

Alternatives to single-use plastics: Appendix A Alternatives to single-use plastics matrix

Alternative to plastic	Food safety (including; contamination, physical damage, shelf life, traceability and allergen concerns)	Convenience and acceptance (including labelling, branding, consumer perceptions and acceptance)	Circularity (including biodegradability, recyclability, reusability)	Production and input costs (including; material, labour, energy, infrastructure/investment requirements)	Market characteristics (including; price, market size and growth predictions)
Paper	Slightly worse: not sealable/airtight, moderate physical protection, regular shelf life, traceable, no allergen concerns, permeable.	Mixed or similar performance: suitable for labelling and branding, not transparent, perceived as sustainable by consumers, well known.	Slightly better: Biodegradable (can release methane, a strong green-house gas, if buried in a landfill)[ii], recyclable, but not if contaminated with food, crease or plastic coating [iii], limited reusability.	Mixed or similar performance: water, chemicals, printing inks and energy intensive production[iv], deforestation risks, infrastructure scaled and available.	Mixed or similar performance: cheap, mature market, compound annual growth rate of 3.9% from 2023 to 2028[v].
Glass	Mixed or similar performance: sealable, strong physical protection, extended shelf life (oxygen, moisture and UV light barrier), traceable, no allergen concerns, impermeable	Slightly worse: stickers required for labelling and branding, transparent, well known by consumers, heavier than alternatives and risk of shattering[vii].	Slightly better: non-biodegradable, recyclable, food and grease contaminations and not preventative, [viii] indefinite reusability.	Mixed or similar performance: energy intensive production and recycling, abundant raw materials[x], infrastructure scaled and available.	Mixed or similar performance: higher price than plastic and more expensive to transport, mature market, compound annual growth rate 3.5% from 2023 to 2028[xi].
Metal	Mixed or similar performance: sealable for packaging, strong physical protection, extend shelf life, traceable, no allergen concerns, impermeable.	Mixed or similar performance: stickers required for labelling and branding, not transparent, well known by consumers, light and convenient (aluminium foil).	Slightly better: non-biodegradable, cost effective recycling compared to new production [xii], long term reusability.	Slightly worse: energy intensive production[xiii], harder to obtain raw materials compared to other alternatives, infrastructure scaled and available.	Mixed or similar performance: more expensive than plastic, mature market, compound annual growth rate 3.4% from 2023 to 2028[xiv].
Natural fibrous material such as bamboo, cotton, jute	Significantly worse: not sealable, moderate physical protection, shortened shelf life, tracing difficulties, allergen concerns from source material and permeable.	Slightly worse: stickers required for labelling and branding, not transparent, no evidence found on acceptance.	Slightly better: biodegrades in natural conditions, non-recyclable, medium term reusability,	Slightly better: low energy production, abundant raw material, high water and land requirements for certain materials such as cotton[xv], competes with food agriculture.	No evidence on price, market size and growth.
Synthesised from biomass; Seaweed polysaccharidies	Mixed or similar performance: sealable, weak physical protection, extended shelf life (antimicrobial and antioxidant properties), traceable, allergen concerns from source material	Slightly worse: stickers required for labelling and branding, transparent, no evidence found on acceptance	Significantly better: biodegrades quickly in natural conditions, non-recyclable, limited reusability, limited knowledge on the ecological impacts of seaweed farms [xvi].	Slightly better: abundant, fast growing raw material source which combats ocean acidification[xvii], high production costs, continued investment needed for scale up	Mixed or similar performance: infant industry price is high which reflects current costs[xviii], global compound annual growth rate of 16.50% from 2022 to 2029 (valuation of \$181 million in 2021)[xix].
Synthesised from bioderived monomers: Polylactic acid (PLA)	Mixed or similar performance: sealable, strong physical protection, regular shelf life, traceable, allergen concerns (dependent on source material), impermeable.	Mixed or similar performance: stickers required for labelling and branding, transparent, some evidence of bioplastics perceived as unsustainable[xx], consumers unlikely to be able to differentiate between bio-based and petroleum plastics[xxi].	Slightly worse: biodegradable only in industrial conditions at temperatures of at least 55 degrees [xxii], waste PLA can contribute to plastic litter in terrestrial and marine environments [xxiii], recyclable, but not currently at scale[xxivxxvxxvi], risks contaminating current plastic recycling systems[xxvii], reusable, PLA can derive from fossil-based sources or food waste/by-product[xxviii].	Mixed or similar performance: abundant material sources, significant water input[xxix], opportunity cost for food crop production, small negative impact on food security, environmental costs of using pesticides and fertilisers[xxx].	Slightly better: readily available in filament and pellets, production growth predicted[xxxix].

