**International Journal of Pharmacy and Pharmaceutical Research (IJPPR)**
Volume 31, Issue 12, December 2025 **ijppr.humanjournals.com** ISSN: 2349-7203

# A Comprehensive Review on Bioactive Components and Pharmacological Activities of the Banana Flower (*Musa sp.*)

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Received: 15 November 2025 Revised: 29 November 2025 Accepted: 16 December 2025

**ABSTRACT:**

The banana flower, or male bud, from various *Musa* species (Musaceae family), is a traditional functional food and ethnomedicinal agent widely used across Asia, Africa, and Latin America. Historically considered an agricultural by-product, scientific research has increasingly validated its immense potential as a source of diverse bioactive compounds and therapeutic agents. This comprehensive review synthesizes the current knowledge on the phytochemical constituents, nutritional profile, and a wide spectrum of pharmacological activities of the banana flower. Key bioactive compounds include high levels of polyphenols, flavonoids, tannins, saponins, and dietary fiber. Studies have consistently demonstrated its potent antioxidant, anti-hyperglycemic, anti-cancer, antimicrobial, anti-inflammatory, and galactopoietic properties. The mechanistic insights into these activities, particularly the inhibition of $\alpha$-amylase and $\alpha$-glucosidase for anti-diabetic effects, apoptosis induction in cancer cells, and $G1$ cell-cycle arrest in Benign Prostatic Hyperplasia (BPH) models, underscore its promise as a valuable resource for developing novel nutraceuticals and pharmaceutical agents.

**Keywords:** Musa species, Bio active compounds, Ethnomedicinal uses, Nutraceutical potential.

## 1. INTRODUCTION:

### 1.1. Botany and Traditional Significance

The banana plant (*Musa* spp.) is a significant staple crop globally, cultivated in over 130 countries, primarily in tropical and subtropical regions. While the fruit is the main product, the large, tear-shaped, dark purple inflorescence, commonly known as the banana flower or banana blossom, is a widely consumed vegetable and traditional medicine ingredient, particularly in Southeast Asia, India, and East Africa [1]. The flower is utilized in various culinary preparations, including soups, curries, and salads [2].

### 1.2. Ethnomedicinal Uses

For centuries, indigenous communities and folk medicine practitioners have utilized the banana flower to manage a wide range of ailments. Traditional applications include:

- Treatment of common illnesses such as bronchitis, constipation, diarrhea, and peptic ulcers [3].
- Use in specific conditions like heart pain, asthma, and stomach cramps [3].
- Therapeutic application for respiratory diseases and to help relieve kidney stones [5].

- A traditional remedy in Northeast India for anaemia and arthritis, and consumed during menstruation to reduce menstrual cramps and recover from excessive blood loss [6].

- It is specifically prized for its benefits in women's health, notably as a natural galactagogue to increase milk production in lactating mothers [7].

The objective of this review is to consolidate scientific data from in vitro, in vivo, and analytical studies on the banana flower, linking its phytochemical composition to its diverse pharmacological properties.

**2. Phytochemical and Nutritional Profile**

The therapeutic value of the banana flower is directly correlated with its rich and complex matrix of primary nutrients, secondary metabolites, and fiber.

**2.1. Major Phytochemical Classes**

Phytochemical screening of various banana flower extracts (methanolic, ethanolic, aqueous) confirms the presence of several key bioactive classes [8]:

- Polyphenols (Phenolics and Flavonoids): These are the most abundant and well-studied secondary metabolites, responsible for the potent antioxidant activity [9]. Specific phenolic compounds identified in the inflorescence include gallic acid, catechin, isoquercetin, quercetin, rutin, and tannic acid [7].

- Saponins: Present in the extract, saponins are known for their cholesterol-lowering properties and potential to inhibit cancer cell growth [4].

- Tannins: Contribute to the flower's astringent taste and possess notable antifungal and antibacterial effects [4].

- Alkaloids, Glycosides, and Steroids: Crude extracts also contain these compounds, suggesting a broad spectrum of bioactivity [7].

