



## POLYHERBAL STRATEGY FOR GLYCEMIC CONTROL: REVIEW ON THE COMBINED ANTIDIABETIC EFFECTS OF "WATER AMARANTH AND DRAGON FRUIT"

Dr. M. Lakshmi Surekha\*<sup>1</sup>, J. Santhi Priya\*<sup>2</sup>, B. Abhinaya Geethika<sup>3</sup>

<sup>1</sup>Professor, <sup>2</sup>Assistant Professor,

A.M. Reddy Memorial College of Pharmacy, Petlurivaripalem, Narasaraopet, Palnadu, Andhra Pradesh, 522601.

<sup>3</sup>Research Scholar, A M Reddy Memorial College of Pharmacy, Petlurivaripalem, Narasaraopet, Palnadu, Andhra Pradesh, 522601.



\*Corresponding Author: Dr. M. Lakshmi Surekha

Professor, A.M. Reddy Memorial College of Pharmacy, Petlurivaripalem, Narasaraopet, Palnadu, Andhra Pradesh, 522601.

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### ABSTRACT

Diabetic Mellitus is a metabolic disorder characterized by chronic hyperglycemia and associated complications. The exploration of plant based nutraceuticals has gained attention as supportive approach to diabetes management. Water Amaranth is a nutrient-dense leafy vegetable rich in dietary fiber, minerals and antioxidant phytochemicals, which may contribute to improved glycemic control by delaying carbohydrate absorption and enhancing insulin sensitivity. Dragon fruit pulp contains soluble fiber, polyphenols and betalains that help reduce postprandial glucose levels and oxidative stress. The combination of water amaranth and dragon fruit pulp offers synergistic antidiabetic potential due to their complementary nutritional and functional properties. This study highlights their role in glucose regulation and evaluates their suitability for nutraceuticals tablet formulation.

**KEYWORDS:** Diabetes Mellitus, Water Amaranth, Dragon Fruit, Herbal formulation.

### 1. INTRODUCTION

**1.1** Diabetes mellitus is a chronic metabolic disorder characterized by elevated blood glucose levels due to impaired insulin secretion, insulin resistance or both. Persistent hyperglycemia leads to long-term complications such as neuropathy, retinopathy, nephropathy and cardiovascular diseases. Although several synthetic oral hyperglycemic agents are available, their long-term use may be associated with side effects including hypoglycemia, gastrointestinal disturbances and hepatic or renal stress. Therefore, there is growing interest in developing plant – based formulation that are safe, cost – effective and suitable for prolonged administration. In this context, water amaranth and dragon fruit pulp have attracted attention as potential natural antidiabetic agents for herbal tablet formulation.

**1.2** Water Amaranth, scientifically known as *Amaranthus viridis*, is a leafy vegetable widely cultivated in tropical and subtropical regions. It belongs to the family Amaranthaceae and is traditionally consumed as a nutritious vegetable. The plant is rich in bioactive compounds such as flavonoids, polyphenols, alkaloids, saponins, tannins and dietary fiber. It also contains essential vitamins (A, C, and E) and minerals like iron, calcium and magnesium. These phytoconstituents contribute significantly to its pharmacological activities, particularly its antioxidant and antihyperglycemic effects. The antidiabetic potential of water amaranth is mainly attributed to its ability to inhibit carbohydrate-digesting enzymes such as alpha amylase and alpha glucosidase, thereby reducing glucose absorption in the intestine. Its high fiber content slows gastric emptying and delays glucose uptake, which helps control postprandial blood

sugar levels. Additionally, the antioxidant compounds present in the plant help reduce oxidative stress, a major factor in pancreatic beta-cell dysfunction in diabetes. Some studies also suggest that extracts of *Amaranthus viridis* may enhance insulin sensitivity and improve lipid metabolism, making it beneficial in managing type 2 diabetes mellitus.



