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Research Article

SYSEPHALUM DULCIFICUM: THE MIRACLE BEHIND THE MIRACLE FRUIT!

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Abstract:

Synsepalum dulcificum is also called as "wonder fruit," "magic fruit," "miracle fruit," and "flavor fruit." It is a shrub that can reach a height of 20 feet (6.1 meters) in its natural habitat, but rarely exceeds 10 feet in cultivation. The fruit has a low sugar content and includes miracle, a glycoprotein molecule. The glycoprotein adheres to the taste bud on the tongue when the fleshy section of the fruit is eaten, making sour meals taste sweet. While the specific mechanism of this shift is uncertain, it is thought that the glycoprotein miraculin operates by altering sweet receptors, causing them to respond to acids rather than sugar and other sweet substances. Because of its flavor modifying and non-caloric properties, miraculin could be used as a sweet fix for our palate. The use of miraculous berries or miraculin in the development of novel foods for dietitians and diabetics has the potential to change the health food sector. Because of its high vitamin C concentration, the fruit can also be used as an anti-cancer supplement. It has also been discovered to improve insulin sensitivity, suggesting that it could be utilized as an adjuvant in the treatment of diabetes individuals with insulin resistance. Its applications are intriguing because of the taste modification function, particularly as an alternative sweetener and antioxidant, as well as for treating chemotherapy patients' dyspepsia. The purpose of this project is to provide an overview of the miracle berry and miraculin, including its features, limitations, and current and potential applications in the food and therapeutic industries.

Key words : Miraculin, Taste modifier, Miracle berry, Sweet fix, Diabetes.

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1.INTRODUCTION:

Non-nutritive sweeteners (NNS) or artificial sweeteners, which provide a sweet taste without calorie (cal), have evolved into a common aspect of daily lifecycle and are progressively employed in a number of ways of nutritional and therapeutic goods. Miracle berry (*Richadella dulcifica*/ *gymnema Sylvester* / *Synsepalum dulcificum*) has been researched as a sweetness enhancer. ^(1, 2)*Synsepalum dulcificum*, an evergreen shrub native to tropical West Africa, produces this berry. The plant can be observed growing in the wild on the outskirts of virgin woods. Although the plant can grow up to 20 feet in height in its natural setting, its basic form is shrubby. After 2–3 years of growth, the plant bears its first fruits. It features a huge seed encased in a thin coating of berry flesh that has a slight cherry flavor. The red and yellow ripe berry patterns of the shrub are available. The red berry does not taste sweet on its own, but it has a distinctive taste-modifying effect that can last up to two hours or more, making acidic foods like sour lime,

lemon, grape juice, and even vinegar taste sweet. *S. dulcificum* leaf samples were generally high in carbohydrate and moisture, whereas the roots were high in carbohydrate, moisture, and fiber. Thin, papery, leathery, and evergreen leaves. ⁽³⁾Monosaccharide content, molecular weight (Mw), and in vitro bioactivities (antioxidants, glucosidase inhibition) of polysaccharides from miracle fruit seeds and leaves were investigated in this work. ⁽⁴⁾

1.1 Source:

Several bioactive elements have been detected in the leaflet of *S. dulcificum*, including –sitosterol, stigmasterol, pheophytin-a and b, lupeol, lupenone, -tocopherol, and quinine, while the seed is plentiful in phenolics and proteins. The Leaf and Pits of miracle fruit are abundant in biomolecules that served as bio reductants in the manufacturing of AgNPs (silver nanoparticles), as evidenced by the preceding. ⁽⁵⁾

Table no.1.1
TAXONOMICAL CLASSIFICATION

Taxonomical rank	Name
Kingdom	Plantae
Subkingdom	Viridiplantae
Infrakingdom	Streptophyta
Division	Tracheophyta
Infradivision	Angiospermae
Class	Magnoliopsida
Superorder	Asteranae
Order	Ericales
Family	Sapotaceae
Genus	<i>Synsepalum</i>
Species	<i>Synsepalum dulcificum</i>



