Insect protein as an emulsifier

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Introduction

The increasing global population and consumer demand will make the provision of protein a serious future challenge. The lower environmental impact of insect farming makes the consumption of insects an appealing solution, although negative preconceptions on eating insects is present in many developed countries.

However, recent consumer studies have suggested that introducing "invisible insects" into food products may be a route to enhancing consumer acceptance[1]. For this reason, the incorporation of insect protein as a food emulsifier might have greater success in terms of consumer acceptance and could pave the way for consumption of unprocessed insects.

The aim of this research was to investigate the applicability of mealworm protein as an emulsifier in typical food emulsion formulations and processing conditions in view of providing a sustainable and dairy free alternative emulsifier.

Materials and Methods

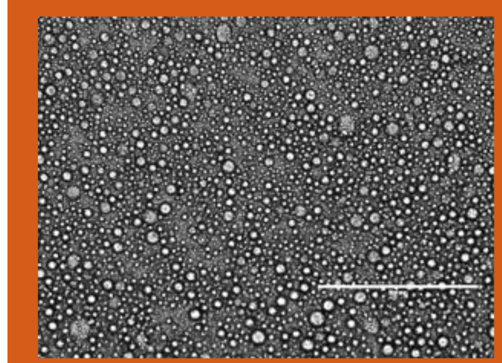
Live mealworms, *Tenebrio molitor* 18-26 mm, supplied by Monkfield Nutrition (Royston, UK) were frozen at – 80 °C for 24 h before freeze drying for 48 h. The freeze dried mealworms were ground to a fine powder. Lipid and protein extraction was carried out following published protocol[2,] after which a pH 7 soluble fraction was isolated.

Oil-in-water emulsions were prepared by mixing 80 g of aqueous pH 7 protein solution (0.44% protein, DM) with 20 g of sunflower oil followed by homogenisation using a high shear overhead mixer (L5M Series fitted with emulsor screen, Silverson, Chesham, UK) operating at 8,000 rpm for 2 min. The emulsions were stored at 25 °C for 24 h before pH, ionic strength or temperature stress tests were carried out. The emulsions were then stored for an additional 24 hr before microstructural analysis.

