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Miracle Fruit- Wild Edible Fruit with Potential Health Benefits

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The miracle fruit, also known as the "miraculous berry" or "miracle berry," is a tropical plant native to West Africa and parts of the Sapotaceae family. It produces red and yellow ripe berries, with the red berry being the most famous for its ability to impart a sweet flavor to food. The plant grows in frost-free conditions with low soil pH, moderate shade, and high humidity. The miracle fruit contains a high concentration of phenolic compounds (36.7%) and flavonoids (51.9%), with the skin having higher antioxidant activity (22.6%) than the pulp (18.9%). The European Food Safety Authority (EFSA) approved dried S. dulcificum fruits as an innovative food item in 2021, allowing humans to consume up to 10 mg/kg body weight per day. Miraculin, a phytochemical found in the fruit, has antidiabetic, anti-cancer, and anti-hyperuricaemic properties.

Key words: miracle fruit, miraculin, therapeutic benefits

Introduction

The miracle fruit, also called as "miraculous berry" or "miracle berry," is a fruit of the tropical plant Synsepalumdulcificum, which is indigenous to West Africa and a member of the Sapotaceae family. It is called with different names like "Agbayun," "Uninaa," "Uneonu," "Unighini," and "Uni." Gymnema sylvestre is an Indian variety of a miracle berry that is botanically synonymized with Asclepias geminate, Periploca sylvestris, and Marsdenia sylvestris. In addition to tropical Africa, Australia, Malaysia, and Sri Lanka, it is indigenous to India. Sugar Destroyer and Gudmar are other names for it. While the fruits of Gymnema sylvestre are harvested in the winter, the flowers are harvested in April and November.

Although it also grows naturally on farms, around homes and in secondary bushes, the plant is most frequently seen growing in the wild on the edges of virgin woods. Its fruit features a large seed that is covered in a translucent pulp. A thin skin envelops its pulp. There are two types of ripe berries on the plant: red and yellow. The red berry is appropriately termed "miracle fruit" because, although it is not particularly sweet on its own, it miraculously imparts a sweet flavor to food—even sour food—when it is taken or licked.

The tropical miracle tree (Synsepalum dulcificum L.) has dense foliage and grows 6 to 15 feet tall, producing berry fruit (Inglett and May, 1968; Inglett et al., 1965). Its glabrous underside leaves are typically grouped at the tips of the branches and measure 5–10 cm in length and 2–3.7 cm in width. According to James et al. (1993), the brownish-red flowers often yield pulp that is 2 cm long and contains fruits with a single seed apiece. Frost-free conditions with low soil pH (4.5–5.8), moderate shade, and high humidity are ideal for the plant's growth. It may be advised to put them 4 meters apart, as the seeds require 14–21 days to germinate. It bears fruit twice a year, both after the end of the rainy season, and begins to fruit at the age of three to four. Miracle berry fruit can produce 4-5 kg or 12-15kg annually. The age, branching and habitat of the plant can all affect this yield. The seeds resemble coffee beans in size. West Africa, where it originated, is the finest place to cultivate it. Fresh fruit

has a short shelf life of two to three days. Commercial application requires that the pulp be kept without being eaten. After freeze-drying, its shelf life could range from 10 to 18 months.

Fig.1. Miracle fruit

The miracle fruit known for its taste modifying properties due to presence of protein which is called miraculin. Miraculin stimulates sweet taste receptors when sour acids come into contact, even though miraculin itself does not taste sweet.

Fig. 2. Interaction of miraculin and taste buds

Significance of miraculin: Miraculin is a homodimeric glycosylated protein consisting of 191 amino acid residues with a maximum sweetness value 400,000 times more than sucrose on a molecular basis. The impact occurs seconds after the fruit is consumed and lasts between thirty minutes and two hours, after which Miracul dissociates from the taste receptors due to the activity of

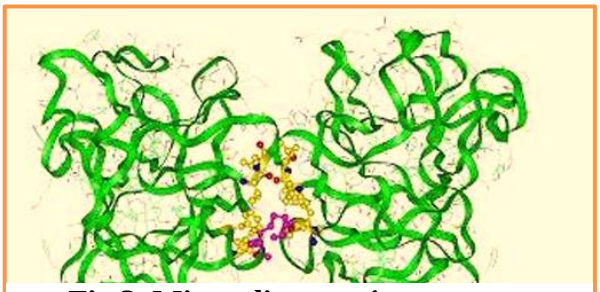


Fig.3. Miraculin protein structure

alivaryamylase. Miraculin interacts with class C sweet receptors, which consist of the heterod imers TAS1R2/TAS1R3.

