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# The Number of Health-Promoting Substances That All Edible Vascular Plants Contain Compared to the Total Number of Health-Promoting Substances of Five Wild Edible Plants (WEPs)

Mauri K. Åhlberg *

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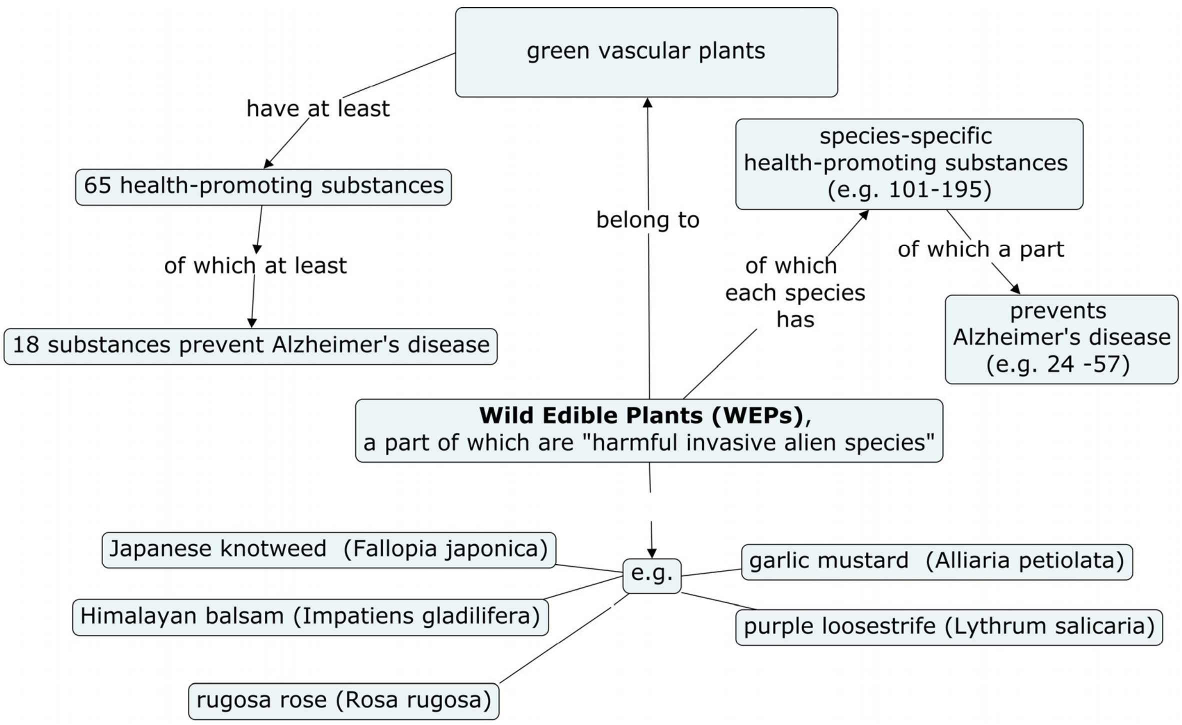
*Article*

# The Number of Health-Promoting Substances That All Edible Vascular Plants Contain Compared to the Total Number of Health-Promoting Substances of Five Wild Edible Plants (WEPs)

**Mauri K. Åhlberg**

The University of Helsinki; mauri.ahlberg@helsinki.fi

**Abstract:** Introduction: The research results of wild edible plants (WEPs) are scattered over separate research fields and sources, such as phytochemical studies, nutrition sciences, ethnobotany, and plant sciences. I integrate separate fields for foraging practice. The results are new and practical. The research questions: (1) How did I find 65 health-promoting substances in all green vascular WEPs? (2) According to experimental research, how many of these substances prevent Alzheimer's disease? (3) How many species-specific health-promoting substances do five selected invasive WEPs contain? (4) How many Alzheimer's disease-preventing, species-specific health-promoting substances do these five selected invasive WEPs have? Methods: Data is sought using research databases. All claims are referenced so accurately that every researcher can check the results. Results: All green vascular WEPs contain at least 65 health-promoting substances, and at least 18 prevent Alzheimer's disease. Five exemplary WEPs contain a species-specific number (101 - 165) of health-promoting substances, at least 24 -57 preventing Alzheimer's disease. These five species are alien invasive species. They provide ecosystem services like food. Conclusions: The results offer profound reasons for using foraged WEPs and cultivated green edible vascular plants to promote health and longevity. Using the five alien invasive species researched for culinary purposes is wise.




The graphical abstract is a concept map.

**Keywords:** wild edible plants; wild food plants; functional food; foraging; Mediterranean diet; health; longevity; phytochemicals; good environment; sustainability

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## 1. Introduction

In the title and the graphical abstract, I use the botanical term 'vascular plants.' The practical definition of 'vascular plants' is the following. Flowering plants, gymnosperms, horsetails (Equisetum), and ferns are all vascular plants. They possess vascular tissues and have true stems, leaves, and roots. Vascular tissues transport water, minerals, and photosynthesis products throughout the plant. Some algae and lichens are edible. They do not belong to vascular plants. They don't have vascular tissue. Algae and lichens have no root system, stem, or leaves.

The Mediterranean diet, a widely studied and highly beneficial diet, underpins our research (Åhlberg (2021, 2022b). Initially, the Mediterranean diet included Wild Edible Plants (WEPs). According to numerous research reports, this diet 1) promotes health and longevity and 2) prevents various modern diseases, including coronary and Alzheimer's disease. A vital component of this diet is consuming locally available green plants, which are rich in health-promoting substances. According to Volinia & al. (2024) and Åhlberg (2019 -2024), foraging WEPs has become essential in Europe for many reasons, like promoting sustainability, a good environment, a good life, health, and longevity.

Invasive WEPs are an emotional theme. The ecosystem services they provide need a rational discussion. All WEPs that I meta-researched belong to alimurgic plants. Three species are invasive in Europe and two in North America. The European invasive WEPs are Fallopia japonica, Impatiens glandulifera and Rosa rugosa. The American invasive WEPs are Alliaria petiolata and Lythrum salicaria. They all provide many ecosystem services, such as wild food for humans.

Capurso (2024) wrote a historical analysis of the Mediterranean diet. He calls the earliest known version a "bread-olive oil-wine" triad with legumes, cheeses, and sheep and goat meat. Capurso (2024) does not mention Wild Edible Plants (WEPs) in his overview. He mentions, "barbarian populations, between 400 and 800 CE, made the diet enriched with products from wild, uncultivated areas, meat from game and pigs, and vegetables". Wild vegetables are mentioned in the quotation.

De Cortes Sánchez-Mata et al. (2016) and Åhlberg (2019, 2020a, 2020b, and 2022a) provide knowledge of the Mediterranean diet from the viewpoint of wild edible plants (WEPs). There is plenty of evidence that WEPs have been consumed since prehistoric times in the Mediterranean countries.

Åhlberg (2019) compared ethnobotanical lists of WEPs foraged and consumed in different parts of the world. Many of the best WEPs are edible weeds spread nearly globally through agriculture, such as Taraxacum officinale, Sonchus arvensis, Sonchus oleraceus, Chenopodium album, Achillea millefolium, and Artemisia vulgaris. Because they are practically global, they are local almost everywhere.

Åhlberg (2020a and 2020b) searched for WEPs that have 1) a long history of use, 2) an extensive distribution, and 3) experimental research that shows that the species is not toxic and promotes health. The result was 94 species in the boreal, temperate, and subtropical vegetation zones. In these books, I refer to many biochemical mechanisms of health-promoting substances when they are described in the latest research articles.

Åhlberg (2022a) selected 75 species of the earlier 94 species for a book dedicated to the Finnish audience. The book also includes the latest research results on health-promoting substances in English.

Sustainable global food chains require safeguarding the future of food sources and the environment. Applying Paura & Marzio (2022), Monari & al. (2021), and Marrelli & al. (2020), WEPs are examples of alimurgic plants. In times of famine caused by war, drought, plant diseases, pests, or any other cause, alimurgic plants provide food. When there is little else to eat, edible weeds and other

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WEPs, such as alimurgic plants, provide health-promoting raw materials for food. Top chefs use these plants to create tasty and healthy portions (e.g., Egebjerg & al. (2018) and Tallberg & al., 2023). Since 2016, research has grown exponentially.

Nowadays, we often know in detail the health-promoting chemical constituents of WEPs. Research has also revealed many biochemical mechanisms on how these substances promote health. Christodoulou & al. (2023) and Åhlberg (2022) classify WEPs as natural functional foods.

Biodiversity decline, climate change, war, famine, overpopulation, hunger, obesity pandemic, and Alzheimer's disease are examples of current crises. In these crises, some people are worried about invasive alien species. The European Union has developed a strategy to eradicate them. The latest EU document on this theme is the European Commission (2022a).

I present the latest research on three invasive alien WEPs in Europe and two in North America. The three invasive alien WEPs in Europa are Japanese knotweed (Fallopia japonica), Himalayan balsam (Impatiens glandulifera), and rugosa rose (Rosa rugosa). The two invasive alien WEPs in North America are garlic mustard (Alliaria petiolata) and purple loosestrife (Lythrum salicaria).

From the sustainability viewpoint, I forage mainly soft new aerial parts of these WEPs. I eat rose petals and hips raw. I never gather all plant material. I allow WEPs to grow new leaves, petals, and hips. As described in Åhlberg (2019, 2020 a, 2020b, and 2022a), tender leaves of other foraged WEPs I usually boil first because 1) it kills possible bacteria and parasites, 2) it removes antinutrients such as water-soluble oxalic acid and extra nitrates, 3) it increases the availability of many health-promoting substances by breaking cell walls. Boiling is ordinary in Mediterranean countries (Arias-Rico al. 2020; Seal al. 2023; Sergio al. 2020).

The following research questions structure the paper:

1) How did I find 65 health-promoting substances in all green vascular WEPs?

2) According to experimental research, how many of these substances prevent Alzheimer's disease?

3) How many species-specific health-promoting substances do five selected invasive WEPs contain?

4) How many Alzheimer’s disease-preventing, species-specific health-promoting substances do these five selected invasive WEPs have?

## 2. Materials and Methods

Everybody can check all claims of species and their health-promoting substances using the following research databases, which I have used in my research:

1) Europe PMC: https://europepmc.org/

2) Google Scholar: https://scholar.google.com/

3) PubMed: https://pubmed.ncbi.nlm.nih.gov/

4) PubChem: https://pubchem.ncbi.nlm.nih.gov/

5) HMDB: Human Metabolome Database: https://hmdb.ca/

6) Science Direct: https://www.sciencedirect.com/

7) Web of Science Core Collection: https://clarivate.com/products/scientific-and-academic-research/research-discovery-and-workflow-solutions/web-of-science/web-of-science-core-collection/

8) Wiley Online Library: https://www.onlinelibrary.wiley.com/

I have used keywords: <the scientific name of plant species>, <chemical constituents>, <name of the specific substance>, <health>, and <Alzheimer’s disease>.

## 3. Results

**How did I find 65 health-promoting substances in all green vascular WEPs?**

I remember two exciting events when I developed my approach to compare the roles of health-promoting substances in plants and humans:

 doi:10.20944/preprints202410.1307.v2



1) According to Harborne (1980, 439), "One end-product of phenolic metabolism in all vascular plants is the lignin of the cell wall, a complex co-polymer of phenylpropanoid units…" After this finding, I checked what later experimental research found about lignin's health benefits. Then, I checked what research has found about lignin's role in plants.
2) Huang & al. (2020) compared substances that plants and humans need in their article 'Plant Nutrition for Human Nutrition.' According to Huang & al. (2020, 825), "…there is a difference in number of mineral elements required between plants and humans (Takahashi, 1993). Plants only require 14 essential mineral elements while humans require 23 (Table 1) (Takahashi, 1993)." Huang & al. (2020)'s source is a Japanese textbook, "Takahashi, 1993". Huang & al. (2020) focus on the transport systems of mineral elements in rice. They do not compare the role of these mineral elements in plant or human metabolism. I took Huang & al.'s list (2020, 826) as hypotheses to test plant and human health-promoting metabolism. I found interesting new experimental research on how these mineral elements were vital for plant and human metabolism.

In my earlier book on WEPs (Åhlberg 2019 – 2020a), I was not interested in the role of health-promoting substances in plants, only for humans. I invented this integrating meta-research approach when I wrote my first research article on this theme (Åhlberg 2021). First, I found one health-promoting substance claimed to be in every green vascular plant; then I found 24, and finally, 52 health-promoting substances (Åhlberg 2021). From Åhlberg (2021 and 2022b), we know that all edible green vascular plants contain at least 57 health-promoting substances, according to experimental research. In Åhlberg (2021), the number of health-promoting substances is 52. The publisher's final editing of Åhlberg (2022b) was so time-consuming and painful that I had no energy to check the last printed version. In the first version of Åhlberg (2022b), I had four new health-promoting substances: 1) acetylcholine, 2) choline, 3) phytic acid, and 4) terpenoids. In the last version of Åhlberg (2022b), I found the fifth one: tocopherols. However, this figure 57 was only in the text; according to the abstract, the figure was 56.

While reading the research sources for the current paper, I realized that all vascular green edible plants contain at least eight more health-promoting substances. There is experimental evidence that 1) galactolipids, 2) oxylipins, 3) phenylpropanoids, 4) phospholipids, 5) plant fats, 6) plant lipids, 7) salicylic acid, and 8) sphingolipids belong to the new list of 65 health-promoting substances that all green edible vascular plants contain. Of these 65 health-promoting substances, 18 prevent Alzheimer's disease, according to experimental research articles. I have written a paragraph about these eight new substances.

According to Haslam & Feussner (2022) and Suh & al. (2022), all land plants contain (1) sphingolipids. According to Dong & Lin (2021), all green vascular plants have (2) phenylpropanoids. According to Kim (2020) and Suh & al. (2022), all green vascular plants contain (3) oxylipins, (4) phospholipids, (5) plant fatty acids, (6) plant lipids, and (7) galactolipids. According to Ding & al. (2023), Jia & al. (2023), Mishra & Baek (2021), and Yang & al. (2023), both bacteria and plants, in particular land plants, produce (8) salicylic acid. Salicylic acid is one of the most essential plant hormones. According to the research databases, all eight substances promote human health. Plant lipids are the overarching concept covering plant fatty acids, galactolipids, and sphingolipids. Lipid synthesis involves several cell organelles. Fatty acids are synthesized in chloroplasts. Fatty acids are directly combined with glycerol to become galactolipids, a significant component of the chloroplast membrane. Fatty acids are transferred to the cytoplasm to bind with glycerol in the endoplasmic reticulum to become phospholipids of the cell membrane. I present vignettes of these eight health-promoting substances that all (wild) edible vascular plants contain: 1) galactolipids, 2) oxylipins, 3) phenylpropanoids, 4) phospholipids, 5) plant fatty acids, 6) plant lipids, 7) salicylic acid, and 8) sphingolipids. The references inside the vignettes follow the style of my earlier vignettes in Åhlberg (2020a, 2020b, 2021, 2022a, and 2022b). For a convincing presentation, I use vignettes with (1) the claims on how each substance promotes health, (2) what is their function in plants, and (3) references that support these claims.

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**galactolipids**

FOR HUMANS: According to Kuan & al. (2022), Cheng & al. (2016), and Winther & al. (2016), galactolipids have the following health-promoting properties: 1) antioxidants, 2) reduce oxidative stress in cells, 3) anti-inflammatory, 3) improve skin wrinkles, moisture, and elasticity in healthy subjects, and 4) antitumor.