- Bract-Specific Components: The colourful outer bracts, which are often discarded, contain unique bioactive constituents such as anthocyanins (e.g., delphinidin, pelargonidin, paeonidin, and malvidin) and cycloglycosides [4].

**2.2. Protein and Amino Acids**

The banana flower is a source of protein, with maximum yields reported under optimized alkaline extraction conditions [10].

- Yield and Characterization: Maximum protein yield of 252.25 *mg*/*g* has been obtained, significantly higher than enzymatic extraction [10].

- Chemical Fingerprinting: Chemical analysis confirmed the presence of tyrosine and tryptophan in the extracted protein [10]. These amino acids have been linked to the flower's significant antibacterial potential against various pathogenic bacteria [10].

**Floral Formula:**

Male flower: Br, Ebrl, %, $P_{(3+2)}$+1,$A_{3+3}$>$G_0$.

Female flower: Br, Ebrl, %, $P_{(3+2)}$+1,$A_0$,$G_{(3)}$.

Bisexual flower: Br, Ebrl, %, $P_{(3+2)}$+1>$A_{3+3}$,$G_{(3)}$.

**2.3. Nutritional Composition**

The flower provides a healthy balance of macro and micronutrients [2]:

- Dietary Fiber: Both the outer and inner bracts are exceptionally rich in dietary fiber, with inner bracts showing up to 66.22% and outer bracts 61.13% on a dry basis [11]. This high fiber content is crucial for managing gastrointestinal health and metabolic disorders [11].

- Minerals: It is an excellent source of essential minerals, including potassium, calcium, magnesium, iron, and phosphorus [2]. The high iron content is often cited as the basis for its traditional use in treating anaemia [6].

- Vitamins: The flower is a good source of vitamins, notably Vitamin A, Vitamin C, and Vitamin E [2]. Wild varieties have shown particularly high levels of carotenoids and Vitamin E [6].

## 3. Pharmacological Activities and Mechanisms

### 3.1. Antioxidant Activity

The powerful antioxidant activity is a unifying property across all studies on the banana flower [2].

#### 3.1.1. Activity and Correlation

- The antioxidant potential is highly correlated with the Total Phenolic Content (TPC) and Total Flavonoid Content (TFC) [9].

- Studies comparing different Malaysian cultivars (*Pisang Abu*, *P. Berangan*, *P. Nipah*, *P. Susu*, *P. Mas*) have shown variation in their antioxidative capacity, suggesting that choice of cultivar is an important factor in bioactivity [3].

- The activity is typically measured by free radical scavenging assays, such as the DPPH and ABTS assays, demonstrating its efficacy in neutralizing free radicals that cause cellular damage [9].

### 3.2. Anti-hyperglycemic and Anti-diabetic Potential

The banana flower has proven effective in mitigating key aspects of Type 2 Diabetes Mellitus [3].

#### 3.2.1. Enzyme Inhibition

- $\alpha$-Amylase and $\alpha$-Glucosidase Inhibition: The aqueous and ethanolic extracts demonstrate an ability to inhibit the intestinal enzymes $\alpha$-amylase and $\alpha$-glucosidase 3. This mechanism suppresses the digestion and absorption of carbohydrates, thereby reducing postprandial blood glucose spikes [3]. The inhibitory effect is comparable to commercial anti-diabetic drugs [3].

- Glucose Dialysis Retardation Index (GDRI): Fiber-rich fractions, especially the inner and outer bracts, exhibit a high GDRI, confirming their potential to slow down glucose absorption in the gut [11].

#### 3.2.2. *In Vivo* Effects

- In diabetic animal models, banana flower extracts have been shown to significantly reduce blood glucose levels, and decrease markers of long-term glucose control, such as glycosylated haemoglobin [5].

- The extract also helped inhibit the formation of Advanced Glycation End-products (AGEs), a major contributor to diabetes-related complications like renal failure [4].

### 3.3. Anti-cancer Potential

Research supports the flower's role in cancer chemoprevention and therapy [12].