**1.2 Water Amaranth.**

**1.3** Dragon fruit pulp, obtained from *Hylocereus undatus*, is another promising natural ingredient for antidiabetic formulations. Commonly known as pitaya, this fruit belongs to the Cactaceae family and is widely cultivated in tropical regions. The pulp is rich in bioactive compounds such as betalains (betacyanins and betaxanthins), flavonoids, phenolic acids, vitamin C, and soluble dietary fiber. These components exhibit strong antioxidant, anti-inflammatory, and glucose-regulating properties. The antidiabetic action of dragon fruit pulp is associated with its ability to improve insulin resistance and protect pancreatic  $\beta$ -cells from oxidative damage. The high antioxidant content helps neutralize free radicals, thereby reducing cellular stress linked to diabetes progression. Furthermore, its soluble fiber and oligosaccharides act as prebiotics, improving gut microbiota composition and enhancing glucose metabolism. Studies have indicated that regular consumption of dragon fruit may reduce fasting blood glucose levels and improve overall glycemic control.



**1.3 Dragon Fruit.**

## 2. METHODOLOGY

**2.1** For the development of an antidiabetic herbal tablet containing water amaranth and dragon fruit pulp, a systematic pharmaceutical methodology must be followed, beginning with raw material selection and ending with finished tablet evaluation. Water amaranth is obtained from fresh leaves of *Amaranthus viridis* (or other suitable *Amaranthus* species). The leaves should be authenticated botanically, washed thoroughly to remove dirt, and shade-dried at controlled temperature (below 45°C) to preserve thermolabile phytoconstituents such as flavonoids and phenolic compounds. After complete drying, the material is pulverized using a mechanical grinder and passed through a standard sieve (e.g., 60 mesh) to obtain uniform powder. For aqueous extraction, the powdered material is soaked in distilled water (1:10 w/v ratio) and subjected to maceration for 24–48 hours with intermittent stirring or alternatively processed using hot percolation/Soxhlet extraction. The extract is filtered and concentrated under reduced pressure using a rotary evaporator. The concentrated extract is then dried by spray drying or freeze-drying to obtain a stable powdered extract suitable for tablet formulation. Dragon fruit pulp is obtained from ripe fruits of *Hylocereus undatus*. The fruits are washed, peeled manually, and the pulp is separated hygienically. The pulp is homogenized and subjected to drying (preferably freeze-drying to retain betalains, vitamin C, and antioxidant compounds). The dried pulp is pulverized into fine powder and sieved to ensure uniform particle size. Standardization of both amaranth extract and dragon fruit powder is carried out by evaluating total phenolic content, flavonoid content, antioxidant activity (DPPH assay), and in vitro antidiabetic activity such as  $\alpha$ -amylase and  $\alpha$ -glucosidase inhibition assays. Moisture content, microbial load, and phytochemical screening should also be performed to ensure safety and quality.

**2.2** For tablet formulation, the dried extracts are weighed accurately according to the desired dose (based on preformulation studies and literature evidence for hypoglycemic activity). The formulation may be prepared using the wet granulation or direct compression method. In wet granulation, the extract powders are blended with excipients such as microcrystalline cellulose (diluent), starch (disintegrant), and polyvinylpyrrolidone (binder). A suitable granulating fluid (e.g., purified water or hydroalcoholic solution) is added gradually to form a damp mass, which is passed through a sieve to form granules. The granules are dried at controlled temperature, re-sieved, and mixed with lubricants like magnesium stearate and glidants such as talc. The final blend is compressed into tablets using a tablet compression machine with appropriate hardness and weight settings. In the direct compression method, all powdered ingredients are blended uniformly and compressed directly without granulation, provided flow properties are adequate.