Miraculin is used as a natural low-calorie sweetener along with some other like thaumatin, brazein, curculin and mabilin that could replace synthetic sweeteners.

Extraction and mechanism of miraculin: Miraculin can be extracted from miraculous berries using both sequential and direct methods. For free chemicals, sequential extraction uses double and alkaline extraction, whereas direct extraction separates the pulp and seeds. A modified process that included homogenization, freeze-drying, and lyophilized pulp powder suspension was used to produce miraculin. Solvent extraction, ion-exchange chromatography, immobilized metal affinity chromatography, and reverse micelle systems are some of the techniques that have been employed to purify miraculin. Nevertheless, solvent extraction is costly and time-consuming, whereas IMAC is easy to use and effective but challenging to scale up.

Miraculin mechanism involves, at neutral pH, miraculin binds to the VFD of TAS1R2 in an inactive form to initiate mode of action. Through the interaction of extracellularly protonated TAS1R2 with the active form of miraculin, extracellular acidification causes a partial activation of the sweet taste receptors. Weak intracellular acidity is necessary for this activation. The intracellular cascade is frequently used to identify bitter and umami flavors. The Gβγ subunit separates from the Gα subunit following TASR activation, triggering phospholipase C-β2 (PLC-β2) and generating IP3. The ATP channel Pannexin-1 (PX1) and TRPMP5 are activated by this interaction with the IP3 receptor, which releases Ca2+ from the endoplasmic reticulum (ER) and ultimately stimulates gustatory afferent neurons.

