

# SUSTAINABLE EXTRACTION OF CHITIN FROM *HERMETIA ILLUCENS* BIOMASSES FOR PROCESS OPTIMIZATION AND FUTURE CHITOSAN PRODUCTION

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## INTRODUCTION

Chitin is a structural polysaccharide composed of  $\beta$ -(1 $\rightarrow$ 4)-N-acetyl-D-glucosamine units (Fig. 1) and is the second most abundant biopolymer after cellulose in arthropods and fungi<sup>1,2</sup>. Chitosan, the deacetylated form of chitin (Fig. 2), shows improved solubility and functional properties such as biocompatibility, biodegradability, antimicrobial activity and metal chelation, supporting applications in biotechnology, food preservation and biomedicine<sup>2,3</sup>. The increasing demand for sustainable alternatives has driven interest in renewable bio-based materials<sup>3</sup>. Conventional chitin production from crustacean waste is limited by seasonality, geographic variability and allergenicity<sup>2</sup>. Insect-derived chitin, especially from the black soldier fly *Hermetia illucens* (Diptera: Stratiomyidae), is a promising alternative (Fig. 3).

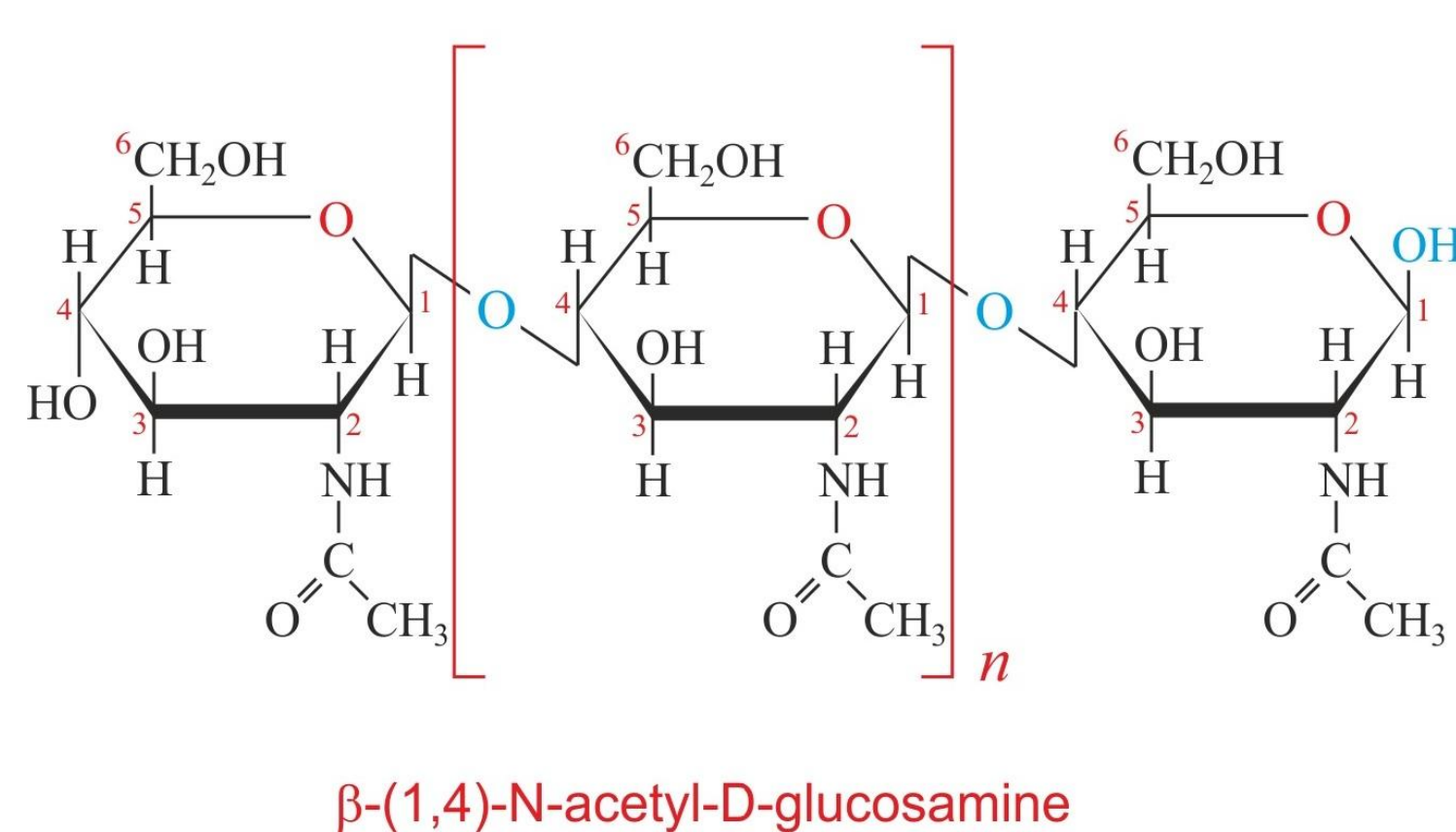


Fig 1. Chemical structure of chitin showing  $\beta$ -(1 $\rightarrow$ 4)-linked N-acetyl-D-glucosamine repeating units

