A Meticulously Study on Phynonutrients and Salubrious Effects of (Siraitia Grosvenorii)

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Abstract

Siraitia grosvenorii is also known as Luo Han Guo, and Monk fruit that is a very important medicinal and functional plant in nature. Recently, it has gained a lot of scientific interest due to its rich diversity. Pharmacological activities are attributed to its most active bioactive compounds, the tetriterpenoid glycosides, known as mogrosides. The secondary metabolites are synthesized through complex biotic interactions involving the plant metabolic pathways directed through specific enzymes, transcription factors, and symbiotic microorganisms that inhabit the rhizosphere. In this study, it dwells on the features and functional relevance of these biotic constituents in monk fruit with respect to biosynthesis of metabolites, plant health, and environmental adaptation. In further discussion the recent advances from molecular biology and biotechnology that shed light on these interactions for additional insights into sustainable cultivation and bioactive compound enhancement that is supporting in the improvement of the biotic components within the monk fruit as a platform that increase its agricultural productivity and use in human health.

Keywords: - Tetraterpenoid glycosides, Symbiotic Microorganisms, Rhizosphere, Pharmacological

1. Introduction

Monk Fruit or Luo Han Guo, scientifically known as *Siraitia grosvenorii*, is a perennial plant that comes under the Cucurbitaceae family (Itkin M etal., 2016). It is primarily found in southern China that is cultivated for more than two hundred years. The fruit was meant to be used for curing sore throat, cough, and digestive discomfort in traditional Chinese medicine (Dharmananda S., 2004). However, it is acquired a scientific as well as commercial status for its remarkable natural sweetness as well as advantageous biological properties. The sweet taste of monk fruit is due to the presence of compounds such as mogrosides, which contains triterpenoid glycosides that are sweetened in taste. That is equivalent to 300 times that of sucrose but carry almost no calories (Harshita, 2023; Pandey & Chauhan, 2019).

At present, the bioactive as well as biotic constituents of the fruit include polysaccharides, flavonoids, amino acids, essential oils, vitamins, and phenolic compounds contribute to its medicinal potential. As the most sweetening and bio-functional component, mogroside V is one among the glycosides and exhibits several physiological activities, including being antioxidant, anti-inflammatory, hypoglycemic, and anti-carcinogenic effects (Suri et al., 2020). Other mogrosides, such as IV, VI, siamenoside I, and 11-oxo-mogroside V, add to its pharmacological property. All these accumulated molecules contribute to the functional role of the plant in maintaining metabolic balance, preventing cells from undergoing oxidative damage, and even enhancing general well-being (Pandey & Chauhan, 2019; Suri et al., 2020; Harshita, 2023).

The more recent studies shows the acknowledgement that biotic compounds of *S. grosvenorii* can favourable affect on human health by regulating the gut microbiota, to reducing the oxidative stress, and improving immune responses. Monk fruit extract and its natural source and non-toxic nature gives bioactive richness. Monk fruit is now being widely investigated for incorporation into food and pharmaceuticals use, as a leader in sustainable and health-improving natural sweetness (Li etal., 2014).

Mogrosides is a group of natural compounds, specifically triterpene glycosides that are responsible for the intense sweetness of monk fruit. They are extracted from the fruit of the *Siraitia grosvenorii* plant and used as a natural, low-calorie sweetener. Beyond sweetness, research suggests mogrosides have potential antioxidant, anti-inflammatory, and anti-diabetic properties, though more human studies are needed (Qihan Guo etal., 2024).