IN PLANTS: According to Suh & al. (2022), Zhu & al. (2022), and Kim (2020), galactolipids: 1) are a component§ of the chloroplast membrane, 2) take part in photosynthesis, 3) prevent lack of phosphorus (P): "the plastid membranes mainly consist of glycolipids, while extraplastidic membranes mainly consist of phospholipids. Under P-deficiency conditions, phospholipids can be degraded to release the phosphate group; then the non-phosphorus galactolipids are compensatively synthesized to replace the phospholipid".

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**oxylipins**

FOR HUMANS: According to Shinto & al. (2022) and Caligiuri (2017), oxylipins have the following health-promoting properties: 1) antiaging, 2) prevent cardiovascular disease;3) prevent heart disease, 4) take part in immunity, 5) prevent inflammation, 6) prevent blood coagulation, and 7) take part in vascular tone regulation, 7) may prevent Alzheimer's disease.

IN PLANTS: According to Sugimoto (2022), oxylipins 1) take part in plant growth, 2) take part in development, 3) take part in interactions with biotic and abiotic stressors, 4) take part in plant-environment interactions, 5) take part in plant-pathogen interactions, 6) take part in plant-plant interactions, 7) act as defense phytohormones, 8) take part in the activation of secondary metabolite accumulation, such as alkaloids and terpenoids, which act as toxic compounds to pathogens and pests.

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**phenylpropanoids**

FOR HUMANS: According to Jaye & al. (2022), Navarre & al. (2022), Neelam & al. (2020), and Kolaj & al. (2018), **phenylpropanoids** have the following health-promoting properties:1) antioxidant, 2)

 doi:10.20944/preprints202410.1307.v2



anti-inflammatory, 3) antimicrobial, 4) antidiabetic, 5) anticancer, 6) renoprotective, 7) hepatoprotective, 8) cardioprotective, 8) protect mitochondria, 9) neuroprotective, and 10) may prevent Alzheimer's disease.

IN PLANTS**:** According to Ramaroson & al. (2022), Dong & Lin (2020, and Deng & Lu (2017), phenylpropanoids: 1) are a large class of plant secondary metabolites derived from aromatic amino acids, mostly phenylalanine; 2) mainly include flavonoids, lignin, lignans, monolignols, hydroxycinnamic acid, phenolic acids, stilbenes, and coumarins; 3) are widely distributed in the plant kingdom; 4) take part in plant development; 5) are essential components of cell walls; 6) take part in plant defense against biotic or abiotic stresses; 7) protect against high light and UV radiation; 8) phytoalexins against herbivores and pathogens, and 9) act as floral pigments to mediate plant-pollinator interactions.

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**phospholipids**

<u>FOR HUMANS</u>: According to Chang & al. (2022) and Küllenberg & al. (2012), <u>**phospholipids**</u> promote health in the following ways: 1) anti-inflammatory, 2) anticancer, 3) prevent coronary heart disease, 4) reduce cholesterol levels, 5) prevent platelet aggregation, 6) prevent hypertension, 7) reduce risk of arteriosclerosis, 8) promote the intestinal absorption of cholesterol and other lipids, 9) promote brain health by carrying essential polyunsaturated fats to the brain, 10) improve memory, 11) improve cognition, 12) improve immunological functions, and 13) prevent liver diseases.

<u>IN PLANTS</u>: According to Khosa (2022), Shu & al. (2022), and Wang & al. (2022), phospholipids: 1) are components of cell membranes, 2) phospholipids take part in the coordination of fundamental life processes at the cellular level, 3) take part in cell signaling, and 4) regulate flowering.

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**plant fatty acids**

**FOR HUMANS:** 1) According to Cai & al. (2022), Casillas-Vargas & al. (2021), Trautwein & McKay (2020), and Marsiñach & Cuenca (2019), **plant fatty acids** have the following health-promoting properties: 1) take part in several metabolic and structural functions, 2) are components of the cell membranes, 3) take part in the transport of vitamins, 4) regulate the concentration of lipids in plasma; 5) produce precursors of eicosanoids, decosanoids, steroid hormones, and biliary acid, which are fundamental for the adequate functioning of the metabolism; 6) the most crucial energetic nutrient. Researchers recommend that at least 20% of the total energy intake should derive from lipids; 7) reduce the risk of cancers; 8) positively influence dyslipidemia; 9) lower the risk of cardiovascular diseases; and 10) antibacterial.
**IN PLANTS:** According to Kalinger & al. (2020): 1) Plants use fatty acids to synthesize acyl lipids for many different cellular, physiological, and defensive roles, such as 2) the synthesis of the essential membrane, 3) storage, 4) surface lipids, 5) the production of various fatty acid-derived metabolites used for signaling, and 6) the production of various fatty acid-derived metabolites used for defense.

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**plant lipids**

FOR HUMANS: According to Amadi & al. (2022), Lim & al. (2022), and Yin (2022), **lipids** 1) are crucial to several functional processes in the body, 2) are crucial to the storage of energy, 3) are crucial to the regulation of hormones, 4) are crucial to the transportation of nutrients, and 5) regulate adaptive immunity (T cells), 6) a moderate amount of unsatisfied omega-3 fatty acids prevent inflammations, 7) The brain has the highest lipids content after the adipose tissue. A part of its unsatisfied fatty acids usually comes from plants.
IN PLANTS: According to Suh & al. (2022), Kim (2020), and Macabuhay & al. (2022), **lipids** 1) are one of the primary biological molecules in plants, 2) have a wide variety of functions in plant cells, both as structural components and as bioactive substances, 4) are essential for the integrity of cells and organelles by acting as a hydrophobic barrier for the membrane, 5) are involved in cell signaling, 6) are component of the chloroplast membrane, take

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part in photosynthesis, 8) store energy for seed germination, 9) contribute to defense against diseases, 10) contribute to defense against pests, and 11) take part plant root–microbe interactions.

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**salicylic acid**

FOR HUMANS: According to Ding & al. (2023), Thrash-Williams & al. (2016), Randjelovic & al. (2015), and Baxter & al. (2001), salicylic acid has the following health-promoting properties: 1) antioxidant, 2) anti-inflammatory, 3) cardioprotective,4) antidiabetic and 5) neuroprotective.

IN PLANTS**:** According to Ding & al. (2023), Jia & al. (2023), Mishra & Baek (2021), and Yang & al. (2023), both bacteria and land plants produce salicylic acid. One of the most essential phytohormones is salicylic acid. Plants use salicylic acid: 1) signaling in heat production (thermogenesis), **2)** as a signaling molecule during pathogen infection; 3) The increased levels of salicylic acid are associated with the induction of defense genes and systemic acquired resistance (plant immunity); 4) Salicylic acid is the critical signal molecule in regulating the activation of local and systemic defense responses against infections by pathogens; 5) Salicylic acid has a regulatory role in abiotic stresses, like heat stress and drought, and biotic stresses, such as the systemic acquired resistance-mediated defense response against pathogen infection; 6) Salicylic acid regulates plant growth and development processes, such as photosynthesis, respiration, vegetative growth, seed germination, flowering, senescence, etc.

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| **sphingolipids** |
| **FOR HUMANS**: According to Sugawara (2022), Yamashita & al. (2021), and Norris & Blesso (2017), **sphingolipids** have the following health-promoting properties:<br>1) anti-inflammatory, 2) prevent dyslipidemia, 3) prevent nonalcoholic fatty liver disease, 4) improve skin barrier function, 5) prevent diseases, 6) prevent cancer, 7) prevent metabolic syndrome, 8) improve lipid absorption, 9) improve metabolism,<br>**IN PLANTS**: According to Haslam & Feussner (2022), Suh & al. (2022), and Zeng & Yao (2022), Sphingolipids are essential metabolites found in all plant species. **Sphingolipids**: 1) take part in maintaining plasma membrane integrity. They are components of cell membranes; 2) take part in responses to biotic and abiotic stresses; 3) participate in intracellular signaling; 4) are essential for controlling cellular homeostasis; and 5) regulate plant immunity.<br>REFERENCES<br>*Haslam, T & Feussner, T. 2022. Diversity in sphingolipid metabolism across land plants. Journal of Experimental Botany 73(9), 2785–2798, https://doi.org/10.1093/jxb/erab558*<br>*Norris, G. & Blesso, C. 2017. Dietary sphingolipids: potential for management of dyslipidemia and nonalcoholic fatty liver disease. Nutrition Reviews 75(4), 274–285. https://doi.org/10.1093/nutrit/nux004*<br>*Sugawara, T. 2022. Sphingolipids as functional food components: benefits in skin improvement and disease prevention. Journal of Agricultural and Food Chemistry 70(31), 9597–9609.*<br>*Suh, M. & al. 2022. Plant lipids: trends and beyond. Journal of Experimental Botany 73(9), 2715–2720. https://doi.org/10.1093/jxb/erac125*<br>*Yamashita, S. & al. 2021. Dietary sphingolipids contribute to health via intestinal maintenance. International Journal of Molecular Sciences 22, 7052, 1-18. https://doi.org/10.3390/ijms22137052*<br>*Zeng, H. & Yao, N. 2022. Sphingolipids in plant immunity. Phytopathology Research 4,20, 1-19.* |

According to Åhlberg (2021, 2022b and the evidence presented above), the list of **65** health-promoting substances that all green vascular (wild) edible plants contain is as follows: 1) acetylcholine, 2) alpha-linolenic acid, 3) antheraxanthin, 4) ascorbic acid, 5) beta-carotene, 6) beta-sitosterol, 7) biotin, 8) caffeic acid, 9) calcium, 10) carotenoids, 11) chlorophylls, 12) chloride, 13) choline, 14) citric acid, 15) copper, 16) dietary fibers, 17) fatty acids, 18) flavonoids, 19) folic acid, 20) galactolipids, 21) glutathione, 22) iron, 23) lignins, 24) linoleic acid, 25) lutein, 26) manganese, 27) magnesium, 28) melatonin, 29) molybdenum, 30) neoxanthin, 31) niacin, 32) nickel, 33) nitrates, 34) oleic acid, 35) oxylipins, 36) pantothenate, 37) phenolic acids, 38) phenolic compounds, 39) phenylpropanoids, 40) phospholipids, 41) phosphorus, 42) phylloquinone, 43) phytic acid, 44) phytosterols, 45) plant fatty acids, 46) plant lipids, 47) plant proteins, 48) polyphenols, 49) polysaccharides, 50) potassium, 51) pyridoxine, 52) riboflavin, 53) salicylic acid, 54) selenium, 55) silicon, 56) sodium, 57) sphingolipids, 58) sulfur, 59) terpenoids, 60) thiamin, 61) tocopherols, 62) violaxanthin, 63) xanthophylls, 64) zeaxanthin, 65) zinc.

**How many Alzheimer's disease-preventing health-promoting substances do all green vascular plants have, according to experimental research?**

After reviewing experimental research of these 65 substances shared by all green vascular plants, I have concluded that all edible green vascular plants include at least the following 18 substances that prevent Alzheimer's disease: 1) alpha-linolenic acid, 2) ascorbic acid, 3) caffeic acid, 4) carotenoids,

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5) choline, 6) dietary fibers, 7) flavonoids, 8) lutein, 9) melatonin, 10) phenolic acids, 11) phenolic compounds, 12) phenylpropanoids, 13) phytic acid, 14) polyphenols, 15) polysaccharides, 16) silicon, 17) terpenoids, and 18) tocopherols.

**How many species-specific health-promoting substances do five selected invasive WEPs contain? How many Alzheimer's disease-preventing, species-specific health-promoting substances do these five selected plants have?**

My second subtheme concerns five wild edible plants that some researchers and environmental administrators regard as "invasive alien species" that should be eradicated. Foragers and WEP researchers disagree strongly. These five invasive species provide ecosystem services such as health-promoting foods. For this paper, I checked the latest research on what health-promoting substances these five plants contain.

In the following alien-invasive WEP presentations, I use expressions like "**142** (65+77) health-promoting substances…". In parentheses, figure 65 is the number of health-promoting substances common to all wild edible vascular plants according to Åhlberg (2021, 2022b, and the evidence presented in this article). The second figure of the sum is the species-specific substances that promote health, according to the evidence presented in this article. The example of 77 species-specific substances is from the aerial parts of Japanese knotweed (Fallopia japonica).

The five species presented in this article are attached with the list of substances that prevent Alzheimer's disease. I show the number of substances in the following form: **60** (18 + 42). This example is from Japanese knotweed (Fallopia japonica). In parentheses, the first figure is 18. All green vascular wild edible plants contain 18 substances that prevent Alzheimer's disease, according to Åhlberg (2021, 2022a, 2022b, and the evidence presented in this article). The second figure (42) after the plus operator is the number of species-specific substances that prevent Alzheimer's disease, according to experimental research.

**Subtheme 1: Three Invasive Alien WEPs in Europe**

**Japanese knotweed (*Fallopia japonica*)**

DISTRIBUTION: According to GBIF (2024), Japanese knotweed (Fallopia japonica) is widely distributed globally.

HEALTH-PROMOTING PROPERTIES: I checked experimental studies and found that Japanese knotweed leaves (*Fallopia japonica*) have at least **142** (65+77) health-promoting substances that promote health. I take resveratrol as an example because all tissues of Japanese knotweed contain it. Resveratrol promotes health in the following ways: 1) antioxidant, 2) anti-inflammatory, 3) anticancer, 4) antiviral, 5) antidiabetic, 6) anti-obesity, 7) anti-metabolic syndrome, 8) cardiovascular protective, 9) antiplatelet, 10) anti-hypertension, 11) antiaging, 12) protects against neurodegenerative diseases, such as Alzheimer's disease, 13) anti-stroke, 14) nephroprotective, 15) hepatoprotective, 16) delays the progression of osteoarthritis, and 17) maintains genome stability, promoting a longer and healthier life. (Leaves of Japanese knotweed (Fallopia japonica) contain **57** (18 + 39) substances that prevent Alzheimer's disease. I list them at the end of the species description.)

WARNINGS**:** Japanese knotweed (Fallopia japonica) contains oxalic acid. It is wise to use it with calcium (Ca) and magnesium (Mg) sources, such as cheese or yogurt.

**SUGGESTIONS FOR USE:** A wise option is to use leaves and shoots of Japanese knotweed (Fallopia japonica) in the Mediterranean-style boiled mixtures of wild edible plants.

According to Ke & al. (2023), the Chinese have used thousands of years of rhizomes of Japanese knotweed (*Fallopia japonica,* synonyms *Polygonum cuspidatum, and Reynoutria japonica*) as medicine. They need to learn research on aerial parts of Japanese knotweed (*Fallopia japonica*) for food. In the conclusion of Ke & al. (2023) article, they express the need: "… aerial parts should receive more attention." Åhlberg (2020a, 2020b, and 2023) has focused on research on aerial parts. I present the results below.

Milanovića & al. (2020) and Cucu (2021) regard Japanese knotweed (*Fallopia japonica*) as a harmful invasive alien species. But this species also provides ecosystem services, which I'll present evidence of. Milanovića & al. (2020) present a general framework for discussion but do not

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understand the importance of foraging this species for food. According to Shimoda & Yamasaki (2016), in the homeland of this species, it is valued as a wild edible plant. It was recorded in the oldest history book in Japan in 720 AD**.**

According to Cucu (2021), a particular ecological service of Japanese knotweed (*Fallopia japonica*) is that bees create healthy honey from the nectar of the female flowers. Female flowers of Japanese knotweed (*Fallopia japonica*) are a great source of nectar, which is rich in fructose and glucose. Therefore, pollinating insects, such as bees, visit the flowers.