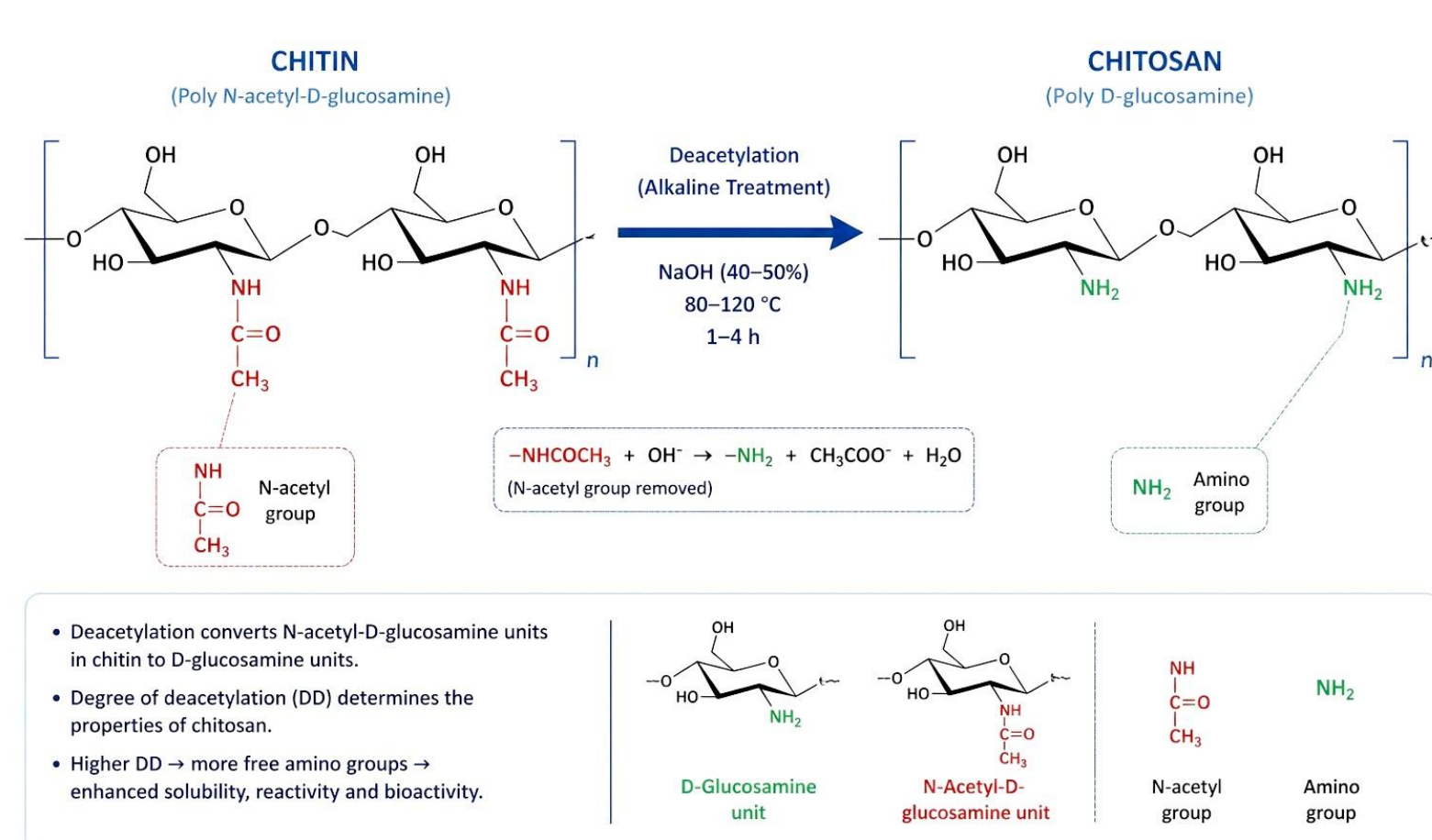


Fig 2. Deacetylation of chitin to form chitosan

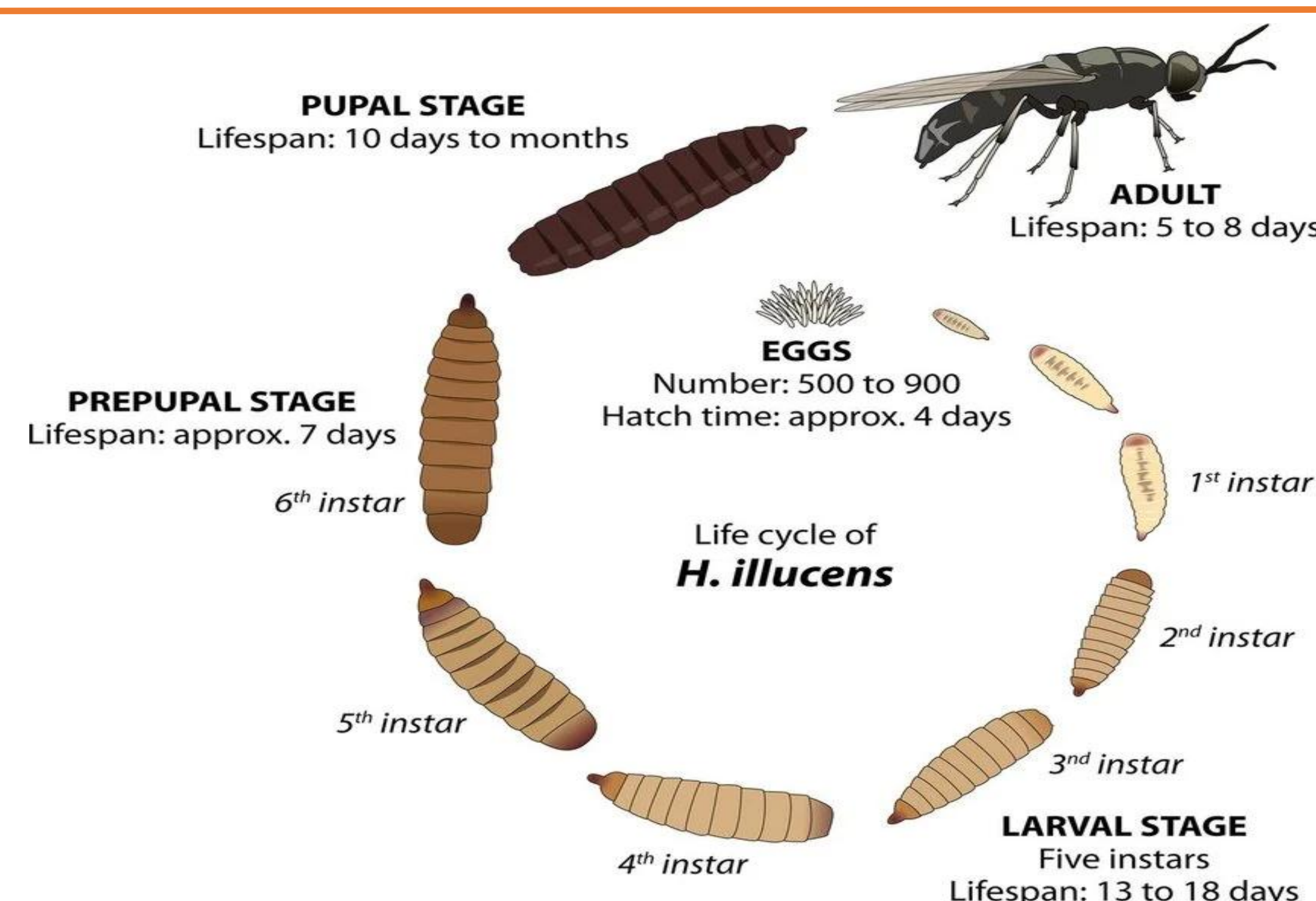


Fig 3. Life cycle of *H. illucens*, illustrating the developmental stages from egg, larva, prepupa and pupa to adult

This species efficiently converts organic waste into valuable biomass, enabling circular economy strategies in which larvae, pupal exuviae and adults are used as feedstocks for chitin extraction and chitosan production<sup>4</sup>. Studies show that *H. illucens* chitosan has properties comparable to crustacean sources, with strong film-forming ability<sup>5</sup>. This project aims to develop a biodegradable packaging film from *H. illucens* chitosan reinforced with natural clays; accordingly, this study evaluates chitin yield and biomass recovery from three biomasses to support process optimization and green extraction approaches.

