



Antioxidant and free radical scavenging activities of selected edible flowers used in human nutrition: A comprehensive review

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Abstract

Oxidative stress resulting from excessive production of reactive oxygen species (ROS) is a major contributor to aging and various chronic diseases. Natural antioxidants derived from plant sources play a vital role in neutralizing these free radicals and maintaining cellular homeostasis. Edible flowers, traditionally used in food and herbal medicine, are emerging as valuable sources of bioactive phytochemicals with potent antioxidant properties. This review compiles and critically evaluates the free radical scavenging activities of five commonly consumed edible flowers—*Clitoria ternatea*, *Hibiscus rosa sinensis*, *Moringa oleifera*, rose (*Rosa* spp.), and banana flower (*Musa* spp.). Their phytochemical composition, antioxidant mechanisms, *in vitro* scavenging potential, and functional health significance are discussed. The collective evidence supports their potential application as functional foods and nutraceutical ingredients for oxidative stress management and disease prevention.

Keywords: Antioxidants, free radicals, edible flowers, *Clitoria Ternatea*, *Hibiscus Rosa Sinensis*, *Moringa Oleifera*, *Rosa* Spp., banana flower (*musa* spp.)

Introduction

Reactive oxygen species (ROS) such as superoxide anion, hydroxyl radical, hydrogen peroxide, and singlet oxygen are continuously generated during normal cellular metabolism. When the antioxidant defense system fails to neutralize these species, oxidative stress occurs, leading to lipid peroxidation, protein denaturation, DNA damage, and mitochondrial dysfunction. Oxidative stress is closely associated with aging and the development of chronic diseases including cancer, cardiovascular disorders, diabetes, and neurodegenerative diseases (Halliwell and Gutteridge, 2015)^[6].

Dietary antioxidants provide essential protection against oxidative damage. In recent years, interest has shifted from synthetic antioxidants to natural sources due to safety concerns. Edible flowers represent an underexplored yet nutritionally rich group of plant materials traditionally consumed in teas, curries, salads, and medicinal preparations. Among them, *Clitoria ternatea*, *Hibiscus Rosa sinensis*, *Moringa oleifera*, *Rosa* spp., and banana (*Musa* spp.) flowers are widely consumed in tropical regions and possess significant antioxidant potential.

This review highlights their free radical scavenging properties, phytochemical profiles, and relevance in functional nutrition.

Mechanism of Free Radical Scavenging

Plant-derived antioxidants neutralize free radicals through:

1. Electron donation
2. Hydrogen atom transfer
3. Metal ion chelation
4. Inhibition of lipid peroxidation
5. Enhancement of endogenous antioxidant enzymes

Phenolic compounds play a dominant role due to their hydroxyl groups that stabilize free radicals via resonance (Prior *et al.*, 2005)^[13].

Clitoria ternatea

It is commonly called as Butterfly Pea Flower. *Clitoria ternatea* flowers are rich in ternatin anthocyanins, flavonoids, and phenolic acids (Kazuma *et al.*, 2003)^[8]. Several studies demonstrate strong DPPH, ABTS, and hydrogen peroxide scavenging activities in aqueous and ethanolic extracts (Chayaratanasin *et al.*, 2015; Jeyaraj *et al.*, 2020)^[4, 7]. The antioxidant activity increases with concentration and correlates positively with total phenolic content.

These antioxidants contribute to neuroprotective, anti-inflammatory, antidiabetic, and anti-aging properties of butterfly pea flowers (Mukherjee *et al.*, 2008)^[12].



Clitoria ternatea



Rose spp



Moringa oleifera flowers



Banana (*Musa spp.*) flower



Hibiscus rosa sinensis

***Hibiscus rosa-sinensis* L. (family: Malvaceae)**

Commonly known as China rose or shoe flower, is widely used in traditional medicine and as an ornamental and edible flower. Recent phytochemical and pharmacological studies have established its significant antioxidant and free radical scavenging potential.

The flowers of *H. rosa-sinensis* contain a rich spectrum of bioactive compounds including flavonoids, phenolic acids, anthocyanins, tannins, alkaloids, and vitamin C (Vankar and Srivastava, 2008; Rao *et al.*, 2011). These phytochemicals are primarily responsible for its strong antioxidant capacity.

Flavonoids and phenolics contribute to electron donation and hydrogen atom transfer mechanisms, while anthocyanins enhance radical stabilization through resonance structures (Prior *et al.*, 2005)^[13].

