: An *in vitro* assay. J Nutr Metabol, 2015, 364185 (2015)
Moreau RA, Whitaker BD, Hicks KB. Phytosterols, phytostanols, and their conjugates in foods: Structural diversity, quantitative analysis, and health-promoting uses. Prog Lipid Res, 41, 457-500 (2002)
Ng RFL, Zainal Abidin N, Shuib AS, Israf Ali DA. Inhibition of nitric oxide production by *Solanum melongena* and *Solanum macrocarpon* on RAW 264.7 cells. Front Life Sci, 8, 241-248 (2015)
Oboh G, Ekperigin MM, Kazeem MI. Nutritional and haemolytic properties of eggplants (*Solanum macrocarpon*) leaves. J Food Compos Anal, 18, 153-160 (2005)
Odetola AA, Iranloye YO, Akinloye O. Hypolipidaemic potentials of *Solanum melongena* and *Solanum gilo* on hypercholesterolemic rabbits. Pak J Nutr, 3, 180-187 (2004)
Ojo MO, Oni OK, Zubair AB, Femi FA, Audu Y, Etim B, Adeyeye SA. Influence of fermentation period on the chemical and functional properties, antinutritional factors, and *in vitro* digestibility of white lima beans flour. J Food Sci, 89, 9047-9059 (2024)
Ojo OO, Taiwo KA, Scalon M, Oyedele DJ, Akinremi OO. Influence of pre-treatments on some nutritional and anti-nutritional contents of *Solanum macrocarpon* (Gbagba). Am J Food Sci Nutr, 2, 32-39 (2015)
Okwu DE. Evaluation of the chemical composition of indigenous spices and flavouring agents. Glob J Pure Appl Sci, 7, 455-459 (2001)
Olajire AA, Azeez L. Protective effects of *Solanum macrocarpon* against air pollution-induced oxidative stress in rats: Toxicological and histopathological studies. Adv Chem Sci, 1, 1-11 (2012)
Oluwagunwa OA, Alashi AM, Aluko RE. *Solanum macrocarpon* leaf extracts reduced blood pressure and heart rate after oral administration to spontaneously hypertensive rats. Curr Top Nutraceutical Res, 17, 282-290 (2019)
Osukoya OA, Ajiboye BO, Oyinloye BE, Owero-Ozeze OS, Ojo OA, Kappo PA. Aqueous extract of *Solanum macrocarpon* Linn leaf abate diabetic cardiomyopathy by attenuating oxidative stress and inflammation in rats. J Food Biochem, 46, e14172 (2022)
Otshudi AL, Vercruysse A, Foriers A. Contribution to the ethnobotanical, phytochemical and pharmacological studies of traditionally used medicinal plants in the treatment of dysentery and diarrhoea in Lomela area, Democratic Republic of Congo (DRC). J Ethnopharmacol, 71, 411-423 (2000)
Oyesola OA, Sampson II, Augustine AA, Adejoke OB, Taiwo GE. Comparison of phytochemical constituents of ethanol leaf extracts of *Solanum macrocarpon* and

Vernonia amygdalina. Asian J Nat Prod Biochem, 20, 6-10 (2022)

Ross AC, Caballero B, Cousins RJ, Tucker KL. Modern nutrition in health and disease. Jones Bartlett Learn, 3, 280-281 (2020)

Sambo HS, Olatunde A, Kiyawa AS. Phytochemical, proximate and mineral analyses of *Solanum incanum* fruit. Int J Chem Mater Environ Res, 3, 8-13, (2016)

Sereno AB, Bampi M, dos Santos IE, Ferreira SMR, Bertin RL, Krüger CCH. Mineral profile, carotenoids and composition of cocona (*Solanum sessiliflorum* Dunal), a wild Brazilian fruit. J Food Comp Anal, 72, 32-38 (2018)

Siji S, Nandini PV. Chemical and nutrient composition of selected banana varieties of Kerala. Int J Eng Sci, 3, 239829 (2017)

Sodipo OA, Abdulrahman FI, Akan JC, Akinniyi JA. Phytochemical screening and elemental constituents of the fruit of *Solanum macrocarpum* Linn. Cont J Appl Sci, 3, 85-94 (2008)

Solanke SB, Tawar MG. Phytochemical information and pharmacological activities of eggplant (*Solanum melongena* L.): A comprehensive review. J Pharm Pharmacol, 1, 103-114, (2019)

Sood A, Kaur P, Gupta R. Phytochemical screening and antimicrobial assay of various seeds extract of Cucurbitaceae family. Int J Appl Biol Pharm Technol, 3, 401-409 (2012)

Tegegne M, Abiyu E, Libesu S, Bedemo B, Lewoyehu M. Phytochemical investigation, antioxidant and antibacterial activities of the fruit extracts of *Solanum anguivi*. Biotechnol Biotechnolog Equip, 35, 1480-1491 (2021)

Vargas-Arana G, Merino-Zegarra C, Riquelme-Penaherrera M, Nonato-Ramirez L, Delgado-Wong H, Pertino MW, Parra C, Simirgiotis MJ. Antihyperlipidemic and antioxidant capacities, nutritional analysis and UHPLC-PDA-MS characterization of cocona fruits (*Solanum sessiliflorum* Dunal) from the peruvian amazon. Antioxidants, 10, 1566 (2021)

Wahua C, Sam SM. Taxonomic studies on *Solanum macrocarpon* Linn. and *Solanum incanum* Linn. Sci Afr, 15, 80-90 (2016)

World Health Organization (WHO). Natural toxins in food. Available from: https://www.who.int/news-room/fact-sheets/detail/natural-toxins-in-food. Accessed Mar. 3, 2023.

Yadav SK, Sehgal S. Effect of home processing and storage on ascorbic acid and β-carotene content of bathua (*Chenopodium album*) and fenugreek (*Trigonella foenum graecum*) leaves. Plant Foods Hum Nutr, 50, 239-247 (1997)

https://doi.org/10.11002/fsp.2025.32.4.579