2. Phytochemicals

Phytochemicals include Flavonoids, Polysaccharides, Amino acids, Vitamins, and Phenolic compounds and so on.

a) Flavonoids

Flavonoids are polyphenolic compounds that are found in nature, It is important in building the antioxidant systems of fruits, scavenging harmful free radicals from cell and cell membranes, and protecting tissues in the body. Flavonoids have been mentioned to have anti-inflammatory and cardioprotective effects, as well as being able to improve the immune response (Harshita, 2023). The major Flavonoids identifies in *Siraitia grosvenorii* include kaempferol, quercetin, apigenin, rutin, and luteolin, Isoorientin, Isovitexin. Kaempferol is a strong antioxidant to reduce the oxidative stress and help in anticancer and cardioprotective effect. Quercetin is an anti-allergic and anti-viral and anti-oxidant activity to reduce the blood pressure and enhance the immunity and cardiovascular disease. Apigenin helps in protecting DNA and possess the anti-anxiety, anti-inflammatory and anti-cancer properties. Rutin strength the blood vessels and improve the circulation of blood. It helps in anti-aging, anti-clotting and anti-oxidant properties. Luteolin helps to the formation of reactive oxygen species and modulate enzyme activity to exhibit anti-tumor and neuroprotective effect. Isoorientin occur in fruit tissue and it is potent with anti-oxidant and anti-inflammatory compounds and help to reduce the lipid peroxidation from oxidative stress. Isovitexin is derived from apigenin such as Flavone C- glycoside. It is found in pulp and peel of Monk fruit. It provides UV protection and helps in anti-diabetic, anti-oxidant and neuroprotective (Wu J etal., 2022). Preventing oxidation of low-density lipoproteins (LDL), due to the action of flavonoids on health, may reduce heart disease risk, specifically in heart and vascular health. The beneficial health effects, along with the increased pharmacological performance of the fruit as a possible ingredient in functional foods that support longevity and wellness, are again seen in combination with mogrosides.

b) Polysaccharide

Polysaccharides are complex sugars that concentrates the immune-boosting and antioxidant effects rely on them. They act in activating immune cells such as macrophages and lymphocytes that defend the body against infections to ensure a healthy gut microbiome (Suri et al., 2020). Lipids are also delayed in oxidation and the damage to tissues caused by oxidative stress. Anti-aging, anti-fatigue, and anti-tumor activity are among the findings. The major Polysaccharides isolated from *Siraitia grosvenorii* are SGP-1, SGP-2, and SGP-3, that are composed of primarily glucose, mannose, galactose, and arabinose. Complicated carbohydrates are essential for the therapeutic as well as nutritional value of the plant. SGP-1 has potent antioxidant potential and defends cells from oxidative stress by scavenging reactive oxygen species. SGP-2 improves immune functions by activating macrophages and lymphocytes and will increase immune defense. SGP-3 promotes healthy aging and reduces fatigue by enhancing energy metabolism and minimizing cell damage induced by oxidative processes. These bioactive polysaccharides work together to maintain the cellular, metabolic, and immune balance and place monk fruit in a good position as a source for natural antioxidant and nutraceuticals (Pandey & Chauhan, 2019). Due to their relatively large molecular size, they are capable of interacting with reactive molecules, it makes them so powerful as natural antioxidants. Thus, the role of monk fruit polysaccharides is critically important in terms of immune health and overall vitality.

c) Aminoacids and Proteins

Monk fruit naturally synthesizes the number of amino acids and proteins that build this fruit's nutrition and biological activity. Enzymes are produced, tissues are repaired, and metabolic processes are managed. The major amino acids identified include glutamic acid, aspartic acid, alanine, leucine, lysine, valine, and arginine (Pandey & Chauhan, 2019). Glutamic acid arrives at energy production and cell signaling while aspartic acid notes the participation of amino acid biosynthesis and energy metabolism for fruit itself. Alanine being involved in protein generation and glucose regulation helps in stress tolerance. Leucine also stimulates protein synthesis, regulating enzymes that coordinate tissue growth and cell protection. Such as collagen formation in tissues, that requires lysine. Secondary metabolite formation in the fruits is tied up with the biosynthesis of mogrosides. Valine balances nitrogen compound in the form of tissue-building-associated repair and homeostasis process. Arginine serves as a precursor for nitric oxide and regulates metabolism and growth in plants. In short, all these amino acids contribute to the nutrition, metabolism, and bio functional properties of monk fruit, providing justification for its claim as a true health-promoting plant (Pandey & Chauhan, 2019). Some amino acids are found in the fruit as building blocks for mogrosides and other metabolites that provide sweetness and medicinal benefit to this fruit. These compounds act to regulate cell-growth behaviour and hold water and nitrogen balances in tissues. Thus, the presence enhances the nutritional worth of monk fruit as a natural sweetener and functional for health maintenance at the metabolic level.