Several *in vitro* assays confirm the strong free radical scavenging potential of *H. Rosa-sinensis* flower extracts:

- **DPPH radical scavenging assay:** Methanolic and aqueous extracts show dose-dependent scavenging activity, comparable to ascorbic acid (Vankar and Srivastava, 2008).
- **ABTS radical cation assay:** Confirms broad-spectrum antioxidant capacity against both hydrophilic and lipophilic radicals (Rao *et al.*, 2011).
- **Hydroxyl radical scavenging:** Protects biomolecules from oxidative degradation and lipid peroxidation (Sivaraj *et al.*, 2014).
- **Superoxide radical scavenging:** Demonstrates inhibition of ROS generation in cellular systems (Kumar *et al.*, 2013).
- **Ferric reducing antioxidant power (FRAP):** Indicates strong electron donating ability of floral extracts (Rao *et al.*, 2011).

The antioxidant activity is positively correlated with total phenolic and flavonoid content, suggesting these compounds are the major contributors to radical scavenging efficacy.

The free radical scavenging activity of *H. rosa-sinensis* contributes to several pharmacological properties including Anti-inflammatory activity, Hepatoprotective effects, Anti-diabetic potential, Anti-aging and cytoprotective effects.

By reducing oxidative stress, *Hibiscus* flower antioxidants help prevent cellular damage and support metabolic and cardiovascular health (Kumar *et al.*, 2013; Sivaraj *et al.*, 2014).

***Moringa oleifera* Flowers**

Moringa oleifera flowers contain phenolics, flavonoids, carotenoids, and vitamins A, C, and E (Sreelatha and Padma, 2009)^[17]. *In vitro* studies demonstrate effective DPPH and FRAP scavenging activity, indicating strong electron-donating capacity (Verma *et al.*, 2009)^[19].

Although antioxidant activity is slightly lower than *Hibiscus* and clitoria, moringa flowers provide balanced antioxidant and nutritional benefits, supporting their use in functional diets.

Rose spp

Edible rose petals are rich in phenolic acids, flavonoids, anthocyanins, vitamin C, and tannins (Kumar *et al.*, 2009; Baydar and Baydar, 2013)^[2, 9]. Methanolic extracts show strong DPPH, ABTS, hydroxyl, and superoxide radical scavenging activities (Saeed *et al.*, 2012)^[14].

Rose antioxidants contribute to anti-aging, anti-inflammatory, cardioprotective, and skin-protective effects, supporting their traditional use in beverages, syrups, and cosmetic formulations. The ayurvedic preparation *Gulkand* from rose petals is traditionally used for various health benefits. Traditional uses of *Gulkand* claims of energy boosting, blood purification, relief from hyperacidity, menstrual cramps, nosebleeds and heat-related fatigue, and as a refreshing tonic with antioxidative properties (Shukla *et al.*, 2024)^[15]

Banana Flower (*Musa* spp.)

Banana flower is nutritionally rich in phenolic compounds, flavonoids, dietary fibre, and minerals (Bhaskar *et al.*, 2012)^[3]. Both aqueous and ethanolic extracts demonstrate significant DPPH, FRAP, and hydroxyl radical scavenging activities (Someya *et al.*, 2002; Kumar *et al.*, 2016)^[10, 16]. The antioxidant activity, combined with high fibre content, contributes to antidiabetic, hepatoprotective, and lipid-lowering properties.

Comparative Free Radical Scavenging Activity

Flower Major Active Radicals Scavenged

<i>Clitoria ternatea</i>	DPPH, ABTS, H ₂ O ₂ , Superoxide
<i>Hibiscus rosa-sinensis</i>	DPPH, ABTS, Hydroxyl, Superoxide
<i>Rose</i> spp.	DPPH, ABTS, Hydroxyl, Superoxide
Banana flower	DPPH, FRAP, Hydroxyl, Nitric oxide
<i>Moringa oleifera</i>	DPPH, FRAP, Superoxide, H ₂ O ₂

Comparative Antioxidant Potential

Overall antioxidant efficacy among studied flowers follows the approximate order:

Hibiscus > *Clitoria* ≈ Rose > Banana flower > *Moringa*

However, variation depends on extraction methods, solvents, concentration, and environmental factors.

Applications in Food and Pharmaceutical Industries

These edible flowers are increasingly used as:

- Natural food colorants
- Herbal teas and beverages
- Nutraceutical supplements
- Functional food additives
- Cosmetic antioxidant ingredients

Their natural origin, safety, and cultural acceptance enhance consumer preference.

Conclusion

The edible flowers *Clitoria ternatea*, *Hibiscus Rosa sinensis*, *Moringa oleifera*, *Rosa indica*, and banana flower (*Musa* spp.) are potent sources of natural antioxidants with significant free radical scavenging properties. Their rich phytochemical composition enables effective neutralization of reactive oxygen species, offering protection against oxidative stress-related disorders. Incorporation of these flowers into daily diets and functional food products represents a sustainable and scientifically supported strategy for health promotion and disease prevention.

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