**2.3** Post-compression evaluation tests are essential to ensure tablet quality. These include weight variation test, hardness test, friability test, disintegration time, and in vitro dissolution study. Stability studies are conducted under ICH guidelines to assess shelf life. Additionally, the formulated tablets should undergo in vivo evaluation in suitable animal models of diabetes (such as streptozotocin-induced diabetic rats) to confirm blood glucose-lowering activity. If results are favorable, clinical trials may be conducted to establish safety and efficacy in humans. Thus, the methodology for preparing an antidiabetic tablet using water amaranth and dragon fruit pulp involves careful extraction, standardization, granulation, compression, and quality evaluation to ensure therapeutic effectiveness, stability, and patient safety.

### 3. OVERVIEW OF DIABETES MELLITUS

Diabetes mellitus is classified mainly into:

#### 3.1 Type 1 Diabetes

- Autoimmune destruction of pancreatic  $\beta$ -cells
- Absolute insulin deficiency

#### 3.2 Type 2 Diabetes

- Insulin resistance and reduced insulin secretion
- Most common form of diabetes

#### 3.3 Prediabetes

- Intermediate metabolic stage with elevated blood glucose levels

Effective control of postprandial glucose levels is essential in preventing diabetes complications.

### 4. Polyherbal Strategy in Diabetes Management

Polyherbal therapy is widely used in traditional medicine systems such as Ayurveda and Chinese medicine.

#### 4.1 Advantages

- Synergistic effects
- Multi-target action
- Reduced toxicity
- Improved efficacy

#### 4.2 Plant combinations may regulate

- Carbohydrate digestion
- Insulin sensitivity
- Oxidative stress
- Inflammation

### 5. Water Amaranth (*Amaranthus* spp.)

#### 5.1 Botanical Description

Water amaranth belongs to the **Amaranthaceae** family and is widely cultivated as a leafy vegetable in tropical regions.

#### 5.2 Phytochemical Constituents

Major bioactive compounds include:

- Flavonoids

- Phenolic compounds
- Saponins
- Alkaloids
- Dietary fiber
- Vitamins and minerals

These compounds contribute to antioxidant and antidiabetic activities.

#### 5.3 Antidiabetic Activity

Experimental studies show that *Amaranthus hybridus* leaf extract significantly reduces blood glucose levels in diabetic rats and improves antioxidant enzyme activity.

The plant also improves lipid profiles and protects tissues from oxidative stress associated with diabetes.

#### 5.4 Mechanisms of Action

Water amaranth may control blood glucose through:

- Enhancement of insulin secretion
- Reduction of oxidative stress
- Improvement of glucose uptake
- Inhibition of carbohydrate digestion enzymes

### 6. Dragon Fruit (*Hylocereus* spp.)

#### 6.1 Botanical Description

Dragon fruit, commonly known as **pitaya**, belongs to the **Cactaceae** family and is widely cultivated in tropical and subtropical regions.

#### 6.2 Phytochemical Components:

Dragon fruit contains several beneficial compounds such as:

- Betacyanins
- Flavonoids
- Phenolic acids
- Vitamin C
- Dietary fiber

These compounds exhibit strong antioxidant activity.

#### 6.3 Antidiabetic Effects

Studies have shown that dragon fruit peel and pulp can reduce glucose absorption and inhibit carbohydrate digestion enzymes such as  $\alpha$ -amylase and  $\alpha$ -glucosidase.

A meta-analysis of clinical studies also reported that dragon fruit consumption significantly reduced fasting plasma glucose levels in individuals with prediabetes.

#### 6.4 Mechanisms of Action

The antidiabetic effects of dragon fruit are attributed to:

- Inhibition of carbohydrate digestion enzymes
- Improvement of insulin sensitivity
- Reduction of oxidative stress
- Protection of pancreatic  $\beta$ -cells

### 7. Combined Antidiabetic Effects of Water Amaranth and Dragon Fruit

Combining water amaranth and dragon fruit may produce **synergistic effects** due to their complementary

phytochemical profiles.