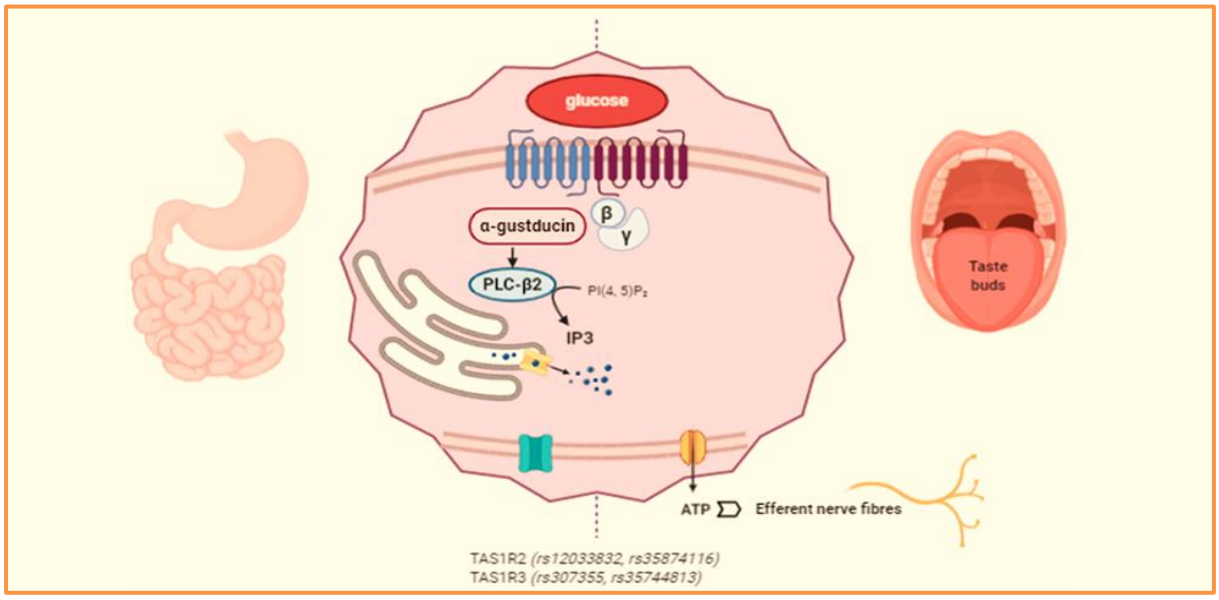


Fig.3. Miraculin Mechanism

The miracle berry fruit's proximate composition decreased when the moisture content decreased from 9.73% to 6.45% (db). Higher proximal values at high moisture content may be attributable to the fruit's low dry matter content.

Table. 1. Proximate composition:

S.No	Components	Yellow variety	Red variety
1.	Moisture	45.12	59.55
2.	Ash	0.87	4.36
3.	Fiber	0.57	6.24
4.	Fats	2.1	3.26
5.	Protein	2.48	7.75
6.	Carbohydrates	48.85	18.84

Table .2. Vitamins and mineral composition:

S.No	Vitamins (%)	
1.	Vitamin-A	0.04
2.	Vitamin-C	22.69
3.	Vitamin-D	0.01
4.	Vitamin-K	0.02
	Minerals (ppm)	
1.	Calcium	100
2.	Chromium	0.01
3.	Cobalt	0.01
4.	Copper	6.22
5.	Iron	24.2
6.	Zinc	9.49

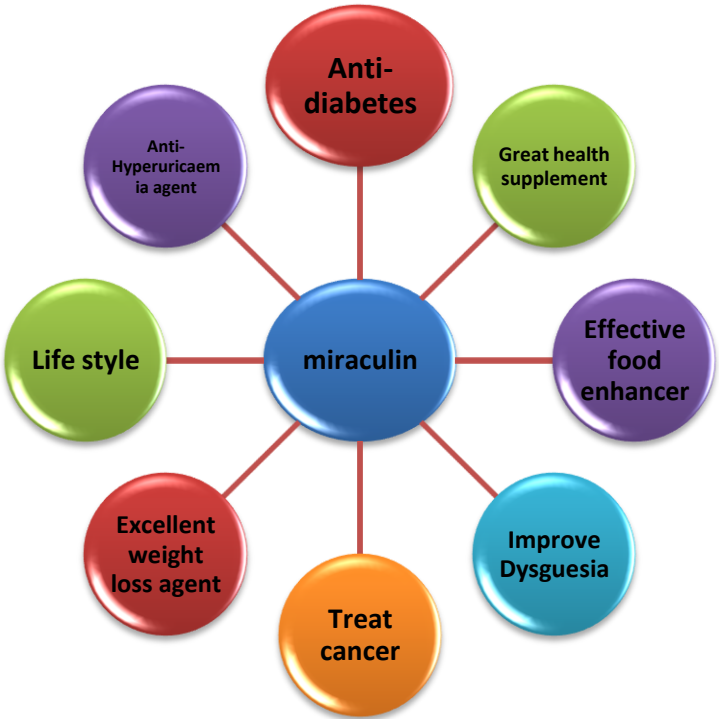
Table 3. bioactive compounds composition

Components	Fresh fruit weight	Dry fruit weight
Phenolics (mg/100g)	229.80	32.46
Antioxidants (µ mol Trolox/ 100g)	187.68	26.51

Higher concentrations of phenolic compounds (36.7%) and flavonoids (51.9%) are found in the fruit's skin than in its pulp, which has 15.8% phenolic compounds and 11.9% flavonoids. Because phenolic and flavonoid content and antioxidant activity are directly correlated, the skin has a higher antioxidant activity (22.6%) than the pulp (18.9%). Recent research on the nutritional status of the pulp by Nkwocha (2014) showed that S. dulcificum pulp is a significant source of calcium, iron, and vitamin C.

