“Sustainable carotenoid synthesis from cheese whey: Evaluation of key fermentation parameters and carotenoid profile using two novel *Rhodosporidium kratochvilovae* strains”

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Renewable resources: the key of Circular Economy

1.3 billion food waste

1/3 of annual produced food

20% dairy by-products

From linear economy

Natural resources → Take → Make → Dispose

To a circular economy

28.7% reduction of food waste in 2020 (vs. 2016)

Target: 50% by 2025
Renewable resources: the key of Circular Economy

Dairy factory → Dairy products

Dairy by-products (cheese whey) → Waste management

Resources → Environmental pollution

CAROTENOIDs ← High value-added products
Production of high value-added compounds: Carotenoids

Global Carotenoid Market Value

- **2018:**
  - 1.25 billion
  - 71% synthetic

- **2025:**
  - 1.74 billion

- **2028:**
  - 3.7%

Shift to natural carotenoids

- Cosmetics
- Pharmaceuticals
- Supplements
- Feed
- Food
Production of high value-added compounds: Carotenoids

- Unusual carotenoids
- Antioxidant activity

Market demand

- ✓ Unusual carotenoids
- ✓ Antioxidant activity
Biotechnological production of carotenoids

**Synthetic**
- (-) Only colorants
- (-) Toxic effects
- (-) Generate waste

**Natural**
- (+) Antioxidant
- (+) Vitamin A precursor
- (+) Anti-inflammatory activity

**Microbial**
- (+) Control cultivation parameters
- (+) ↓ Production time
- (+) Wide color range
Biotechnological production of carotenoids by red yeasts

Importance of red yeasts
- High growth rate
- Low cost raw materials
- Variety of culture parameters (°C, pH)

Rhodosporidium kratochvilovae
- Unusual carotenoids
- Oleaginous

Novel unexplored yeasts

Rhodosporidium kratochvilovae

Unusual carotenoids

Oleaginous

Novel unexplored yeasts
Objectives

Submerged fermentations

Novel yeasts
*Rh. kratochvilovae*
Y-42, Y-43

Enzymatically hydrolyzed cheese whey

HPLC analysis

Optimization:
- C/FAN 40, 60
- Temperature (23, 28, 33°C)

Carotenoids
Effect of C/FAN & temperature

*Rh. kratochvilovae Y-42*

- Optimum incubation temperature → strain-dependent
- Lower C/FAN → higher carotenoid production
Fermentation pattern at optimum culture conditions

**Rh. kratochvilovae Y-42**

**Conditions:**
- C/FAN 40
- 28 °C

**Total biomass:** 15.3 g/L

**Max carotenoid production:** 2.5 mg/L

**Graphs showing:**
- Glucose, Galactose, FAN concentration over fermentation time (h)
- Biomass, Lipids, Carotenoids concentration over fermentation time (h)
Fermentation pattern at optimum culture conditions

**Rh. kratochvilovae Y-43**

**Conditions:**
- C/FAN 40
- 23 °C

**Glucose, Galactose (g/L)**
- Fermentation Time (h)

**FAN mg/L**
- Conditions:
  - C/FAN 40
  - 23 °C

**Total biomass:** 17.8 g/L

**Max carotenoid production:** 2.7 mg/L
Identification of produced carotenoids

**Spectrophotometric analysis**

![Graph showing absorption spectrum with peaks at 445, 470, and 502 nm]

- Absorption values:
  - 445 nm
  - 470 nm
  - 502 nm

- Wavelengths of interest:
  - Lycopene:
    - 445 nm
    - 470 nm
    - 502 nm

**TLC analysis**

- Sample:
  - Similar Rf: 0.75

- Developing Solvents: Acetone: Hexane (3:7)

- Reference standard: Lycopene
Identification of produced carotenoids: HPLC analysis

**HPLC- DAD analysis**

- **Torularhodin**
- **Torulene**
- **γ-carotene**
- **Lycopene**

**Lycopene**: 95-98% of produced carotenoids

**Composition of produced carotenoids**

- Independent of:
  - Culture conditions
  - Strain
Conclusions

- Cheese whey → alternative low-cost fermentation substrate

- Best culture conditions:
  - Y-42 → C/FAN 40, 28 °C → 2.5 mg/L carotenoids
  - Y-43 → C/FAN 40, 23 °C → 2.7 mg/L carotenoids

- Carotenoids composition was independent of culture conditions

- Bioprocess resulted in high purity of lycopene

- Next steps: ✓ Bioreactor fermentations
  ✓ Green extraction methods

Think Green
THANK YOU FOR YOUR ATTENTION!

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https://foodbiomes.eu/

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