### 7.1 Potential Benefits

#### 1. Improved Glycemic Control

- Reduced glucose absorption
- Improved insulin sensitivity

#### 2. Enhanced Antioxidant Activity

- Neutralization of free radicals
- Protection of pancreatic cells

#### 3. Regulation of Lipid Metabolism

- Reduction in cholesterol levels
- Prevention of metabolic syndrome

#### 4. Multi-target Action

- Enzyme inhibition
- Anti-inflammatory effect
- Improved metabolic function

## 8. USES/APPLICATIONS

### 8.1 Glycemic Control

Water amaranth (*Amaranthus spp.*) and dragon fruit (*Hylocereus spp.*) contain bioactive compounds such as flavonoids, phenolics, and dietary fiber that help regulate blood glucose levels. These compounds may enhance insulin sensitivity and reduce glucose absorption in the intestine, making the combination beneficial for managing hyperglycemia.

### 8.2 Antioxidant Activity

Both plants are rich in antioxidants such as vitamin C, betacyanins, and phenolic compounds. These antioxidants help reduce oxidative stress, which is a major factor contributing to diabetes complications including neuropathy, nephropathy, and cardiovascular diseases.

### 8.3 Support for Insulin Function

Phytochemicals present in water amaranth and dragon fruit may improve pancreatic  $\beta$ -cell function and stimulate insulin secretion. This helps in maintaining proper glucose metabolism and preventing excessive blood sugar levels.

### 8.4 Regulation of Lipid Profile

The combination may help improve lipid metabolism by reducing total cholesterol, triglycerides, and low-density lipoprotein (LDL). This is particularly beneficial for diabetic patients who often experience dyslipidemia.

### 8.5 Functional Food Development

Water amaranth leaves and dragon fruit pulp or peel extracts can be incorporated into functional foods such as juices, smoothies, herbal teas, nutraceutical supplements, or dietary powders aimed at supporting glycemic control.

### 8.6 Nutritional Support

Both plants are rich in essential nutrients including

vitamins, minerals, and dietary fiber. Regular consumption may support overall metabolic health and provide additional nutritional benefits for individuals with diabetes.

### 8.7 Potential for Herbal Drug Development

The combination of these two plants could be used in developing polyherbal formulations, herbal capsules, or plant-based antidiabetic products with fewer side effects compared to synthetic drugs.

## 9. LIMITATIONS

### 9.1 Lack of Extensive Clinical Studies

Although several experimental and animal studies show promising antidiabetic effects, there are limited human clinical trials evaluating the combined effects of water amaranth and dragon fruit. More clinical research is needed to confirm their efficacy and safety.

### 9.2 Variability in Phytochemical Composition

The concentration of bioactive compounds in both plants may vary depending on factors such as soil conditions, climate, cultivation methods, and harvesting time. This variability may affect the consistency of therapeutic effects.

### 9.3 Standardization Challenges

Polyherbal formulations require proper standardization of dosage, extraction methods, and active compounds. Currently, standardized formulations combining water amaranth and dragon fruit are not well established.

### 9.4 Possible Interactions with Antidiabetic Drugs

Consumption of these plant extracts along with conventional antidiabetic medications may lead to excessive lowering of blood glucose levels. Therefore, medical supervision is necessary when combining herbal and pharmaceutical treatments.

### 9.5 Limited Long-Term Safety Data

Long-term safety studies on the continuous use of these plant extracts in high doses are still limited. Further toxicological evaluation is required to determine safe dosage levels.

### 9.6 Storage and Stability Issues

Bioactive compounds such as betacyanins in dragon fruit are sensitive to heat, light, and oxygen. Improper processing or storage conditions may reduce the effectiveness of the formulation.

## 10. CONCLUSION

Polyherbal therapy offers a promising approach for the management of diabetes mellitus. Water amaranth and dragon fruit possess significant antidiabetic properties due to their rich phytochemical composition and antioxidant activity. The combination of these plants may provide synergistic benefits for glycemic control by improving insulin sensitivity, inhibiting carbohydrate digestion enzymes, and reducing oxidative stress.

Further clinical studies are necessary to confirm their therapeutic efficacy and develop effective herbal formulations for diabetes management.

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