d) EssentialOils

Essential oils of monk fruit are aromatic compounds that are responsible for their mild scent and flavour. They show antimicrobial and antifungal effects, which help against the microbial contamination and improves the food safety from microbial spoilage, while they have anti-inflammatory effects. The major components are identified include limonene, citral, linalool, β-caryophyllene, and geraniol (Harshita, 2023). In addition, Limonene is a strong antioxidant that having some antimicrobial functions, while citral has strong antibacterial and anti-inflammatory capacities to complement the therapeutic use of this plant. Linalool is admired for its properties to relax and de-stress, which adds in the total aroma and therapeutic activity of the plant. Β-caryophyllene acts as an anti-inflammatory by interfering with oxidative pathways, while geraniol exhibits the antimicrobial and antioxidant properties that further ensure the flavour retention and protection against spoilage from microorganisms. Together, these volatiles improve the fragrance properties and stability status of the monk fruit, thus validating its pharmacological importance in food products and medications as well as cosmetics formulations. Via those oils, it is possible to alleviate mild symptoms of respiratory disease and potentially cause a decrease in systemic body inflammation. Moreover, this aroma promotes the palatability of products based on monk fruit as one of its attractive features to consumers. Being all-natural and safe, these monk fruit essential oils make for an excellent substitute to artificial preservative and synthetic flavouring agents.

e) VitaminsandMinerals

Monk fruit carries the vitamins and minerals-the two essentials component are needed to satisfy its nutritional value. This makes it is a considerable source of vitamin C, which is strong as an antioxidant activity, mainly concerning immunity and in the formation and regeneration of collagen after oxidative injury (EFSA, 2019). In addition, mineral constituents such as zinc, magnesium, and potassium regulate enzyme activity, nerve signaling, and stability of electrolytes within the body. Zinc activates various enzymes, and its main functions are support of the immune defences and regeneration of cells. On the other hand, magnesium is responsible for many metabolic pathways, such as energy generating processes, protein synthesis, and the regulation of functions of normal nerves and muscles. Electrolytes such as potassium perform important functions like regulating nerve impulses, muscle contractions, and electrotype balance in body fluids to ensure hydration and optimal heart functioning. Hence, all these minerals point to maintaining metabolic stability, neuromuscular coordination, and electrolyte equilibrium underlining the importance of monk fruit as a nutrient-rich natural product deserving health-promoting property. These micronutrients in totality govern normal metabolic, muscular, and heart functions. They together with mogroside and flavonoids enhance the overall protective and restorative power of monk fruit.

f) PhenolicCompounds:

