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Dairy by-product valorisation for carotenoid production by *Rhodosporidium toruloides*

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Oral Presentations #7

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The management of agri-food residues and by-products represents a major environmental and economic challenge, particularly in the context of increasing food demand and population growth. Currently, many of these residues are still treated through low-value routes, such as composting, anaerobic digestion or energy recovery, while a significant fraction is disposed of without effective valorisation. These strategies do not fully exploit the potential of agri-food waste as renewable feedstock for the production of high-value bioproducts, resulting in limited circularity and inefficient use of carbon and nutrients. In this context, the production of high-value bioproducts such as carotenoids represents a promising strategy, since they are gaining increasing attention in the food, nutraceutical and health-related industries as natural alternatives to synthetic additives. Their applications as natural colorants, vitamin supplements and anti-ageing ingredients, together with their reported antimicrobial properties, are driving the expansion of the global carotenoid market, which is expected to reach USD 2.9 billion by 2029 [1].

In this work, the valorisation of dairy industry by-products for carotenoid production using the oleaginous red yeast Rhodosporidium toruloides ATCC 204091 was evaluated. Cheese whey was utilized as a low-cost substrate. Prior to fermentation, the whey was pasteurized at 90 °C for 30 minutes. Since this yeast cannot assimilate lactose, a preliminary hydrolysis step was performed using beta-galactosidase. To identify the most favourable cultivation conditions for carotenoid production by R. toruloides, a design of experiments (DOE) approach was applied using synthetic media representative of the composition of two types of whey, primary and concentrated whey. The optimal conditions identified were then used with the corresponding real whey substrates in a 0.5-L bioreactor under aeration, at pH 6 and 30ºC. The total carotenoid concentration ranged from 28 to 42 mg/L, with a carotenoid content of 800 µg/g dry cell weight. Torulen was the predominant compound, reaching an accumulation of 289 µg/g of cells.

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References

[1] BCC Research, *The Global Market for Carotenoids*, Report Code: FOD025H, BCC Publishing, 2025.

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