Journal of
Food Bioactives
International Society for
Nutraceuticals and Functional Foods
Original Research
J. Food Bioact. 2023;23:74–78

Analysis of the nutritional composition of round-leaved mallow (*Malva pusilla*) leaves: a short communication

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DOI: 10.31665/JFB.2023.18356
Received: September 19, 2023; **Revised received & accepted:** September 29, 2023
Citation: Devrim-Lanpir, A., Ali Redha, A., Freije, A., Allehdan, S., Madan, D., Rondanelli, M., and Perna, S. (2023). Analysis of the nutritional composition of round-leaved mallow (*Malva pusilla*) leaves. J. Food Bioact. 23: 74–78.

Abstract

Malva pusilla (MP), known as round-leaved mallow, is one of the undesirable plants due to its harmful effects on crop fields. This study aimed to evaluate its nutritional composition in order to reveal the possible beneficial aspects of this plant. Leaves of MP were analysed for their fatty acid profile, mineral composition, and phenolic content. The study results showed that MP has greater phenolic (95.42 ± 5.25 mg GAE/g) extract and flavonoid (40.8 ± 3.01 mg CE/g DW) contents compared to literature data of *Malva parviflora*, a *Malva* species known for its phenolic and flavonoid content. In addition, α-linoleic acid was detected to be the most abundant fatty acid content (56.25 ± 1.83%). Thus, this species might be used as an antioxidant agent given its high phenolic, flavonoid and n-3 fatty acid content. In addition, this species has a recognizable content in terms of Mg, Zn, K, Ca and Fe (1,422.4 ± 6.57, 115.42 ± 0.33, 444.32 ± 2.13, 5,594.26 ± 64.22 and 65.63 ± 0.28 mg/100 g DM, respectively). These findings showed that MP could be a promising plant for the food, supplement or health industries.

Keywords: *Malva pusilla*; Round-leaved mallow; Nutritional analysis; Fatty acids; Minerals.

1. Introduction

Malva pusilla (MP), also known as the round-leaved mallow belonging to the *Malvaceae* family, is a fast-growing annual weed that is present in temperate Asia, Turkey, Iran, the Caucasian region, and temperate regions of the world. It can generally grow to 20–50 cm tall, and the apex is rounded. Its flowers usually have 3–4 fascicles and are white to pink-purple in colour (Makowski and Morrison, 1989). This plant prefers a warm temperate climate to grow; however, it is classified as a tolerant plant with its ability to withstand temperatures down to −15 °C, all-year rainfall or tropical dry summers (Makowski, 1995). Given its hard seed coat, MP can remain dormant in the soil for up to 100 years (Chauhan et al., 2006).

The *Malvaceae* family includes a variety of plants such as cotton, mallow, and okra that are used for beneficial purposes, including food supply or therapeutic purposes (Fakhfakh et al., 2017). Research on Malva species has highlighted its benefits for various medical purposes including diabetes, insulin resistance (*M. Parviflora*) (Gutierrez et al., 2012), lipid abnormalities, oxidative stress (*M. Parviflora* and *M. sylvestris*) (Gutierrez, 2017), anti-inflammatory and anticancer activities (*M. sylvestris*) since ancient times (Samavati and Manoochehrizade, 2013; Wang, 2005). However, although some species of the *Malvaceae* family has a wide range of bioactivities, MP belongs to the troublesome part of the extended family due to the negative impacts on crops. This weed is a wild mallow plant that often grows unintentionally in fields, landscapes, and gardens, and is listed as invasive in many countries, including Canada, the US, Denmark, the Czech Republic, France, Norway, and Germany (Seebens et al., 2017). It has been reported that it can reduce flax and lentil yield by 15 to 100% and wheat yield by 15 to 60%, respectively (Makowski, 1995). Several attempts to remove the plant from the fields to preserve seed yield have often been unsuccessful, as it has long and hard roots that are resistant to herbicides. Although a bioherbicide, isolated from anthracnose, showed positive effects on yield efficiency, it seems to be effective only at harvest time and suitable weather conditions (Makowski and Mortensen, 1997). Since it is well proven that it is really difficult to eradicate the MP plant completely (Grant et al., 1990), this study aims to evaluate its nutritional composition and examine the possibility of utilising this unwanted weed for other applications with respect to the fact that the *Malva* genus has been reported for a wide range of bioactivities.

