

In Vitro Antidiabetic Effects of Phytochemicals

Introduction

- **Phytochemicals** are plant-derived bioactive compounds with antioxidant, anti-inflammatory, and metabolic-regulating activities.
- They are abundant in fruits, vegetables, herbs, and seeds, and include **polyphenols, anthocyanins, betalains, and flavonoids**.
- **Type 2 Diabetes Mellitus (T2DM)** is a global metabolic disease caused by insulin resistance or impaired insulin secretion, leading to chronic high blood sugar.
- Conventional drugs (e.g., metformin, sulfonylureas) can have side effects and do not address oxidative stress and inflammation.
- **Phytochemicals can:**
 - Enhance insulin sensitivity (via GLUT4 activation)
 - Inhibit carbohydrate-digesting enzymes (α -amylase and α -glucosidase)
 - Reduce postprandial glucose spikes and protect pancreatic β -cells

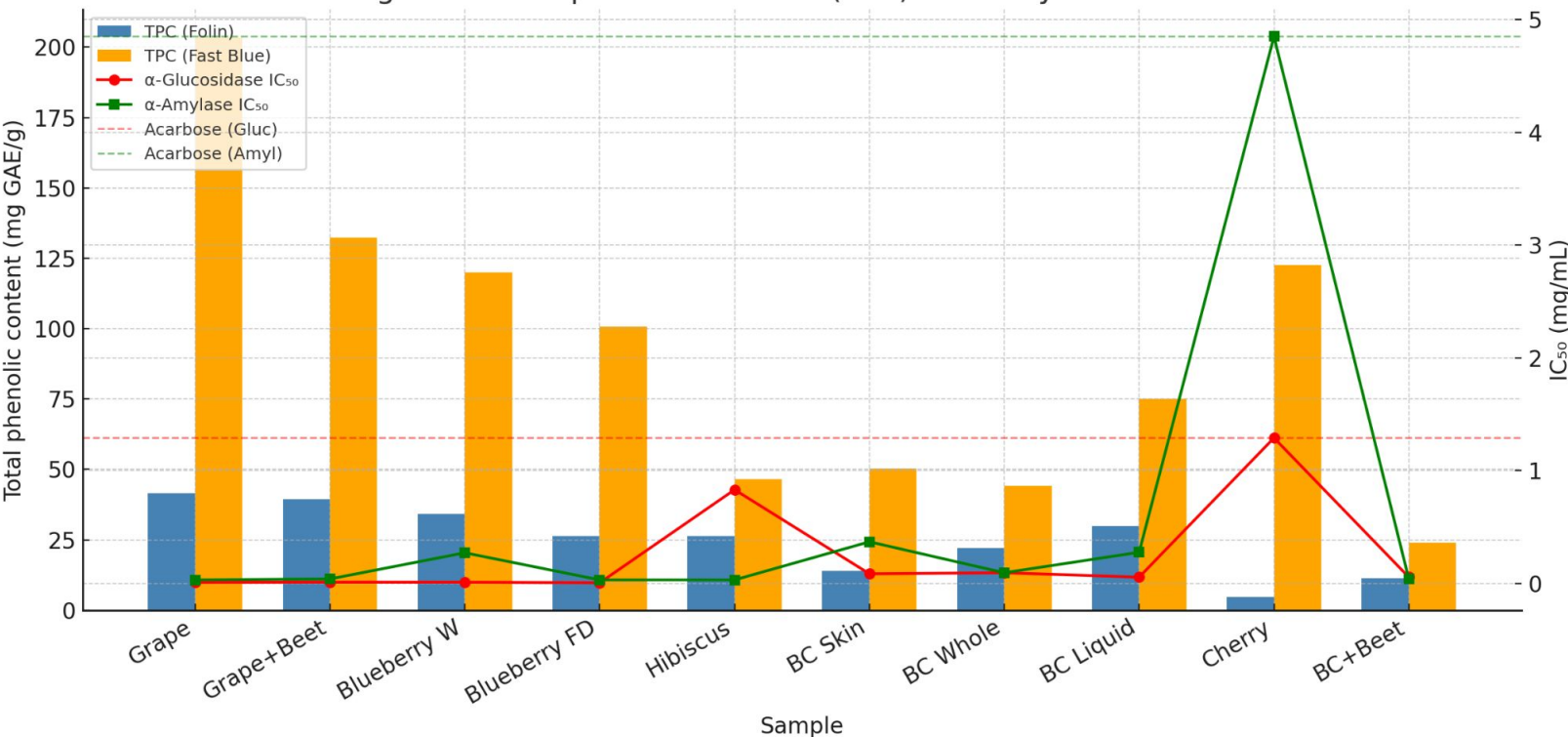
Aim: To explore the antidiabetic potential of phytochemical-rich plant extracts and combinations.