Consumption: DMB made from dried S. dulcificum fruits which was authorized as an innovative food item in the EU in 2021 following a favorable scientific assessment by the European Food Safety Authority (EFSA). The panel determined that it is safe for humans to consume up to 10 mg/kg body weight (bw) per day. A 90-day oral dosage of 2000 mg/kg bw daily, however, was likewise shown by the EFSA to be free of side effects.

Therapeutic benefits of Miraculin:



Antidiabetic activity: There was a notable hypoglycemic impact from S. dulcificum fruits. The presence of miraculin and other phytochemicals in the plant, including flavonoids and saponins, was proposed as the cause of the observed effect. Few studies reported that biochemical and pathological changes in type 2 diabetes were considerably improved in rats given the plant extract orally for 21 days. Animals with diabetes treated with the extract had their altered glycated hemoglobin and blood levels of interleukin-6 and tumor necrosis factor alpha normalized.

Anti-Cancer Activity: The chemicals {(þ)-syringaresinol and (þ)-epi-syringaresinol} discovered in S. dulcificum have been shown to exhibit significant antioxidant activity in vitro and to inhibit human skin cancer cells, according to a previous evaluation. The phenolic components found in S. dulcificum leaf compounds were thought to be responsible for the antimutagenic action. Syringic acid, trans-p-coumaric acid, veratric acid, vanillic acid, and p-hydroxybenzoic acid are among the active phenolics found in the sample.

Anti-hyperuricaemic activity: Uric acid is produced through the action of xanthine oxidase. In animals, xanthine oxidase catabolizes uric acid to allantoin; hence, inhibiting xanthine

oxidase will directly prevent the synthesis of uric acid. Using miracle fruit extracts was also shown to protect the kidneys. As a novel plasma uric-lowering agent, it has in fact been presented. It was found that patients who took a typical dosage of DMB tended to lower their uric acid levels within normal ranges.

Industrial applications: Miracle fruit is a raw fruit that can be processed and utilized as an addition in food, medicine, and cosmetics. Historically, the plant fruit is referred to as miracle plant because of its unique taste-modifying property that causes sour edibles to taste sweet after the mouth has been exposed to the fruits. There has been a growing interest in the potential usage of the plant for centuries by local people of West Africa where the fruit has been used to sweeten sour foods and beverages such as Koko and Kenkey made from fermented maize and millet, and palm wine. With the growth of the food industry, new uses for the pulp's ability to change taste and the peel's (outer cover) hues have appeared. Two times as much color change is exhibited by S. dulcificum as by FD&C Red No. 2, a substance used in food manufacturing. Species-specific anthocyanin pigments provide carbonated drinks with remarkable stability, particularly at low temperatures for long-term preservation.

The miraculous berry's limitations and preservation: Richadella dulcifica, also known as the miracle berry, is extremely perishable. Below pH 3 and above pH 12, it is thermolabile and inactivated. Due to its degradation at high temperatures, it is not utilized in cooking or processed goods. By applying a polysaccharide chitosan layer, preservation methods can get around these restrictions. The miracle fruit can also be freeze-dried at -20° F for about three months before usage without suffering any major deterioration. Because of its high stability, the miraculin protein itself can be kept in solution or in pure form for up to six months without losing its functionality.35 Ziploc bags are an option for long-term storage.

Repercussions of Miracle Fruit: The adverse effects of miracle fruit, espite having a wealth of medicinal benefits, miracle fruit should be used carefully. High blood acidity levels may result from this fruit's ability to change the pH balance. Regular use may also result in heartburn, digestive disorders, and other gut-related issues.

Products available in the market

Conclusion

A fascinating plant, S. dulcificum has important nutritional and pharmacological qualities. This African medicinal plant holds significant commercial value and has the potential to be used in food and nutritional supplements. The miraculous fruit plant contains antihyperuricemia, anticancer, antioxidant, and cholesterol-lowering qualities. The benefits of miraculin, a low-calorie sweetener and anti-diabetic drug, are substantial. To perform safety assessments and standardize known components, more research is required. In addition to its extensive library of bioactive chemicals, the miracle fruit plant may also have pharmaceutical activities in the future.

