



Dry Valorisation of Crop Waste using peanut and pea crops as example

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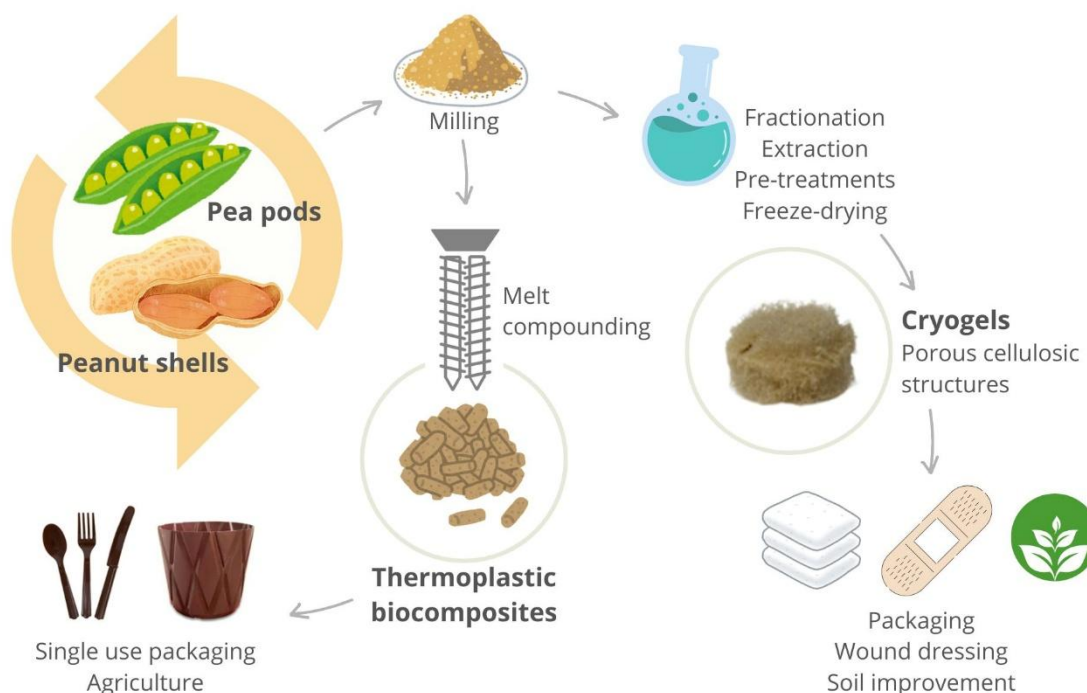
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Problem Statement

The production and processing of peanut and pea crops generate significant amounts of agricultural side streams, particularly peanut shells and pea pods, which are often underutilised or disposed of into low value markets. This linear management approach not only represents a loss of potentially valuable bio-based resources, but also contributes to environmental burdens associated with waste handling and inefficient biomass use. At the same time, there is a growing demand for sustainable materials to replace fossil-based plastics and high-impact products. However, integrating lignocellulosic residues from these crops into high-performance applications remains challenging due to variability in composition, limited knowledge of their functional properties, and the need for compatible processing strategies. Addressing these challenges is essential to unlock the full potential of crop residues within circular bioeconomy models.

Solution

To address the underutilisation of crop residue, example residues of peanut shells and pea pods were utilised, with an integrated valorisation strategy developed focusing on their application as functional bio-based materials. The side streams were characterised in terms of composition and physicochemical properties and subsequently processed as lignocellulosic fillers for thermoplastic biocomposites and as raw materials for the development of lightweight aerogels. Optimised compounding and processing routes were established to ensure compatibility with polymer matrices and to enhance mechanical and thermal performance, while tailored fibre suspension and drying approaches were applied to obtain structured aerogel materials. This dual approach demonstrates how agricultural residues can be transformed into high-value products for sustainable material applications, contributing to resource efficiency, waste reduction, and the advancement of circular bioeconomy models in peanut and pea crop value chains.



Benefits

The proposed valorisation approach delivers multiple environmental, economic, and technological benefits across the peanut and pea value chains. By converting peanut shells and pea pods into functional fillers for thermoplastic biocomposites and into structured aerogels, the potential exists to redirect significant volumes of low-value agricultural residues from disposal towards high-performance material applications. This contributes to waste reduction, improved resource efficiency, and lower reliance on fossil-based raw materials. The incorporation of these lignocellulosic side streams can reduce the overall carbon footprint of polymer-based products while enhancing material properties such as stiffness and lightweight performance. In addition, the development of scalable processing routes creates new market opportunities for farmers, processors, and bio-based industries strengthening rural economies and supporting the transition towards a circular and sustainable bioeconomy.

Practical recommendations

Based on this study to maximise the uptake of peanut shells and pea pods in bio-based material applications, stakeholders should implement systematic characterisation and quality control protocols to ensure consistent composition and performance of the side streams. Standardised pre-treatment, drying, and milling procedures are recommended to improve compatibility with thermoplastic matrices and to optimise aerogel processing. Close

collaboration between farmers, processors, and material manufacturers is essential to secure stable supply chains and traceability of residues. In addition, pilot-scale validation and techno-economic assessment should be carried out to support industrial scalability and market adoption. Integrating these practices into existing peanut and pea processing chains will facilitate the efficient transformation of agricultural waste into high-value, sustainable materials within a circular bioeconomy framework.

Environmental Impact

The valorisation of peanut shells and pea pods into biocomposites and aerogels has the potential to reduce the environmental footprint of material manufacturing systems. By diverting these lignocellulosic side streams from low-value uses or disposal, greenhouse gas emissions associated with waste management are avoided and the embedded biogenic carbon is retained in long-life materials. Replacing a proportion of fossil-based polymers and non-renewable raw materials with bio-based fillers and structures further contributes to reduced carbon emissions and resource depletion. Ongoing work includes the assessment of carbon footprint, energy demand, and life cycle impacts of the developed materials, enabling scenario analysis to optimise processing conditions and maximise environmental benefits across the peanut and pea value chains.

1. Global Warming Potential (GWP): Increased local production of legumes secures less use of imported soy.
2. Eutrophication Potential (EP): Increased production of legumes reduce the use of chemical Nitrogen fertilisers

Weblinks (FSH will incorporate the links once the Practice Abstracts are posted online)

<https://valpropath.eu/>

About this practice abstract and VALPRO Path

These practice abstracts were elaborated in the VALPRO Path project based on the EIP AGRI abstract format. VALPRO Path, a Horizon Europe project spanning 4 years, from September 2022 until August 2026. With the participation of 22 partners from 9 countries, VALPRO Path is developing fresh possibilities, validating and showcasing ways to enhance plant protein production for food and feed in the EU.



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Project website: <https://valpropath.eu/>