Samples

- Grapes • Grapes with Beetroot • Blueberry (BB fast dried) • Blueberry (BB whole) • Hibiscus (H) • Blackcurrant (skin) (BC_Skin) • Blackcurrant (whole) (BC_Whole) • Blackcurrant (liquid) (BC-Liquid) • Cherry (Cherry-Liquid) • Blackcurrant with Beetroot

Results

Figure 1. Total phenolic content (TPC) and enzyme inhibition



Anthocyanin Content of Phytochemical Extracts

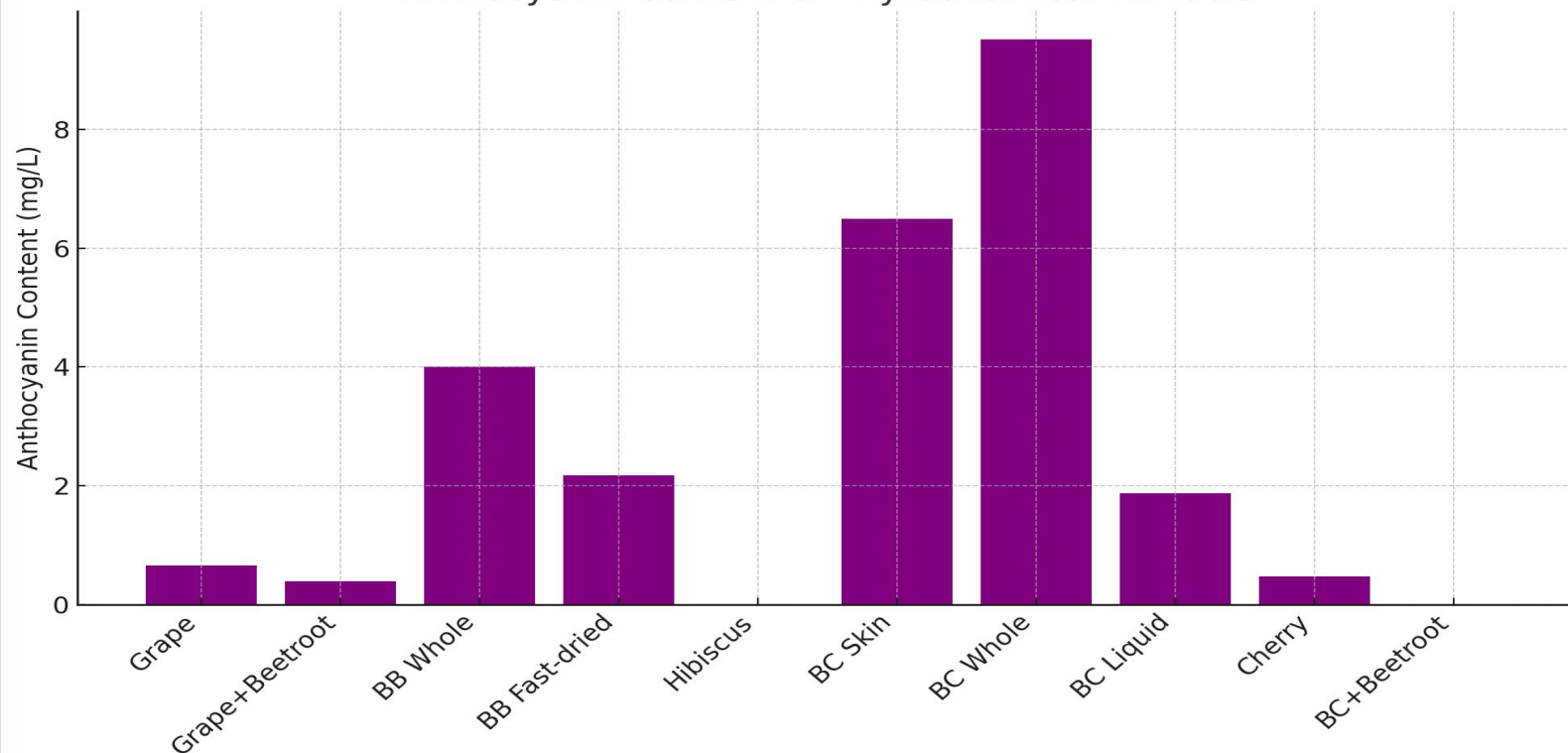
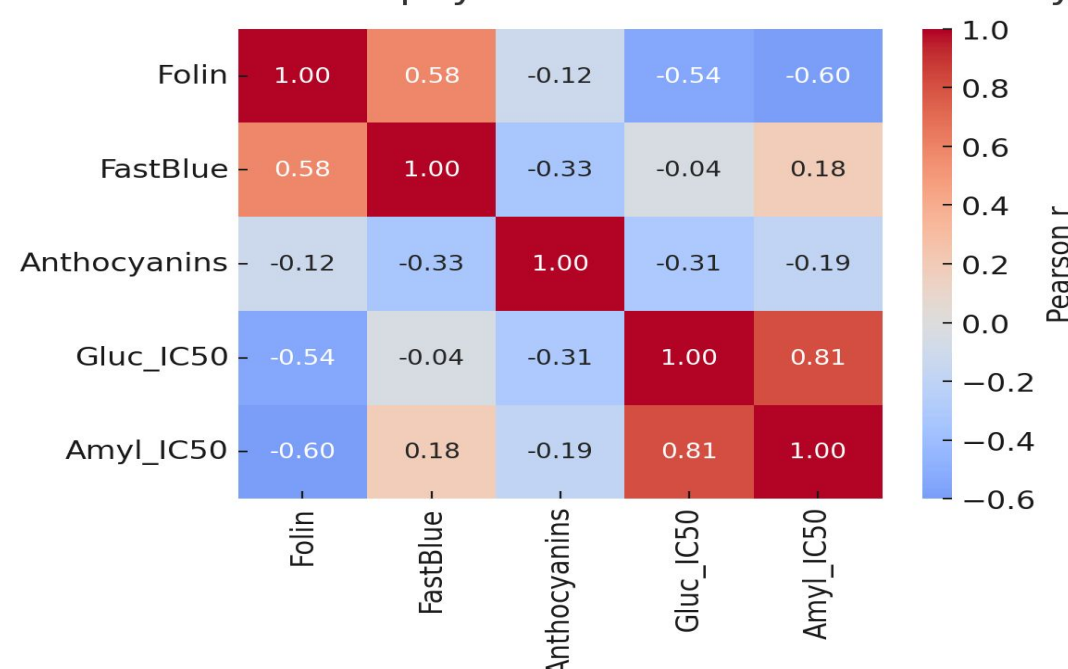