According to Shimoda & Yamasaki (2016, 449), from 927, there were written instructions on gathering Japanese knotweed (Fallopia japonica) spring shoots for the emperor. According to these over thousand-year-old guidelines, subjects conserve shoots in salt for later cooking. According to Shimoda & Yamasaki (2016, 453), the Japanese still use spring shoots of Japanese knotweed (*Fallopia japonica*) for cooking. In Japan, it is a trendy wild edible plant in spring. According to Nyman (2018, 6), Japanese knotweed (*Fallopia japonica*) was brought to Great Britain in the 19th century as an ornamental plant and as a food and medicinal plant. In Europe, its use for food has remained insignificant. I hope this will change because of the new experimental research on health-promoting substances of Japanese knotweed (*Fallopia japonica).*

Kallas (2023, 199 – 230) discusses Japanese knotweed (*Fallopia japonica*) as a WEP. According to Kallas (2023, 225): “I have found no historical or scientific records of people eating the leaves of our knotweeds, so I assume that they are not edible.” Åhlberg (2020a and 2022a) and Osawa (2024) found research evidence of the edibility of Japanese knotweed (*Fallopia japonica*) leaves.

According to Lachowicz & Oszmiański (2019), Japanese knotweed leaves and stems (*Fallopia japonica*) contain health-promoting substances suitable as raw materials for functional food. According to Lachowicz & al. (2019, 700), leaves of Japanese knotweed (Fallopia japonica) are an excellent source of resveratrol and piceid. According to Chen & al. (2015), piceid is polydatin. Polydatin (piceid) and resveratrol may change each other in the living organism. Basholli-Salihu & al. (2016) describe in detail how this happens. According to Chen & al. (2015), polydatin protects the nervous system. Japanese researchers Kurita & al. (2016, 31) recommend using young leaves of Japanese knotweed (Fallopia japonica) for food, as they do in Japan. They published their research in the Italian Journal of Food Science.

**Figure 1.** Foragers can use the soft new leaves of Japanese knotweed (Fallopia japonica) in Mediterranean-style boiled mixtures of WEPs. These leaves are non-toxic and contain many health-promoting substances, including resveratrol. (Photo © Mauri K.Åhlberg).

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**Figure 2.** The Japanese boil or fry spring shoots of Fallopia japonica. They contain oxalates. Japanese knotweed spring shoots are used with food containing calcium and magnesium ions, such as cheese, whole-grain bread, or both. (Photo © Mauri K.Åhlberg).

Kurita & al. (2016) found plenty of neochlorogenic acid in the leaves of Japanese knotweed (*Fallopia japonica*). Leaf extract of Japanese knotweed (*Fallopia japonica*) is a potent antioxidant. Kurita & al. (2016, 31) recommend using young leaves of Japanese knotweed (Fallopia japonica) for food, as they do in Japan. They published their research in the *Italian Journal of Food Science*.

According to Lachowicz & al. (2019, 700), leaves of Japanese knotweed (Fallopia japonica) are an excellent source of resveratrol and piceid. According to Chen & al. (2015), piceid is polydatin. Resveratrol may change to polydatin (piceid), and polydatin may change to resveratrol in the living organism. Basholli-Salihu & al. (2016) describe in detail how this happens. According to Chen & al. (2015), polydatin protects the nervous system. According to Girardi & al. (2022, 923), "emodin and resveratrol were detected in all plant tissues" of Fallopia japonica.

Japanese knotweed (Fallopia japonica) contains 142 (65+77) health-promoting substances. I have listed the 77 species-specific health-promoting substances at the end of this species description.

Resveratrol is an excellent example of the 142 health-promoting substances of Japanese knotweed (*Fallopia japonica*). I present resveratrol in more detail in the following vignette.

According to Alesci & al. (2022), Wu & al. (2022), Zhu & al. (2022), Alauddin & al. (2021), Grinan-Ferre & al. (2021), Xiong & al. (2021), Kumar & al. (2020), Matsuno & al. (2020), Martínez & al. (2019) and Singh, A. & al (2019a) **resveratrol** has following health-promoting properties: 1) antioxidant, 2) anti-inflammatory, 3) anticancer, 4) antiviral, 5) antidiabetic, 6) anti-obesity, 7) anti-metabolic syndrome, 8) cardiovascular protective, 9) antiplatelet, 10) anti-hypertension, 11) antiaging, 12) protects against neurodegenerative diseases, such as Alzheimer's disease, 13) anti-stroke, 14) nephroprotective, 15) hepatoprotective, 16) delays the progression of osteoarthritis, and 17) maintains genome stability, promoting a longer and healthier life. According to Zhua & al. (2019), resveratrol has protective effects on stress-induced depression and anxiety. They present a molecular biological mechanism for it. According to Grinan-Ferre & al. (2021), resveratrol is a

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powerful antioxidant and "possesses pleiotropic actions, exerting its activity through various molecular pathways." Kumar & al. (2020) state that resveratrol can cross the blood-brain barrier. Neuroinflammation is a part of Alzheimer's disease. Resveratrol prevents neuroinflammation.

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**The answer to the research sub-question: How many health-promoting substances do the aerial parts of Japanese knotweed (*Fallopia japonica)* contain?**

In this paper, I have presented evidence that all vascular green plants contain at least 65 health-promoting substances. In addition to these, Cucu & al. (2021), Lachowicz & al. (2019), Lachowicz & Oszmiański (2019), Mikulic-Petkovsek & al. (2022), and Åhlberg (2020a) found from published research the following 77 health-promoting, species-specific substances in aerial parts of Japanese knotweed (*Fallopia japonica):* 1) 3-feruloylquinic acid, 2) 3-p-coumaroylquinic acid, 3) 4-caffeoylquinic acid, 4) 5-caffeoylquinic acid, 5) 5-p-coumaroylquinic acid, 6) anthraquinones, 7) apigenin, 8) astringin, 9) betulinic acid, 10) caffeoylquinic acids, 11) caftaric acid, 12) catechin gallate, 13) chlorogenic acid, 14) cis-resveratroloside, 15) coumarins, 16) dicaffeoylquinic acid, 17) emodin, 18) epicatechin, 19) ferulic acid, 20) flavanols, 21) flavones, 22) flavonols, 23) gallic acid, 24) galloylhexoside, 25) isorhamnetin hexoside, 26) kaempferol, 27) kaempferol hexoside, 28) kaempferol-3-rhamnoside, 29) kaempferol-3-rutinoside, 30) lignans, 31) luteolin, 32) luteoxanthin, 33) myricetin-3-rhamnoside, 34) neochlorogenic acid, 35) neochrome, 36) neoxanthin, 37) oleanolic acid, 38) p-coumaric acid, 39) piceatannol hexoside, 40) piceid, 41) polydatin, 42) proanthocyanidins, 43) procyanidin B2, 44) procyanidin dimer 1, 45) procyanidin dimer 2, 46) procyanidin dimer 3, 47) procyanidin tetramer 1, 48) procyanidin tetramer 2, 49) procyanidin tetramer 3, 50) procyanidin tetramer 4, 51) procyanidin trimer 1, 52) procyanidin trimer 2, 53) procyanidin trimer 3, 54) procyanidin trimer 4, 55) procyanidin trimer 5, 56) procyanidin trimer 6, 57) procyanidin trimer 7, 58) quercetin, 59) quercetin acetyl hexoside, 60) quercetin dihexoside, 61) quercetin-3-arabinofuranoside, 62) quercetin-3-arabinopyranoside, 63) quercetin-3-galactoside, 64) quercetin-3-glucoside (isoquercitrin) , 65) quercetin-3-rhamnoside (quercitrin), 66) quercetin-3-xyloside, 67) quinones, 68) resveratrol, 69) rutin (quercetin-3-rutinoside), 70) stilbenes, 71) syringic acid, 72) t-cinnamic acid, 73) trans-coutaric acid, 74) trans-piceid 1, 75) trans-piceid 2, 76) trans-resveratroloside, and 77) ursolic acid.

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**The answer to the research sub-question: How many Alzheimer's disease-preventing substances do the aerial parts of Japanese knotweed (*Fallopia japonica)* contain?**

Out of the total **142** (65+77) health-promoting substances that Japanese knotweed (*Fallopia japonica*) has, the aerial parts of Japanese knotweed (*Fallopia japonica*) contain the following **57** (18 + 39) **substances that prevent Alzheimer's disease**: 1) alpha-linolenic acid, 2) ascorbic acid, 3) caffeic acid, 4) carotenoids, 5) choline, 6) dietary fibers, 7) flavonoids, 8) lutein, 9) melatonin, 10) phenolic acids, 11) phenolic compounds, 12) phenylpropanoids, 13) phytic acid, 14) polyphenols, 15) polysaccharides, 16) silicon, 17) terpenoids, 18) tocopherols, 19) 4-caffeoylquinic acid, 20) 5-caffeoylquinic acid, 21) anthraquinones, 22) apigenin, 23) betulinic acid, 24) caffeoylquinic acids. 25) catechin, 26) chlorogenic acid, 27) coumarins, 28) dicaffeoylquinic acid, 29) emodin, 30) epicatechin, 31) essential oils, 32) ferulic acid, 33) flavanols, 34) flavones, 35) flavonols, 36) gallic acid, 37) isoquercitrin, 38) kaempferol, 39) lignans, 40) luteolin, 41) luteoxanthin, 42) neochlorogenic acid, 43) neoxanthin, 44) oleanolic acid, 45) p-coumaric acid, 46) piceid, 47) polydatin, 48) proanthocyanidins, 49) procyanidin B2, 50) quercetin, 51) quercitrin, 52) quinones, 53) resveratrol, 54) rutin, 55) stilbenes, 56) syringic acid, and 57) ursolic acid.

CONCLUSION: Chemical research has shown that the aerial parts of Japanese knotweed (Fallopia japonica) contain at least 142 valuable health-promoting substances, including resveratrol, emodin, and polydatin. These delicate aerial parts can be used as ingredients for healthy food.

**Himalayan balsam (Impatiens glandulifera)**

DISTRIBUTION: According to GBIF (2024), Himalayan balsam (Impatiens glandulifera) is widely distributed globally.

GENERAL HEALTH-PROMOTING PROPERTIES: From published research, I have found **137** (65 + 72) substances in aerial parts of Himalayan balsam (Impatiens glandulifera) that promote health according to experimental research in the following ways: 1) antioxidant, 2) anti-inflammatory, 3) antimicrobial, 4) antifungal, 5) antiviral, 6) antitumor, 7) anticancer, 8) cardioprotective, 9) anti-obesity, 10) arthritis-protective, 11) pulmonary and asthma-protective, 12) ovary-protective, 13) UV-protective, 14) antidepressant, 15) neuroprotective. 16) Aerial parts of Himalayan balsam (Impatiens glandulifera) contain **46** substances that prevent Alzheimer's disease, according to experimental research.

WARNINGS: Himalayan balsam (Impatiens glandulifera) has sharp needle-shaped oxalate crystals in almost all tissues. They are called raphides of calcium oxalate, which can irritate the intestine's mucous membrane. That is why it is not wise to eat leaves or stems. They can be vomiting (emetic). (The seeds may be an exception because many researchers have reported that children eat seeds of Himalayan balsam (Impatiens glandulifera).) Himalayan balsam (Impatiens glandulifera) is a toxic cadmium (Cd) hyperaccumulator. Researchers have found cadmium (Cd) in all researched parts of Himalayan balsam (Impatiens glandulifera). Accordingly, in clean, healthy environments, it is wise to only forage leaves, flowers, and seeds of Himalayan balsam (Impatiens glandulifera).

SUGGESTIONS FOR USE: Use boiling water to make water-infusion (water decoction) of Himalayan balsam (*Impatiens glandulifera)* fresh or dried leaves, shoots, and flowers. This herbal water extract is health-promoting. Start with small doses. Taste a flower, whether you can eat it fresh. It is worth trying because flowers contain many health-promoting substances. Seeds, both raw and mature, are tasty and healthy. Seeds have more unsaturated omega-3 fatty acids than unsaturated omega-6 fatty acids. This proportion promotes health.

Himalayan balsam (*Impatiens glandulifera)* is an invasive alien species with an extensive distribution (Figure 3).

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**Figure 3.** Extensive distribution of *Impatiens glandulifera*. The native range and the invaded range. This map is from Coakley & Petti (2021), an open-access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. https://doi.org/10.3390/biology10070619.

Milanovića & al. (2020) regard Himalayan balsam (Impatiens glandulifera) mainly as a harmful invasive alien species. However, this species also provides ecosystem services, which I will present evidence of. Milanovića & al. (2020) present a general framework for discussion but do not understand the importance of foraging this species for food.

Himalayan balsam has large inflorescences. It blooms in late summer. Prdun & al. (2022) state that Himalayan balsam (Impatiens glandulifera) is a significant nectar source for bees in late summer. It produces plenty of nectar with pollen and sugars. It attracts plenty of bees.

Leaves and flowers of Himalayan balsam (Impatiens glandulifera) are best in boiled-water extracts. Almost all parts of this plant have raphides (needle-like sharp calcium oxalate crystals). I have not found any research on raphides in flowers or seeds. Children eat seeds without any harm, as I have done. Raphides do not enter drinks, which are tonic, refreshing, and full of health-promoting substances. Juice (water extract) of flowers of Himalayan balsam (Impatiens glandulifera) is cooling and tonic. (Tonic means medicine for invigorating: increasing physical or mental strength.) Drink only in moderate doses.

According to Kayani & al. (2015, 192), Pakistanis make decoction out of flowers and leaves of Himalayan balsam (*Impatiens glandulifera*). According to Kayani & al. (2015, 192), Pakistanis make a powder after drying the Himalayan balsam (Impatiens glandulifera) flowers and leaves. They use this powder to make juice with health-promoting properties: 1) it provides a cooling effect, 2) it improves sleep, and 3) it heals depression.

According to Balogh (2008, 133):" The nut flavored seeds and cooked young leaves, and shoots said (sic!) to be edible." Balogh (2008, 133 presents no research references. According to Kraehmer & Bauer (2013, 378 and 382), leaves and shoots contain raphides of calcium oxalate (oxalate crystals, which have a sharp needle-like shape), which may irritate the intestine's mucous membrane. According to Hoover and Wijesinha (1945), intestinal calcium oxalate is insoluble. In their ethnobotanical research, Qureshi & al. (2007, 2278) found that infusions of Himalayan balsam (*Impatiens glandulifera*) flowers are cooling and tonic. Ch & al. (2013, 247 – 248) found that locals use flower juice as a cooling agent and tonic in their ethnobotanical research.

Without any sources, Singh & Arora (1978, 82) claim that the seeds of Himalayan balsam (Impatiens glandulifera) are" the seeds which taste like nuts are eaten raw." Srivastava (1988, 205) made an ethnobotanical study on which Himalayan balsam (Impatiens glandulifera) seeds are eaten raw in India. According to Nasim & Shabbir (2012, 63), Himalayan balsam (*Impatiens glandulifera*)

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seeds are eaten raw in Pakistan. According to Nasim & Shabbir (2012, 63)," … its flavor is famous in young ones."

According to ethnobotanical research by Thakur & al. (2017, 3), locals in the Himalayan mountains eat Himalayan balsam (*Impatiens glandulifera)* fruits. According to Nasim & Shabbir (2012, 63), Pakistanis boil young shoots and leaves of Himalayan balsam (*Impatiens glandulifera*) into expectorant. Kumar & al. (2009, 1254) conducted ethnobotanical research on medicinal plants in India. People they interviewed allocated Himalayan balsam (*Impatiens glandulifera)* into the same category as common dandelion (*Taraxacum officinale*) and pomegranate (*Punica granatum*), which are used as 1) tonic, 2) appetizer, and 3) cooling agents. According to Gairola & al. (2014, 634 and 655), Indian people use Himalayan balsam as a tonic and aphrodisiac. Tonic means medicine for invigorating: increasing physical or mental tone and strength.

According to Orzelska-Górka & al. (2019, 206 -207), extracts made of Himalayan balsam (*Impatiens glandulifera*) have the following health-promoting properties: (1) antioxidant, (2) antimicrobial, (3) cytostatic, (4) anti-anxiety, and 5) antidepressant. According to Szewczyk & al. (2018b, 11), extracts made of aerial parts of Himalayan balsam (*Impatiens glandulifera*) are (6) anti-inflammatory.

