Summary for the final report

Protein enriched refreshing beverages made from sweet lupines – value-improving of raw materials from plant origin creating a protein rich functional beverage base by means of a novel dual stage fermentation process (Protein Enriched Refreshing Beverages)

Lupins represent a promising vegan raw material for the production of protein-rich beverages without resorting to animal protein sources such as whey. Protein-rich beverages have gained an increasing market share in recent years. For small and medium-sized breweries in particular, which have been affected by declining beer consumption in Germany in recent years, the inclusion of such beverages in their portfolio could open up an important new sales market. However, to make such lupin-based beverages attractive for small and medium-sized breweries, existing equipment and traditional processes should be applicable for the innovative production process.

Therefore, the aim of the project was the development of a production process based on lupins that can be implemented in traditional breweries. By developing a germination process for sweet lupins a lupin malt high in soluble protein as a basis for protein-rich beverage prototypes should be produced. The process-relevant key data of the enzymes from germinated lupin seeds and from fruit/vegetable juices were determined in order to develop an enzymatic fermentation process for the production of a substrate for lactic acid fermentation. In parallel to this work, suitable lactic acid bacteria were screened on the basis of a model substrate consisting of hydrolysed lupin flour. Through optimization of the fermentation parameters, suitable microbial strains and parameters should be identified with which an optimized sensory taste of the later lupin malt hydrolyzates can be achieved. A further step was the development of a solid-liquid separation process to provide a lupin-based substrate for lactic acid fermentation. The focus was placed on the use of conventional lauter tuns and the associated cake filtration after the mashing process. Fermentation approaches, which resulted in increased protein solubility and sensory acceptance, in addition to a degradation of anti-nutritional ingredients, were transferred to lupin malt. Finally, a scale-up of the developed processes as well as stabilization experiments, application trials and product analysis were performed.

Germination proved to be effective for processing lupins. The strong shift of the protein from high to low molecular weight fractions explained the significant increase in protein solubility in the acidic pH range. The flatulence-promoting raffinose family oligosaccharides (RFO) were broken down during germination. Alkaloids and phytic acid were significantly reduced. Therefore, when processing lupins, germination should be considered as a target step for refining the seeds.

Enzymatic fermentation directly with lupin malt has been proven to be ineffective due to the high swelling capacity. Since the lautering process has shown to be impractical, filtration (e.g. press mash filter) should be used for commercial implementation.

The use of freshly produced fruit and vegetable juices for enzymatic hydrolysis of lupin malt proved successful in increasing the solubility of lupin proteins at the isoelectric point. As a result, the molecular weight distribution in the range of <15 kDa increased significantly. The increased protein solubility from the seed enabled protein contents of the beverage bases of 25–46% of the dry substance, depending on the juice used. At the same time, however, the addition of juice led to an increase in the sugar- (glucose, fructose, sucrose), phytic acid- and, with the supporting use of papain, also to an increase in RFO concentrations.

The lactic acid fermentation of the hydrolysates reduced the sugar content and increased the protein solubility at pH 4.5 as well as the protein contents of the samples. Optimization of the fermentation parameters (in particular by using heterofermentative microorganisms and a longer fermentation time), increased the protein solubility at pH 4.5 to up to 95% while reducing the RFO concentration. The extension of the fermentation time proved relevant for sugar degradation and was generally advantageous for the sensory optimization of the beverage samples.

Sensory analysis identified three of the initial 53 approaches as particularly promising for beverage development. After the production on a semi-technical scale, the beverages a subsequent tasting with a larger number of participants revealed great potential for further development to market maturity. Analytical studies confirmed a low calorie content, a very high, claimable protein content and the hypotonic character of all three beverages. Flavoring of the final products neutralized off-flavors and increased acceptance. The products show a high protein solubility and an advantageous composition of the ingredients. Both before and after flavoring, the developed products can be claimed as “high in protein” and show the potential for the production of protein-rich lupin beverages with refreshing character.

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.

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