Phenolic compounds are plant-derived antioxidants that are used in bioactivity maintenance. They scavenge the reactive oxygen species to inhibit the peroxidation of lipids, and protect cells from oxidative damage. The primary phenolics identified include gallic acid, caffeic acid, ferulic acid, p-coumaric acid, chlorogenic acid, and vanillic acid (Suri et al., 2020). Gallic acid functions as a strong antioxidant and antimicrobial agent which protects cells from oxidative damage. Caffeic acid exhibits anti-inflammatory properties as well as hepatoprotective activities, whereas ferulic acid has a beneficial effect on cardiovascular health and acts against reactive oxygen species. The ability of p-coumaric acid to stimulate antioxidant enzymes enhances its protection against lipid peroxidation- induced damage, while chlorogenic acid from chia contributes to the regulation of glucose metabolism and thus of oxidative stress. Finally, the well-known antimicrobial and antioxidant food source vanillic acid further protects the fruit. All these polyphenolic constituents enhance the nutraceutical capabilities of monk fruit by improving antioxidant potential, increasing anti-inflammatory capacity, and enhancing overall nutraceutical significance (Gong F etal., 2024).Thus, it supports the use of the fruit in health-promoting applications. Apart from all these antioxidant effect, they also possess anti-inflammatory and antibacterial effects which help prevent chronic diseases such as diabetes, arthritis, and cardiovascular diseases. Also, the phenolics would act together with flavonoids by strengthening the body's defence system against environmental and metabolic stress (Ban M.C etal., 2020). The higher reducing capacity of phenolics enables the life and efficacy of monk fruit extracts even longer for food and medicine purposes.

3) Salubrioususe

Due to bioactive compounds in monk fruit. They used in anti-inflammatory, antioxidant, anti-hyperglycemic, and anti-cancer properties (Li et al., 2014; Suri et al., 2020). The traditional practice involves the use of sore throat, cough, fever, and digestive problems, while in modern use there is the management of disorders such as diabetes, oxidative and inflammatory conditions. Specifically, the extraction from mogrosides used to reduce the blood glucose and oxidative damage and can be developed into a natural therapeutic agent. These compounds being non-toxic and has plant origin with their medicinal properties in nature.

a) Antidiabetic and Anti hyperglycaemic activity:-

The effect of symbiotic yogurt play very important role in type 2 diabetes mellitus liver lipid. It helps in fatty acid biosynthesis, bile secretion and glyoxylate and dicarboxylate metabolism that helps in liver (Ban etal., 2022).

It also play important role in antidiabetic effect. It cause an improvement in the insulin response in glucose tolerant ,there is an accumulation of insulin in the pancreas, there is the amelioration of kidney functioning to enhance the activity of antioxidant activity in liver and plasma(Suzuki etal.,2007).

b) Anticarcinogenic activity:-

This fruit extract help in colorectal cancer and throat cancer by its antiproliferatrive property of triterpene glycoside that is a strong sweetener to prevent the development of colorectal and laryngeal cancer to inhibit the proliferation of cancer cells that is HT29 and Hep -2 cells. They have the ability to suppress the activity of cancer cells and most of the phyto chemicals help to fight the cancer cells of throat and colorectal cells (Liu etal., 2016).

c) Antibacterial activity:-

There is the specific sweetener compound present in the monk fruit that is called as mongrosides. They have antimicrobial properties. These compounds help to inhibit the activity of antimicrobial compounds such as *Streptococcus mutants*, *Fusobacterium nucleatum*, *Actinobacillus actinomycetemcomitans,Candida albicans* (Suri etal.,2020).

d) Antioxidant Activity:-

In monk fruit mogrosides have antioxidant activity against oxidative stress and inflammation activity with the help of scavenging properties of free radicals. They help in protect the kidney cells with the help of this fruit extract. It helps to defend the healthy cell of human body (Konno etal. 2022).

4) Conclusion

It is a highly valued natural plant for the presence of extremely rich beneficial phytochemicals in monk fruit (*Siraitia grosvenorii*). These include various phytochemicals are present in this fruit juice. All these bioactive molecules confer strong antioxidant, and antidiabetic properties on monk fruit. Hence, the relatively high sweetness levels, thermal stability, and zero-calorie content. Monk fruit emerges as an excellent natural choice and replacement for artificial sweeteners. Indeed, there is the wide functional properties present in the monk fruit that use of this ingredient in food and pharmaceuticals for maintaining health and preventing diseases. In general, monk fruit is a safe, sustainable, and health-promoting natural resource, with much possible scope for future prospects in natural products.

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