Himalayan balsam (*Impatiens glandulifera*) has oxalate crystals in its tissues that have a sharp needle-like shape. They are called raphides of calcium oxalate, which can irritate the intestine's mucous membrane. According to Kraehmer & Bauer (2013, 378 and 382), researchers have found calcium oxalate raphides in almost all Himalayan balsam tissues (Impatiens glandulifera). They present only one photograph of raphides of calcium oxalate. In the photo, there are plenty of sharp raphides between cells. According to Ch & al (2013, 248), leaves of Himalayan balsam (*Impatiens glandulifera*), when eaten fresh (raw), are emetic. In medicine, emetic means that a substance is vomiting. The cause for emitting is probably raphides of calcium oxalate, which are in almost all tissues of Himalayan balsam (Impatiens glandulifera).

According to Kumar & al. (2009, 1254), (Nasim & Shabbir 2012, 63), and (Kayani & al. 2015, 192), foragers can cook shoots and leaves of Himalayan balsam (*Impatiens glandulifera*) for 1) tonic, 2) cooling the body, 3) expectorant, 4) sleep-promoting drink, and 5) to heal depressions. The sharp raphides of calcium oxalate probably remain in plant tissues if only the liquid is drunk. According to Guil & al. (1997, 102), most of the insoluble oxalates in other high-oxalate plants like spinach (Spinacia oleracea) and rhubarb (*Rheum rhaponticum*) do not solve into water. According to Coakley & al. (2019), Himalayan balsam (*Impatiens glandulifera*) is a hyperaccumulator of toxic cadmium (Cd). All researched parts of Himalayan balsam (*Impatiens glandulifera*) accumulate cadmium (Cd). Accordingly, only in clean and healthy environments is it wise to forage leaves, flowers, and seeds of Himalayan balsam (Impatiens glandulifera).

I have selected phenolic acids to represent health-promoting substances in Himalayan balsam (Impatiens glandulifera). According to Szewczyk & Olech (2017), Himalayan balsam (Impatiens glandulifera) contains significant phenolic acids. According to Åhlberg (2022a), all main edible parts of Himalayan balsam (Impatiens glandulifera) contain phenolic acids: leaves, flowers, and seeds.

| **phenolic acids** |
|---|
| FOR HUMANS: According to Caruso al.& (2022), Rashmi & Negi (2020), Kumar & Goel (2019, Călinoiut & Vodnar (2018), and Szwajgier & al. (2018, phenolic acids have the following health-promoting properties: 1) antioxidants, 2) anti-inflammatory, 3) antimicrobial, 4) anticancer, 5) anti-allergic, 6) antidiabetic, 7) immunoregulatory, 8) anti-thrombotic, 9) anti-atherogenic, 10) cardioprotective, 11) neuroprotective, and 12) prevent Alzheimer's disease. |
| IN PLANTS: According to Marchiosi & al. (2020) and Kumar & Goel (2019), phenolic acids are among plants' most widely distributed phenolic compounds. They are ubiquitous in both wild and cultured edible plants. Phenolic acids have critical biological roles. Many participate in the |

 doi:10.20944/preprints202410.1307.v2



biosynthesis of structural components of the cell wall. Others are crucial for defense responses to pathogens and herbivores.

Marchiosi & al. (2020, 893) divides simple phenolic acids into three groups: Group 1: benzoic acid and benzoic acid derivates, e.g., 1.1) benzoic acid, 1.2) gallic acid, 1.3) protocatechuic acid, 1.4) p-hydroxybenzoic acid, 1.5) salicylic acid, Group 2: cinnamic acid and cinnamic acid derivatives, e.g., 2.1) cinnamic acid, 2.2) p-coumaric acid, 2.3) caffeic acid, 2.4) ferulic acid and 2.5) sinapic acid, and Group 3: others, e.g., 3.1) catechol, 3.2) pyrogallol, and 3.3) chlorogenic acid.

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**Figure 4.** Flowering Himalayan balsam (*Impatiens glandulifera*). Using only water decoctions or infusions of shoots is wise because all tissues have sharp needle-like oxalate crystals. (Photo © Mauri K.Åhlberg).

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**Figure 5.** Seeds of Himalayan balsam (*Impatiens glandulifera*). On the left are green raw seeds, half-mature seeds in the middle, and mature dark seeds on the right. All these seeds are edible. (Photo © Mauri K.Åhlberg).

Seeds of Himalayan balsam (Impatiens glandulifera) contain over three times more omega-3-unsaturated fatty acids than omega-6-unsaturated fatty. This ratio promotes health. Seeds also contain **oleic acid,** the primary health-promoting fatty acid in extra-virgin olive oil.

According to Granado-Casa & Didac (2019), **oleic acid** is the primary monounsaturated fatty acid in olive oil and nuts, two essential foods in the Mediterranean diet. According to Gavahiana & al. (2019, 222), extra virgin olive oil contains oleic acid. It promotes healthy bacterial diversity in the gut. Wild edible plants often contain oleic acid. According to Granado-Casa & Didac (2019) and Sales-Campo & al. (2013), oleic acid has the following health-promoting properties: 1) prevents metabolic syndrome, 2) prevents high blood pressure, 3) prevents overweight (obesity), 4) prevents hyperglycemia, 5) prevents atherogenic lipid profile, 6) prevents insulin resistance, 7) prevents inflammation, 8) prevents prothrombotic alterations, 9) bactericidal, 10) fungicidal, 11) anticancer, and 12) attenuation of the effects of autoimmune diseases.

**The answer to the research sub-question: How many health-promoting substances do the aerial parts of Himalayan balsam (Impatiens glandulifera) contain?**

According to Szewczyk & al. (2016), Szewczyk & Olech (2017), Szewczyk & al. (2018), Szewczyk & al. (2019a), Szewczyk & al. (2019b), Orzelska-Górka & al. (2019), Vieira & al. (2016), and Åhlberg (2020a and 2022): **Aerial parts** (leaves, shoots, flowers) of Himalayan balsam (*Impatiens glandulifera*) contain **137** (65+72) health-promoting substances: 1) (E)-ligustilide, 2) (Z)-ligustilide, 3) 4-ethylguaiacol, 4) 4-hydroxybenzoic acid, 5) alpha-copaene, 6) alpha-phellandrene, 7) alpha-selinene, 8) alpha-terpineol, 9) alpha-terpinyl acetate, 10) astragalin, 11) beta-elemene, 12) beta-ionone epoxide, 13) beta-phellandrene, 14) borneol, 15) bornyl acetate, 16) butylphthalide, 17) campesterol, 18) carvacrol, 19) carvone, 20) chondrillasterol, 21) coumarins, 22) delta-cadinene, 23) eriodictyol, 24) essential oils, 25) gallic acid, 26) gamma-cadinene, 27) gamma-elemene, 28) gamma-muurolene, 29) gamma-terpinene, 30) gentisic acid, 31) geranyl acetate, 32) glanduliferin A, 33) glanduliferin B, 34) guaiacol, 35) heptacosane, 36) heptanal, 37) hexahydrofarnesyl, 38) hyperoside, 39) isoquercitrin, 40) kaempferol, 41) limonene, 42) linalool, 43) methyl palmitate, 44) monoterpene hydrocarbons, 45) myricetin, 46) myristic acid, 47) naphthoquinones, 48) oxygenated monoterpenes, 49) oxygenated sesquiterpenes, 50) palmitic acid, 51) p-coumaric acid, 52) p-cymene, 53) phellandral, 54) phytol, 55) piperitone, 56) p-isopropylbenzaldehyde, 57) protocatechuic acid, 58) quercetin, 59) saponins, 60) sitostanols, 61) sitosterols, 62) spinasterol, 63) syringic acid, 64) terpinen-4-ol, 65) terpinen-7-al, 66) terpinolene, 67) T-muurolol, 68) trans-carveol, 69) trans-ferulic acid, 70) trans-piperitol, 71) tricosane, and 72) vanillic acid.

**The answer to the research sub-question: How many Alzheimer's disease-preventing substances do the aerial parts of Himalayan balsam (Impatiens glandulifera) contain?**

The 137 health-promoting substances of Himalayan balsam (Impatiens glandulifera) include **46** (18+28) chemicals that **prevent Alzheimer's disease according to experimental research:** 1) alpha-linolenic acid, 2) ascorbic acid, 3) caffeic acid, 4) carotenoids, 5) choline, 6) dietary fibers, 7) flavonoids, 8) lutein, 9) melatonin, 10) phenolic acids, 11) phenolic compounds, 12) phenylpropanoids, 13) phytic acid, 14) polyphenols, 15) polysaccharides, 16) silicon, 17) terpenoids, 18) tocopherols, 19) (E)-ligustilide, 20) (Z)-ligustilide, 21) 4-ethylguaiacol, 22) alpha-selinene, 23) alpha-terpineol, 24) alpha-terpinyl acetate, 25) astragalin, 26) borneol, 27) butylphthalide, 28) carvacrol, 29) carvone, 30) coumarins, 31) eriodictyol, 32) essential oils, 33) gamma-terpinene, 34) guaiacol, 35) hydroxycinnamic acids, 36) hyperoside, 37) isoquercitrin, 38) kaempferol, 39) limonene, 40) linalool, 41) myricetin, 42) naphthoquinones, 43) p-cymene, 44) protocatechuic acid, 45) quercetin, and 46) saponins.

**The answer to the research subquestion: How many health-promoting substances do the flowers of Himalayan balsam (Impatiens glandulifera)) contain?**

**FLOWERS:** Applying Åhlberg (2020a, 2022a, and 2023), Pires & al. (2021), Szewczyk & Olech (2017), and Vieira & al. (2016, 119), **flowers** of Himalayan balsam (*Impatiens glandulifera*) contain **82** (65 + 17) health-promoting substances. The 18 substances that are specific for the **flowers** of Himalayan balsam (*Impatiens glandulifera*) are 1) 4-hydroxybenzoic acid, 2) astragalin, 2) coumarins, 3) eriodictyol, 4) essential oils, 5) gallic acid, 6) gentisic acid,7) hyperoside, 8) isoquercitrin, 9) kaempferol, 10) myricetin, 11) naphthoquinones, 12) p-coumaric acid, 13) protocatechuic acid, 14) quercetin, 15) syringic acid, 16) trans-ferulic acid, and 17) vanillic acid.

The 81 health-promoting substances of the **flowers** of Himalayan balsam (*Impatiens glandulifera* include the next **26** (18 + 8) substances that **prevent Alzheimer's disease**: 1) alpha-linolenic acid, 2) ascorbic acid, 3) caffeic acid, 4) carotenoids, 5) choline, 6) dietary fibers, 7) flavonoids, 8) lutein, 9) melatonin, 10) phenolic acids, 11) phenolic compounds, 12) phenylpropanoids, 13) phytic acid, 14) polyphenols, 15) polysaccharides, 16) silicon, 17) terpenoids, 18) tocopherols, 19) coumarins, 20) essential oils, 21) gallic acid, 22) kaempferol, 23) myricetin, 24) protocatechuic acid, 25) quercetin, and 26) vanillic acid.

**The answer to the research subquestion: How many health-promoting substances do the seeds of Himalayan balsam (Impatiens glandulifera)) contain?**

**SEEDS:** According to Åhlberg (2020a, 2022a) and Szewczyk & al. (2018), **seeds** of Himalayan balsam (*Impatiens* glandulifera) contain **80**(65+15) health-promoting substances. The specific health-promoting 15 compounds in seeds are 1) 9,19-cyclolanostan-3-ol, 24-methylene-, acetate, (3beta), 2) arachidonic acid, 3) azelaic acid, 4) beta-amyrin acetate, 5) campesterol, 6) caprylic acid, 7) chondrillasterol, 8) ergosta-7,22-dien-3-o l, 9) gamma-linolenic acid, 10) oleic acid, 11) palmitic acid, 12) sitostanol, 13) spinasterol, 14) stigmasterol, and 15) triterpenes.

The seeds of Himalayan balsam contain **18** (18 + 0) substances that **prevent Alzheimer's disease**: 1) alpha-linolenic acid, 2) ascorbic acid, 3) caffeic acid, 4) carotenoids, 5) choline, 6) dietary fibers, 7) flavonoids, 8) lutein, 9) melatonin, 10) phenolic acids, 11) phenolic compounds, 12) phenylpropanoids, 13) phytic acid, 14) polyphenols, 15) polysaccharides, 16) silicon, 17) terpenoids, and 18) tocopherols.

CONCLUSION: Himalayan balsam can be a nasty invasive plant if it grows near water. It is a beautiful addition to local flora if it cannot spread without control. Better keep it away from water, especially running water. Chemical research has shown that Himalayan balsam (*Impatiens glandulifera)*contains at least the following number of health-promoting substances: 80 (seeds), 82 (flowers), or 137(aerial parts), including phenolic acids in all of its main edible parts: leaves, flowers, and seeds. Delicate aerial parts can be used for healthy, invigorating decoctions(a concentrated liquor from boiling delicate aerial parts). Flowers can be used as edible decorations. Seeds (light-colored,

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brown, and black) can be consumed raw. Seeds contain **oleic acid,** the primary health-promoting fatty acid in extra-virgin olive oil.

**Rugosa rose (*Rosa rugosa*)**

DISTRIBUTION: According to GBIF (2024), rugosa rose (Rosa rugosa) is widely distributed globally.

HEALTH-PROMOTING PROPERTIES of petals and hips of rugosa rose (Rose rugosa), according to health-promoting properties of ellagitannins: 1) antioxidant, 2) anti-inflammatory, 3) antimicrobial, 4) antiglycative, 4) hepato-protective, 5) beneficial effects on kidney diseases, 4) anti-virus, 5) cardioprotective, 6) neuroprotective, 7) prebiotic, 8) chronic disease prevention, 7) anticancer, 8) antidiabetic, 9) beneficial effects on chronic tissue inflammation, 10) beneficial effects on metabolic syndrome) 11) beneficial effects on obesity-mediated metabolic complications, 12) beneficial effects on gastrointestinal diseases, 13) beneficial effects on eye diseases, 14) beneficial effects on depression, 15) muscle mass protective effects, and 16) beneficial effects on Alzheimer's disease and other neurodegenerative diseases

WARNINGS: I used to warn about salicylic acid before I learned while writing this paper that all green vascular plants contain salicylic acid. According to experimental research, plant salicylic acid promotes health.

SUGGESTIONS FOR USE: The flowers and fruits (rose hips) of the rugosa rose (Rosa rugosa) are widely used in salads or the traditional Mediterranean-style boiled mixtures of wild edible plants. Foragers can use petals for healthy dish decoration.

According to Kelager& al. (2013), *Rosa rugosa* is (1) native to East Asia, (2) one of the most troublesome invasive plant species in natural or semi-natural habitats of northern Europe, and (3) very difficult to control.

According to Dobreva & Nedeltcheva-Antonova (2023, 1), *Rosa rugosa* has been cultivated in East Asia for thousands of years.

*Rosa rugosa* provides many ecosystem services for humans, including 1) petals and 2) rose hips for food. *It* is an important ornamental and economical plant. Its essential oil is expensive and has high economic value. According to Katekar & al. (2022), "… the production of rose essential oil and rose water is a lucrative source of revenue for rural communities."

*Rosa rugosa* may have both flowers (petals) and fruits (hips) simultaneously. According to Xie & al. (2022), *Rosa rugosa purple lines* flowers from spring to autumn. Medveckienė & al. (2023) call *Rosa rugosa purple line* a genotype 'Rubra.' Usually, foragers and growers gather rose petals and hips for different purposes. Rarely have both petals and rose hips been used in the same dish. Strangely, two recent research articles (Razgonova & al. 2022 and Wangg & al. 2022) combined the chemical constituents of rose petals and rose hips. In these two papers, all found phytochemicals are listed, regardless of research results, whether they promote health. I have searched separately for the kinds of <u>health-promoting</u> substances Rosa rugosa petals and rose hips contain.