2. Materials and methods

MP leaves were obtained from four different farming lands in Northern Bahrain and their identity was confirmed by a botanist. Samples were washed with distilled water and dried in an oven at 40°C until reaching a constant mass. After drying, samples were ground into a fine powder. The fatty acid profile was determined using gas chromatography-flame ionization detector (GC-FID) (further details available in the File S1), mineral content using inductively coupled plasma optical emission spectrometer (ICP-OES) (further details available in the File S1), and phenolic, flavonoid and antioxidant content (based on the ferric reducing ability of plasma (FRAP) assay) by ultraviolet/visible (UV/VIS) spectrophotometry according to previously published methods (Ali Redha et al., 2018; Mohammed et al., 2023).

3. Results and discussion

3.1. Fatty acid composition

Although there are many studies on the phytochemical components of *Malva* species in the literature, few studies have been examined its fatty acid composition. Table 1 shows the fatty acid profile of MP leaves. The most abundant fatty acid in MP is polyunsaturated fatty acids (61.2%), mainly α-linolenic acid (56.25 ± 1.83%) followed by palmitic acid (12.8 ± 1.4) and hexadecenoic acid (5.8 ± 0.2). Consisted with our findings, previous studies analysed *M. sylvestris* found that the leaves of *M. sylvestris* have greater percentages of α-linolenic acid: 5.0 ± 0.36 to 35.5 ± 2.9% (Barros et al., 2010) and 67.79 ± 0.96% (Delfine et al., 2017). It is well documented that α-linoleic acid is an essential fatty acid with antioxidant and anti-inflammatory properties that has a variety of beneficial properties on human health, including immunological diseases (Charoenwoodhipong et al., 2020), brain development (Leyrolle et al., 2022), cancer (Hardman, 2004), and cardiovascular diseases (Sala-Vila et al., 2022) . In addition, a report on n-3 and lamb nutrition indicated that feeding lamb with plants rich in n-3 fatty acid increases n-3 fatty acid content in lamb (Nguyen et al., 2018). Thus, MP may provide benefits for increasing dietary n-3 intake in both human and animal nutrition. Besides that, the use of MP strains to produce n-3 supplements may be a good option for the vegan community as it is important for vegans and some vegetarians to get enough plant-based n-3 supplements (Craig, 2009). Future research is needed to clarify this potential application regarding MP leaves.

3.2. Mineral content

Table 1 illustrates the mineral content of MP leaves. The findings show that MP species is rich in minerals, especially magnesium (1,422.4 ± 6.57 mg/100 g dry mass (DM)), zinc (115.42 ± 0.33 mg/100 g DM), potassium (444.32 ± 2.13 mg/100 g DM), calcium (5,594.26 ± 64.22 mg/100 g DM) and iron (65.63 ± 0.28 mg/100 g DM) content. MP found to have greater calcium, magnesium, sodium, iron and zinc content compared to *M. neglecta*, a commonly-used plant to treat common cold in Iran (355.4, 196.0, 49.3, 9.9, and 3.6 mg/g DM; respectively) (Seyyednejad et al., 2010). Both macro and micro minerals are of importance for proper maintenance of bodily functions, including inflammation regulation, bone formation, and immunologic regulation of both innate and adaptive defence (Weyh et al., 2022). Thus, plants high in minerals can be used for various purposes such as human nutrition, the production of dietary supplements and animal nutrition to fulfil dietary requirements. Given the study findings, as MP leaves with high mineral content, it is recommended to be evaluated with this aspect. This plant may be beneficial for bone mineralization with Ca content, immunological regulation with Zn and Fe content, haemoglobin formation and metabolism regulation with Fe content for both human and animal nutrition. In addition, producing dietary supplements using MP leaves could be a great addition to the vegan supplement industry. Further research on the use of this plant in both human and animal nutrition is recommended.

3.3. Phenolic and flavonoid content, and antioxidant activity

Total phenolic and flavonoid contents and antioxidant activity of MP were detected as 95.42 ± 5.25 mg gallic acid equivalents (GAE)/g DM, 40.8 ± 3.01 mg catechin equivalents (CE)/g DM, and 70 ± 1 µmol Fe^{2+}/g DM; respectively. Based on these findings, MP species has greater total phenolic and flavonoid content compared to *M. parviflora*, the *Malva* species proven to be rich in phenolic compounds (10.98 ± 0.52 mg GAE/g extract and 5.64 ± 0.84 mg catechin/g extract, respectively). Oxidative stress has been a well-known inducer for many chronic diseases, including immunologic diseases, neurodegenerative diseases, cancer, cardiovascular diseases and diabetes (Reuter et al., 2010). Prolonged

