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PHYTOCHEMICAL PROFILES AND ANTIOXIDANT PROPERTIES OF FOUR MEDICINAL PLANTS: IMPLICATIONS FOR HEPATOPROTECTION IN VETERINARY RESEARCH — A MINI-REVIEW

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Abstract: *Melilotus officinalis, Agrimonia eupatoria, Verbena officinalis, and Linum usitatissimum contain bioactive constituents of interest for research on antioxidant activity and hepatoprotection. This narrative mini-review summarizes their main phytochemical characteristics, experimental evidence relevant to liver protection, and potential relevance to veterinary research. Particular attention is given to the type of preparation investigated, distinguishing whole extracts, enriched fractions, and isolated compounds. Experimental animal studies have reported hepatoprotective effects for selected preparations of M. officinalis, A. eupatoria, and flaxseed lignans in chemically induced liver injury, whereas cellular studies have identified potentially protective constituents of V. officinalis. However, differences in phytochemical composition, administered preparations, experimental models, doses, treatment timing, and evaluated outcomes limit direct comparisons among the four species. Antioxidant activity alone should not be considered evidence of hepatoprotective efficacy, and the safety of each preparation requires specific evaluation. Future research should focus on reproducible phytochemical characterization, appropriately designed efficacy and safety studies, and validation in veterinary target species. Current evidence supports further experimental investigation, while clinical application in veterinary medicine requires additional validation.*

Keywords: *medicinal plants; phytochemical characterization; antioxidant activity; hepatoprotection; veterinary research.*

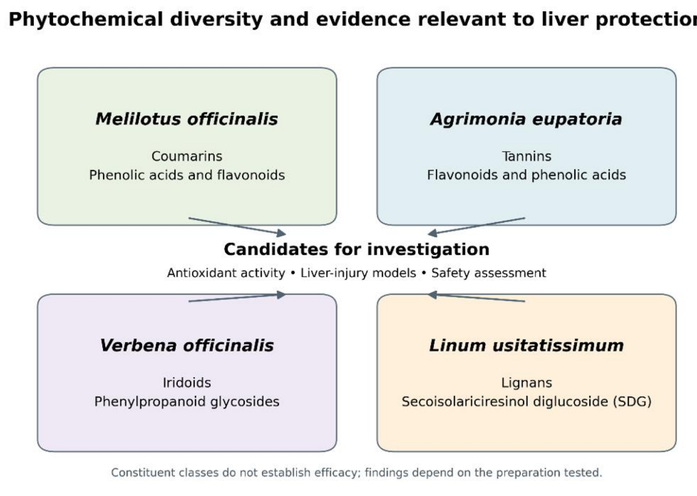
• Introduction

The investigation of medicinal plants as potential sources of hepatoprotective agents requires a clear distinction between phytochemical composition, antioxidant activity and demonstrated protection against liver injury. *Melilotus officinalis*, *Agrimonia eupatoria*, *Verbena officinalis* and *Linum usitatissimum* exhibit distinct phytochemical profiles, including phenolic acids, flavonoids, coumarins, iridoids, phenylpropanoid glycosides and lignans. Selected experimental studies have investigated their antioxidant, anti-inflammatory and hepatoprotective properties. However, the presence of bioactive compounds or antioxidant activity alone does not establish therapeutic efficacy. Experimental findings must be interpreted according to the plant preparation, extraction procedure, administered dose and biological model. This narrative mini-review examines the phytochemical characteristics and antioxidant properties of these four medicinal plants, evaluates the available experimental evidence relevant to hepatoprotection and highlights the limitations and research priorities for their potential application in veterinary medicine.

• Comparative phytochemical composition

The four selected medicinal plants exhibit distinct phytochemical profiles, depending on their characteristic constituents and the plant material used for extraction. *Melilotus officinalis* contains coumarins, phenolic acids and flavonoids. Compounds isolated from a 70% ethanolic extract include coumarin, caffeic acid, luteolin, quercetin and hydroxybenzoic acid glycosides, with selected constituents exhibiting antioxidant or anti-inflammatory activities. *Agrimonia eupatoria* is characterized by phenolic constituents, particularly tannins, flavonoids and phenolic acids. Phytochemical investigations have also examined the anti-inflammatory and hepatoprotective properties of a characterized herb extract. *Verbena officinalis* contains iridoids, phenylpropanoid glycosides, phenolic acids and flavonoids. Its phytochemical diversity highlights the importance of distinguishing the biological activities of isolated metabolites from those of whole extracts or fractions. *Linum usitatissimum* contains lignans, particularly secoisolariciresinol diglucoside. The phytochemical composition varies according to the preparation, including whole seeds, seed extracts, flaxseed oil and lignan-enriched fractions. The main phytochemical constituents and comparative characteristics of these four species are summarized in Figure 1. Differences in plant material, extraction procedures and chemical composition emphasize the importance of evaluating each preparation individually and relating its phytochemical profile to the observed biological effects.

Figure 1. Comparative phytochemical profiles of four medicinal plants relevant to hepatoprotection.



• Experimental evidence relevant to hepatoprotection

Melilotus officinalis: A methanolic extract of *M. officinalis*, administered orally at 50 and 100 mg/kg, improved biochemical indicators of liver injury and histopathological findings in mice exposed to paracetamol or carbon tetrachloride. However, these effects are specific to the extract and experimental conditions investigated.
Agrimonia eupatoria: An *A. eupatoria* herb extract prepared with 40% ethanol was investigated for its phytochemical composition, anti-inflammatory and hepatoprotective properties. The findings support further investigation of chemically characterized preparations, considering differences in extraction methods and experimental conditions.
Verbena officinalis: Verbenalinosides A and B, verbenalin and verbascoside isolated from *V. officinalis* improved cell survival in ethanol-induced injury models using LO2 and HepG2 cells. However, these findings are limited to cellular models and do not establish hepatoprotective efficacy in animals.
Linum usitatissimum: Pretreatment with a flaxseed lignan preparation (800 mg/kg/day) reduced serum ALT, AST and total bilirubin levels and increased hepatic SOD and GSH in mice with paracetamol-induced liver injury. These findings apply specifically to the lignan preparation tested and do not establish efficacy against pre-existing liver injury.
Comparative Interpretation: The selected studies provide experimental evidence from animal models and cellular assays, using different extracts, isolated compounds and lignan preparations. Differences in experimental models, preparation composition, administered doses and treatment timing prevent direct comparisons of hepatoprotective efficacy among the four species. Furthermore, protective effects observed after pretreatment should not be interpreted as evidence of therapeutic efficacy against established liver injury. These findings emphasize the importance of chemical characterization, appropriate experimental controls and safety assessment before potential veterinary application.

• Conclusions

Melilotus officinalis, Agrimonia eupatoria, *Verbena officinalis* and *Linum usitatissimum* contain bioactive constituents with potential relevance to antioxidant activity and hepatoprotection. Experimental animal studies provide preliminary evidence supporting the hepatoprotective potential of selected M. officinalis and *A. eupatoria* extracts and flaxseed lignan preparations, while cellular studies identify potentially protective compounds from *V. officinalis*. However, differences in phytochemical composition, experimental models and treatment conditions prevent direct comparisons of their efficacy. Safety assessments remain essential, particularly regarding coumarin content in M. officinalis and the reported mutagenic activity of a *V. officinalis* aqueous extract. Further research should focus on standardized, chemically characterized preparations, comprehensive efficacy and safety evaluations, and validation in veterinary target species before clinical application.