According to Cendrowski & al. (2017): "The main polyphenol fraction in Rosa rugosa petals was ellagitannins constituting from 69 to 74% of the total petals' polyphenols."

**The answer to the research sub-question: How many health-promoting substances do the <u>petals</u> of rugosa rose (Rosa rugosa*)* contain?**

According to **(**Cendrowski & al. (2017), Dobreva & Nedeltcheva-Antonova (2023), Dobson & al. (1990), Feng & al. (2014), Katekar & al. (2022), Lu & Wang (2018), Maciąg & Kalemba (2015), Manjiro & al. (2008), Nowak & al. (2014), Olech & al. (2019), Sulborska & al. (2012), and Zhang & al. (2019)**, the <u>petals</u> of rugosa rose (Rosa rugosa) contain the following 130 health-promoting substances in addition of the 65 health-promoting substances that all green vascular plants contain**: 1) (+)-catechin (cianidanol), 2) )aliphatic alcohols, 3) alpha-cadinol, 4) alpha-curcumene, 5) alpha-glucans, 6) alpha-phellandrene, 7) alpha-pinene, 8) alpha-terpineol, 9) anthocyanins, 10) apigenin, 11) apigenin 7-O-glucoside, 12 astragalin, 13) avicularin, 14) beta-caryophyllene, 15) beta-caryophyllene oxide, 16) beta-citronellol, 17) beta-glucans, 18) beta-pinene, 19) borneol, 20) bornyl acetate, 21) cadalene, 22) camphene, 23) caprylic acid, 24) catechin, 25) cis-linalool oxide, 26) cyanidins, 27)

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docosanal, 28) docosanol, 29) dodecanol, 30) eicosane, 31) ellagic acid, 32) ellagitannins, 33) essential oils, 34) eugenol, 35) euscaphic acid, 36) flavan-3-ols, 37) flavones, 38) flavonoid glycosides, 39) flavonols, 40) gallic acid, 41) gamma-muurolene, 42) gentisic acid, 43) geranial, 44) geranic acid, 45) geraniol, 46) geranyl acetate, 47) geranyl formate, 48) glycosides, 49) hemiterpenes, 50) heneicosane, 51) heptanal, 52) hexacosane, 53) hydrolyzable tannins, 54) hyperoside, 55) isocaryophyllene, 56) isoquercitrin, 57) isorhamnetin 3-O-glucoside, 58) kaempferol, 59) kaempferol 3,4-di-O-glucoside, 60) kaempferol derivatives, 61) kaempferol-3-O-rutinoside, 62) lauric acid, 63) limonene, 64) linalool, 65) linalyl acetate, 66) methyl eugenol, 67) methyl jasmonate, 68) monoterpene acids, 69) monoterpene esters, 70) monoterpene hydrocarbons, 71) monoterpene oxygenated, 72) monoterpenes, 73) myrcene, 74) myricetin 3,5-di-O-glucoside, 75) nonadecene, 76) nerol, 77)neryl acetate, 78) neryl acetone, 79) octyl butyrate, 80) oleic acid, 81) p-coumaric acid, 82) p-cymen-8-ol, 83) p-cymen-9-ol, 84) pelargonidins, 85) pentacosane, 86) pentadecan-2-one, 87) peonidin 3,5-di-O-glucoside, 88) peonidin 3,5-di-O-glucoside, 89) peonidin 3-O-glucoside, 90) peonidin 3-osophoroside, 91) peonidins, 92) phenylacetaldehyde, 93) phenylethyl salicylate, 94) proanthocyanidins, 95) procyanidins, 96) protocatechuic acid, 97) quercetin, 98) quercetin 3,4-di-O-glucoside, 99) quercetin 3,4-O-diglucoside, 100) quercetin 3-O-glucosyl-xyloside, 101) quercetin 3-O-rhamnoside, 102) quercetin derivatives, 103) quercitrin, 104) quinine, 105) rosamultin, 106) rose oxides, 107) rugosin D, 108) rutin, 109) sabinene, 110) salicylic acid, 111) sanguiin, 112) sanguiin H-2, 113) sesquiterpene, 114) sesquiterpene hydrocarbons, 115) sesquiterpene oxygenated, 116) sinapic acid, 117) stearic acid, 118) tannins, 119) tellimagradin II, 120) terpenoid alcohols, 121) terpenoids, 122) terpinen-4-ol, 123) tetracosane. 124) thymol, 125) tiliroside, 126) T-muurolol, 127) tormentic acid, 128) tricosane, 129) triterpenoids, and 130) undecanal.

**Conclusion: Total number of health-promoting substances in rose petals is at least 195 (65 + 130).**

**The answer to the research sub-question: How many health-promoting substances do the hips of rugosa rose (Rosa rugosa) contain?**

**Hips**

According to Singh & Gairola (2023), edible wild rose hips have great potential for food security.

According to Zhou & al. (2023), people are becoming more health-conscious about the nutritional and health benefits of rose hips. "The rosehip is an underutilized and sustainably produced fruit with great potential to generate value-added products."

According to Olech & al. (2017), *Rosa rugosa* provides one of the most enormous hips for food products. They are tasty.

According to Olech & al. (2019), *Rosa rugosa* hips are the most abundant source of health-promoting polysaccharides such as alpha-glucan and beta-glucan.

According to Skrypnik & al. (2019): "This study showed the high nutritional value of rose hips, especially of the species *Rosa rugosa* Thunb."

Stuper-Szablewska & al. (2023) state that *Rosa rugosa* hips have antifungal and antiviral properties.

**The answer to the research sub-question: How many Alzheimer's disease-preventing substances hips of rugosa rose (Rosa rugosa) contain?**

According to Åhlberg (2020a and 2022a), Al-Yafeai & al. (2018), Cunja & al. (2016), Dashbaldan & al. (2021), Medveckienė & al. (2023), Milala & al. (2021), Nijat & al. (2021), Nowak, R. (2005, Nowak (2006), Olech & al. (2017), Olech & al. (2019), Olech & al. (2023), Stuper-Szablewska & al. (2023), Xie & al. (2022), the hips of rugosa rose (Rosa rugosa) contain the following 100 health-promoting substances in addition of the 65 health-promoting substances that all green vascular plants contain: 1) 2-hexenoic acid methyl ester, 2) 2-octenal, 3) 3-feruloylquinic acid, 4) 24-methylenecycloartanol, 5) afzelin, 6) alpha-amyrenone, 7) alpha-amyrin, 8) alpha-cryptoxanthin, 9) alpha-farnesene, 10) alpha-glucans, 11) alpha-pinene, 12) apigenin, 13) astragalin, 14) avicularin, 15) beta-amyrin, 16) beta-cryptoxanthin, 17) beta-glucans, 18) beta-ionone, 19) beta-myrcene, 20) betulinic acid, 21) butyric acid, 22) campesterol, 23) caprylic acid methyl ester, 24) catechin, 25) cholesta-3,5-dien-7-one, 26) cis-3-

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hexenal, 27) corosolic acid, 28) cyanidin-3-glucoside, 29) decanal, 30) decanoic acid, 31) docosane, 32) dodecanoic acid, 33) edulan, 34) ellagic acid, 35) ellagitannins, 36) erythrodiol, 37) essential oils, 38) farnesyl acetone, 39) flavanols, 40) flavanols, 41) fumaric acid, 42) gallic acid, 43) gamma-terpinene, 44) geranial, 45) geraniol, 46) guaiacol, 47) heneicosane, 48) hexadecanoic acid, 49) hexahydrofarnesyl acetone, 50) isofucosterol, 51) juglanin, 52) kaempferol, 53) lauric acid methyl ester, 54) limonene, 55) linalool, 56) linolenic acid methyl ester, 57) lupeol, 58) luteolin, 59) lycopene, 60) maslinic acid, 61) methyl caprate, 62) myristic acid, 63) naringenin, 64) neral, 65) nonanal, 66) obtusifoliol, 67) octanal, 68) oleanolic acid, 69) oleanolic aldehyde, 70) palmitic acid methyl ester, 71) p-cymene, 72) pentacosane, 73) phloridzin, 74) phytoene, 75) pomolic acid, 76) procyanidins, 77) quercetin, 78) quercetin-3-O-sophoroside, 79) quercitrin, 80) quinic acid, 81) rutin, 82) safranol, 83) scutellarin, 84) sitostenone, 85) steroids, 86) stigma sta-3.5-dien-7-one, 87) stigmasterol, 88) stilbenoids, 89) tannins, 90) terpinolene, 91) tetracosane, 92) trans-geranyl-acetone, 93) tricosane, 94) triterpenoid acids, 95) triterpenoids, 96) ursolic acid, 97) ursolic aldehyde, 98) uvaol, 99) vitexin, and 100) Z-nerolidol.

**Conclusion: According to experimental studies, rose hips contain at least 165 (65+100) health-promoting substances.**

Milanovića & al. (2020, 3) present rugosa rose (Rosa rugosa) as a harmful invasive alien species. However, they understand this species also provides many ecosystem services (seven listed) and disservices (two listed). Foragers have found that rugosa rose (Rosa rugosa) provides food for humans and other ecosystem services, of which I'll present evidence. Milanovića & al. (2020) present a general framework for discussion but do not fully understand the importance of foraging this species for food. According to Zhanga & al. (2019, 938) and Olech & al. (2019,2), in different cultures, petals, and rosehips of rugosa rose (Rosa rugosa) have been used for a long time as a health-promoting food. The petals of rugosa roses (Rosa rugosa) are more significant than many others and smell and taste good. Often, there are plenty of them. Also, the hips of the rugosa rose (*Rosa rugosa*) are the biggest I have seen in roses.

According to Ng & al (2005), Rosa rugosa-flower extract increases the activities of antioxidant enzymes and their gene expression and reduces lipid peroxidation. According to Aisa & al. (2019), the edible and medicinal properties of rugosa rose (*Rosa rugosa*) are widely applied in the world: rose oil, rose sauce, rose cake, rose wine, rose tea, rose herbs, and other applications According to Cendrowski & al. (2017), "the petals of Rosa rugosa are a valuable source of bioactive compounds and can be considered a healthy, valuable resource." According to Nowak & al. (2013, 1), their utilization could be much higher despite the wide availability of raw materials from *Rosa rugosa*. This situation is likely to result from poor knowledge about the nutritional and medicinal properties of the species and a lack of comprehensive information on its chemical composition.

**Hips**

According to Singh & Gairola (2023), edible wild rose hips have great potential for food security.

According to Zhou & al. (2023), people are becoming more health-conscious about the nutritional and health benefits of rose hips. "The rosehip is an underutilized and sustainably produced fruit with great potential to generate value-added products."

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Stuper-Szablewska & al. (2023) state that *Rosa rugosa* hips have antifungal and antiviral properties.

**The answer to the research sub-question: How many Alzheimer's disease-preventing substances hips of rugosa rose (Rosa rugosa) contain?**

According to Åhlberg (2020a and 2022a), Al-Yafeai & al. (2018), Cunja & al. (2016), Dashbaldan & al. (2021), Medveckienė & al. (2023), Milala & al. (2021), Nijat & al. (2021), Nowak, R. (2005, Nowak (2006), Olech & al. (2017), Olech & al. (2019), Olech & al. (2023), Stuper-Szablewska & al. (2023), Xie & al. (2022), the hips of rugosa rose (Rosa rugosa) contain the following 100 health-promoting substances in addition of the 65 health-promoting substances that all green vascular plants contain: 1) 2-hexenoic acid methyl ester, 2) 2-octenal, 3) 3-feruloylquinic acid, 4) 24-methylenecycloartanol, 5) afzelin, 6) alpha-amyrenone, 7) alpha-amyrin, 8) alpha-cryptoxanthin, 9) alpha-farnesene, 10) alpha-glucans, 11) alpha-pinene, 12) apigenin, 13) astragalin, 14) avicularin, 15) beta-amyrin, 16) beta-cryptoxanthin, 17) beta-glucans, 18) beta-ionone, 19) beta-myrcene, 20) betulinic acid, 21) butyric acid, 22) campesterol, 23) caprylic acid methyl ester, 24) catechin, 25) cholesta-3,5-dien-7-one, 26) cis-3-hexenal, 27) corosolic acid, 28) cyanidin-3-glucoside, 29) decanal, 30) decanoic acid, 31) docosane, 32) dodecanoic acid, 33) edulan, 34) ellagic acid, 35) ellagitannins, 36) erythrodiol, 37) essential oils, 38) farnesyl acetone, 39) flavanols, 40) flavanols, 41) fumaric acid, 42) gallic acid, 43) gamma-terpinene, 44) geranial, 45) geraniol, 46) guaiacol, 47) heneicosane, 48) hexadecanoic acid, 49) hexahydrofarnesyl acetone, 50) isofucosterol, 51) juglanin, 52) kaempferol, 53) lauric acid methyl ester, 54) limonene, 55) linalool, 56) linolenic acid methyl ester, 57) lupeol, 58) luteolin, 59) lycopene, 60) maslinic acid, 61) methyl caprate, 62) myristic acid, 63) naringenin, 64) neral, 65) nonanal, 66) obtusifoliol, 67) octanal, 68) oleanolic acid, 69) oleanolic aldehyde, 70) palmitic acid methyl ester, 71) p-cymene, 72) pentacosane, 73) phloridzin, 74) phytoene, 75) pomolic acid, 76) procyanidins, 77) quercetin, 78) quercetin-3-O-sophoroside, 79) quercitrin, 80) quinic acid, 81) rutin, 82) safranol, 83) scutellarin, 84) sitostenone, 85) steroids, 86) stigma sta-3.5-dien-7-one, 87) stigmasterol, 88) stilbenoids, 89) tannins, 90) terpinolene, 91) tetracosane, 92) trans-geranyl-acetone, 93) tricosane, 94) triterpenoid acids, 95) triterpenoids, 96) ursolic acid, 97) ursolic aldehyde, 98) uvaol, 99) vitexin, and 100) Z-nerolidol.

**Conclusion: According to experimental studies, rose hips contain at least 165 (65+100) health-promoting substances.**

Milanovića & al. (2020, 3) present rugosa rose (Rosa rugosa) as a harmful invasive alien species. However, they understand this species also provides many ecosystem services (seven listed) and disservices (two listed). Foragers have found that rugosa rose (Rosa rugosa) provides food for humans and other ecosystem services, of which I'll present evidence. Milanovića & al. (2020) present a general framework for discussion but do not fully understand the importance of foraging this species for food. According to Zhanga & al. (2019, 938) and Olech & al. (2019,2), in different cultures, petals, and rosehips of rugosa rose (Rosa rugosa) have been used for a long time as a health-promoting food. The petals of rugosa roses (Rosa rugosa) are more significant than many others and smell and taste good. Often, there are plenty of them. Also, the hips of the rugosa rose (*Rosa rugosa*) are the biggest I have seen in roses.

According to Ng & al (2005), Rosa rugosa-flower extract increases the activities of antioxidant enzymes and their gene expression and reduces lipid peroxidation. According to Aisa & al. (2019), the edible and medicinal properties of rugosa rose (*Rosa rugosa*) are widely applied in the world: rose oil, rose sauce, rose cake, rose wine, rose tea, rose herbs, and other applications According to Cendrowski & al. (2017), "the petals of Rosa rugosa are a valuable source of bioactive compounds and can be considered a healthy, valuable resource." According to Nowak & al. (2013, 1), their utilization could be much higher despite the wide availability of raw materials from *Rosa rugosa*. This situation is likely to result from poor knowledge about the nutritional and medicinal properties of the species and a lack of comprehensive information on its chemical composition.

