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Larch (*Larix decidua* L.) fibre waste: characterization of a functional feed ingredient.

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SPOKE, WP AND TASK

Spoke 8. Circular economy in agriculture through waste valorization and recycling. **WP 8.1:** Producing new products to upgrade waste value. **Task 8.1.1.** Valorization of the waste by green chemistry to obtain high value molecules or new products.
Biomolecules and biopolymers showing biological properties and/or technological application for agriculture (e.g. molecules for plant protection, biostimulants, etc.) will be extracted, purified, characterized and tested from agricultural wastes, co-products and by-products, through new "green" chemical, physical and chemical-physical approaches (e.g. green solvents, NADES, fluorous solvents, ionic liquids, microwave-, ultrasound- and enzyme -assisted extractions, supercritical fluid, molecules functionalization).

BACKGROUND AND AIM

The potential use of industrial by-products as animal feed has gained considerable attention in the quest for sustainable and eco-friendly solutions. By addressing the challenges of **sustainable animal nutrition**, the valorization of biomass residuals as feed ingredients is a key aspect of the circular economy.
In the larch woodworking industry, wood shavings or sawdust is a fibre waste product. In previous studies, larch fibre waste (*Larix decidua* L.) was evaluated for its health-beneficial compounds, namely flavonoids (taxifolin, TXF; dihydrokaempferol, DHK), and terpenoids (larixol, LX; larixyl acetate, LXA) and their antioxidant and anti-inflammatory potential effects [1, 2] also enhancing its use in animal nutrition [3, 4].
This study aimed to evaluate and compare the bioactive compounds and antioxidant potential of larch fiber waste (native to the mountains of central Europe) obtained from five woodworking companies, to verify possible differences in their composition.

MATERIAL AND METHODS

Hexane, methanol and water were selected as solvents in a cascade of extraction processes of the 5 larch samples. Extracts were analyzed by UPLC-PDA, to quantify TXF, DHK, LX, and LXA **(Figure 1)**. ABTS assay was used to determine the antioxidant activity (EC_{50} mg/mL).

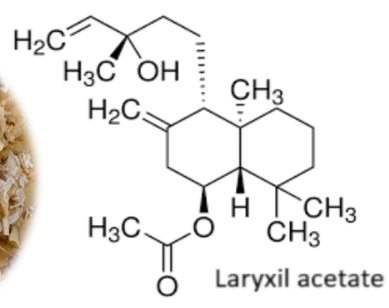
RESULTS

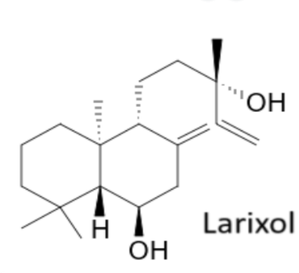
The results were reported as a percentage range from a means of 5 analyzed samples. LX and LXA, TXF and DHK were present in different ranges, with a strong dependence on the analyzed sample, as reported in **Table 1**. No bioactive compounds were detected in the water extracts, due to the previous exhaustion process using methanol as extraction solvent. The rewarding antioxidant activity results evaluated by ABTS assay are reported in **Table 1.**

Figure 1. Larch fibre waste extraction and characterization.

1) n-Hexane
Targeting apolar compounds (*Larixol and larixyl acetate with antibacterial activity)*

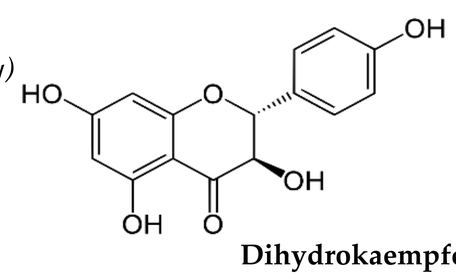
Exhausted biomass was consequently extracted with…

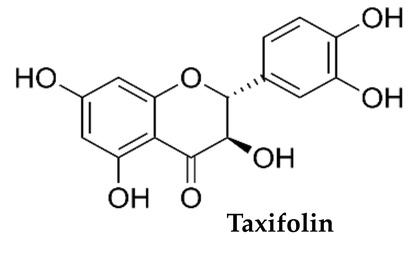




2) Methanol
Targeting flavonoids (*taxifolin and dihydrokaempferol with antioxidant activity)*

Exhausted biomass was consequently extracted with…





3) Water
Targeting arabinogalactans

Table 1. Quantification of main bioactive principles by UPLC-PDA (as % of w/w), and antioxidant activity evaluated by ABTS assay.

	Yield (% w/w)	LX (% w/w)	LXA (% w/w)	TXF (% w/w)	DHK (% w/w)	ABTS assay (EC_{50}, mg/mL)
Hex extract	0.4-0.8	0.80-15.70	8.70-14.50	-	-	-
MeHO extract	1.3-5.7	-	-	16.20-23.20	6.40-24.00	0.002
milli-Q H_2O extract	5.8-12.0	-	-	-	-	0.012

CONCLUSIONS

- The larch fiber waste samples deriving from different geographical region were demonstrated to contain variable % of bioactive compounds;
- Larch fibre hexane extracts contain larixol and larixyl acetate, important secondary metabolites for their pharmacological activity;
- The high content of taxifolin and dihydrokaempferol in larch fibre methanol extracts, demonstrated a promising antioxidant activity exploitable for the development of advances functional feed ingredient;
- Larch fibre waste from woodworking companies requires further attention as a functional feed ingredient in supporting metabolism and animal health.

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