



ANTIHYPERGLYCEMIC AND ANTIOXIDANT PROPERTIES OF PHENOLIC COMPOUNDS FROM MORINGA OLEIFERA LEAVES DURING IN VITRO DIGESTION



F. Limón-Aguilera¹, J.L. Monribot-Villanueva², J.A. Guerrero-Analco², A. Pérez-Vásquez³, D. Guajardo-Flores⁴, E. Cruz-Huerta^{1*}

¹ Centro de Investigación y Desarrollo en Alimentos, Universidad Veracruzana, Xalapa, Veracruz, Mexico

² Laboratorio de Química de Productos Naturales, Red de Estudios Moleculares Avanzados, Instituto de Ecología A. C., Clúster Científico y Tecnológico BioMimic®, Xalapa, Veracruz, Mexico

³ Colegio de Posgraduados, Tepetates, Veracruz, Mexico

⁴ Tecnológico de Monterrey, Centro de Biotecnología FEMSA, Monterrey, NL, Mexico

* Corresponding author elvacruz@uv.mx

BACKGROUND

Diabetes mellitus is one of the leading causes of morbidity and mortality worldwide. Because of this, much research focuses on the search for natural compounds and ingredients with antidiabetic activity. Moringa (*Moringa oleifera* Lam) is a plant that in recent years has caused great interest due to its significant content of phenolic compounds with potential beneficial effects on human health.

AIM

Characterize the phenolic profile of moringa leaf powder and analyze their antioxidant and antihyperglycemic properties during *in vitro* digestion.

RESULTS

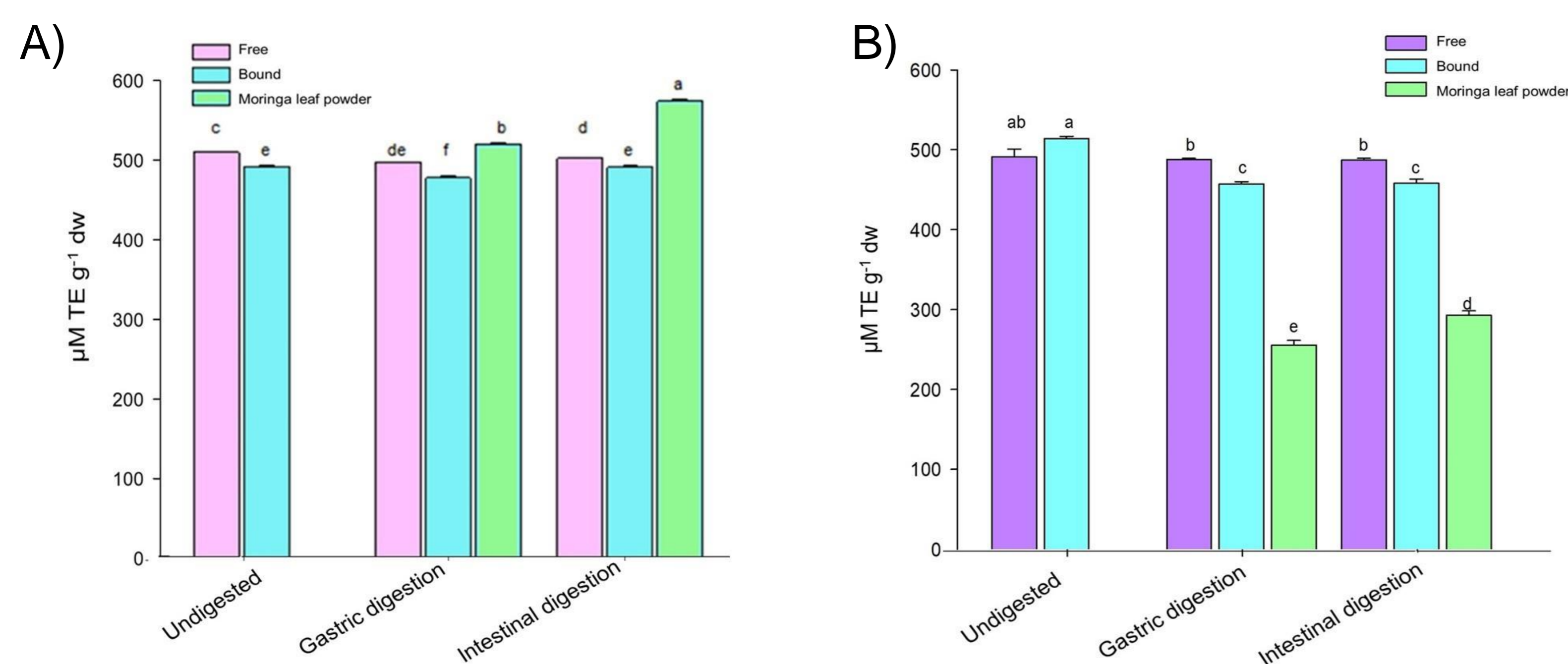


Figure 1. Antioxidant capacity by ABTS (A) and DPPH (B) assays in free and bound phenolics and moringa leaf powder after simulated gastrointestinal digestion. Mean \pm standard deviation of three replicates. Different letters denote significant differences ($p \leq 0.05$).

