Summary for the final report

EXtrusion texturization of PLant and INsect proteins and its Effect on Digestibility (EX-PLAIN-E-D

Alternative protein sources are becoming increasingly important in light of the growing global population. To ensure an adequate supply of nutrients, foods containing alternative proteins must offer optimal nutritional quality. Plant proteins are often used as alternative protein sources in sustainable foods, such as extrudates, but in many cases they are deficient in essential amino acids. One possible solution is to combine several protein sources to improve nutritional quality. Especially since their approval by the EFSA, insects have also become the focus of food research in Europe. However, the nutritional quality of insect proteins is influenced by other components such as fat and chitin, which is why fractionation processes are crucial for obtaining high-quality protein ingredients.

The Explained project aimed to determine the influence of fractionation conditions during protein extraction from mealworm biomass on the nutritional quality of the extracted proteins. Amino acid profiles, protein digestibility, and trace element bioavailability were analyzed to assess nutritional quality. In addition, the nutritional value of commonly used plant proteins was analyzed in order to develop combinations of insect and plant proteins that have an improved nutritional profile for humans. Both plant-based and insect-based protein ingredients were examined in terms of their techno-functional properties. The potential for further processing of nutritionally optimized mixtures of insect and plant proteins using thermophysical processes (extrusion) to produce textured proteins, as well as the nutritional quality of such products, were also largely unclear and were investigated. Finally, the insect protein produced was evaluated using life cycle assessment and was compared with protein from beef and soy.

During the Explained project, a fractionation process for producing mealworm isolate was successfully developed, which involves the following process steps. Commercially bred mealworms were blanched, coarsely chopped, and freeze-dried. Before defatting, the mealworms were further chopped. Various methods for degreasing the mealworms were tested, including oil pressing, Soxhlet solvent degreasing with different solvents, and extraction using supercritical CO_2. The best results were achieved using CO_2 extraction. In order to define suitable conditions for aqueous extraction followed by isoelectric precipitation, the protein solubility of the defatted mealworm meal was first determined. The highest solubility of the mealworm protein was found in the alkaline range, with a maximum value of 40% at pH 11. Based on the results of the solubility curve, several extraction conditions were tested on a laboratory scale, followed by a scale-up with the most promising parameters. Mealworm protein isolates with a protein content of almost 80% were produced, although the extraction yield was only at about 6%.

For the combinations of plant protein and insect protein, four different plant proteins (wheat gluten, soy protein isolate, sunflower protein concentrate, and pea protein isolate) were comprehensively characterized and their functional properties determined in addition to insect protein ingredients. The plant proteins exhibit very different functional properties. The results on the emulsifying properties of mealworm-based ingredients are particularly interesting. While defatted mealworm concentrate shows no emulsifying properties, mealworm protein isolate exhibits excellent emulsifying properties that are far superior to those of the plant proteins examined. Based on the amino acid composition of the plant proteins and the mealworm protein, seven different mixtures were developed and produced with the aim of achieving the best possible amino acid composition. Defatted mealworm meal was used for making the mixtures, as the quantities of isolate obtained were insufficient due to the low yield. The protein mixtures were extruded, with different process parameters first being tested and varied to define the best possible extrusion conditions. In addition to characterizing the powder mixtures, the protein digestibility-corrected amino acid score (PDCAAS) of the individual proteins and the mixtures was determined before and after extrusion. Two protein combinations could be developed having a PDCAAS value close to 1.0, which is the optimum. Extrusion did not impair the PDCAAS but even increased it minimally. In contrast, the analysis of trace elements showed that their bioavailability was reduced by extrusion.

In application trials, texturates and defatted mealworm meal were used to develop and produce burger patties, waffles, pasta, and meatballs. Among the burger patties, those containing a blend of mealworm and plant protein texturate performed better in terms of popularity, beef-like color, and firmness than the reference, for which only pea protein isolate texturate was used. The usage of defatted mealworm meal in waffles, pasta, and meatballs showed that the firmness and cohesion of the structure decreased with increasing mealworm content. It is therefore recommended that a proportion of 10% mealworm meal should not be exceeded for these applications.

As part of a life cycle assessment, mealworm protein was compared with protein from beef and soy. It was found that defatting using supercritical CO_2 has a significantly higher impact than conventional solvent degreasing, despite the reuse of CO_2. However, it would be conceivable to combine different degreasing methods to reduce this effect. Nevertheless, it was shown that mealworm protein is a nutritious and more sustainable alternative, especially when compared to beef protein.

IVLV members can download the complete final project report from our homepage. All you need is to register in the section “My IVLV”. Non-members can request the final report from the IVLV office at office@ivlv.org .

Gefördert durch:

INDUSTRIELLE GEMEINSCHAFTSFORSCHUNG

Bundesministerium für Wirtschaft und Klimaschutz

aufgrund eines Beschlusses des Deutschen Bundestages

The IGF project 01IF00352C was funded by the Federal Ministry of Economics and Energy based on a resolution of the German Bundestag.