



Hermetic bagging system

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Problem Statement

Food-grade pulses and pulse flours must retain their identity, quality and safety from the field to the processor. Conventional bulk storage in silos is often unsuitable for small or differentiated lots because it requires substantial fixed investment and may lead to commingling, loss of traceability and dependence on ventilation or chemical fumigation. Smaller 25 kg bags are flexible but create high handling requirements, generate more packaging waste and do not allow operators to verify hermeticity. During storage and shipment, exposure to oxygen, moisture fluctuations, insects and fungi can reduce product quality, shorten shelf-life and increase the risk of contamination or mycotoxin development. These constraints are particularly relevant for organic producers, niche processors and plant-protein value chains that require residue-free pest control and reliable farm-to-processor traceability.

Solution

The proposed system, studied within the VALPRO path project, combines a standard polypropylene raffia big bag (approximately 1 m³ and 500-750 kg capacity) with a low-cost internal polyethylene liner that can be sealed hermetically. After filling, the liner is checked for leaks with an automatic pressure decay test and a controlled atmosphere is created by injecting carbon dioxide (CO₂) or nitrogen (N₂). The low-oxygen, high-CO₂ environment suppresses insects and microorganisms, stabilises moisture and limits oxidative deterioration. Each bag remains a separate, identifiable logistics unit, allowing information on field origin, crop variety, production practices and environmental indicators to travel with the product. The system is portable, can be transported on a pallet, is modular and suitable for on-farm storage, temporary storage and direct shipment to millers or food processors without the need for a dedicated silo.

Benefits

Trials demonstrated complete mortality of insects under the tested controlled-atmosphere conditions, while insects multiplied in untreated controls. Moisture remained stable and no fungal growth was detected after four months of storage. The approach can therefore preserve food-grade pulses and flours without routine chemical insecticides, while reducing contamination risk and maintaining batch identity. For farmers and processors, the main benefits are flexible storage capacity, direct farm-to-processor shipment, easier segregation of gluten-free or organic products, reduced manual handling compared with 25 kg bags, and the possibility of serving higher-value markets with verified traceability. Controlled atmosphere may also slow fat oxidation and rancidity in products such as chickpeas, supporting longer shelf-life and improved nutrient stability.

Practical recommendations

- **Use appropriate products:** Apply the system to clean, food-grade pulses or flours with moisture content suitable for safe storage. Do not use hermetic packaging to correct already mouldy, excessively wet or heavily contaminated material.
- **Protect and position the liner:** Insert the polyethylene liner carefully inside the raffia big bag, inflate it so that it adheres to the walls, and avoid punctures during filling, lifting and pallet handling.
- **Seal and test hermeticity:** Close the liner using a validated sealing procedure and check for leaks with a pressure decay test before gas injection. Hermeticity is essential because poor seals or mechanical damage can reduce the concentration-time exposure required for pest control.
- **Create and monitor the atmosphere:** Inject CO₂ or N₂ using suitable fittings and safety procedures. Record initial concentration and monitor its evolution, especially during the first days when CO₂ sorption by the grain can cause a rapid decrease. Maintain the atmosphere for the validated treatment period.
- **Maintain traceability:** Assign a unique bag identifier linked to field, variety, harvest date, moisture, treatment, gas concentration, storage conditions and destination. Use the bag as the traceable unit throughout storage and shipment.
- **Plan reuse and end-of-life:** Inspect the outer bag and liner after unloading. Reuse components only when food-safety and mechanical integrity are guaranteed, and select recyclable materials and local collection routes wherever possible.
- **Train operators:** Provide short training on liner installation, filling, sealing, gas handling, leak testing, monitoring and safe opening. Carbon dioxide can displace oxygen, so treatment and opening must be carried out in ventilated areas with appropriate risk controls.

Environmental Impact

The hermetic bagging system can reduce environmental impacts in several parts of the pulse value chain. Controlled-atmosphere pest management avoids or reduces phosphine and other chemical fumigants, lowering pesticide residues, operator exposure and emissions associated with repeated treatments. Stable moisture and suppression of insects and fungi reduce post-harvest losses, meaning that fewer land, water, fertiliser and energy inputs are wasted per tonne of edible product delivered. By maintaining quality during longer storage and shipment, the system may also reduce rejected lots and food waste.

Compared with many small bags, one large traceable unit requires less handling and can reduce the number and mass of packaging items used per tonne. Modular on-farm storage and direct shipment to processors can avoid construction and operation of dedicated silos, support shorter supply chains and reduce intermediate loading and unloading. The environmental balance nevertheless depends on liner production, gas supply, transport distance, reuse rate and recycling. For this reason, users should minimise plastic thickness while maintaining performance, favour recyclable mono-material solutions, optimise gas consumption, prevent liner damage and establish recovery routes. Environmental assessment should consider the complete system, including avoided product loss and chemical fumigation, rather than packaging material alone.

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

<https://valpropath.eu/>

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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/>