

# Biodegradable technologies for removing bleachable stains in laundry



## Background

Stains are a common household issue, and while standard laundry detergents handle many, certain stains require more specialized treatments. Laundry stains can be categorized by the cleaning agents needed to remove them: surfactants for oily stains (e.g., cooking oil, frying fat), enzymes for protein- and carbohydrate-based stains (e.g. blood, porridge), and bleach for bleachable stains (e.g. berries, wine).

Bleachable stains present a significant challenge, especially in liquid detergent formulations. Traditionally, solid laundry detergents use oxygen-based bleaching agents, whereas liquid detergents are limited to certain complexing agents and polymers. For example, sodium citrate, a common complexing agent, is effective at softening water but lacks the strength to tackle tough stains on its own. Metal organic frameworks (MOFs) and advanced polymers like polyethylenimine (PEI) offer better stain removal but come with high costs, fabric residue issues, limited stain applicability and environmental concerns. Additionally, oxidative agents like hydrogen peroxide, chlorine bleach, and phthalimido-peroxycaproic acid (PAP), though powerful, often lead to fabric damage, fading and sustainability concerns. There is also a notable gap in the availability of biobased and biodegradable bleaching agents that are both environmentally friendly and stable under the required liquid detergent formulation conditions (pH 8 +/-0.4; presence of enzymes). Altogether, the current solutions for liquid detergents fail to provide a balance of effectiveness, fabric safety, and environmental sustainability.

## What we're looking for

We are looking for innovative and sustainable solutions for removing a range of bleachable food stains, particularly those involving natural pigments commonly found in berries, tomatoes, wine, and spices.

## Solutions of interest include:

- Removal of anthocyanin, tannin and polyphenol-based food stains (e.g., berries, red wine, tea, coffee, chocolate, curry, curcuma)
- Removal of apocarotenoid and carotene-based food stains (e.g., roots, leaves, algae, carrot and citrus peel/juice)
- Removal of capsanthin and capsorubin-based food stains (e.g., capsicum/paprika, peperoni)
- Removal of lycopene-based food stains (e.g., tomato, ketchup, tomato sauce)

**Our must-have requirements are:**

- Applicable to at least one of the mentioned categories of bleachable stains
- Effective in in-wash applications at 30°/40° C, pH ~8, and at realistic concentrations
- Compatible with common liquid detergent ingredients (e.g., enzymes, surfactants, builder, fragrances)
- Preliminary data suggesting potential efficacy and performance

**Our nice-to-have's are:**

- Uses renewable feedstocks in their chemistry or ingredient composition
- Ecological & toxicological data as per [OECD/EU test guidelines](#)
- Biodegradability data according to OECD test guidelines
- Known cost in use (e.g., xy €/washing cycle or xy €/kg of raw material)

**What's out of scope:**

- Solutions that are not biodegradable.
- Solutions that negatively interact with liquid detergent ingredients (e.g., enzymes, surfactants, builder, fragrances, etc.).
- Reductive bleaching agents (e.g., sulfites, dithionite), hydrogen peroxide, chlorine bleach, and bleaching technologies (e.g., UV-bleach, ozone, plasma, electro-bleach), as these approaches have already been extensively explored.

**Acceptable technology readiness levels (TRL): Levels 3-7**

1. Basic principles observed
2. Concept development
3. Experimental proof of concept
4. Validated in lab conditions
5. Validated in relevant environment
6. Demonstrated in relevant environment
7. Regulatory approval
8. Product in production
9. Product in market

**What we can offer you****Eligible partnership models:**

- Sponsored research

**Benefits:****Sponsored Research**

Funding is proposal-dependent starting with a feasibility study or proof-of-concept, up to \$100,000 with the potential for expansion based on results and opportunities

Please contact the University of South Florida Technology Transfer office representative for submission – Roisin McNally at [rmcnally@usf.edu](mailto:rmcnally@usf.edu)