2. PHYTOCHEMICAL CONSTITUENTS

The mash of *S. dulcificum* contains 8.055 percent tryptophan, 1.35 percent phenylalanine, 0.7 percent isoleucine, 0.5 percent tyrosine, 1.05 percent methionine, 0.4 percent proline, 0.69 percent valine, 1.1 percent threonine, 0.4 percent histidine, 0.5 percent alanine, 1.02 percent glutamine, 1.6 percent glutamic acid, 0.7 percent glycine, due to its high content of these amino acids, it's unbeatable as a source of raw material for medications and diet supplements. Adult lysine requirements are given special attention, as this essential amino acid is most likely to be limited in the cereal-based diets typical of communities in many parts of the developing world. In this investigation, phenylalanine levels were found to be much greater than daily consumption. Concerns about phenylalanine's safety stem from the aberrant brain development seen in people with phenylketonuria. Those with a normal capacity to metabolize phenylalanine, on the other hand, are largely safe from this amino acid. Important amino acids that must be provided in the diet have been recognized as the building blocks of all proteins in the body, as well as several hormones. In this study, an adequate number of necessary amino acids demonstrating the fruit's great nutritional potential was obtained. Although no single plant can offer people with sufficient amounts of all required amino acids, *S. dulcificum* pulp can be combined with other foods to produce useful amounts of the amino acids. *S. dulcificum* pulp contains 5.67 percent oxalates, 0.03 percent phytates, and 0.02 percent hemagglutinin, according to the antinutrient composition.⁽⁴⁾

Examining the extracts for phytochemicals:

When compared to other bioactive chemicals found, phytochemical analysis of the extracts (petroleum ether and water) revealed that *S. dulcificum* is rich in cardiac glycosides and polyphenols.⁽⁴⁾ In miracle berry flesh rutin, quercetin, myricetin, leutin, anthocyanin were found.⁽⁵⁾

Table no.2.1: Phytochemical constituents composition of Synsepalum dulcificum

Composition	percent
Flavonoids	57.01
Tannins	7.12
Saponins	3.45
Alkaloids	0.0001
Glycosides	0.0001
resins	0.0003

Table no.2.2: Composition of nutrients

antinutrients	Percent
oxalates	5.67
phytates	0.03
haemagglutinin	0.02

Table no.2.3: Chemical Constituents

Chemical class	Compound name	Reference
Alkaloid	Dihydro-Feruloyl-5-Methoxytyramine N-Cis-Caffeoyltyramine N-Cis-Feruloyl-Tyramine N-Trans-Feruloyl-Tyramine 4-Acetyl-3,5-Dimethoxy-P-Quinol	(2,6)
Lignan	(+)-Syringaresinol (+)-Epi-Syringaresinol	(2,6)
Phenolic acid	Cis-P-Coumaric Acid Trans-P-Coumaric Acid P-Hydroxybenzoic Acid Syringic Acid Vanillic Acid Isovanillic Veratric Acid Methylparaben	(2,6)
Glycoprotein Oil substance	Miraculin 4-Hydroxy-2- Oxetanone Anthocyanins	(5)

Phytosterols Triterpenes	B-Sitosterol and Stigmasterol Pheophytin-A Pheophytin-B Lupeol Lupenone Lupeol Acetate A -Tocopheryl Quinone A -Amyrin B-Amyrin Acetate	(4)
Color pigment Flavonoid	Cyanidin-3-O-Glucoside Cyanidin-3-Monogalactoside Delphinidin-3- Monoarabinoside Cyanidin-3-Monoarabinoside Delphinidin-3-O- Glucoside Quercetin-3-Monogalactoside Kaempferol-3- Monoglucoside Myricetin-3-Monogactoside	(5)

3. THEORIES OF MECHANISM OF TEST MODIFICATION

Specific method by which miraculin works is unknown.

1] Dzendolet proposed that the anions of some acids, such as citric acid's citrate ion, are sweet but are generally suppressed by the sour flavor. By inhibiting the sour receptor sites, the anion's sweet taste may be detected.