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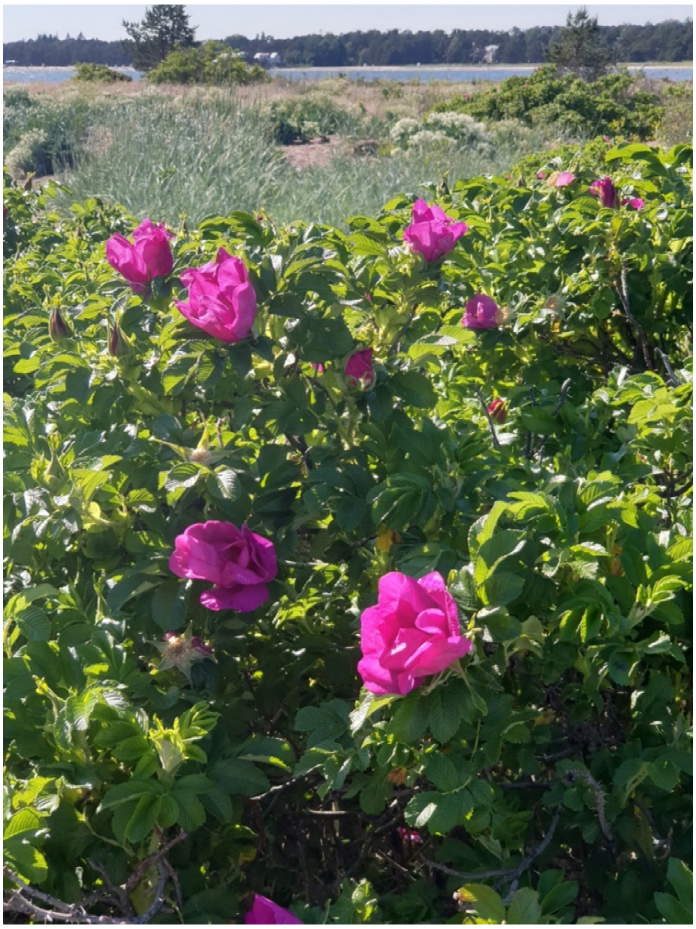

**Figure 6.** The rugosa rose (Rosa rugosa) is also known as the "beach rose" in English because it thrives on sandy beaches. Its petals and hips promote health and longevity and are an essential ecosystem service. (Photo © Mauri K.Åhlberg).

**Figure 7.** Rugosa rose (Rosa rugosa, purple line) has flowers and rosehips from early summer to late autumn in a good environment. It provides plenty of beautiful flowers and hips containing more health-promoting substances than other WEPs. (Photo © Mauri K.Åhlberg).

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Cendrowski & al. (2017): "Due to the high content of bioactive compounds, especially polyphenolic compounds, including anthocyanins, flavonols, and ellagitannins, Rosa rugosa petals can be a valuable raw material for the production of health preparations."

Cendrowski & al. (2017): ". Fresh petals of Rosa rugosa were collected from ***the industrial-scale plantation of the company "Polska Roza"*** located in Kotlina Kłodzka (Poland) in June 2011, June 2012, and June 2013."

Both petals and hips of rugosa rose (Rosa rugosa) contain ellagitannins. I have selected ellagitannins as an example of over 165 (hips)-195 (petals) health-promoting substances that this invasive plant (*Rosa rugosa*) provides for humans as a free ecosystem service. I present them in more detail in the following vignette.

| **ellagitannins** |
|---|
| According to Chen & al. (2022), García-Villalba & al. (2022), Gopalsamy & al. (2022), Al-Harbi & al. (2021), D'Amico & al. (2021), Hoseinynejad & al. (2021), Miloševic & al. (2021), Yüksel & al. (2021), Dreger & al. (2020), Li & al. (2020), Luca (2019, 17), Yoshida & al. (2018), Muthukumaran & al. (2017, 240 - 241), and Sangiovanni & al. (2013), ellagitannins have the following health-promoting properties: 1) antioxidant, 2) anti-inflammatory, 3) antimicrobial, 4) antiglycative, 4) hepato-protective, 5) beneficial effects on kidney diseases, 4) anti-virus, 5) cardioprotective, 6) neuroprotective, 7) prebiotic, 8) chronic disease prevention, 7) anticancer, 8) antidiabetic, 9) beneficial effects on chronic tissue inflammation, 10) beneficial effects on metabolic syndrome) 11) beneficial effects on obesity-mediated metabolic complications, 12) beneficial effects on gastrointestinal diseases, 13) beneficial effects on eye diseases, 14) beneficial effects on depression, 15) muscle mass protective effects, and 16) beneficial effects on Alzheimer's disease and other neurodegenerative diseases. Schink & al. (2018) describe how ellagitannins prevent inflammations using molecular biology.<br>REFERENCES<br>*Al-Harbi, S.& al. 2021.Urolithins: The gut-based polyphenol metabolites of ellagitannins in cancer prevention, a review. Frontiers in Nutrition, Volume 8, article 647582, 1 – 15.*<br>*Chen P. & al. 2022. Recent advances and perspectives on the health benefits of urolithin b, a bioactive natural product derived from ellagitannins. Frontiers in Pharmacology 13:917266*<br>*D'Amico, D. & al. 2021. Impact of the Natural Compound Urolithin A on Health, Disease, and Aging. Trends in Molecular Medicine 27(7), 687 – 699.*<br>*Dreger, M. & al. 2020. Pharmacological properties of fireweed (Epilobium angustifolium L.) and bioavailability of ellagitannins. A review. Herba Polonica 66(1), 52 – 64.*<br>*García-Villalba, R. & al. 2022. Ellagitannins, urolithins, and neuroprotection: Human evidence and the possible link to the gut microbiota. Molecular Aspects of Medicine. Available online 5 August 2022, 101109. In Press, Corrected Proof.* https://doi.org/10.1016/j.mam.2022.101109<br>*Gopalsamy, R. & al. 2022. Health functions and related molecular mechanisms of ellagitannin-derived urolithins, Critical Reviews in Food Science and Nutrition.* https://doi.org/10.1080/10408398.2022.2106179<br>*Li, Q. & al. 2020. Anti-renal fibrosis and anti-inflammation effect of urolithin B, ellagitannin-gut microbial-derived metabolites in unilateral ureteral obstruction rats. Journal of Functional Foods, Volume 65, article 103748, 1 – 13.*<br>*Miloševic M. & al. 2021. Memorable food: fighting age-related neurodegeneration by precision nutrition. Frontiers in Nutrition, Volume 8, article 688086, 1 – 13.*<br>*Sangiovanni, E. & al. 2013. Ellagitannins from Rubus berries for the control of gastric inflammation: in* |

*vitro and in vivo studies. PLoS ONE, Volume 8(8), article e71762, 1 – 12.*
*Yüksel, A. & al. 2021. Phytochemical, phenolic profile, antioxidant, anticholinergic, and antibacterial properties of Epilobium angustifolium (Onagraceae). Journal of Food Measurement and Characterization. Published online 12. 7. 2021, 1 – 10.*
*Yoshida, T & al. 2018. The chemical and biological significance of oenothein B and related ellagitannin oligomers with macrocyclic structure. Molecules, Volume 23, article 552, 1–21.*

**The answer to the research sub-question: How many Alzheimer's disease-preventing substances do the petals of rugosa rose (Rosa rugosa) contain?**

Petals of rugosa rose (*Rosa rugosa*) contain at least **195** health-promoting substances. They include the next **35** (18 + 17) compounds that **prevent Alzheimer's disease** according to experimental research: 1) alpha-linolenic acid, 2) ascorbic acid, 3) caffeic acid, 4) carotenoids, 5) choline, 6) dietary fibers, 7) flavonoids, 8) lutein, 9) melatonin, 10) phenolic acids, 11) phenolic compounds, 12) phenylpropanoids, 13) phytic acid, 14) polyphenols, 15) polysaccharides, 16) silicon, 17) terpenoids, 18) tocopherol, 19) anthocyanins, 20) apigenin, 21) catechin, 22) ellagic acid, 23) ellagitannins, 24) essential oils, 25) flavonols, 26) gallotannins, 27) isorhamnetin, 28) kaempferol, 29) limonene, 30) linalool, 31) myricetin, 32) procyanidins, 33) quercetin, 34) rutin, and 35) sinapic acid.

**The answer to the research sub-question: How many Alzheimer's disease-preventing substances do the hips of rugosa rose (Rosa rugosa) contain?**

Fruits (rosehips) of rugosa rose (*Rosa rugosa*) contain **over 165** health-promoting compounds and ions; they include the following **39** (18+ 21) compounds that **prevent Alzheimer's disease** according to experimental research: 1) alpha-linolenic acid, 2) ascorbic acid, 3) caffeic acid, 4) carotenoids, 5) choline, 6) dietary fibers, 7) flavonoids, 8) lutein, 9) melatonin, 10) phenolic acids, 11) phenolic compounds, 12) phenylpropanoids, 13) phytic acid, 14) polyphenols, 15) polysaccharides, 16) silicon, 17) terpenoids, 18) tocopherol, 19) anthocyanins, 20) apigenin, 21) beta-caryophyllene, 22) catechin, 23) chlorogenic acid, 24) ellagitannins, 25) essential oils, 26) hespiridin, 27) hydroxycinnamic acids, 28) isorhamnetin, 29) kaempferol, 30) kaempferol-3-o-glucoside, 31) linalool, 32) luteolin, 33) lycopene, 34) myricetin (raw fruits), 35) naringin, 36) nobiletin, 37) quercetin, 38) rutin, and 39) taxifolin.

CONCLUSION: Rosa rugosa is regarded as a harmful invasive species. However, from the viewpoint of foraging, it is a welcome addition to a local flora: Its petals and hips contain more health- and longevity-promoting substances than other foraged plants. Its flowers and hips are also tasty and beautiful. They can be consumed raw or cooked. In nature, straight from the bushes, they are delicious snacks.

**PART 2: Invasive alien species in North America**

*Garlic Mustard (Alliaria petiolata)*

DISTRIBUTION: According to GBIF (2024), garlic Mustard (Alliaria petiolata) is widely distributed globally.

**HEALTH-PROMOTING PREVENTIVE PROPERTIES:** Garlic mustard (Alliaria petiolata) has **100** health-promoting substances. One of them is apigenin, which promotes health in the following ways: 1) antioxidant, 2) anti-inflammatory, 3) antidiabetic, 4) beneficial role in amnesia and Alzheimer's disease, neuroprotective agent against Alzheimer's and Parkinson's diseases, 5) beneficial effects in depression and insomnia, 6) anticancer, protects from cancer in many ways, 7) mitigates rheumatoid arthritis, 8) alleviates autoimmune disorders, and 9) in elderly males increases androgen production for health; improves testosterone production, contributing to normal spermatogenesis and preventing age-related degenerative diseases associated with testosterone deficiency. Garlic mustard (Alliaria petiolata) has 24 substances that prevent Alzheimer's disease.

WARNINGS: Earlier, researchers warned about erucic acid. Nowadays, experimental research shows that it promotes health.

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**SUGGESTIONS FOR USE:** The leaves of garlic mustard (Alliaria petiolata) smell like garlic. As with all wild edible weeds, it is wise to use only reasonable amounts in boiled mixtures of wild edible plants, preferably in the Mediterranean way.

According to Garcia-Herrera & Sanches-Mata (2016, 148), garlic mustard (Alliaria petiolata) belongs to traditional Mediterranean wild edible plants. When the leaves are crushed, the new leaves of garlic mustard (Alliaria petiolata) have a garlic odor. According to Fleischhauer & al. (2016, 126–127), Central Europeans use garlic mustard (Alliaria petiolata) in salads, soups, and other dishes. According to Lucchetti & al. (2019, 4), Italians use flowers and leaves of garlic mustard (Alliaria petiolata) in salads and to decorate dishes. According to Motti & al. (2022), Italians use garlic mustard as a vegetable.

According to Egebjerg & al. (2018, 134), leaves of garlic mustard (Alliaria petiolata) contain erucic acid, 31 percent of all lipids, and 0,5 % dry weight. According to Mira & al. (2019, 5), seeds of garlic mustard (Alliaria petiolata) contain erucic acid, over 40 % of the total lipid content, 28%. According to EU CONTAM (2017, 1), the safe use of erucic acid is 7 mg per kg body weight. According to experimental research by Takahashi & al. (2021), erucic acid ameliorates obesity-induced metabolic disorders.

According to Altinoz & Ozpinar (2019), Dawkins & al. (2023), Galanty & al. (2023), Goya & al. (2023), Kim & al. (2016), Repsold & al. (2018), and Takahashi & al. (2021), (1) erucic acid is a health-promoting compound, and (2) erucic acid prevents Alzheimer' disease.

According to Sajna (2017), (1) in Europe, garlic mustard (Alliaria petiolata) is a "native humble understorey species." Its habitats are forest understorey, forest edge, and ruderal site. (2) In North America, it is an invasive species.

In Europe, garlic mustard (Alliaria petiolata) has a patchy distribution. Where it grows, it can be expected. People spread it in Europe because it is an excellent wild edible plant. In North America, people regard it as a harmful invasive plant. Arrington (2020) suggests people could forage it and cook food in big cities like New York. Arrington (2020) understands that edible invasive plants provide ecosystem services.

According to Cavers & al. (1979, 221), garlic mustard (Alliaria petiolata) came to Canada probably with the first immigrants, who valued it as a culinary and medicinal plant. According to Rahman & al. (2018), Australians use garlic mustard (Alliaria petiolata) in salads.

According to Fleischhauer & al. (2016, 126 - 127), Central Europeans use garlic mustard (Alliaria petiolata), like other wild vegetables, in various dishes, including salads and soups. According to Ivanova & al. (2023), Bulgarians eat garlic mustard in salads and dishes of boiled wild edible plants. According to Lucchetti & al. (2019, 4), Italians use leaves and flowers of garlic mustard (Alliaria petiolata) to flavor salads and other dishes. Also, other Europeans use garlic mustard (Alliaria petiolata) in various dishes as an edible green and aromatic spice.

According to Rahman &- al. (2018), garlic mustard (Alliaria petiolata) is an invasive species in Australia. Australians use leaves of garlic mustard (Alliaria petiolata) in salads.

According to Grieve (1959, 221), "Alliaria petiolata was probably introduced from Europe by the early colonists who valued it as a medicinal and salad plant."