#### 3.3.1. Apoptosis and Cytotoxicity

- An in vitro study on the ethanol extract demonstrated cytotoxic activity against HeLa (cervical cancer) and CHO (Chinese hamster ovary) cell lines [12].

- The active fraction, rich in phenols, was found to induce apoptosis (programmed cell death) more effectively in the treated HeLa cells compared to CHO cells, identifying one of the key anti-cancer mechanisms [12]. The concentration required to inhibit growth by 50% (*IC*50) was reported to be 20*μg/mL* for the bioactive fraction on HeLa cells [12].

**3.4. Anti-inflammatory and Anti-BPH Activity**

Recent studies have explored the application of banana flower extract (BFE) in mitigating inflammatory diseases [13].

- Suppression of Benign Prostatic Hyperplasia (BPH): BFE was found to effectively suppress BPH in an *in vivo* rat model [13].

- Mechanism of Action: The BFE's effect involves two primary pathways [13]:

1. Anti-inflammatory Regulation: It helps regulate the inflammatory response in the prostate tissue [13].

2. Cell-Cycle Arrest: BFE induces *G*1 cell-cycle arrest in the prostatic epithelial cells, thereby preventing their uncontrolled proliferation [13].

**3.5. Antimicrobial and Anthelmintic Activities**

The flower's extracts and isolated compounds show broad-spectrum activity against various pathogens [10].

- Antibacterial Action: The isolated protein fraction exhibits an antibacterial potential against both Gram-positive and Gram-negative bacteria [10]. Specific pathogens inhibited include *Bacillus subtilis*, *Bacillus cereus*, and *E. coli* [5].

- Antifungal and Anthelmintic: Methanolic extracts have shown activity against *Candida albicans* [4]. It also possesses anthelmintic (anti-worm) properties [5].

**3.6. Galactopoietic Activity (Lactation) and Anemia Management**

The traditional use of the banana flower for promoting maternal health is scientifically supported [5].

- Lactation: The flower extract possesses galactopoietic effects, helping to increase maternal milk production, a benefit often sought by breastfeeding mothers [7].

- Anemia**:** Its high iron content facilitates the production of red blood cells, helping to raise the haemoglobin level and address iron-deficiency anemia [5].

**4. Food Applications and Future Perspectives**

**4.1. Utilization in Food Products**

The banana flower's rich composition makes it an ideal candidate for food fortification and product development.

- Functional Fiber Ingredient: Due to its exceptional dietary fiber content, the bracts can be used as a high-fiber food ingredient, offering benefits like increased water-holding capacity and oil-holding capacity, which are desirable for improving the texture and quality of baked goods [11].

- Nutraceuticals: The extract's antioxidant and anti-hyperglycemic properties suggest its use as a dietary supplement or additive in various food matrices, such as dark chocolate or cookies, to enhance their nutritional and functional value [9].

**4.2. Safety and Toxicology**

Acute oral toxicity studies on banana flower extracts in animal models have typically indicated its non-toxic nature at tested doses, confirming its safety profile for traditional consumption 4. However, extensive long-term toxicity and clinical human trials are still necessary to fully establish its safety and efficacy as a standardized pharmaceutical agent.

## 5. CONCLUSION:

The banana flower, a valuable yet often underutilized agricultural by-product, is a powerhouse of bioactive compounds, including a diverse array of polyphenols, flavonoids, and high-quality protein and fiber. Scientific research has unequivocally validated the flower's traditional uses by demonstrating potent pharmacological activities, most notably as an antioxidant (due to phenolics/flavonoids), an anti-diabetic agent (via $\alpha$-glucosidase inhibition), and a compound with significant anti-cancer and anti-BPH potential (through cell-cycle arrest and apoptosis). Further focused studies on isolating, purifying, and clinically testing its specific bioactive molecules are warranted to transition the banana flower from a traditional vegetable to a standardized, globally recognized nutraceutical and pharmaceutical resource.