2] According to Kurihara and Beidler, the glycoprotein miraculin, binds to the receptor membrane near the sweet receptor site. Acids then modify the conformation of the sweet receptor site to make it "fit" the sugar groups on the glycoprotein, resulting in a sweet sensation.(7)⁰

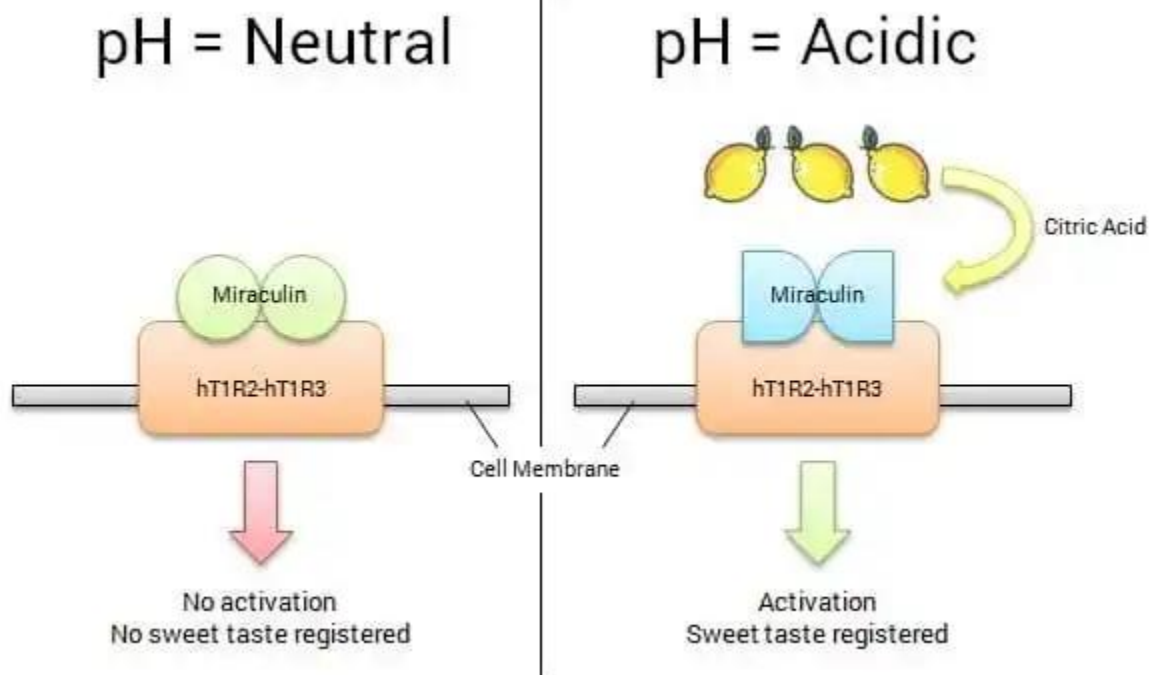


Fig No. 3.1 Mechanism of Taste Modifying Activity of Miraculin

4. MIRACLE BERRY DYNAMIC APPLICATIONS

Aside from its capacity to fool tongue receptors, the fruit is recognized to have a variety of health benefits and applications. The following are some of the benefits and applications of this berry.

4.1 Progression as a health food in hyperuricemia

High levels of uric acid synthesis or reduced renal uric acid excretion produce hyperuricemia, which is related with inflammation. Hyperuricemia is caused by poor renal excretion in the large amount of people with primary gout. ROS (Reactive Oxygen Species) and cytokine production cause hyperuricemia by activating the inflammation. MSU (Monosodium-urate) has also been proven to activate the inflammation, causing oxidative stress and inflammation in monocytes and macrophages. There are many treatments for anti-gout on the market today, including non-steroidal anti-inflammatory drugs. For acute gout; these drugs are usually used as a first-line therapy. When adverse responses such as gastrointestinal toxicity, renal toxicity, and gastrointestinal bleeding occur, however, their use is called into doubt. Consequently, it's critical to find improved anti-gout arthritis medications. Antioxidants have been shown to protect against MSU-induced inflammation activation. ABTS (2,2-azino-bis (3-ethyl-benzothiazoline-6-sulfonic acid), DPPH (1,1-diphenyl-2-picrylhydrazyl) and FRAP (ferric-reducing/antioxidant power) are the traditional free radical scavenging methods used for evaluation of antioxidant activity of the extracts. According to certain studies, miracle fruit possesses antioxidant properties, and miraculin powder (MFP) has higher total phenolic components, flavonoids, and anthocyanins than miracle fruit water extract (MFWE). As a result, miracle fruit powder has a stronger free radical scavenging activity than MFWE. MFP and MFWE also inhibited xanthine oxidase activity. MFWE, and other miracle fruit components now have antioxidant characteristics and can assist to decrease hyperuricemia. Furthermore, butanol obtained from miraculin fruit has been discovered to be an excellent remedy for acute gouty arthritis, so it has capacity to be developed as a New health food. Aside from that, it's worth noting that all components of plant have therapeutic use. Some studies looked into the antioxidant properties of phenolics and flavonoids which were observed in the skin, pulp, and seeds of miracle fruit and suggested that it could be a good source of antioxidants for functional food applications. Some researchers investigated the total phenolic content and DPPH radical scavenging activities of