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Produced by microorganisms: Polyhydroxyalkanoates (PHAs)	Mixed or similar performance: sealable, strong physical protection, extended shelf life, traceable, allergen concerns (dependent on source material)	Mixed or similar performance: stickers required for labelling and branding, transparent, some evidence of bioplastics perceived as unsustainable ^[xxxiii] , consumers unlikely to be able to differentiate between biodegradable PHA and non-biodegradable plastics ^[xxxiv] .	Slightly better: Biodegradable under natural conditions ^[xxxv] , recyclable but not widely recycled ^[xxxvi] , can be made from fossil-based sources or food waste/by-product ^[xxxvii] , no evidence on reusability of material.	Slightly worse: high production costs associated with feedstock and carbon sources ^[xxxviii] , use of chemicals ^[x] , more research required to identify cost-reducing innovations ^[xli] .	Mixed or similar performance: less available than PLA, low total production levels currently, but significant growth predicted ^[xliii] .
Reducing packaging (either no packaging or less packaging)	Significantly worse: contamination risk, physical damage risk, reduced shelf life, some tracing difficulties, allergen concerns from cross contamination of exposed foods such as nuts.	Slightly worse: labelling and branding limitations, product visibility, growing consumer trend ^[xliii] , less convenient, especially for wet foods and liquids. Consumers may have to bring their own packaging.	Significantly better: less materials and resources used, less waste, requires bulk packaging products for example, dispensers.	Slightly better: reduced inputs, requires initial infrastructure investment.	Slightly better: packaging free shops are opening at an increasing rate in the whole of Europe ^[xliiv] .
Reusing packaging	Slightly worse: potentially sealable, strong physical protection, regular shelf life, some tracing difficulties, allergen concerns depend on packaging type	Mixed or similar performance: stickers required for labelling and branding, can be transparent, growing consumer trend ^[xlv] , less convenient ^[xlvi] .	Significantly better: reuse circularity, requires bulk packaging products for example, dispensers.	Slightly better: reduced input requirements, investment required for in-store infrastructure for example, dispensers, washing services, reverse transport logistics ^[xlviix] .	Slightly better: trials on reusable packaging systems occurring in large supermarkets such as Tesco and Waitrose, global reusable food packaging market predicted to have a compound annual growth rate of 10.4% from 2019 to 2027 ^[xlix] .
Recyclable packaging and systems	Mixed or similar performance: sealable, strong physical protection, extended shelf life, traceable, no allergen concerns	Mixed or similar performance: stickers required for labelling and branding, can be transparent, accepted by consumers ^[i] .	Slightly better: recycling circularity, process inefficiencies and energy costs, not feasible for some materials for example, multicoated wrappers, thin plastics.	Slightly worse: reduced input requirements but virgin material needed to sustain durability of material ^[ii] , inefficiencies with current waste separation and infrastructure ^[liii] .	Mixed or similar performance: more expensive than virgin material ^[liii] , long running system, growth is highly dependent on government policy.
Active packaging	Slightly better: antimicrobial and/or antioxidant, extended shelf life, traceable, allergen concerns from source material	Novel to consumers, convenience from extended shelf life, consumers are unfamiliar with a mild to slightly positive attitude to this technology ^[liv] .	Slightly worse: biodegradability varies per product, not recyclable, not reusable.	Slightly worse: high research costs ^[lv] , inputs and production costs vary significantly per product.	Mixed or similar performance: compound growth rate of 6.6% from 2022 to 2027 ^[lvi] .
Intelligent packaging	Slightly better: potential to extend shelf life, increased visibility of food data throughout supply chain ^[lvii] .	Slightly better: Add on for labelling and branding, convenient for suppliers, retailers and consumers, consumers are unfamiliar with a mild to slightly positive attitude to this technology ^[lviii] .	Slightly worse: Biodegradability varies per product, not recyclable, no evidence on reusability.	Slightly worse: high research costs ^[lix] , inputs and production costs vary significantly per product.	Mixed or similar performance: compound growth rate of 6.6% from 2022 to 2027 ^[lx] .

Note: Alternatives are rated by category, with conventional plastics as the benchmark. Dark red means that the alternative performs significantly worse than plastics in that category, orange is slightly worse, beige is similar or mixed performance, light green is slightly better, and dark green is significantly better.

This rating system was designed through consultation with the FSA, expert advisors and desk research. In some instances, value judgements had to be made regarding what is more important in each category, so that we could determine a rating.

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