Aqueous Enzymatic Processing of Rapeseed for Production of High Quality Products

S. K. Jensen, H. S. Olsen, and H. Sørensen

INTRODUCTION

Production and optimal utilization of rapeseed are of great economical importance for many countries (Larsen and Sørensen 1985). Rapeseed contains oil (40–46%) and protein (20–30%) of high quality, but also glucosinolates. Glucosinolates can be critical for both oil and protein quality, especially if too high concentrations of these compounds or especially their degradation products are present in the oil and protein products (Bjerg et al. 1987a; Sørensen 1988). Novel processing methods of rapeseed have therefore attracted considerable attention.

Rapeseed proteins have a well-balanced amino acid composition, which is reflected by a high biological value (Bjerg et al. 1983). However, too high content of glucosinolates and their degradation products, aromatic choline esters, and hulls in rapeseed products can pose serious problems (Bille et al. 1983; Sørensen 1985 and 1988). With respect to the glucosinolates, various experiments have revealed benefits of feeding animals and poultry with rapeseed meals from double-low varieties instead of such products from single-low varieties (Vogt 1981; Rundgren 1983; Thomke et al. 1983; Bell 1984; Sørensen 1985). However, optimal utilization requires high-quality double-low varieties and efficient processing to avoid problems with rapeseed meal used as a protein source or milk substitute for young fast-growing animals such as piglets, mink, and calves (Sørensen 1988) and eventually in food for human consumption. The various problems caused by individual glucosinolates, and even more harmful effects from glucosinolate degradation products, have been documented by the use of pure compounds in animal trials (Bjerg et al. 1989).

Traditional rapeseed processing (pressing and hexane extraction) results often in appreciable glucosinolate degradation. Reported values are in the range of 40–60%...
for aliphatic glucosinolates (Daun 1986) and even higher for indolyl glucosinolates (Campbell and Cansfield 1983). The unstable 4-hydroxyglucobrassicin, which is quantitatively dominating in double-low rapeseed (Bjerg et al. 1987b), is often nearly totally degraded in traditional methods of processing.

In addition to traditional rapeseed processing, various types of other processes have been used for the removal of glucosinolates, glucosinolate degradation products, and other compounds reducing the quality of rapeseed meal. These processes comprise physical, chemical, enzymatic treatments; heat treatment followed by water extraction (Rauchberger et al. 1979); aqueous ethanol extraction (Van Megen 1983), eventually after myrosinase treatment (Finnigan et al. 1989); ammoniation (Kirk et al. 1966; Keith and Bell 1982); methanol ammonia-water extraction (Naczk et al. 1986); preparation of protein concentrates (Mieth et al. 1984); and other detoxification procedures (Vaccharino et al. 1978; Maheshwari et al. 1981; Lacroix et al. 1988).

The aim of the present work was to introduce a gentle procedure for rapeseed processing based on aqueous extraction without the use of organic solvents for production of high quality products. This process (Olsen 1988) involves inactivation of myrosinases, use of cell-wall degrading enzymes on milled seeds suspended in water, and centrifugations resulting in four fractions: oil, protein-rich meal, syrup, and hulls. The effects of this process are evaluated in chemical-biochemical analysis and animal trials.

EXPERIMENTAL

Materials
Seeds of Danish-grown varieties of double-low rapeseed (Brassica napus L.) were obtained from Trifolium Silo A/S (Taastrup, Denmark). Enzymes used in the processing were the multi-activity enzyme mixture SP-311. This was a special experimental version of SPS-ase (Soya polysaccharide degrading complex) produced by Novo-Nordisk A/S (Bagsværd, Denmark) from a selected strain of Aspergillus niger (Adler-Nissen et al. 1984). SP-311 has been found suitable for degradation of the rapeseed cell walls, and this enzyme mixture had catalytic activity toward hydrolysis of pectic substances, hemicellulose, cellulose, and other cell wall constituents. The enzyme mixture (SP-311) produced in fermentation plants, purified, and standardized by Novo-Nordisk A/S was used in this form based on weight amounts and without other descriptions of various activities and units.

Methods
Myrosinase activity was determined in McIlvaine buffer (pH 6.7) with sinigrin (33 μM) as substrate and measuring A_{233} (Buchwaldt et al. 1986). One unit (U) = 1 μmol sinigrin hydrolyzed per minute at 25°C (ε = 9,000 cm x ml/mmol).