miracle fruit extracts from the skin, pulp, and seed, while others investigated to promote human health the phenolics and flavonoids content of miracle fruit flesh which gives antioxidant activity is used. Polyphenols found in miracle fruit seed extracts were also found to be potent antioxidants. According to studies, the antioxidant and anti-tyrosinase effects of constituents of miracle fruit stems, implying potential applications in food supplementation and medical cosmetology. The inhibitory effects of miracle fruit leaf aqueous extracts on oxidative and mutation damage and attributed them in part to its phenolic components that are active.

4.2 As a cancer-fighting supplement

Person having cancer has a complicated issue that is linked to changes in taste. TSAs (Taste and Smell Alterations) are widespread and mainly occur as a result of a treatment. During the course of a disease or treatment, changes in the body are detected, such as shape, receptor surface modifications, neuronal coding disruption, or a decrease in the number of normal cells. TSAs are frequently the result of all of these changes. Anti-neurotic medicines and radiation therapy given to cancer patients can alter tongue receptors, causing a person to lose their ability to taste. Patients who are undergoing radiation treatment experience a metallic taste, which is the cause of their health deterioration due to their inability to taste food. Changes in taste in cancer patients undergoing chemotherapy are widespread, but they are understudied. Chemotherapy lowers the immune system, rendering people more vulnerable to infection, which is the leading cause of death among cancer patients. Supplementing with miracle fruits can boost nutritional intake, which can lead to better patient outcomes. Miraculin binds to taste receptors in an acidic environment, producing a sweet perception of the foods consumed, hence increasing food palatability by concealing some disagreeable flavors.⁽⁷⁾ Miracle berry has also been shown to reduce insulin resistance as well as prevent cancer cell growth and malignant transformation *in vitro*.⁽⁶⁾ Patients receiving chemotherapy or radiotherapy who took miracle fruit supplements before normal meals had a higher food intake due to the pleasant flavor modifications caused by miraculin. Healthcare practitioners should consider administering a Miracle Fruit supplement to patients experiencing taste alterations as a result of chemotherapy, based on the responses of the study participants. The mechanism of the taste altering property of the miraculin has been studied by several investigators. According to Kurihara and Beidler (1969) sweetness is induced when the miraculin molecule binds to the taste .hT1R2-hT1R3 . The

human taste receptor that activate at low PH. The doors of Mira clean required for this eats not less than 0.1 mg. The miracle in solution of a a 2.3 microgram when held in mouth for 5 minute the effect last long for 3 hours.

4.3 As a source of protein

Because a significant amount of carbohydrate, fat, and protein was assessed during the proximate evaluation of the *Synsepalum dulcificum* berry pulp, the fruit pulp can be safely utilized as food or a component in food preparation. According to the findings of several researches, the moisture content was 45.12 percent, the protein content was 2.48 percent, and the carbohydrate content was 48.84 percent. Tannin 2.90 0.64 mg/100g, phytate 5.21 0.92 mg/100g, glycosidic cyanide 0.03 0.00 mg/100g, steroid 1.560.03 mg/100g, and oxalate 11.04 0.29 percent are among the anti-nutrients. All of the anti-nutritional levels were found to be below acceptable safety limits. There were also several phytochemicals detected, such as flavonoids, resins, and steroids, all of which were found to be below their respective fatal dosages. According to a study, *S. dulcificum* pulp contains essential amino acids like tryptophan, phenylalanine, isoleucine, methionine, threonine, histidine and non-essential amino acids like tyrosine, valine, alanine, glutamine. According to the amino acid profile, the fruit pulp contains both necessary and non-essential amino acids in significant amounts. This distinguishes the fruit as a unique and extraordinary raw material or ingredient for the manufacture of medicinal medicines and dietary supplements. According to one study, the fruit has a sufficient number of necessary amino acids, indicating that it has a high nutritional value.