## METHODS

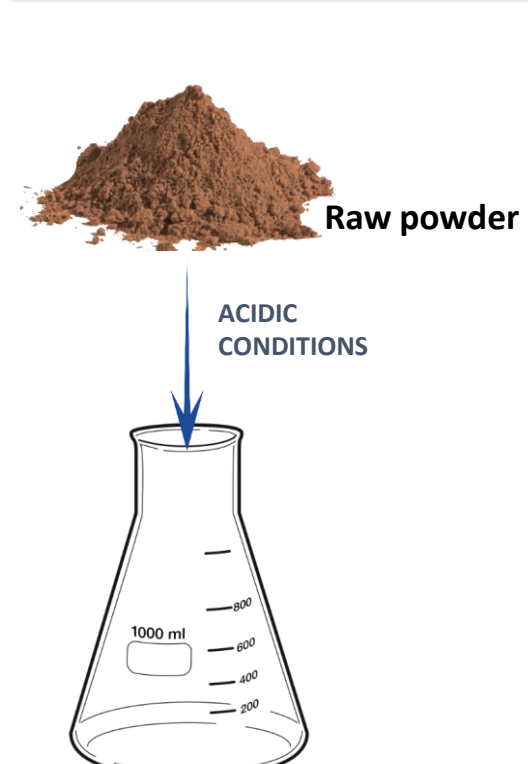
### Raw sample preparation



Fig 4. Collected *H. illucens* samples

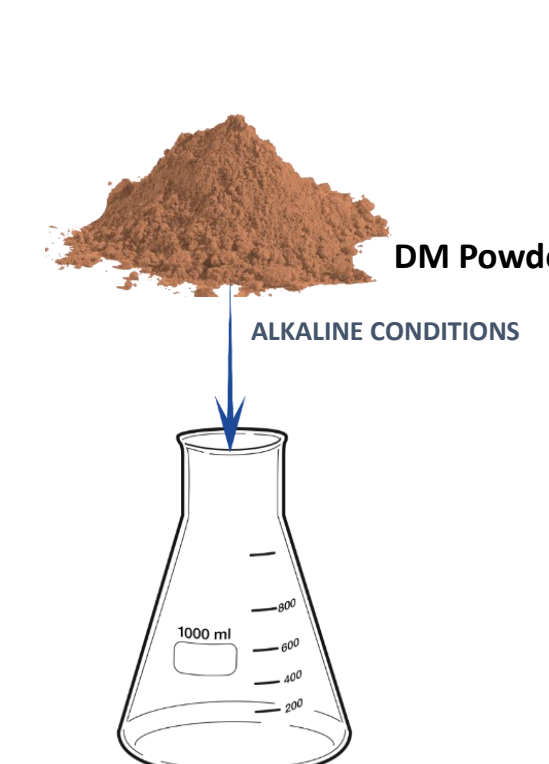
- *H. illucens* larvae, pupal exuviae and dead adults collected
- Washed and dried at 60 °C for 24–48 h
- Ground into fine powder

### Demineralization (DM)



- Raw powder treated with 0.5 M formic acid (1:10 m/v) for 1 h at room temperature
- Removes inorganic components, mainly calcium carbonate
- Samples filtered and washed with distilled water until neutral pH
- Dried at 60 °C overnight to obtain demineralized powder

### Deproteinization (DP)



- Demineralized material treated with 2 M NaOH (1:10 m/v) at 80 °C for 2 h
- Removes proteins; efficiency depends on initial biomass composition
- Samples filtered and washed with distilled water
- Dried at 60 °C overnight to obtain unbleached chitin

Chitin yield was calculated as the percentage ratio of the final dry chitin weight to the initial dry insect biomass Eq. (1):

$$\text{Chitin yield (\%)} = \frac{\text{dry weight of chitin (g)}}{\text{dry weight of the original raw insect sample (g)}} \times 100 \quad \text{Eq. (1)}$$

Future work includes bleaching unbleached *H. illucens* chitin to improve purity via pigment removal, with expected minor yield losses to be evaluated<sup>5</sup>. Subsequent studies will focus on chitosan production and comparison of green and conventional extraction methods to assess efficiency and sustainability<sup>6</sup>.

