



Digestive Enzymes from the Eurasian Beaver (*Castor fiber*) for Lignocellulosic Fermentation

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Introduction

This project, led by **DBFZ Leipzig** and **TU Dresden**, aims to identify microorganisms and enzymes from the digestive tract of the Eurasian beaver (*Castor fiber*) that enhance **the degradation of lignified biomass**.

The beaver's unique ability to digest lignocellulosic material offers promising potential for optimising fermentation processes, specifically improving the efficiency of **biogas production** and enabling the use of currently untapped feedstocks.

Methods

Samples

- Contents of digestive tracts of eight Eurasian beavers (*Castor fiber*)
- On-site seasonal dietary (region Oderbruch, Germany)
- Microbiota from different parts of the digestive tract (Fig 1 and 2, N° 1-6)

Analysed Parameters

- Total Solids / Volatile Solids
- pH
- Feed Analysis (Van Soest method) - Lignin, Hemicellulose, Cellulose
- Trace element concentrations
- Microbiological characterisation - Morphology and degradation of cellulose, xylan, starch, and pectin through selective media

- Iron (Fe)** was used as an **inert marker** to compare nutrient absorption within the digestive tract

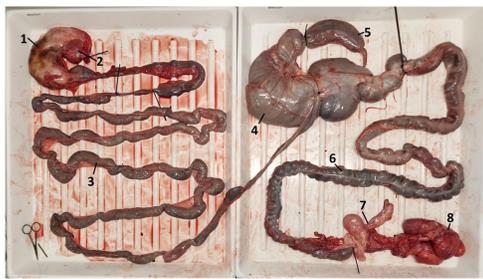


Fig. 1: Digestive tract of Beaver 05; Stomach (1) Cardiac glands (2) Small intestine (3) Caecum (4) Caecal apex (5) Large intestine (6) Male reproductive organs (7) Cloaca (8)

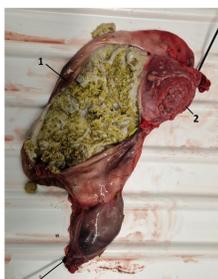


Fig. 2: Dissected stomach (1) with cardiac glands (2)

Results

Digestive Tract Analysis (Fig. 3)

- Cellulose degradation begins in the small intestine
- Lignin (ADL) degradation initiates at the Caecum - Caecal apex

Caecal Apex

- Central site of enzymatic activity
- Key location for lignin breakdown

Digestive Conditions (similar to anaerobic digesters - biogas production)

- Anaerobic
- pH ~ 6
- Temperature: 37 °C

Microorganism Isolation & Characterisation

- ~80 isolates from intestinal contents
- Growth tested on four substrates: cellulose, xylan, starch, lignin
- Detection of cellulase, xylanase, and amylase expression in liquid culture
- Morphological and sequence characterisation performed (Fig. 4)

Laboratory Bioreactor Trials (*Streptomyces thermoviolaceus*) (Fig. 4A)

- 10 L continuous laboratory scale bioreactors
- Two strategies:
 - Biomass pre-treatment in a separate disintegration stage prior to fermentation
 - Direct microbial addition to the fermenter



Fig. 3: Progression of Fe concentration in g/kg TS, lignin as ADL (Acid Detergent Lignin), and cellulose in %TS along the digestive tract of the examined beavers

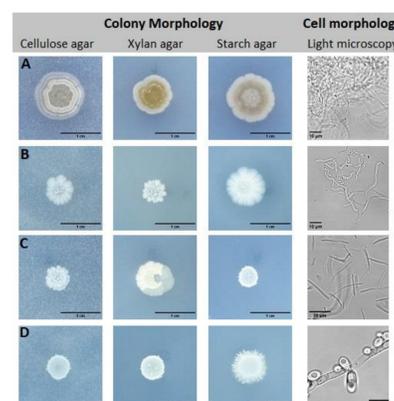


Fig. 4: Microscopic characterisation of sequenced isolates with regard to colony morphology and cell morphology (bright-field microscopy) on selective media under aerobic cultivation

- A) *Streptomyces thermoviolaceus*
- B) *Bacillus* sp.
- C) *Bacillus megaterium*
- D) *Candida albicans*

Conclusion

The **Eurasian beaver microbiome** represents a valuable and, underexplored source of enzymes with great potential in biotechnological processes. Additional microbial strains capable of lignocellulose degradation are currently being characterised to evaluate their suitability for further **application in biogas fermenters**.

Note

The animals examined in this project were not killed beyond the measures already mandated by governmental beaver management programmes and were subsequently made available for scientific research. All procedures were carried out in accordance with German and European legal regulations and were authorised by the relevant local authorities, **GEDO Gewässer- und Deichverband Oderbruch**.