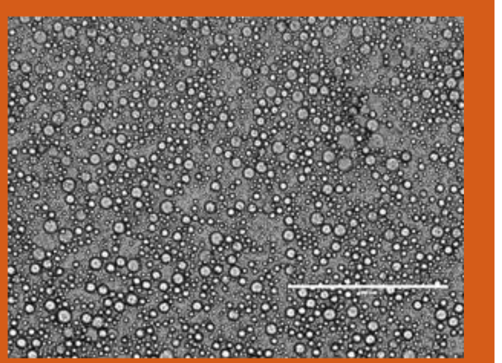
Food Processing Resilience

Salt

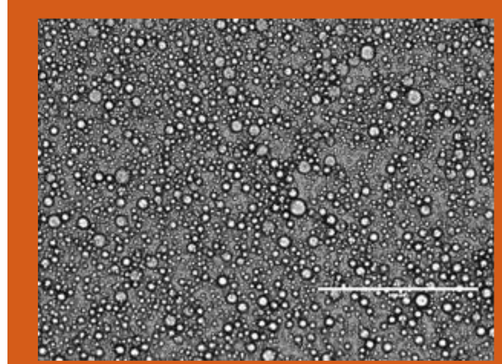
O mM NaCl



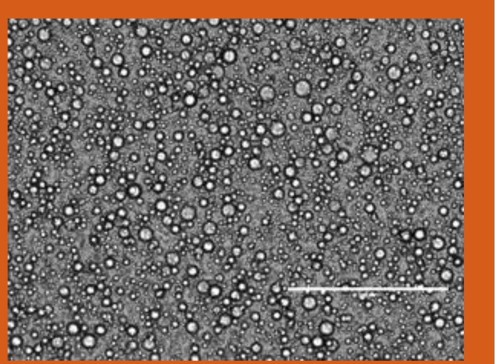
50 mM NaCl



150 mM NaCl



250 mM NaCl

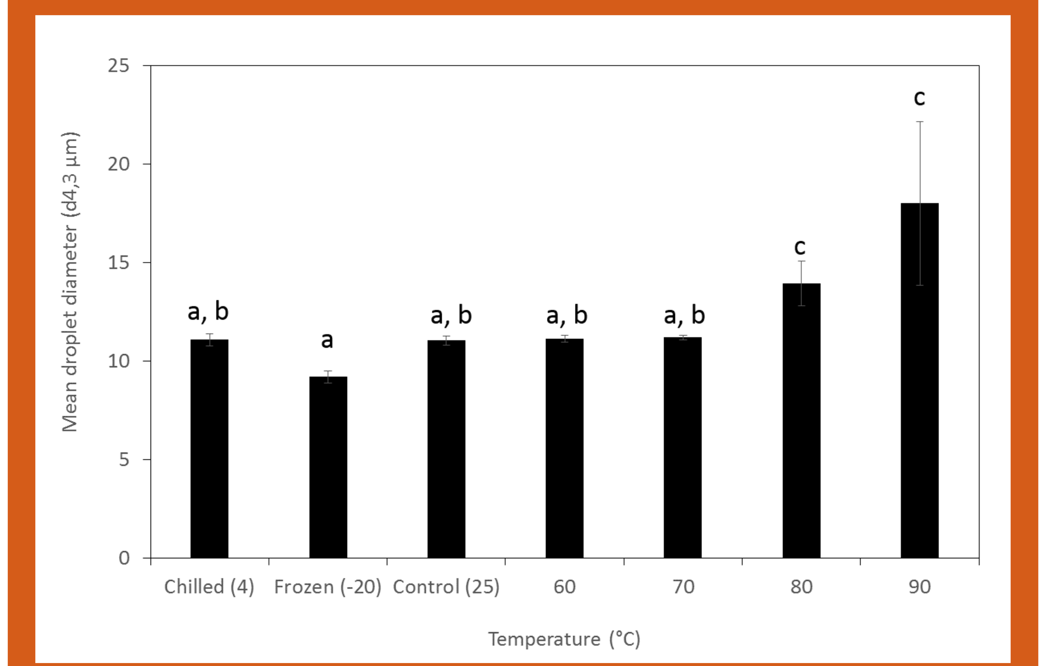


All emulsions exhibited good stability to NaCl with no significant change in droplet size or droplet flocculation compared to the control sample with no added NaCl or over storage.

However, flocculation may occur at higher salt levels based on literature reporting a near net zero zeta potential of mealworm protein at 1 M NaCl[3].

Temperature

There is no significant difference in the degree of flocculation and droplet size for emulsion samples heated up to 70 °C, chilled or frozen.



Mean droplet size for the emulsion heated to 90 °C was considerably larger than the other samples due to the flocculated microstructure.

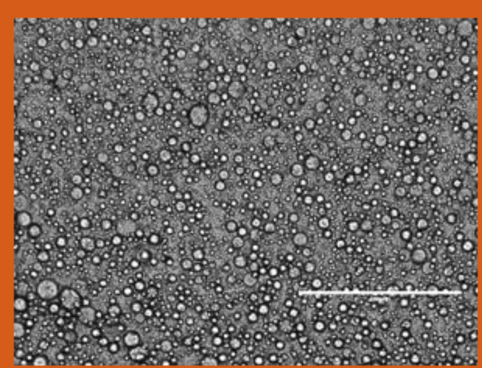
Emulsion samples that were frozen directly after homogenisation had a smaller mean droplet size as the freezing process would have prevented the initial coalescence of oil droplets

pH

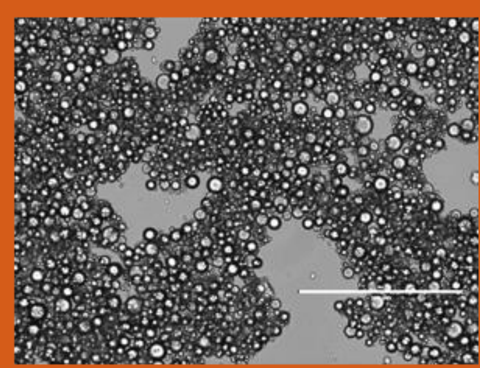
Droplet flocculation was evident at pH 4 which coincides with the lowest net surface charge and largest mean droplet

Flocculation is promoted by the low net surface charge which is indicative of the system being close to the isoelectric point of the protein.

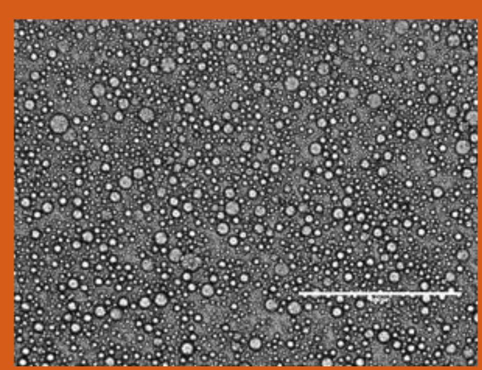
pH 2



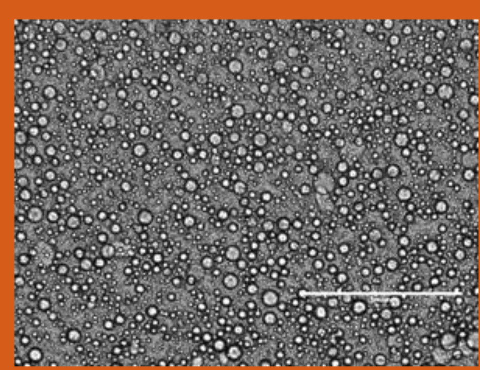
pH 4



pH 6



pH 8



The mean droplet diameters of the emulsions adjusted to pH 2, 6 and 8 are not significantly different from each other.

Drop size data acquired 8 days later were also not significantly different ($p<0.05$), indicating the emulsions were stable to coalescence.

Conclusions

This research has validated that protein isolated from mealworms could be utilised for food processing applications. Mealworm protein stabilised emulsions could be incorporated into formulations containing less than 250 mM sodium chloride as well as products that are chilled, frozen or heated up to 80 °C without altering the microstructure. Further research is required to understand non-microstructural challenges of the use of mealworm protein as a food ingredient including taste, ethics, consumer acceptance and legal.

[1]Schösler, Hanna, De Boer, Joop, & Boersema, Jan J. (2012). *Appetite, 58*(1), 39-47.
[2]Zhao, X., Vazquez-Gutierrez, J. L., Johansson, D. P., Landberg, R., & Langton, M. (2016). *PLoS One, 11*(2).
[3]Azagoh, C., Ducept, F., Garcia, R., Rakotozafy, L., Cuvelier, M-E., Keller, S., Mezdour, S. (2016). *Food Research International, 88*, 24-31.

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