4.4 As a diabetic preventative

The parts of miracle berry that used to decrease glucose levels are fruits and leaves. It has been proven that miracle berry have hypoglycemic effect on the blood glucose level of albino rat.

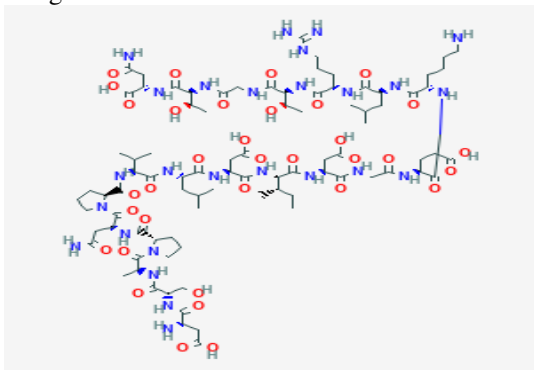


Fig.No.4.1 Chemical Structure of Miraculin

Antioxidant-rich phytochemicals, such as phenolic, flavonoids, and the glycoprotein miraculin, are reported to constitute the main constituents of these substances.

It has also been discovered that the plant's leaves are high in protein, fiber, polysaccharides, and moisture, as well as phytochemicals such as tannin, cardiac glycosides, polyphenols, saponin, and flavonoids. Many natural substances, primarily plant-derived medicines, have been shown in animal and human trials to have the ability to treat diabetes mellitus via an anti-oxidative mechanism.

Several studies have demonstrated that herbal components present in miracle berry fruit and leaf extracts have significant free radical scavenging action in biological systems. Saponins and flavonoids, among all the phytochemicals present, are principally responsible for antidiabetic activity. Flavonoids have been demonstrated to protect cell membranes from damage since they are powerful antioxidants and free radical scavengers. Flavonoids have been shown to have anti-diabetic, anti-inflammatory, anti-microbial, and anti-cancer properties in studies. Flavonoid chemicals have also been identified to be responsible for improving and stabilizing insulin production from pancreatic beta cells. Saponins, on the other hand, have been shown to lower cholesterol levels in the intestine. They have also been shown to impede structure-dependent biological activities, which may help to reduce the metabolic burden that should be in the liver. On the other hand, the glycoprotein miraculin, which is responsible for transforming a sour taste into a sweet flavor in the tongue, can improve insulin sensitivity. As a result, it can be used to create healthy foods for diabetic individuals with insulin resistance. It was remarkable to discover that the leaves have -glucosidase inhibitory activity as well as antioxidant activity. Glucosidase is a carbohydrate digesting enzyme that has been used to treat postprandial hyperglycemia as a treatment strategy. (8,9)

4.5 Anti-microbial agent.

Antibacterial action against the bacteria was given by the oil extracted from Leaf of miracle Fruit. It also inhibited tumor growth in a cancer cell line. The total flavonoids in the leaf extract can increase liver glycogen and antitumoral activity in mice. Heartburn, indigestion, low appetite, and other symptoms including atherosclerosis, high blood pressure, and diabetes can all be improved by *Synsepalum dulcificum* leaf extracts. It can also help with immunity and liver function.

It Can be concluded that antibacterial compound against *L. monocytogenes* can be obtained from the crude extract of *S. dulcificum* from mature and young leaves with better performance from mature leaf of the methanolic extract of *M. alba*.

4.6As food colorants.

The red anthocyanin pigment found in miracle fruit could be used as food colorant, it obtained from

extraction and purification of this pigment. The pigment gives Orange red solution when added to carbonated water and other carbonated sugar solution. Its stability was comparable to that of anthocyanin found from other sources. In water, at one PH ratio of extinction coefficient of the pigment preparation compared to that of FD d and c red number 2 was 2.03. hense flavonoid and anthocyanin pigment obtained from miracle fruit have potential of natural food colorant.

