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Biorefining of Oilseed Crops as Basis for Molecular Farming of High Quality Products

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Introduction

Cruciferous oilseeds are very suitable raw materials for industrial processing and a broad variety of high quality and thereby added value products can be obtained using the developed Bioraf technology. The aqueous enzymatic oil extraction performed at Bioraf, Denmark, provides an excellent basis for high value end products in a process aimed at complete utilization of the biomaterial. Avoiding waste materials as well as harmful organic solvents ensure a process fitted for future regulations on ecological processing methods.
The aqueous enzymatic oil extraction now developed as a third generation method of this unique biotechnology for agro industry (Bagger et al. 1996; Palmieri et al. 1998) gives the basis for separation and isolation of high value natural products in molecular farming programmes and as such it is also an important supplement to the traditional oil mill extraction and processing technology. New high quality products can thus be obtained from the oilseed crops, e.g. special edible and technical oils and additives, protein concentrates and isolates, dietary fibres along with several single compounds and mixtures of compounds with potential biocidal, antioxidative or health related beneficial effects.

Process requirements

In order to get high quality products it is of great importance to have a well-analysed and controlled process. Efficient methods of analyses for control of the processing conditions and for product composition and quality are therefore very important and have been developed for determination of individual native compounds and possible transformation products thereof (Sørensen and Sørensen, 1998; Bjergegaard et al. 1998). These methods comprise HPCE-MECC and supercritical fluid techniques (SFT = SFC + SFE) for determination of glucosinolates, glucosinolate derived products, individual chlorophylls, tocopherols, vitamins, phenolics, triacylglycerols and phospholipids (Buskov et al. 1997 and 1998; Agerbirk et al. 1998; Bjergegaard et al. 1998). Inactivations of native enzymatic systems as myrosinases and lipoxygenases are vital for the process, and these inactivations are performed in a relatively selective process without long-term heat treatment as this may cause problems with respect to transformation of native biomolecules into artefacts.

Applied technology

Separations of the aqueous emulsions obtained in the enzyme catalyzed cell wall degradation process comprise the use of decanters, centrifuges, filtration, ultrafiltration, flash chromatography, precipitation and crystallization techniques, which result in the variety of different products. Even as it is an advanced processing technique, it is a relatively simple type of biotechnology, which does not leave any waste- or unused products. The performed preliminary technical / economic feasibility studies including market research indicate, that a combined production can be a viable investment.

Product description

Oil:

The oil product is divided into two different qualities. Edible oil and technical oil, tailor-made to meet the different requirements for these types of oils. Both oils contain natural antioxidants that are beneficial with respect to storage and as free radical scavengers. The process conditions are designed for omission of oil degumming and the initial enzyme inactivation minimizes the degradation products from glucosinolates, which reduce the need for extensive oil refining.

Protein concentrates:

Different protein products are produced in the process. These products differ from each other in physical properties caused by differences in protein content, protein composition and type. New types of protein products are produced to meet the requirements for specific industrial applications as for example emulsifiers and surface-active protein-lipid products.

The amino acid composition of the proteins makes them well suited for use as high quality feed products or as food. Special products with lipophilic proteins associated with amphiphilic lipids have been produced.

Hulls:

Fiber pellets for feed are produced from meals of the hulls and remaining unused syrup.

Phospholipids:

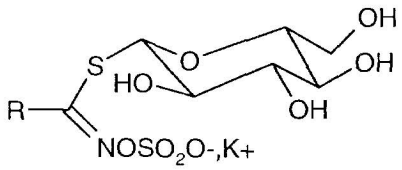
Phopholipids can be isolated by SFT and preparations with different composition of the most common phospholipids can be made.

Myrosinase:

A cheap and simple technique for isolation of great amounts of pure dry myrosinase has been developed.

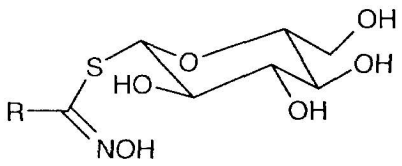
Glucosinolates:

Different intact glucosinolates have been isolated and can be produced in large scale. Examples of glucosinolates are the rapeseed glucosinolates and specific compounds as e.g. epi-progoitrin, gluconapin, glucobarbarin, glucotropaeolin, glucoraphanin, sinalbin and sinigrin. These glucosinolates have the common structures shown below with variations in the R-group:

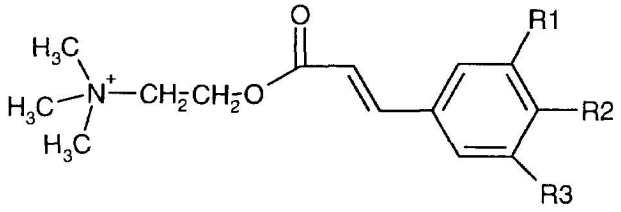


Desulfo glucosinolates:

Desulfo glucosinolates corresponding to the intact glucosinolates mentioned above have also been produced.



Choline esters:
Aromatic choline esters as for example sinapine have been isolated for various experimental purposes as e.g. natural antioxidants. Sinapine contains methoxy groups as R1 and R3 and a hydroxy group as R2.



Myrosinase, glucosinolates, desulfo glucosinolates and aromatic choline esters can be purchased from Bioraf Denmark and additional informations can by request be given concerning these products.

Conclusion

Biorefining of agricultural crops rich in protein and oil, as oilseed rape and other *cruciferous* plants, are possible with use of an initial enzyme catalysed cell wall degradation in aqueous solution. The following separations of the obtained aqueous emulsion are based on use of decanters, centrifuges, filtration, ultrafiltration, SFT and FC techniques. These gentle biotechnology processes give an initial removal of the hulls and the opportunities for production of high quality – added value products as special oils, proteins and various types of other natural products. The developed Bioraf techniques are operating in Pilot Plant scale with use of up to several hundreds of kilograms of seed and this biotechnology seems to be an efficient tool needed for utilization of various natural products in system known as molecular farming.

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