Figure 3. Correlation between phytochemical content and enzyme inhibition



Objectives

1. Quantify **Total Phenolic Content (TPC)** using Folin–Ciocalteu and Fast Blue BB assays
2. Measure **anthocyanin and betalain content** spectrophotometrically
3. Evaluate **α -amylase and α -glucosidase inhibitory activity (IC_{50})**
4. Compare **single vs combination extracts** to detect synergistic or antagonistic effects
5. Correlate **phytochemical content with enzyme inhibition activity**

Methods

Total Phenolic Content (TPC) Assays

- **Folin-Ciocalteu:** 10 μ L sample + 40 μ L reagent + 150 μ L Na_2CO_3 ; incubate 30 min; read at 765 nm. Gallic acid standard: $y = 0.0029x + 0.0174$, $R^2 = 0.9972$.
- **Fast Blue BB:** 200 μ L sample + 20 μ L reagent + 20 μ L NaOH; incubate 2 h; read at 420 nm. Gallic acid standard: $y = 0.0029x + 0.0553$, $R^2 = 0.9868$.

Anthocyanins

Samples diluted in pH 1.0 and 4.5 buffers, incubated 15 min; absorbance at 520/700 nm. Content calculated as $(A \times MW \times DF \times 1000) / (\epsilon \times 1)$, $MW = 449.2$, $\epsilon = 26,900$.

Enzyme Inhibition

- **α -Glucosidase:** Pre-incubate 0.5 U/mL enzyme 10 min at 37 $^{\circ}C$, add 2.5 mM pNPG; read 405 nm. Acarbose $IC_{50} = 1.287$ mM.
- **α -Amylase:** Pre-incubate 1 U/mL enzyme 10 min at 37 $^{\circ}C$, add 2 mM CNPG3; read 405 nm. Acarbose $IC_{50} = 4.853$ mM.

Key Results

- **Grape** showed the highest TPC and potent enzyme inhibition
- **Blackcurrant (whole & skin)** and **whole blueberry** had the highest anthocyanin levels
- **Anthocyanin-rich extracts** \rightarrow strong **α -glucosidase inhibition**
- **α -amylase inhibition** was weaker and more variable
- **Combinations (e.g. grape+beetroot, blackcurrant+beetroot)** showed altered activity \rightarrow possible **synergistic or antagonistic interactions**
- Strong **negative correlation** between phytochemical content and α -glucosidase IC_{50} (more phytochemicals = stronger inhibition)

Conclusion

Phytochemical-rich extracts, particularly from **grapes, blueberries, and blackcurrants**, show potent antidiabetic activity through α -glucosidase and α -amylase inhibition, with **IC_{50} values far lower** than acarbose. Their effectiveness depends on composition, processing, and extract combinations, which can enhance or reduce activity. These results highlight their **strong potential** as natural agents in functional foods, nutraceuticals, and dietary strategies for managing postprandial hyperglycemia and **type 2 diabetes**.

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