Table 1. Nutritional analysis data of *Malva pusilla* leaves

Nutrient	Mean content (±SE)
Lipids	
Total lipids (g/g DM)	0.14 ± 0.01
Fatty acids (%)	
C6:0	0.713 ± 0.207
C8:0	0.533 ± 0.049
C10:0	1.217 ± 0.921
C12:0	1.433 ± 0.286
C13:0	1.726 ± 0.106
C14:0	2.774 ± 0.109
C16:0	12.829 ± 1.393
C16:1n9	5.821 ± 0.176
C16:1n7	1.131 ± 0.094
C17:0	1.011 ± 0.147
C18:0	2.274 ± 0.257
C18:1n9	1.758 ± 0.250
C18:1n7	0.718 ± 0.208
C18:2n6	3.989 ± 1.251
C18:3n3	56.258 ± 1.832
C20:0	0.298 ± 0.174
C20:1n9	0.973 ± 0.701
C20:02	1.001 ± 0.025
C22:0	0.586 ± 0.093
C23:0	0.576 ± 0.229
C24:0	0.922 ± 0.341
SFAs	26.9 ± 1.7
MUFAs	10.4 ± 0.5
PUFAs	61.3 ± 1.5
Minerals (mg/100 g DM)	
Mg	1,422.4 ± 6.57
Mn	35.16 ± 0.18
Fe	65.63 ± 0.28
Na	770.79 ± 5.01
Zn	115.42 ± 0.33
K	444.32 ± 2.13
Ca	5,594.26 ± 64.22
Cu	8.33 ± 0.13
Phytochemicals	
Total phenolic content (mg GAE/g DM)	95.42 ± 5.25
Total flavonoid content (mg CE/g DM)	40.8 ± 3.01
Antioxidant activity	
FRAP assay (µmol Fe^{2+}/g DM)	70 ± 1

Standard error of the mean (SE); dry mass (DM); caproic acid (C6:0); caprylic acid (C8:0); capric acid (C10:0); lauric acid (C12:0); myristic acid (C14:0); palmitic acid (C16:0); hypogenic acid (hexadecenoic acid) (C16:1 n-9); palmitoleic acid (C16:1 n-7); heptadecanoic acid (C17:0); stearic acid (C18:0); vaccenic acid (C18:1 n-7); oleic acid (C18:1n-9); linoleic acid (C18:2n-6); α-linolenic acid (C18:3 n-3); arachidic acid (C20:0); eicosenoic acid (C20:1 n-9); eicosadienoic acid (C20:2); behenic acid (C22:0); tricosanoic acid (C23:0); lignoceric acid (C24:0); saturated fatty acids (SFAs); monounsaturated fatty acids (MUFAs); polyunsaturated fatty acids (PUFAs); gallic acid equivalents (GAE); catechin equivalents (CE).

exposure to an increased prooxidant load can cause structural problems at the mitochondrial DNA level that are difficult or impossible to reversible, as well as abnormality in gene expression, resulting in functional changes in various enzymes and cellular functioning/pathways (Sharifi-Rad et al., 2020). At this point, dietary antioxidants are considered a significant agent for protecting body against increased oxidative load by acting as free radical scavengers and maintaining homeostasis in the body (Pizzino et al., 2017). Plant polyphonic compounds constitute an important part of dietary antioxidants. With its powerful antioxidant specialities, Flavonoids and phenolic compounds provide various benefits such as regulating the body's immune system, especially fighting free radicals. Thus, with its higher flavonoid and phenolic content, MP might be used for an important antioxidant agent against various diseases induced by oxidative stress. Further studies are needed to clarify in detail which phenolic components of MP are more dominant in order to use it as an antioxidant agent and to determine the suitability of its use in humans.

4. Future perspectives

MP leaves have shown promising nutritional composition in this preliminary study. Future research is required to investigate the phenolic and polyphenol profile of this invasive weed. In addition, further phytochemical investigations are required to identify and characterise other bioactive compounds such as terpenoids, alkaloids, phytosterols, and organosulfur compounds. Upon the understanding of the phytochemical profile of the leaves, hypothesis could be developed to guide researchers to investigate the bioactive properties of the leaves.

Ethical approval and participation consent

Not applicable.

Consent for publication

Not applicable.

Availability of data and materials

Data available within the article or its supplementary materials.

Funding

The authors declare that no funding, grant, or other support was received during the preparation of this manuscript..

Conflict of interest

All authors declare no conflict of interest.

Author contributions

Asli Devrim-Lanpir: Formal analysis, Writing - Original Draft, Writing - Review & Editing. Ali Ali Redha: Writing - Original Draft, Writing - Review & Editing. Afnan Freije - Conceptualization, Methodology, Supervision. Sabika Allehdan - Methodology. Duaa Madan - Investigation. Mariangela Rondanelli - Conceptualization. Simone Perna - Conceptualization, Methodology, Supervision - Project administration.

Supplementary material

File S1. Supplementary materials and methods.

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