

The results of this study demonstrate that invasive plant biomass represents a valuable bioresource, serving as a source of biologically and pharmacologically active compounds, particularly lipids and fatty acids.

By comparing traditional extract on solvents with green, low-toxicity, biogenic solvents, we showed that environmentally friendly solvents achieve comparable or superior performance in lipid extraction.

The studied species revealed distinct biochemical profiles:

- Bohemian, Japanese, and Sakhalin knotweed exhibited elevated levels of palmitic acid (above 60.0 mg/100 g⁻¹), omega-3 fatty acids — including linolenic acid (up to 51.0 mg/100 g⁻¹) — and the omega-6 fatty acid linoleic acid (up to 22.0 mg/100 g⁻¹).
- Canadian goldenrod and lupine also showed a high content of linolenic acid (314.4 and 446.7 mg/100 g, respectively) and palmitic acid (99.8 and 189.6 mg/100 g, respectively).

Overall, the findings indicate that invasive plant biomass can serve as a promising feedstock for biorefinery applications, while simultaneously supporting invasive species eradication and advancing bioeconomy goals.

Introduction

Invasive plants threaten biodiversity, agriculture, forestry, and human/animal health. However, their biomass can be a valuable bioresource. This study investigates the potential of common Northern European invasive plants — lupine (*Lupinus polyphyllus*), Canadian goldenrod (*Solidago canadensis*), and knotweeds (*Reynoutria japonica*, *R. bohemica*, *R. sachalinensis*) — as sources of biologically and pharmacologically active lipids and fatty acids.

We compare traditional extraction solvents with green alternatives, demonstrating promising yields. Research findings highlight opportunities for invasive biomass biorefining, supporting both eradication efforts and bioeconomy development.

Key words: Extraction | Lipids | Fatty Acids | Invasive Plants | Bioeconomy

Aim

To explore invasive plant biomass as a source of bioactive lipids and fatty acids to support sustainable eradication strategies.

Materials & methods

Sampling locations: Riga, Jēkabpils district (Latvia);

Extraction: Soxhlet extraction with traditional (dichloromethane (CH₂Cl₂), chloroform (CHCl₃), hexane) and green solvents (dimethyl carbonate (DMC), ethyl acetate (EtOAc), methyl tert-butyl ether (MTBE));

Analysis: Lipid extraction with Soxhlet → saponification → derivatization and study by GC/MS, GC/FID methods.

Results

Lipid yields varied significantly across invasive plant parts (Fig. 1), with seeds showing the highest yield (86 mg g⁻¹), followed by leaves (40 mg g⁻¹), blooms (21 mg g⁻¹), stems (10 mg g⁻¹), and roots (lowest) (Fig. 1) and dichloromethane showed the highest efficiency as a solvent (table 1).

Table 1. Yields of lipids (mg g⁻¹) from leaves of invasive plants: solvent impact

Leaves	CHCl ₃	Hexane	DMC	MTBE	CH ₂ Cl ₂	EtOAc
<i>R.japonica</i>	21.8	9.1	13.1	10.7	11.3	15.1
<i>L.polyphyllus</i>	34.2	16.7	20.5	17.2	23.5	25.4
<i>S.canadensis</i>	43.2	19.7	28.6	19.7	31.9	23.5

In *Solidago canadensis*, the free fatty acid content was 129.9 mg 100 g⁻¹ in stems, 720.3 mg 100 g⁻¹ in leaves, 291.2 mg 100 g⁻¹ in roots, and 559.2 mg 100 g⁻¹ in flowers. In *Lupinus polyphyllus* leaves, the content reached 856.1 mg 100 g⁻¹. Among knotweeds, the free fatty acid content was 241.6 mg 100 g⁻¹ in *R. bohemica*, 215.2 mg 100 g⁻¹ in *R. japonica*, and 360.7 mg 100 g⁻¹ in *R. sachalinensis*.

Reynoutria species had the greatest FA diversity (up to 37 FAs), with *R. bohemica* richest (36 FAs). *Lupinus polyphyllus* and *Solidago canadensis* showed slightly lower diversity (28–29 FAs). The number of detected fatty acids (FAs) in this study is considerably higher than those reported in the existing literature. Oleic acid dominated seeds but was absent in leaves, where palmitic, stearic, and linolenic acids were most abundant, particularly in *Reynoutria* and *L. polyphyllus*. The data show that the fatty acid composition of the leaves of different knotweed species is very similar. Major ester-forming FAs (C16:0, C14:0, C18:0, C18:1n-9, C12:0) were present in all samples, aligning with earlier reports on knotweed's bioactive potential.

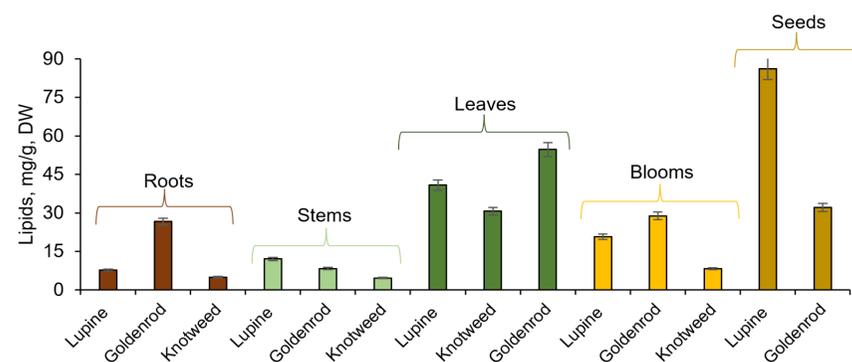


Fig. 1. The concentration of lipids in the different parts of Lupine, Knotweed and Goldenrod (*L.polyphyllus*, *S.canadensis*, *Reynoutria* spp.).

Among the plants studied, only extracts of lupin contained dietary omega-3 polyunsaturated docosatrienoic acid (0.21%), which can significantly find to possess anti-inflammatory and antitumor properties with potential nutraceutical and cosmetic uses (Chen et al., 2021). Biosynthesis of docosatrienoic acid follows the elongation and desaturation pathways of ω6 and ω3 poly-unsaturated fatty acids (Meesapyodsuk et al., 2023) which resembles docosahexaenoic acid eicosapentaenoic acid formation pathway in microorganism (Qiu et al., 2020). It is precisely the market to produce these compounds that the current creation of transgenic plants is primarily aimed at (Ganesh and Hettiarachchy, 2016).

Conclusion

Invasive plants — *Lupinus polyphyllus*, *Solidago canadensis*, and *Reynoutria* spp. — are rich lipid sources, with the highest yields from seeds (86 mg g⁻¹), followed by leaves, blooms, and stems, while roots give the lowest yields. Fatty acid profiles show that *Reynoutria* species share similar leaf compositions but also reveal unique biochemical profiles, confirming their value as a natural source of bioactive compounds. *L. polyphyllus* and *S. canadensis* have comparable compositions but differ in fatty acid proportions. These findings highlight the potential of invasive species for diverse biotechnological applications.

Acknowledgement

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Literature Chen, Y., Qiu, X., Yang, J. (2021) DOI: 10.1080/01635581.2020.1804949 ; Ganesh, V., Hettiarachchy, N.S. (2016) DOI:10.1080/10408398.2013.765383; Meesapyodsuk, D., Sun, K., Zhou, R., Thoms, K., Qiu X. (2023) DOI: 10.1111/pbi.13937 ; Qiu, X., Xie, X., Meesapyodsuk, D. (2020) DOI: 10.1016/j.plipres.2020.101047.