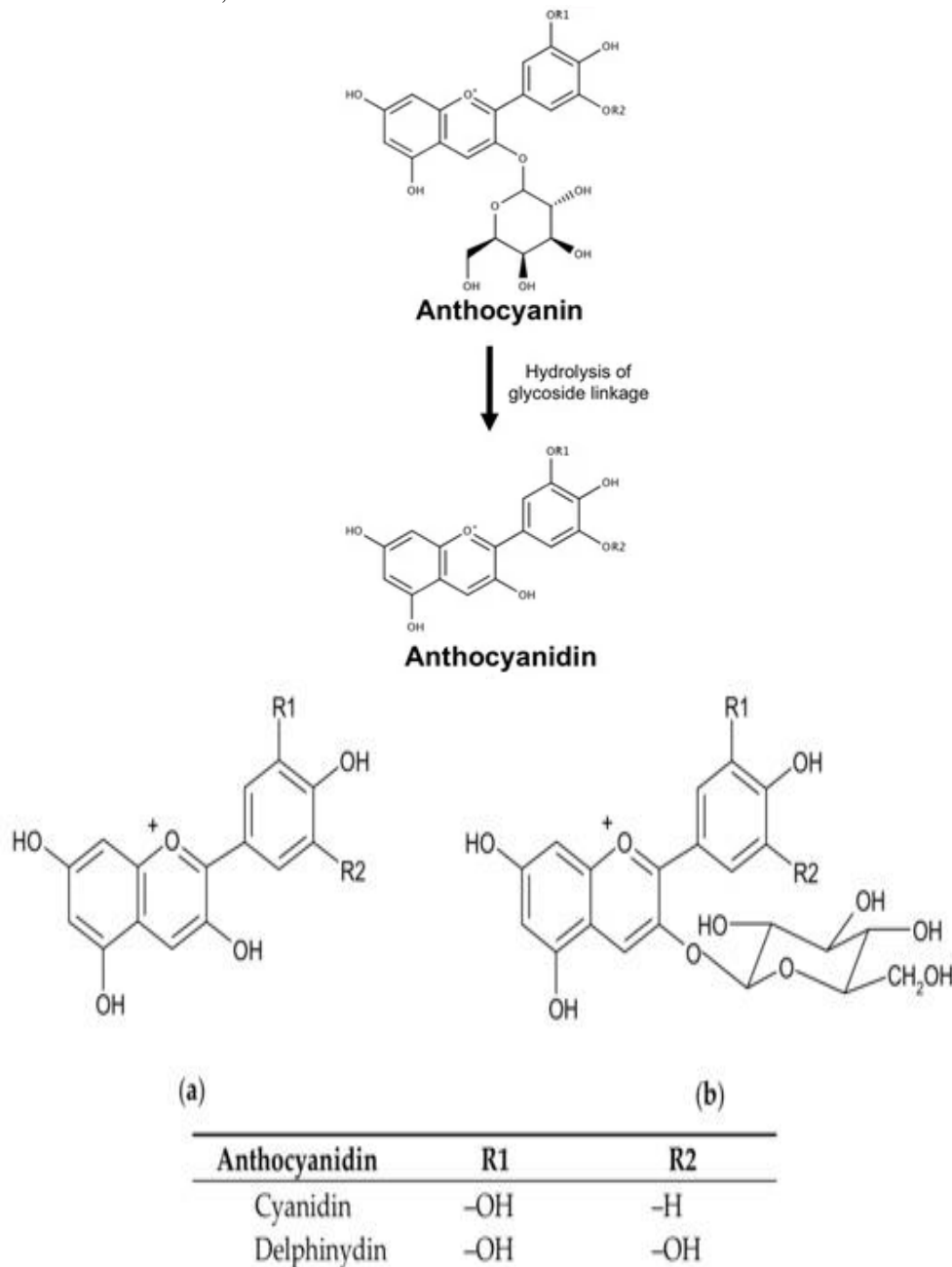


Fig no.4.2 Chemical Structure of major Color Pigments

4.7 As Nutraceuticals

Proteins, lipids, carbs, vitamin C, E, A, and mineral components, as well as polyphenolic chemicals, are abundant in all portions of the wonder fruit. ⁽¹¹⁾ Both the skin and the seed can be employed as dietary supplements for humans and animals. Their high amounts of highly reactive polyphenols qualify them as constituents that could be utilized in the production of nutraceutical treatments for human health protection. ⁽¹⁾ Due to its high phenolic content, skin contributed 43.96 percent of free phenolic compounds and 15.91 percent of freeze-dried solids. The free flavonoid level in the skin was considerably higher than that in the seed and pulp, following the phenolic content pattern. With 15.91 percent of dried solids, the skin produced around 52 percent of total flavonoid. ⁽⁸⁾