## REFERENCES :

1. Marikkar JM, Tan SJ, Salleh A, Azrina A, Shukri MA. Evaluation of banana (Musa sp.) flowers of selected varieties for their antioxidative and anti-hyperglycemic potentials. International Food Research Journal. 2016 Dec 15;23(5).
2. Salem IS, Ameen AA, Mohammed MS. Therapeutic effect of banana flower (banana male bud) on diabetic rats. Egyptian Journal of Nutrition. 2018 Jun 1;33(2):90-120.
3. Govindaraj–E-mail J, Govindaraj-E-mail K, Vidyarekha U, Bhuminathan-E-mail S. A review on the therapeutic potential of Banana flower. Bioinformation. 2022;18(4):349-53.
4. Pushpaveni C, Visagaperumal D, Chandy V. A review on banana blossom: The heart of banana. World Journal of Pharmaceutical Research. 2019;8(11):440-50.
5. Bishnoi P, Ramlal A, Raju D, Saini M, Mallikarjuna BP, Pushpa R, Rajendran A. In vitro culture of soybean (glycine max (L.) Merr.): challenges and solutions. Journal of Crop Improvement. 2025 Jun 8:1-26.
6. Jamoh O, Singh AK, Lego N, Wangchu L, Sarma P, Hazarika BN. Studies on ethnomedicinal, phytochemical and antioxidant activity of wild edible banana flowers consumed by tribals of northeast India. Ann Phytomed. 2024;13(2):603-611.
7. Amornlerdpison D, Choommongkol V, Narkprasom K, Yimyam S. Bioactive compounds and antioxidant properties of banana inflorescence in a beverage for maternal breastfeeding. Applied Sciences. 2020 Dec 31;11(1):343.
8. Sumathy V, Lachumy SJ, Zakaria ZA, Sasidharan S. In vitro bioactivity and phytochemical screening of Musa sapientum flower extract. J Appl Pharm Sci. 2011;1(6):198-203.
9. Begum YA, Deka SC. Chemical profiling and functional properties of dietary fibre rich inner and outer bracts of culinary banana flower. Journal of food science and technology. 2019 Dec;56(12):5298-308.
10. Sitthiya K, Devkota L, Sadiq MB, Anal AK. Extraction and characterization of proteins from banana (Musa Sapientum L) flower and evaluation of antimicrobial activities. Journal of food science and technology. 2018 Feb;55(2):658-66.
11. Bibechana Timsina BT, Nadumane VK. Anti-cancer potential of banana flower extract: an in vitro study.
12. Liu LC, Lin YH, Lin YC, Ho CT, Hung CM, Way TD, Bau DT. Banana flower extract suppresses benign prostatic hyperplasia by regulating the inflammatory response and inducing G1 cell-cycle arrest. in vivo. 2018 Nov 1;32(6):1373-9.
13. Sheng ZW, Ma WH, Jin ZQ, Bi Y, Sun ZG, Dou HT, Li JY, Han LN. Investigation of dietary fiber, protein, vitamin E and other nutritional compounds of banana flower of two cultivars grown in China. African Journal of Biotechnology. 2010;9(25):3888-95.
14. Campus C. *SHER.. EKASHMIR* (Doctoral dissertation, Kashmir University).
15. Jamuna AM, Gopinath C, Ramachandran KM. Inhibitory effect of banana blossom and pseudostem on AGEs formation in streptozotocin induced diabetic rats. J Med Plant Res. 2011;5(2):250-254.
16. Kumar D, Saini M, Sharma PK. Anti-diabetic effect of Musa paradisiaca Linn. flower extract in streptozotocin-nicotinamide induced diabetic rats. J Chem Pharm Res. 2012;4(3):1642-1647.
17. Kumar D, Saini M, Sharma PK. Anti-diabetic effect of Musa paradisiaca Linn. flower extract in streptozotocin-nicotinamide induced diabetic rats. J Chem Pharm Res. 2012;4(3):1642-1647.

How to cite this article:
Thangalakshmi P et al. Ijppr.Human, 2025; Vol. 31 (12): 568-574.
Conflict of Interest Statement: All authors have nothing else to disclose.

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