According to Rodgers & al. (2022, 521), "As a western Eurasian plant, garlic mustard was likely introduced to North America by early colonists as a **medicinal plant and garlic substitute** (Grieve 1959). … Garlic mustard was first formally identified in North America in the 1860s in Long Island, New York, and has since invaded a range of forest understorey and edge communities across the continent …"

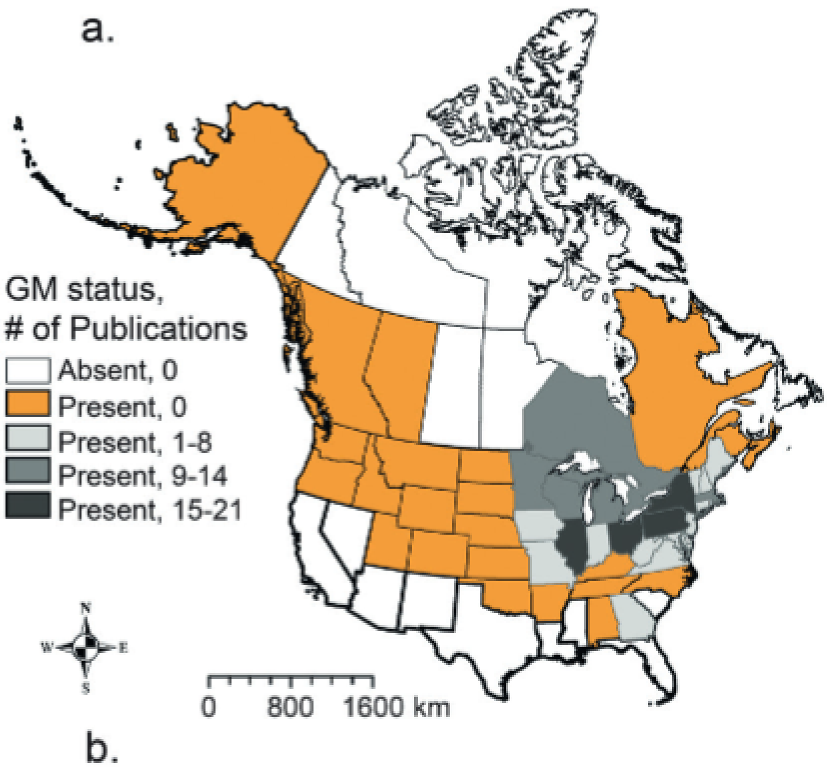


**Figure 8.** Distribution of garlic mustard (Alliaria petiolate) in North America. Source: Rodgers & al. (2022, 522). This open-access article is distributed under the terms of the Creative Commons Attribution license (http://creativecommons.org/licenses/by/4.0/ ), which permits unrestricted reuse, distribution, and reproduction in any medium provided the original work is properly cited. https://doi.org/10.1093/biosci/biac012.

According to Harris & al. (2022), garlic mustard (Alliaria petiolata) produces the secondary compound sinigrin, a type of glucosinolate that defends against herbivores and pathogens and is toxic to North American plants and butterflies.

According to Cavers & al (1979, 218):

> "Beneficial – Potentially, the greatest use of Alliaria petiolata may be as a green vegetable. The leaves and top just before flowering have a higher value of vitamin C, on a weight basis than oranges (Zennie and Ogzewalla 1977). Zennie and Ogzewalla also reported that the leaves at all times of the year have a higher value of vitamin A than spinach (which has the highest level of all the widely marketed garden vegetables). Fernald [Fernando] & al. (1958) suggested that A. petiolata may be used as a salad green or in sandwiches and may be substituted for garlic in cooking. Grieve (1959) reported that some countries use the plant in sauces and salads. They called it "sauce alone."

According to Haribal & Renwick (2001), leaves of garlic mustard (Alliaria petiolata) contain apigenin. According to Dourado & al. (2020), Martin & Touaibia (2020), Kim & al. (2019), Salehi & al. (2019), Nabavi & al. (2018), Madunić & al. (2018) and Ali & al. (2017a), apigenin has the following astounding health-promoting properties: 1) antioxidant, 2) anti-inflammatory, 3) antidiabetic, 4) beneficial role in amnesia and Alzheimer's disease, neuroprotective agent against Alzheimer's and Parkinson's diseases, 5) beneficial effects in depression and insomnia, 6) anticancer, protects from cancer in many ways, 7) mitigates rheumatoid arthritis, 8) alleviates autoimmune disorders, and 9) in elderly males increases androgen production for health; improves testosterone production, contributing to normal spermatogenesis and preventing age-related degenerative diseases associated with testosterone deficiency. Apigenin is safe, even at high doses, and researchers have found no toxicity. Salehi & al. (2019) present molecular biological mechanisms for these properties. According

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to DeRango-Adem & Blay (2021), in natural sources, apigenin is commonly found as an apigenin-glucoside, such as 7-O-glucoside, 6-C-glucoside, or 8-C-glucoside. After ingesting the plant material, these apigenin-glucosides are enzymatically metabolized in vivo into free apigenin (i.e., the aglycone form) and subsequently absorbed.

According to Blazevic and Mastelic (2008), garlic mustard contains more health-promoting isothiocyanates than other volatile substances. Applying Wu (2009), isothiocyanates are small molecules formed from glucosinolate precursors of cruciferous vegetables, such as garlic mustard (Alliaria petiolata). I present **isothiocyanates** in the following vignette.

| **isothiocyanates** |
| --- |
| FOR HUMANS: According to Ahmad & al. (2022), Kamal & al. (2022), Li & al. (2022), Kim (2021), Favela-González & al. (2020), Amron & Konsue (2018, 69), Giacoppo & al. (2015), and Agneta & al. (2013, 1935 - 1939), isothiocyanates have the following health-promoting properties: 1) antioxidants, 2) antimicrobial, 3) antifungal, 4) antiviral, 5) anticancer, anticarcinogenic, 6) anti-obesity, and 7) protect against neurodegenerative diseases, such as Alzheimer's disease.<br>IN PLANTS: According to Martelli & al. (2020, 110), isothiocyanates emerge from the enzymatic hydrolysis of glucosinolates. This enzymatic reaction happens when these plants are crunched or cut, so their cell walls break. The enzymes myrosinase and glucosinolates are usually in separated plant cells. After the cell walls break, myrosinase and glucosinolates come into contact. Their reaction leads to the rapid formation of isothiocyanates.<br>REFERENCES<br>*Agneta, R. & al. 2013. Horseradish (Armoracia rusticana), a neglected medical and condiment species with a relevant glucosinolate profile: a review. Genetic Resources and Crop Evolution 60(7), 1923 – 1943.*<br>*Ahmad, H. & al. 2022. Derived Isothiocyanates on cardiovascular and neurodegenerative diseases. Molecules 27, 624.* https://doi.org/10.3390/molecules27030624<br>*Amron, N. & Konsue, N. 2018. Antioxidant capacity and nitrosation inhibition of cruciferous vegetable extracts. International Food Research Journal 25(1), 65 – 73.*<br>*Favela-González, K. & al. 2020. The value of bioactive compounds of cruciferous vegetables (Brassica) as antimicrobials and antioxidants: A review. Journal of Food Biochemistry 44, e13414.* https://doi.org/10.1111/jfbc.13414<br>*Giacoppo, S. & al. 2015. An overview of neuroprotective effects of isothiocyanates for the treatment of neurodegenerative diseases. Fitoterapia 106, 12-21.*<br>*Kamal, R. & al. 2022. Beneficial health effects of glucosinolates-derived isothiocyanates on cardiovascular and neurodegenerative diseases. Molecules 27(3), 624;* https://doi.org/10.3390/molecules27030624<br>*Kim, J. 2021. Pre-Clinical Neuroprotective Evidence and Plausible Mechanisms of Sulforaphane in Alzheimer's Disease. International Journal of Molecular Sciences 22, 2929.* https://doi.org/10.3390/ijms22062929<br>*Li, X.& al. 2022. The structure basis of phytochemicals as metabolic signals for combating obesity. Frontiers in Nutrition 9, 913883.*<br>*Martelli, A. & al. 2020. Organic isothiocyanates as hydrogen sulfide donors. Antioxidants&Redox Signaling 32(2), 110 – 144.* |

According to Egebjerg & al. (2018, 134), (1) leaves of garlic mustard (Alliaria petiolata) contain erucic acid, 31 % of the total fats, and 0.5 % of dry weight. According to EU CONTAM (2017, 1), a tolerable daily intake of erucic acid is below 7 mg/kg body weight/day. When foragers eat garlic mustard (Alliaria petiolata) as a flavoring substance, spice, or ingredient in mixed vegetables, erucic acid intake is clearly below this limit.

According to Egebjerg & al. (2018, 134), leaves of garlic mustard (Alliaria petiolata) contain sinigrin, a cyanogenic compound. The same is true with many other wild edible plants. The amounts that healthy adults get are so small that there are no problems. A couple of fresh leaves can be eaten raw without any health risks. According to Åhlberg (2019, 23, and 34), wild edible plants are used mainly in boiled mixtures of wild edible plants in Mediterranean countries. According to Encyclopaedia Britannica (2018), the boiling point of hydrogen cyanide is 26 °C. In cooking, hydrogen cyanide evaporates out of food into the air.

According to Guil-Guerrero et al. (2007, 288 and 292), garlic mustard (Alliaria petiolata) contains oxalic acid, but it also includes plenty of calcium (Ca) and magnesium (Mg). Calcium and magnesium oxalates are insoluble. They do not pass through the body outside the intestine; they pass through the body inside the intestine, so they cannot harm health.

**Conclusion: Garlic mustard (Alliaria petiolata), consumed in the Mediterranean way of boiled mixtures of wild edible plants, makes food tasty and promotes health, well-being, and longevity.**

**The answer to the research sub-question: How many health-promoting substances do the aerial parts of garlic mustard (Alliaria petiolata) contain?**

According to Åhlberg (2020a, 2022a), Egebjerg & al. (2018, 134), Cámara & al. (2016, 190), Cipollini & Cipollini (2016), de Cortes Sánchez-Mata & al. (2016, 122), Manchali & al. (2012, 97), Björkman & al. (2011, 540), Dinică. & al. (2010), Lupoae & al. (2010), Blaevi & Masteli (2008), Blazevic & Mastelic (2008), Haribal & Renwick (2001), and Guil-Guerrero & al. (1999) aerial parts of garlic mustard (Alliaria petiolata) contain 36 species-specific health-promoting substances of garlic mustard (Alliaria petiolate) are: 1) 2-phenylethyl alcohol, 2) 2-vinyl-4H-1,3-dithiin, 3) allyl isothiocyanate, 4) allyl thiocyanate, 5) alpha-ionone, 6) apigenin, 7) benzyl isothiocyanate, 8) benzyl thiocyanate, 9) capric acid, 10) caprylic acid, 11) diallyl disulfide, 12) diallyl sulfide, 13) erucic acid, 14) flavone 6-C-glycosides, 15) glucosinolate, 16) isoorientin, 17) isothiocyanates, 18) isovitexin-6-O″β-D-glucoside, 19) lauric acid, 20) methyl palmitate, 21) minerals, 22) myristic acid, 23) nonanal, 24) omega-3 polyunsaturated fatty acids, 25) omega-6 polyunsaturated fatty acids, 26) oxazolidinethiones, 27) palmitic acid, 28) pentadecanoic acid, 29) phytol, 30) polyunsaturated fatty acids, 31) quercetin, 32) sinigrin, 33) swertiajaponin, 34) swertisin, 35) undecanoic acid, and 36) vitamin A.

The <u>101</u> (65+36) health-promoting substances of garlic mustard (Alliaria petiolata) include the following <u>**24**</u> (18 + 6) substances that prevent Alzheimer's disease: 1) alpha-linolenic acid, 2) ascorbic acid, 3) caffeic acid, 4) carotenoids, 5) choline, 6) dietary fibers, 7) flavonoids, 8) lutein, 9) melatonin, 10) phenolic acids, 11) phenolic compounds, 12) phenylpropanoids, 13) phytic acid, 14) polyphenols, 15) polysaccharides, 16) silicon, 17) terpenoids, 18) tocopherols, 19) apigenin, 20) erucic acid, 21) essential oils, 22) isothiocyanates, 23) kaempferol, and 24) quercetin.

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**Figure 9.** Two flowering second-year garlic mustards (Alliaria petiolate) and beneath them the first-year seedlings. Both are tasty and healthy to flavor Mediterranean mixtures of boiled wild edible plants. (Photo © Mauri K.Åhlberg).

CONCLUSIONS: Gaelic mustard (Alliaria petiolata) suits boiled WEP mixtures. It can also be used for other culinary purposes, such as salads. It is a good WEP, not one of the best.

**Purple loosestrife (*Lythrum salicaria*)**

DISTRIBUTION: According to GBIF (2023), purple loosestrife (Lythrum salicaria) is widely distributed globally.

HEALTH-PROMOTING PROPERTIES: I found that the aerial parts of purple loosestrife (Lythrum salicaria) have at least 162 (65+97) health-promoting substances that promote health, according to experimental studies, in the following ways:

Aerial parts of purple loosestrife (Lythrum salicaria) have the following health-promoting properties: 1) antioxidant, 2) anti-inflammatory, 3) antimicrobial, 4) anticancer, 5) painkiller (analgesic), 6) antitussive and bronchodilatory, 7), antidiarrheal, 8) painkiller (antinociceptive), 9) anticoagulant and 10) externally used extracts of purple loosestrife (Lythrum salicaria) to promote skin health.

WARNINGS: None.

SUGGESTIONS FOR USE: The leaves and flowers of purple loosestrife (Lythrum salicaria) are wise to use in Mediterranean-style boiled mixtures of wild edible plants. Foragers use fresh flowers to decorate dishes. I use young shoots, leaves, and flowers of purple loosestrife (Lythrum salicaria) in Mediterranean-style boiled mixtures of wild edible plants and fresh in salads. Foragers may use flowers to decorate dishes and drinks. While walking in nature, I often nibble soft flowering shoots of purple loosestrife (Lythrum salicaria). They are tasty and healthy. They contain more polyphenols than other aerial parts.

Purple loosestrife (Lythrum salicaria) is an invasive species in the USA. Wu & Colautti (2022, 3) present a map of thousands of observations of purple loosestrife (Lythrum salicaria) in North America over 150 years. Most specimens collected are in the Eastern states. The Mid-West also has

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plenty of observations. The Western states have the fewest specimens collected. The authors do not allow copying and presenting their excellent map in other publications. They use the most restrictive license: Creative Commons Attribution-Noncommercial-No Derivatives License 4.0 (CC BY-NC-ND).

Purple loosestrife (Lythrum salicaria) is a good WEP in Europe and Asia. According to Fleischhauer & al. (2016, 195), Central Europeans eat flowers, young, soft shoots, and leaves of purple loosestrife (Lythrum salicaria). Red flowers of purple loosestrife (Lythrum salicaria have a pleasant aroma. Foragers use fresh flowers to decorate dishes. Central Europeans use young, soft shoots and leaves of purple loosestrife (Lythrum salicaria) in salads and young, tender shoots and leaves in boiled mixtures of wild edible plants. According to Couplan (2017, 187), humans have consumed purple loosestrife (Lythrum salicaria) in salads from ancient Greek and Roman times. Couplan (2017, 187) has traveled broadly, and according to him, Asians use purple loosestrife (Lythrum salicaria) as a vegetable in soups. According to Korean researchers Kim & al. (2022), "The aerial part of L. salicaria L. would be the most appropriate for food development."

According to WFO (2023), purple loosestrife (Lythrum salicaria) belongs to the same family, Lythraceae, as a grenade (Punica granatum). Both species have many health-promoting substances.

According to Šutovská & al. (2012), flowering parts of purple loosestrife (Lythrum salicaria) contain polysaccharide-polyphenolic conjugates. According to Šutovská & al. (2012), these polysaccharide-polyphenolic conjugates have antitussive activity and bronchodilatory effect.

According to toxicological tests by Iancu & al. (2021), aerial parts of purple loosestrife (Lythrum salicaria) are not toxic. They contain many health-promoting substances, such as tannins and polyphenols, including anthocyanins. Spectrophotometric determinations of total polyphenols, tannins, and anthocyanins content revealed quantitative values of 16.39% in polyphenols, 10.53% in tannins, and 0.36% in anthocyanins.

**Figure 10.** Flowering purple loosestrife (Lythrum salicaria). The aerial parts are edible. The plant contains 162 health-promoting substances, including 41 chemicals that prevent Alzheimer's disease. (Photo © Mauri K.Åhlberg).

According to The Local Food-Nutraceuticals Consortium (2005, 358-359), Spaniards eat the aerial parts of purple loosestrife (Lytrum salicaria). It contains more polyphenols than 127 studied Mediterranean wild edible plants and fungi.

According to Pirvu & al. (2014), "Lytrum salicaria L. (Fam. Lythraceae), or purple loosestrife, is described with high amounts of polyphenols compounds (up to 18%)." According to Bencsik. & al. (2011), in purple loosestrife (Lytrum salicaria): (1) the highest flavonoid content was measured in the leaves, and (2) total polyphenol contents were higher in the flowering branch tips than in the other organs.

