Thermal treatment of faba bean for flavour improvement

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Legumes Translated

There is more to the potential food use of faba bean than meets the eye. The functional ingredients produced from the bean itself, such as flour or protein isolate and concentrate, can be used to make pasta, crackers, flakes, mayonnaise and dairy or meat analogues. Nevertheless, the use of faba bean in the food industry remains low, especially compared to soy. There is renewed interest in using faba beans in dairy-type aqueous processes. The constraint is the beany off-flavours (also known as *aokusami*) found in legumes. This unwanted flavour is caused by the action of certain enzymes on fats. It can be controlled by gentle heat treatment that denatures the enzymes without greatly affecting the properties of the other proteins. Value chains that incorporate steps for denaturing the enzyme activity are able to offer a product of higher quality with fewer off-flavour compounds.

Outcome

This practice note provides useful information on how to denature flavour-affecting enzymes when developing food products from faba beans.

Off-flavours in faba bean

Volatile compounds (e.g., aldehydes, alcohols, alkanes, ketones and aromatic hydrocarbons) are the sensory elements that affect the flavour perceptions of faba beans. Some of these compounds cause the undesirable flavour notes in faba bean foods produced using aqueous (wet) processing or fermentation. They emerge when the lipids undergo a process of degradation and oxidation catalysed by lipase, lipoxygenase (LOX) or peroxidase (POX). Lipid oxidation is important to consider as it affects the shelf life of food products. The process starts during harvesting, early processing and storage, when seeds are exposed to temperature, pH and moisture variations along with physical damage that degrade the physical barrier between the enzymes and the fatty acids (free or esterified), glucosides and amino acids within the cells of the bean.

Applicability

Theme: Food processing

For: Food ingredient manufacturers

Where: Wet and dry fractionation processes

Timing: Before milling and dehulling

Equipment: Microwave equipment or steam generator

Follow-up: Testing for enzyme activity

Impact: Control of beany flavours

Heat treatment

Heat treatment is an efficient way to inactivate or denature enzymes in any material made from faba bean. The treatment needs to be mild

Whole faba beans. Photograph: Frederick Stoddard

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so it denatures these heat-sensitive enzymes without cooking the rest of the protein, as the cooked protein cannot be extracted to make a milk analogue or protein isolate. The target temperature is around 65–70°C. Possible heat treatments include microwaving, conventional ovens, steaming or kilning in the production line.

Dehulling and milling increase the surface area of lipids exposed to the air and break the cells, increasing the access of enzymes to the lipids. This boosts the formation of unwanted flavour notes. Heat treatment applied prior to dehulling and milling is therefore beneficial. If the beans were dehulled prior to the heat treatment, then the heat-treatment step needs to follow immediately afterwards to prevent the formation of undesirable flavours.

Steaming

Hot steam denatures the enzymes of faba beans. The steam penetrates the cotyledons of the bean effectively.

Pre-treatment of seeds with hot dry steam is an option for smaller mills. It is regularly used to inactivate the lipases of oats. It is therefore an existing process in many smaller mills that can be applied to faba beans. There are industrial-scaled steamers in Europe available for pre-treatment of grains. The settings on a flow-through oven have been optimised for this purpose in Finland. The timing and temperature have to be determined for each individual oven.

Microwaving

Microwaves vibrate the water molecules and the vibration energy transforms to heat. The microwave waves penetrate the cotyledon even more effectively than steam.

Research conducted at the University of Helsinki showed that microwave heating (at 950 W for 1.5 min) of small batches of faba beans inactivated the peroxidase and lipoxygenase.

Achieving the same result on an industrial scale depends on the size of the equipment and sample size. Like conventional oven heating, the timing and energy level have to be determined for each individual oven. Microwaving has a short processing time and is able to spread high temperatures throughout the cotyledons, faster than conventional oven heating. The application of a microwave treatment for faba beans at an industrial scale would require a microwave-based conveyor belt system. This is not commonly used for pre-treatment of grains in Europe.

Testing for enzyme activity

In order to check whether the flavour-affecting enzymes have been denatured, the peroxidase activity can be tested. The minimum heat treatment resulting in inactive peroxidase will result in a product with optimal protein performance and without objectionable flavour. Peroxidase activity is more heat tolerant than lipase and lipoxygenase. If peroxidase activity is successfully inactivated, it is safe to assume that the lipase and lipoxygenase are as well.

Peroxidase activity is generally analysed with a guaiacol-H_2O_2 method. The light absorbance of two solutions, one as the reacting solution and the other as blank, is measured using a spectrophotometer and the enzyme activity is calculated from the result.

In the absence of a spectrophotometer, the enzyme activity can be visually assessed. This requires colour models to determine the colour development indicating the strength of the enzyme activity. Such a visual assessment is normally part of a miller or mill technician's skillset.

Spectrophotometer Model 1. Photograph: Viv Rolfe, licensed under CC BY-ND 4.0.

Key practice points

- There are several ways to denature flavour-affecting lipoxygenase and other endogenous enzymes.
- Millers provide important know-how for implementing the treatment effectively.
- Lipase, lipoxygenase and peroxidase activity can be tested using a guaiacol-H_2O_2 method by spectrophotometer or visual assessment.

Further information

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