Direct Extraction of Astaxanthin from *H. pluvialis*

Reference No: B78052

CHALLENGE

The carotenoid astaxanthin is valued in the cosmetics and dietary supplement industry for its **antioxidant properties** and its reddish-purple color, which is used for coloring different food types, e.g. seafood. The highest concentration occurs in the microalgae *Haematococcus pluvialis (H. pluvialis)*, but astaxanthin can also be chemically synthesized. The last years have shown a growing consumer demand for the natural form. However, the industrial extraction from *H. pluvialis* harbors many disadvantages resulting in high production costs. *H. pluvialis* produces astaxanthin upon nitrate deprival and exposure to high light intensity during which a **thick cell wall** develops. This impedes direct extraction, which is only enabled via a complex multi-step downstream process involving centrifugation, mechanical cell-wall disruption, drying, and supercritical extraction using CO_2. However, harvesting *H. pluvialis* via centrifugation can account for up to 30% of total production costs. Cell-wall disruption and drying are both **energy-intense steps**, and drying at high temperatures holds the considerable **risk of degradation**. In addition, for supercritical CO_2 extraction pressures of up to 1,000 bar are required to achieve sufficient yields. The energy and cost-intense conventional downstream process therefore represents the bottleneck for producing adequate amounts of natural astaxanthin at an **economically favorable scale**.

INNOVATION

We describe a novel downstream process for direct natural astaxanthin extraction from *H. pluvialis*. This method replaces the conventional energy- and cost-intensive industrial process steps of spray drying and CO_2 extraction and presents an **alternative to mechanical cell disruption**. By using a centrifugal partition extractor (CPE), astaxanthin is directly extracted from the algal broth into ethyl acetate, **a green solvent**. To make astaxanthin accessible to the solvent, the cyst cells must either be germinated before the extraction or mechanically disrupted (homogenized). Germination takes places after exposure to growth conditions. The released zoospores contain astaxanthin with a **thin cell membrane**. This allows the direct extraction into ethyl acetate using the CPE. After evaporating the solvent, a **pure astaxanthin** extract is obtained which allows he condensed solvent to be recycled and reused for the following CPE extraction round.

A techno-economic analysis showed the superiority of the novel CPE extraction from homogenised cyst cells or germinated zoospores compared to the conventional industrial process using supercritical CO2 extraction. This enables a direct extraction on site.

COMMERCIAL OPPORTUNITIES

- Increased consumer demand of natural axastanthin can be met
- Replacement of spray drying and CO_2 extraction with direct extraction via CPE
- Lower investment costs for CPE extractor compared to in-house CO_2 extractor
- Highest net present value for extraction from germinated zoospores and homogenized cyst cells

DEVELOPMENT STATUS

Proof of concept

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Technology from TECHNICAL UNIVERSITY OF MUNICH

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