## RESULTS

Table 1 presents the biomass recovery obtained. Values are expressed as mean  $\pm$  standard deviation of three replicates.

Biomass	DM/RAW Recovery (%)	Chitin Yield (%)
Larvae	68.6 $\pm$ 4.6	11.6 $\pm$ 1.8
Pupal exuviae	75.5 $\pm$ 2.4	30.6 $\pm$ 1.1
Dead adults	66.2 $\pm$ 2.2	10.1 $\pm$ 0.8

Table 1. Biomass recovery after DM and chitin yield



Fig 5. Chitin extracted from *H. illucens* larvae (A), pupal exuviae (B) and dead adults (C)

Chitin was successfully extracted from *H. illucens* larvae, pupal exuviae, and adults (Fig. 5). Pupal exuviae showed the highest chitin yield (30.6%), approximately 2.6 $\times$  higher than larvae (11.6%) and 3 $\times$  higher than adults (10.1%). DM/RAW recovery was also highest in exuviae (75.5%).

## CONCLUSIONS

Pupal exuviae of *H. illucens* are the most efficient biomass for chitin extraction, yielding significantly higher chitin content and recovery compared to larvae and adults. This is likely due to their higher structural chitin content and lower proportions of proteins, lipids and minerals. These findings highlight exuviae as a promising sustainable source of chitin<sup>4,5</sup>. Future work should focus on optimizing green extraction methods, including enzymatic and solvent-based approaches to improve efficiency and environmental sustainability<sup>6</sup>.

## REFERENCES

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