Table 1. Inhibition of pancreatic α -amylase and α -glucosidase activities (IC_{50} values) with free, bound phenolics and moringa leaf powder after gastrointestinal digestion *in vitro*.

| Extracts | Inhibition (IC_{50} = mg/mL) | |
|--------------------------|---------------------------------|-----------------------|
| | α -amylase | α -glucosidase |
| Free phenolics | ND | 1.82 ± 1.40^b |
| Bound phenolics (ID) | 3.84 ± 1.72^a | ND |
| Moringa leaf powder (GD) | ND | 3.24 ± 1.80^a |
| Moringa leaf powder (ID) | 3.99 ± 1.29^a | ND |
| Acarbose | 1.36 ± 0.08^b | 1.89 ± 0.21^b |

Values are means of three experiments \pm SD. The values followed by different superscript differ significantly ($p < 0.05$). GD: Gastric digestion, ID: Intestinal digestion, ND: Not detected.

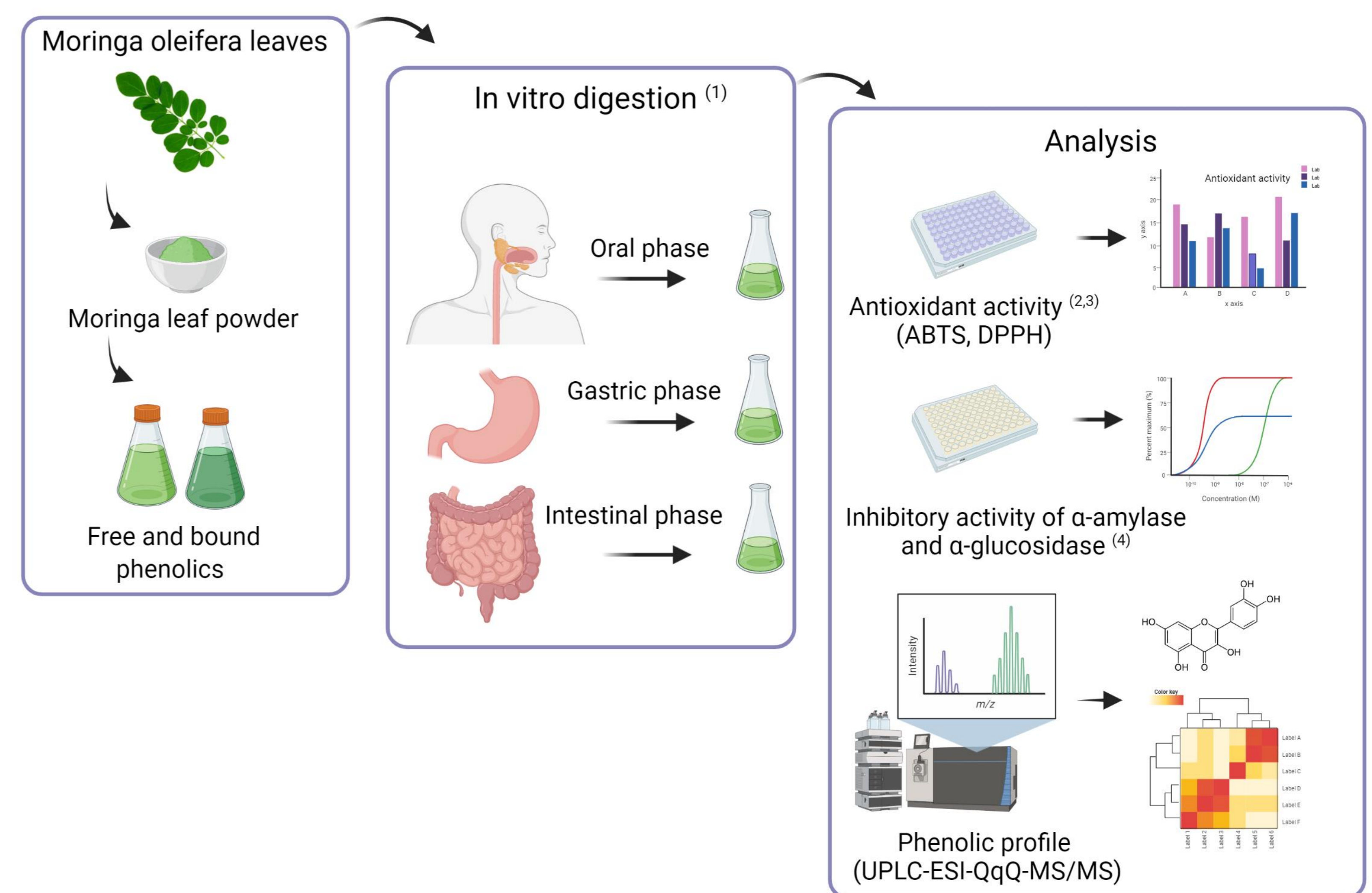
CONCLUSIONS

- In vitro digestion promoted the release of phenolic compounds in moringa leaf powder, and their antioxidant and antihyperglycemic properties were confirmed.
- Free and bound phenolics or moringa leaf powder could be used as nutraceuticals or functional ingredients to prevent and treat type 2 diabetes mellitus.

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MATERIALS AND METHODS



Thirty phenolic compounds, mainly flavonoids, were identified and quantified, of which quercetin-3-glucoside and kaempferol-3-O-glucoside were the major compounds in all samples (Table 2).

Table 2. Identification and quantification of phenolic compounds in free, bound phenolic extracts and moringa leaf powder after digestion *in vitro* by UPLC-MS/MS.

| Compound | Extracts | | |
|-------------------------------|---------------------------------------|---------------------------------------|--------------------------------------|
| | Free | Bound | Intestinal digests |
| Galic acid | 37.17 ± 0.36 | 6.64 ± 0.08 | ND |
