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Abstract Title: Chitin extraction and conversion to chitosan from *Tenebrio Molitor* larvae, adult and exuviae

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Introduction

Chitin is one of the most commonly found polysaccharides in nature. It is found in the exoskeletons of invertebrates, and in fungi, green algae and yeast.
Tenebrio molitor (TM), commonly known as the mealworm beetle is an edible insect species that has gained increasing attention in recent years due to its potential as a sustainable food source. In addition to its nutritional benefits, TM is also a promising source of chitin and chitosan, which are biopolymers with a wide range of industrial applications. TM is particularly attractive for chitin and chitosan production due to its high yields and the simplicity of its artificial breeding methods. Chitosan exhibits antimicrobial and antioxidant properties, which makes it a great material for food packaging applications. At end of life, it has the additional benefit of being biodegradable. The present study aims to determine the yield of chitin and chitosan from different growth stages of TM, as well as to assess their degree of deacetylation (DDA).

Experimental

TM larvae, adults and exuviae were ground to a powder after drying. The insect powders were suspended for 3 h at 95 °C in 1.25 N NaOH solution to remove proteins. The remaining powder was washed and dried. For demineralization, the resulting powder was suspended at room temperature in 2 N HCl solution for 3 h. The resulting chitin was washed, dried and the remaining weight recorded. Subsequently, the chitin was deacetylated by stirring in 50 % NaOH at 95 °C for 3h. The resulting chitosan was seperated, washed and dried. The resulting weight was determined. Degree of deacetylation (DDA) of resulting chitin and chitosan was determined using ATR-FTIR measurements. DDA was calculated by the ratio of amide I band intensity (1655 cm^{-1}) and hydroxyl absorption band (3450 cm^{-1}) as described by following equation:

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$$DDA = \frac{A_{1655}}{A_{3450}} / 1.33$$

Results and Discussion

The yield of chitin and chitosan from different stages of insects has been a topic of interest for researchers. It has been observed that the yield of chitin and chitosan from adults is slightly higher than that from larvae, which is consistent with the findings of previous studies. However, the yield from exuviae was found to be significantly higher than from larvae and adults, which is in line with the understanding that exuviae contains a higher concentration of chitin due to its role in forming the insect's exoskeleton. These results highlight the importance of considering the life cycle stage of the insect when optimizing chitin and chitosan extraction processes. Analysis of the resulting chitosan showed similar degree of deacetylation (DDA) for adults and exuviae and a higher DDA for chitosan extracted from larvae.

Conclusions

Chitin was extracted from various growth stages of TM and subsequently converted to chitosan using chemical extraction methods involving hydrochloric acid and sodium hydroxide solutions. The yield of chitosan varied with the growth stage, with the highest yield obtained from exuviae. The resulting chitosan exhibited comparable degrees of deacetylation (DDA), except for the chitosan derived from larvae, which showed a slightly higher DDA.

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Biography

Max Sturm holds a bachelor and master degree in applied chemistry from Reutlingen University in polymer chemistry. As researcher at Albstadt-Sigmaringen University, he is actively involved in the development of bio-based food packaging and studies on the effect of eBeam treatment on the properties of bio-based polymer films and coatings.

His current active work is within EU projects, among others Recover, where he focuses on the electron beam assisted extraction of insect chitin and conversion to chitosan.