4.8 Forcontrolling obesity

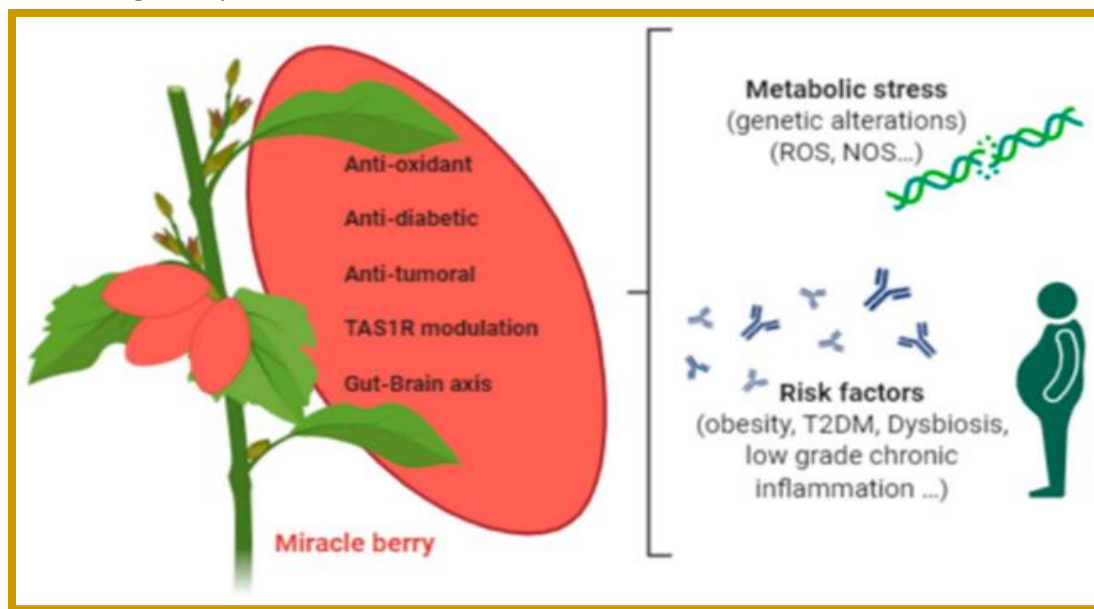


Fig. No 4.3 characteristics of Miracle Berry

4.9. As an anticonvulsantagent

It has discovered that the effects present in aqueous seed extract. Of miracle berry in an experimental study. The seizure induced by stychine drug in mouse can be controlled by giving seed aqueous extract 0.3.mgper kg gave 16.67 percent protection against mortality.⁽¹¹⁾

4.10 . Hepatoprotective activity

Sweet fruitis effective to reduce bilirubin level with 25 to 200 mg per kg methanolic extracts. And extract for 50 mg per kg is effective to reduce serum alkaline phosphate n alanine Aminotransferases .⁽¹¹⁾ The all data has been taken from an experimental study.

The approach involves contacting the fruit with a polyvinyl pyrrolidone slurry, followed by chromatography procedures to absorb the active ingredient. Proteases and tannins are almost eliminated from the final product when the procedure is followed according to the present invention. When made according to the present invention, the active ingredient of this fruit has been verified to be particularly effective in preventing obesity in humans. At concentrations of 10- 7 M, the active principle, often known as "MFP" (miracle fruit principle) or "miraculin," is effective in treating obesity. ⁽¹⁰⁾ Miraculin is a glycoprotein that has a role in healing (a protein that has a carbohydrate group attached to the polypeptide chain). Miraculin has a molecular weight of 24,600 Da, with 86.1 percent polypeptide and 13.9 percent carbohydrate.