References

7. Choi, S. E., & Garza, J. (2020). Effects of different miracle fruit products on the sensory characteristics of different types of sour foods by descriptive analysis. *Journal of food science*, *85*(1), 36-49.

8. Fadeyibi, A. (2021). Engineering and proximate properties of miracle berry fruit (Synsepalum dulcificum L.) essential for its processing equipment design. *Agricultural Engineering International: CIGR Journal*, *23*(4).
9. Achigan-Dako, E. G., Tchokponhoué, D. A., N'Danikou, S., Gebauer, J., & Vodouhè, R. S. (2015). Current knowledge and breeding perspectives for the miracle plant Synsepalum dulcificum (Schum. et Thonn.) Daniell. *Genetic Resources and Crop Evolution*, *62*, 465-476.
10. Gómez de Cedrón, M., Wagner, S., Reguero, M., Menéndez-Rey, A., & Ramírez de Molina, A. (2020). Miracle berry as a potential supplement in the control of metabolic risk factors in cancer. *Antioxidants*, *9*(12), 1282.
11. Njoku, N. E., Ubbaonu, C. N., Alagbaoso, S. O., Eluchie, C. N., & Umelo, M. C. (2015). Amino acid profile and oxidizable vitamin content of Synsepalum dulcificum berry (miracle fruit) pulp. *Food science & nutrition*, *3*(3), 252-256.
12. Inglett, G. E., & Chen, D. (2011). Contents of phenolics and flavonoids and antioxidant activities in skin, pulp, and seeds of miracle fruit. *Journal of food science*, *76*(3), C479-C482.
13. Rodrigues, J. F., da Silva Andrade, R., Bastos, S. C., Coelho, S. B., & Pinheiro, A. C. M. (2016). Miracle fruit: An alternative sugar substitute in sour beverages. *Appetite*, *107*, 645-653.
14. He, Z., Tan, J. S., Abbasiliasi, S., Lai, O. M., Tam, Y. J., & Ariff, A. B. (2016). Phytochemicals, nutritionals and antioxidant properties of miracle fruit Synsepalum dulcificum. *Industrial Crops and Products*, *86*, 87-94.
15. López-Plaza, B., Gil, Á., Menéndez-Rey, A., Bensadon-Naeder, L., Hummel, T., Feliú-Batlle, J., & Palma-Milla, S. (2023). Effect of regular consumption of a miraculin-based food supplement on taste perception and nutritional status in malnourished cancer patients: a triple-blind, randomized, placebo-controlled clinical trial-CLINMIR pilot protocol. *Nutrients*, *15*(21), 4639.
16. López-Plaza, B., Álvarez-Mercado, A. I., Arcos-Castellanos, L., Plaza-Diaz, J., Ruiz-Ojeda, F. J., Brandimonte-Hernandez, M., ... & Palma-Milla, S. (2024). Efficacy and Safety of Habitual Consumption of a Food Supplement Containing Miraculin in Malnourished Cancer Patients: the CLINMIR Pilot Study. *Nutrients*, *16*(12), 1905.
17. Mangla, B., & Kohli, K. (2018). Pharmaceutical and therapeutic potential of miraculin and miracle berry. *Trop J Nat Prod Res*, *2*(1), 12-17.
18. Akinmoladun, A. C., Adetuyi, A. R., Komolafe, K., & Oguntibeju, O. O. (2020). Nutritional benefits, phytochemical constituents, ethnomedicinal uses and biological properties of Miracle fruit plant (Synsepalum dulcificum Shumach. & Thonn. Daniell). *Heliyon*, *6*(12).
19. Ubbaonu, C. N., Alagbaoso, S. O., Agunwa, I. M., & Eluchie, C. N. (2016). Proximate, anti-nutritional and phytochemical composition of the yellow variety of the Synsepalum dulcificum (Miracle fruit) berry. *American Journal of Food Science and Technology*, *4*(4), 102-108.
20. https://www.rubyberry.com/miracle-fruit
21. https://gardenmaster.in/product/miracle-fruit-plant/
22. https://www.lazada.com.ph/products/calabash-tree-cuttings-miracle-fruit-for-planting-i1215210227.html