

Circular Economy in Food Industry Waste Management (BIVALIA Workshop2 - 2026)

Editors: Elena Díaz Nieto; Francisco Heras Muñoz; Juan Antonio Melero Hernández; Manuel Gertrudix
Madrid, BIVALIA, UAM-URJC, 2026
DOI: 10.5281/zenodo.22206833 · CC BY 4.0
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Dairy by-product valorisation for carotenoid production by *Rhodospiridium toruloides*

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HOW TO CITE THIS CONTRIBUTION

A. Susmozas, C. Álvarez, J.L. Fernández, A.D. Moreno, M.J. Negro. (2026). Dairy by-product valorisation for carotenoid production by *Rhodospiridium toruloides*. In: Díaz Nieto, E., Heras Muñoz, F., Melero Hernández, J. A., Gertrudix, M. (Eds.), Circular Economy in Food Industry Waste Management (BIVALIA Workshop2 - 2026), p. 16. BIVALIA, UAM-URJC.
<https://doi.org/10.5281/zenodo.22206833>

Oral Presentations #7

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Keywords: Cheese whey; Microbial carotenoids; red yeast; *Rhodospiridium toruloides*

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 *Rhodospiridium 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 30°C. 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.

Acknowledgements

This work was carried out within the framework of the BIVALIA-CM project [TEC-2024/BIO-177], funded by the Technology Networks call of the Community of Madrid. Authors thanks to Lácteas del Jarama for providing the raw material used in this study.

References

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