According to the research evidence in this paper, purple loosestrife (*Lythrum salicaria*) contains 161 health-promoting substances. The following vignette presents an overview of polyphenols as an example.

| **polyphenols** |
| --- |
| FOR HUMANS: According to Gasmi & al. (2022), Mitra&al. (2022), Rajha&al. (2022), Cassidy&al. (2020), Redd&al. (2020), Reed&de Frietas (2020), Srećković&al. (2020), Durazzo, A.&al. (2019) Gorzynik-Debicka&al. (2018) Qu&al. (2018) and Ignat&al. (2010) polyphenols have the following health-promoting properties: 1) antioxidant, 2) anti-inflammatory, 3) neuroprotective, 4) prevent Alzheimer's disease, 5) anticancer, 6) protect the cardiovascular system, prevention of cardiovascular diseases, 7) reduce the risk of diabetes, 8) lower hypertension, 9) prevent metabolic abnormalities that may include hypertension, central obesity, insulin resistance, hypertension, and imbalance of lipids in the blood, 10) reduce weight in overweight and obese individuals, 11) antitumor, via anti-initiating, anti-promoting, anti-progression, and anti-angiogenesis actions, as well as by 12) modulating the immune system, participate in the immunological defense, 13) protect against oxidative damage on DNA, 14) antiallergic, 15) antimicrobial, and 16) antiviral. The biological activity of polyphenols is strongly related to their antioxidant properties. They tend to reduce the pool of reactive oxygen species (ROS) and neutralize these potentially carcinogenic metabolites. Leri (2020) describes the biomolecular mechanisms of how polyphenols promote health. Mitra & al. (2022) present experimental evidence on how polyphenols synergistically promote health.<br>***According to Coman & Vodnar (2020, 483), over 8000 plant polyphenols are known in plants***.<br>According to Šamec & al. (2021), Singhet & al. (2021), and Marranzano & al. (2018), all higher land plants have polyphenols 1) against abiotic stressors, extreme temperatures, drought, flood, light, UV radiation, salt, and heavy metals. Some polyphenols protect plants against biotic stressors, e.g., 2) against herbivores (plant-eating insects and other animals. 3) against micro-organisms.<br>Polyphenolic compounds against abiotic and biotic stressors include phenolic acids, flavonoids, stilbenoids, and lignans. Some polyphenols participate in 4) plant growth and 5) plant development. According to Åhlberg (2021), all wild edible plants have polyphenols.<br>REFERENCES<br>*Cassidy, L. & al. 2020. Oxidative stress in Alzheimer's disease: a review on emergent natural polyphenolic therapeutics. Complementary Therapies in Medicine, volume 49, article 102294, 1 – 11.*<br>*Gasmi, A. & al. 2022. Polyphenols in metabolic diseases. Molecules 27(19), 6280; https://doi.org/10.3390/molecules27196280*<br>*Leri, M. 2020. Beneficial effects of plant polyphenols: molecular mechanisms.*<br>*International Journal of Molecular Sciences, volume 21, article 1250, 1 – 40.*<br>*Marranzano, M.& al. 2018. Polyphenols: plant sources and food industry applications. Current Pharmaceutical Design 24, 4125 – 4130.* |

*Mitra, S. & al. 2022. Polyphenols: First evidence in the synergism and bioactivities. Food Reviews International. Published online: 24 Jan 2022. DOI: 10.1080/87559129.2022.2026376*
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*Rajha, H. & al. 2022. Recent advances in research on polyphenols: effects on microbiota, metabolism, and health. Molecular Nutrition & Food Research 66, 210067.*
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*Singh, S. & al. 2021. The multifunctional roles of polyphenols in plant-herbivore interactions. International Journal of Molecular Sciences, volume 22, article 1442, 1 – 20.*
*Srećković, N. & al. 2020. Lythrum salicaria L. (Lythraceae) as a promising source of phenolic compounds in the modulation of oxidative stress: Comparison between aerial parts and root extracts. Industrial Crops and Products 155, 112781.*

In this paper, I have presented evidence that all vascular green plants contain 65 health-promoting substances, and purple loosestrife (Lythrum salicaria) has 97 species-specific health-promoting substances.

**The answer to the research sub-question: How many health-promoting substances do the aerial parts of purple loosestrife (Lythrum salicaria) contain?**

According to Al-Snafi (2019), Becker & al. (2015), Iancu & al. (2021), Jiang & al. (2015), Manayi & al. (2013), Manayi & al. (2014), Pirvu & al. (2014), Piwowarski & al. (2015), Rauha & al. (2001), Srećković & al. (2020), Šutovská & al. (2012), Tong & al. (2019) and Tunalier & al. (2007), purple loosestrife (Lyhtrum salicaria) contains the following 97 health-promoting substances: 1) 1,6-di-O-galloylglucose, 2) 1H-pyrrole-2,5-dione, 3) 1-octen-3-ol, 4) 3,3',4'-tri-O-methylellagic acid, 5) 3,3',4'-tri-O-methylellagic acid-4-O-β-D-glucopyranoside, 6) alkaloids, 7) alpha-terpineol, 8) anthocyanins, 9) apigenin, 10) arabinogalactan, 11) apiin, 12) arabinose, 13) aurantiamide, 14) benzoic acid, 15) beta-ionone, 16) betulinic acid, 17) betulinic acid methyl ester, 18) buntansin, 19) castalagin, 20) catechin, 21) cinnamic acid, 22) chlorogenic acid, 23) corosolic acid, 24) coumarins, 25) cyanidin-3-galactoside, 26) cyanidin-3-O-glucoside, 27) daucosterol, 28) decanoic acid, 29) eicosane, 30) ellagic acid, 31) ellagitannins, 32) erythrodiol, 33) esculetin, 34) essential oils, 35) eugenol, 36) ferulic acid, 37) flavan-3-ols, 38) flavone-C-glycosides, 39) galactose, 40) galacturonan, 41) gallic acid, 42) gallotannins, 43) galloyl-bis-HHDP-glucose, 44) galloyl-HHDP-glucose, 45) heneicosane, 46) heptanoic acid, 47) hyperoside, 48) isochlorogenic acid, 49) isoorientin, 50) isovitexin, 51) lactones, 52) limonene, 53) linalool 54) loliolide, 55) luteolin, 56) lythrine, 57) malvidin, 58) methyl gallate, 59) monoterpenes, 60) muramine, 61) myristic acid, 62) n-hexadecanoic acid, 63) nonadecane, 64) nonanoic acid, 65) o-cresol, 66) octadecane, 67) octanoic acid, 68) oleanolic acid, 69) orientin, 70) p-coumaric acid 71) p-cresol, 72) pentadecane, 73) pedunculagin, 74) pentacosane, 75) peucedanin, 76) phytol, 77) polysaccharide-polyphenolic conjugate, 78) quercitrin, 79) rhamnogalacturonan, 80) rosmarinic acid, 81) rutin, 82) salicairine, 83) salicarinin A, 84) sesquiterpenes, 85) rosmarinic acid, 86) steroids (plant), 87) syringic acid, 88) tannins, 89) tricosane, 90) triterpenes, 91) triterpenoids, 92) umbeliferone-6-carboxylic acid, 93) uronic acids, 94) ursolic acid, 95) vanillic acid, 96) vescalagin, and 97) vitexin.

**Conclusion: The aerial parts of purple loosestrife (Lythrum salicaria) contain 162 (65+97) health-promoting substances.**

**The answer to the research sub-question: How many Alzheimer's disease-preventing substances do the aerial parts of purple loosestrife (Lythrum salicaria) contain?**

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The 162 health-promoting substances of purple loosestrife (Lythrum salicaria) include the next 41 (18 + 23) compounds that prevent Alzheimer's disease: 1) alpha-linolenic acid, 2) ascorbic acid, 3) caffeic acid, 4) carotenoids, 5) choline, 6) dietary fibers, 7) flavonoids, 8) lutein, 9) melatonin, 10) phenolic acids, 11) phenolic compounds, 12) phenylpropanoids, 13) phytic acid, 14) polyphenols, 15) polysaccharides, 16) silicon, 17) terpenoids, 18) tocopherols, 19) alpha-terpineol, 20) anthocyanins, 21) apigenin, 22) aurantiamide, 23) catechin, 24) chlorogenic acid, 25) coumarins, 26) ellagic acid, 27) ellagitannins, 28) essential oils, 29) gallotannins, 30) hyperoside, 31) isovitexin, 32) kaempferol, 33) linalool, 34) luteolin, 35) myricetin, 36) myristic acid, 37) oleanolic acid, 38) p-coumaric acid, 39) rutin, 40) vanillic acid, and 41) vitexin.

CONCLUSIONS: Purple loosestrife (Lythrum salicaria) is an invasive species in North America. In Europe, Purple loosestrife (Lythrum salicaria) is an excellent WEP. It contains plenty of polyphenols. The aerial parts of purple loosestrife suit boiled WEP mixtures. The top of an inflorescence is tasty and contains more health-promoting polyphenols than other parts. Flowers can be used to decorate dishes.

## 4. Discussion

In this paper, I have discussed three invasive wild edible species in Europe: Fallopia japonica, Impatiens glandulifera, and Rosa rugosa, and two invasive wild edible species in North America: garlic mustard (Alliaria petiolata) and purple loosestrife (Lythrum salicaria). Applying Milanović & al. (2020), I have presented evidence that these species provide ecosystem services.

In Table 1, I compare these five invasive WEP species regarding the number of health-promoting substances they contain. This is a coarse measure of their effectiveness in sustaining and promoting health and longevity. All are good WEPs, but there are apparent differences in health-promoting potential.

**Table 1.** Five invasive WEP species in order of their health-promoting substances.

| WEP species, aerial parts | Total number of health-promoting substances |
|---|---|
| Rosa rugosa petals | 195 (65+130) |
| Rosa rugosa hips | 165 (65+100) |
| Lythrum salicaria | 162 (65+97) |
| Fallopia japonica | 142 (65+77) |
| Impatiens glandulifera | 137 (65+72) |
| Alliaria petiolata | 101 (65+36) |

In Table 2, I compare these five WEPs in terms of the number of substances they have that prevent Alzheimer's disease, according to experimental research. All WEPs have many substances that prevent Alzheimer's disease. The order of the best species is surprising. The clear winner is Japanese knotweed (Fallopia japonica). The second species is also a surprise. It is Himalayan balsam (Impatiens glandulifera).

**Table 2.** Five invasive WEP species, in order of their health-promoting substances, that prevent Alzheimer's disease.

| WEP species, aerial parts | the number of substances preventing Alzheimer's disease |
|---|---|
| Fallopia japonica | 57 (18+39) |
| Impatiens glandulifera | 46 (18+28) |
| Lythrum salicaria | 41 (18+23) |
| Rosa rugosa hips | 39 (18+21) |

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| | |
|---|---|
| Rosa rugosa petals | 35 (18+17) |
| Alliaria petiolata | 24 (18+6) |

According to Kanmaz & al. (2023), Himalayan balsam (Impatiens glandulifera) is an invasive species in Europe and North America. Kanmaz & al. (2023) are realists: "Preventive measures and monitoring are needed to keep the current distribution under control and prevent further spread to habitats that are already under the impact of global environmental change." It is easier to eradicate in the early phases of its spreading than later when it has conquered large areas. If people value its beauty and other ecosystem services, they may restrict this species to strictly controlled areas.

According to Åhlberg (2020a, 2020b, and 2022a), Alliaria petiolata and Lythrum salicaria are excellent wild edible plants in Europe. Arrington (2021) has a rational approach to these species: Ecosystem services like foraging for food must be balanced for invasive species management, which may be needed occasionally.

Many of these invasive species provide great possibilities as raw materials for food and other uses. For example, according to Wens & Geuens (2022), Japanese knotweed (Fallopia japonica) produces antifungal material against phytopathogenic fungi. The researchers compared extracts of aerial parts from nine plant species. The extract of Japanese knotweed (Fallopia japonica) was the most efficient. In the experiments of Anžlovar & al. (2020), the extracts of Japanese knotweed (Fallopia japonica) were efficient again against some phytopathogenic fungi species.

According to Kunkel & Chen (2021): "The invasive species Alliaria petiolata threatens forest understories as it alters soil nutrients and microbial composition, thereby changing the local plant community." Blossey & al. (2001) discuss differences in distributions of garlic mustard (Alliaria petiolata) in Europe and the USA. In Europe, garlic mustard (Alliaria petiolata) usually grows in separate small patches, but this plant may cover hectares of woodland in the USA.

Rogers & al. (2022) call purple loosestrife (Lythrum salicaria) a "purple menace." This strong expression is because, in the USA, purple loosestrife (Lythrum salicaria) forms large monocultures. In Europe, this species usually grows in separate small patches.

It is best to forage wild edible plants for food from separate patches. Applying Åhlberg (2019 – 2022a), the reason is that the healthiest way to consume wild edible plants is in mixtures of wild edible plants. They are first boiled, then frozen, and when needed, used in small portions in different dishes. For commercial use, more enormous monocultures are beneficial. Only rugosa rose (Rosa rugosa) has been grown and utilized commercially. The other four plants offer great possibilities for humankind, but in my mind, mainly administrative regulations prevent their large-scale use in the food industry.

Salo & al. (2023) discuss global and local wild species harvest. Salo & al. (2023) state that wild species are "important resources for people worldwide, and their harvest is a major driver of ecosystem change." In Åhlberg (2020a), I found that many wild edible plants have an almost global distribution and are used locally. In Western countries, wild species harvest is a nationally neglected opportunity. Salo & al. (2023) and Åhlberg (2019, 2020a, 2020b, 2021, 2022a, 2022b, and this article) try to increase the sustainable use of wild edible plants locally and globally.

According to Marrelli & al. (2020): "The alimurgic flora represents a strategic resource to which it is possible to associate many positive agri-food, ecological, and sociocultural values: food source, organic crops, low environmental impact, enhancement of local resources, conservation of biodiversity, conservation of traditional knowledge, income support to medium-sized companies, and introduction into the diet of new species with medicinal and nutraceutical potential."

Future meta-research will find more health-promoting substances from WEPs because:

(1) According to Huang & Dudareva (2023), there are over 200 000 plant-specialized metabolites (phytochemicals) involved in plant defense, including terpenoids, alkaloids, glucosinolates, cyanogenic glucosides, phenylpropanoids, and fatty-acid derivatives. All of them except cyanogenic glucosides contain known health-promoting substances (Åhlberg 2019 - 2022b; Tahir & al. 2024).

(2) According to Forterre (2024) and Huang & Dudareva (2023), plants and animals (including humans) have similar metabolic processes. This is why plant-specialized metabolites (phytochemicals) involved in plant defense often protect and promote human health and longevity.

## 5. Conclusions

For culinary purposes, I have presented profound reasons for using plenty of varied edible green plants, both wild and cultivated, both native and alien. They promote health and longevity. Many WEPs are edible weeds that have spread globally through human agriculture. Edible weeds are an excellent addition to ordinary harvests, like an extra harvest. If there is a harvest loss because of war, drought, or some other catastrophe, the edible weeds provide functional food for those who know how to gather them and cook healthy and tasty meals. Learning to know WEPs is rewarding. When you know local WEPs, you may forage WEPs, where and when foraging is legally allowed. While walking in a healthy environment, a forager may pick and consume the best parts of WEPs as snacks.

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**Conflicts of Interest:** The author declares no conflicts of interest.

## Abbreviations

The following abbreviations are used in this manuscript:

| | |
|---|---|
| MDPI | Multidisciplinary Digital Publishing Institute |
| DOAJ | Directory of open access journals |
| TLA | Three letter acronym |
| LD | Linear dichroism |

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