Novel Packaging Materials

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Overview

This summary is part of a study investigating novel alternatives to petrochemical plastic packaging, focusing on food and drink packaging. Reducing dependency on petrochemical plastic is particularly important in packaging as 40% of all plastic is used for this purpose [1], which is also the main user of single-use plastic [2]. As a result, various novel packaging materials are appearing which are designed to be more easily disposed in environmentally sustainable ways than petrochemical plastic. This research investigated four contrasting alternatives in-depth to understand the packaging uses they could fulfil, their disposal options, their environmental impact compared to petrochemical plastic and the barriers to their uptake. Academic and non-academic literature (e.g., company websites) were used as well as in-depth interviews with a council waste strategy manager and a composting director, along with responses from a representative of a company which uses one of the alternatives were used to gather this information.

	Mycelium	Seaweed	Feather	Polylactic Acid (PLA)
What is it?	Thin white fibres which are the vegetative part of a fungus. This can be made into packaging as a composite with plant material. The plant material serves as a substrate which the plant material grows on and holds together to create a three-dimensional matrix [3].  FIGURE 1: MYCELIUM BOTTLE CASE (PARADISE PACKAGING COMPANY, 2021).	Packaging made from alginate, agar or carrageenan which is extracted from brown or red seaweed using alkaline treatment [4]. Such packaging can be combined with essential oils to provide high levels of antimicrobial activity [5], and a 95:5 seaweed to microcrystalline cellulose ratio to improve moisture and mechanical barrier properties [6].  FIGURE 2: AGAR BIOPLASTIC PASTA PACKET (SEAWEED PACKAGING, 2019).	Thermoplastics are plastics which can be melted and remoulded numerous times. Thermoplastics can be made from chicken feathers by extracting keratin or by grafting vinyl monomers onto the feathers [7][8].  FIGURE 3: CHICKEN FEATHER POT (DURHAM, 2009).	A thermoplastic produced from fermented starch or sugars from crops such as beets, corn, wheat or potatoes [9][10].  FIGURE 4: PLA PACKAGING [17].
Packaging uses	Similar uses to expanded polystyrene foam: Protection for fruit/vegetables, seafood and drink bottles [11][12].	Various uses including films, sachets, wrappers, interleafs in frozen food packaging and liners for cardboard boxes, as wells as numerous non-food packaging uses [13][14].	Still in development, but being a thermoplastic, has potential to take on various uses fulfilled by PET including films and cups [7][8][15].	Used for various packaging including dip pots, cold cups, sushi trays, wrapping sheets, deli containers, liners for cardboard, packaging windows, platter boxes, salad boxes, bags and bottles [16][17].
Disposal options	Can fully decompose within around one month in home composting [18].	Can full decompose within six weeks in home composting, but seaweed packaging is also being developed to have further disposal options depending on the contents, including edible and water-soluble packaging [14][19].	Likely needs to be disposed in organic waste to go to industrial composting facilities, where it should decompose in about 16 weeks [20].	Needs to be disposed in organic waste to go to industrial composting facilities, where it should break down within 12 [9].
Environmental impacts	Energy is required to run a Heating, Ventilation and Air Control system which is needed for mycelium production [21], although eight times less energy is consumed and 10 times less carbon dioxide is emitted in the production of mycelium packaging than in polystyrene foam production [3].	Possible energy costs associated with transporting raw materials long distances [5][22]. Further energy use from the hot extraction method used in the production of the material [23]. The seaweed undergoes extensive washing, which likely leads to great water demands [23].	Some methods of production may use chemicals which are environmental pollutants, particularly in watercourses, if not handled and disposed of properly [7][8][24][25]. Unknown water usage in production [7][8]. Even in industrial composting conditions, this material likely biodegrades too slowly to be considered compostable. As a result, the material may not be accepted in organic waste collections and therefore end up in landfill.	Will likely degrade no more quickly than petrochemical plastic outside industrial composting conditions [26]. May not always decompose within a composting cycle in industrial composting conditions and so get picked out of the compost (or sometimes even the organic waste) and discarded in landfill. Some concerns that increasing demand for PLA will increase demand for suitable crops, therefore increasing land use and chemical fertiliser/pesticide use, as well as producing effluent waste from starch production [27].

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