| Protocatechuic acid | 49.33 ± 0.31 | 729.74 ± 3.64 | 30.01 ± 0.41 |
| 4-Hydroxybenzoic acid | 16.24 ± 0.34 | 540.07 ± 5.64 | 14.75 ± 0.27 |
| Gentisic acid | 3.69 ± 0.13 | 20.73 ± 0.75 | ND |
| Caffeic acid | 18.96 ± 0.25 | 1805.18 ± 19.91 | 0.57 ± 0.02 |
| Vanillic acid | 5.64 ± 0.15 | 24.42 ± 0.66 | 3.21 ± 0.04 |
| Chlorogenic acid | 104.56 ± 1.37 | 80.69 ± 2.68 | 64.40 ± 1.31 |
| 3-Coumaric acid | 1.75 ± 0.03 | ND | ND |
| 4-Coumaric acid | 9.09 ± 0.12 | 1948.10 ± 1.18 | 6.65 ± 0.16 |
| Ferulic acid | 3.80 ± 0.11 | 667.36 ± 4.88 | 1.74 ± 0.06 |
| Sinapic acid | 0.60 ± 0.05 | 2.78 ± 0.08 | 0.37 ± 0.03 |
| Salicylic acid | 7.77 ± 0.18 | 2.40 ± 0.03 | 2.95 ± 0.14 |
| p-Anisic acid | 3.12 ± 0.16 | 8.28 ± 0.27 | 0.96 ± 0.11 |
| Rosmarinic acid | 22.14 ± 1.21 | 7.07 ± 0.59 | 8.51 ± 0.98 |
| t-Cinnamic acid | 10.18 ± 0.11 | 8.78 ± 0.16 | 4.13 ± 0.03 |
| Vanillin | 5.69 ± 0.10 | 30.59 ± 0.63 | 2.56 ± 0.20 |
| Naringin | 31.60 ± 0.27 | 10.70 ± 0.51 | 5.75 ± 0.05 |
| Procyanidin B2 | 3.74 ± 0.09 | ND | ND |
| t-Resveratrol | 3.45 ± 0.08 | 1.20 ± 0.07 | 1.18 ± 0.06 |
| Citropten | ND | 7.14 ± 0.28 | ND |
| Quercetin | 20.48 ± 1.87 | 289.44 ± 1.64 | ND |
| Quercetin-3-glucoside | 45229.64 ± 3.34 | 81880.81 ± 3.12 | 4363.80 ± 1.42 |
| Quercetin-3,4'-di-O-glucoside | 124.86 ± 1.34 | 30.92 ± 0.27 | 13.13 ± 0.24 |
| Quercitrin | 15.24 ± 3.96 | 13.74 ± 0.11 | ND |
| Luteolin | 1.12 ± 0.11 | 2.12 ± 0.07 | ND |
| Luteolin-7-O-glucoside | 5.97 ± 0.07 | 5.96 ± 0.07 | ND |
| Kaempferol | 3.77 ± 0.27 | 26.11 ± 0.46 | ND |
| Kaempferol-3-O-glucoside | 33291.71 ± 2.22 | 49133.71 ± 1.63 | 3990.53 ± 2.40 |
| Secoisolaricresinol | 6.69 ± 0.26 | 3.52 ± 0.34 | 3.44 ± 0.19 |
| Matairesinol | ND | 1.23 ± 0.04 | ND |

Values correspond to the average \pm standard deviation. ND: Not detected. Concentration is expressed in μ g/g of dried extract.