5. MARKETED PRODUCTS FROM THE MIRACLE FRUIT

In a commercial context, the miracle fruit's potential is interrelated to the sweetener and medicine industries, and this plant and its fruits have been included in the category of promising products. It have been seen that in foreign nation there has already been progress in their consumption alternatives as pills to avoid bitter and sour flavors, but as far as is natural or effective this type of product, is where the giving promissory tag comes into play. That's why this type of fruit can handle alternative agro-industrial production in the field of natural sweeteners at high levels and is an important option for the consumer, which is what is looking with a promising product. ⁽¹²⁾



Fig.No 5.1 Marketed Products from MiraculousBerry.

Currently, a number of dried miracle berry are in US and Taiwanese markets, in the forms of dried berries, powders, and other products, and fresh miracle berry is commonly consumed in Ghana. Miracle berry products are approved for food use at least in the US, Japan, Taiwan, and Ghana. The novel food ingredient is intended to be used in food supplements only with a maximum daily dose of 0.9 g/day distributed in 3 servings a day (0.1g – 0.3g), one before each main meal / food beverage, which is compatible with a good control of a conscious consumption, according to the habits of people taking supplements. The product is unlikely to substitute any other food items within diet and there is no exposure to the fruit or its extract from other food sources.

Table no.4.1 Miracle fruit product specifications ⁽⁵⁾:

Sr.no	Brand name	Ingredients
1	Large miracle frooties	Dried Miracle Fruit pulp, potato starch, Maltodextrins
2	Miracle Frooties	Dried Miracle Berry pulp, potato starch, Maltodextrins
3	Mberry	Sweet fruit paste corn starch
4	Sweet Freaks, Miracle Berry Powder	Miracle berry powder

6.ASPECTS OF THE MIRACULOUS FRUIT'S SAFETY.

There is now insufficient scientific evidence to recognize the proper guidelines for the eating of miraculous fruits. However, it is found that the optimal dose of miracle fruit is determined by a various of parameters, including the person related health, and numerous other properties. In general, there is no risk associated with eating glycoproteins, and considered harmless. Glycoproteins are also easily digested and eliminated by the body. However, one study found that consuming 3,000 times the amount of sweet fruit

concentrate recommended for person intake had no negative consequences. ⁽¹³⁾.

7. LEGAL STATUS

The trial have been started a years ago to take permission for miracle berry product but due to lack of safety data it was Contradicted by FDA of USA.. S.dulcificum Is cultivated n sold in United States .. In bar , resturant it's flavour tripping events are more popular. In Japan there is no restriction to selling the miracle fruit, In European country e miracle fruit counted in list of New food although Miraculin did not have legal status.The pitted n dried miracle berry

i.e.lyophilized fruit is safe to consume at daily intake of 0.7.gmperday said by EFSA pannel on novel food n nutrition . Contradicted in lactating women and pregnant lady due to lack of safety data. Miracle fruit grown large in Asia , us although lack of scientific study.

To experience magic in flavour of taste miracle berry use. In next some years miracle fruit can be seen as sugar solution^(14,15,31)

8. CONCLUSION:

The constituentMiraculin obtained from S.dulcificum berry has huge potential for used in manufacturing of foods. To enhance wellness and Manage two range of illness. It might have been used to create goods forperson who suffer from sugar related illness or who are going through to a radiation for chemotherapy, also used to feed market demand.researchmay be performed on the the development of products that incorporatefruit,branches, rhizomes other components including itself the fruit.

Studies are carried out how to fill the gas by analysing the existing state of consumption and harmlessness of miracle fruit .recognising its future potential as an excellent ingredient for sweet-toothed clients, particularly the increasing diabetic populationall across the world. Because Dracula fruit have not been well explored for their composition, securityn prospective applications, a well-thought-out strategy would be required to position to fruit as a high-potential product that fits the requirements of the pharmaceutical n food companies in more natural ways. Future research should focus on how miracle fruit is best for meal that includes multiple dishes (rather than just one), as well as for certain consumer groups with specific illness conditions. The findings of this study will be helpful in offering insights to the food industry for the increase of functional foods and for the Enhancement of useful nutrients in general.

LIST OF SYMBOLS AND ABBREVIATIONS

NNS	Non nutritive sweetners
Mw	Molecular weight
AAS	Atomic absorption spectroscopy
DPPH	1,1-Diphenyl-2-picrylhydroxyl
MFP	Miracle fruit powder
MFWE	Miracle fruit water extract
TSAS	Taste and smell alterations
AgNPs	Silver nanoparticle

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