RAPESEED CONCENTRATE

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Introduction

Oilseeds are a valuable source of protein which are more and more widely used for human nutrition. Rapeseed protein, according to research recently carried out, has the highest biological value among all sources of oilseed protein (SARWAR et al., 1973; SOSULSKI and SARWAR, 1973).

Rapeseed, like other oilseeds, contains factors, which are precursors of isothiocyanates and oxazolidinethione (RUTKOWSKI and KOZLOWSKA, 1967; ETTEN, 1969). These compounds after oil extraction are present in the meal and thus limit the utilization of rapeseed meal as animal feed. Because of these substances rapeseed is not being used as a source of protein concentrates and protein isolates for human consumption.

The methods used until now for the detoxification of rapeseed were concerned with removing these compounds from the meal by toasting, extraction with organic solvents, fermentation etc. (RUTKOWSKI and KOZLOWSKA, 1967; BOWLAND et al., 1965; STARON, 1970). The use of protein for human consumption, requires other methods of detoxification, making possible the removal of all glucosinolates while preserving the protein.

In recent years new methods of detoxification were reported for whole and crushed rapeseed (BHATTY and SOSULSKI, 1972; EAPEN et al., 1968; SOSULSKI et al., 1972; TAPE et al., 1970). These methods create new possibilities for the use of rapeseed protein in human nutrition. The detoxification of whole seeds by "Diffusion Extraction" depends on the extraction of whole seeds in water (SOSULSKI et al., 1972; KOZLOWSKA and SOSULSKI, 1972a) or in an aqueous solution of ethyl alcohol (BHATTY and SOSULSKI, 1972; KOZLOWSKA and SOSULSKI, 1972b). In this process low molecular compounds such as glucosinolates, sugars and nitrogenous compounds, mostly "non-protein nitrogen" as well as phenolic compounds diffuse from the seed to the solution through the cell membranes.

In the present work, special attention was given to removing glucosinolates from rapeseed using the diffusion extraction method. This first step for obtaining the concentrate is the most important one. The level of glucosinolates in rapeseed and in flour, concentrate, or isolate, determines the possibilities of the use of rapeseed protein in human consumption.

Methods

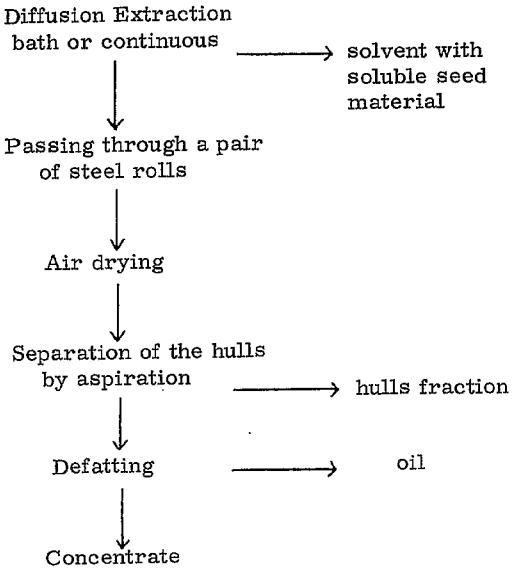
Two varieties of rapeseed, "Span" (Brassica campestris) and "Skrzeszowicki" (Brassica napus) were used.

Diffusion Extraction (DE) of rapeseed was conducted using the following procedures:

- Bath DE: The seeds were extracted with 0,01 N sodium hydroxide at 70, 80 and 90°C using polyethylene bottles in a shaking water bath.
- Continuous DE: Extraction was carried out in a heated open vessel equipped with a strirrer and overflow valve.

The freshly diffused seeds were pressed by a single pair of steel rolls, air-dried and the hulls removed by aspiration. After separation of the hulls, meals were defatted using petroleum ether in a Soxhlet apparatus (Scheme 1).

Scheme 1: The process of DE of whole rapeseed conducted on a laboratory scale



3-Butenyl isothiocyanate (BI), 4-pentenyl isothiocyanate (PI) and 5-vinyl-2-oxazolidinethione (OZT) were determined by the methods of YOUNGS and WETTER (1967).

The sulfur content of the oils was determined by decomposition of the glucosinolates with glacial acetic acid and magnesium turnings in an Erlenmeyer flask. A stream of air was led into a condenser which was fitted with a lead acetate paper disc. The darkness of the lead sulfide deposit on the paper was measured in a densitometer and the ppm of sulfur estimate from a calibration curve (YOUNGS, 1971).

Results and Discussion

Previous studies demonstrated that the diffusion rates of glucosinolates, which are detected as their aglycones, were enhanced by frequent changes of solvent, high temperature, high seed to ratios and the range neutral to alkaline pH of the aqueous medium (SOSULSKI et al., 1972). Three to four 1h-extractions with 0,01 N sodium hydroxide at 60°C were sufficient to remove all but traces of the glucosinolates from samples of rapeseed. Recent experiments have demonstrated that essentially all of the glucosinolates can be diffused from Canadian "Span" rapeseed by two bath extractions when the temperature was increased to 70°C or higher, using a seed to water ratio of 1:20 in each extraction. Similarly, the sulfur content of the oil after 1 h diffusion extraction appeared to decrease as the temperature was raised. Of equal importance was the observation that the sulfur compounds could diffuse from the oil, even though the rate appeared slower than diffusion from the other parts of the seeds. Under the condition employed, at least 1 to 2 hrs of aqueous diffusion extraction at 90°C are required to reduce the sulfur content to a safe level (Fig. 1).

Because the best conditions for the extraction of glucosinolates were obtained at a temperature of 90°C, the next experiment with the Polish rapeseed "Skrzeszowicki" (containing 50 % more glucosinolates than the "Span" variety - table 1), was conducted at 90°C with sodium hydroxide using a seed to solvent ratio of 1:10 or 1:3,3 in each bath extraction.

Table 1: Isothiocyanates and OZT in defatted rapeseeds: Span and Skrzeszowicki

Variety	mg aglucones/g meal			
	BI	PI	OZT	total ITC+OZT
Span	3.4	2.3	2.4	8.1
Skrzeszowicki (undehulled)	3.2	1.0	12.7	16.9
Skrzeszowicki (dehulled)	4.1	1.4	15.8	21.3

For the purpose of accelerating the rate of extraction of glucosinolates, dehulled seeds were used (Fig. 2). It was noted that glucosinolates were completely extracted from dehulled seeds after 1,5 hours of extraction, whereas the intact seeds still contained traces of these compounds after 3 hrs. Thus, dehulling the seeds allows shortening the time of extraction and reducing the amount of solution by about 50 %. Further reduction of the ratio of seeds to solution caused a slower decrease of glucosinolates in relation to time, even though after 3 hrs. of extraction the amount of these compounds were the same as in seeds that were extracted at a seed to water ratio 1:10.

Figure 1: Influence of temperature and number of 1 h bath extractions with 0.01 N sodium hydroxide on the diffusion of glucosinolates from intact Span seeds and the sulfur content of the oil

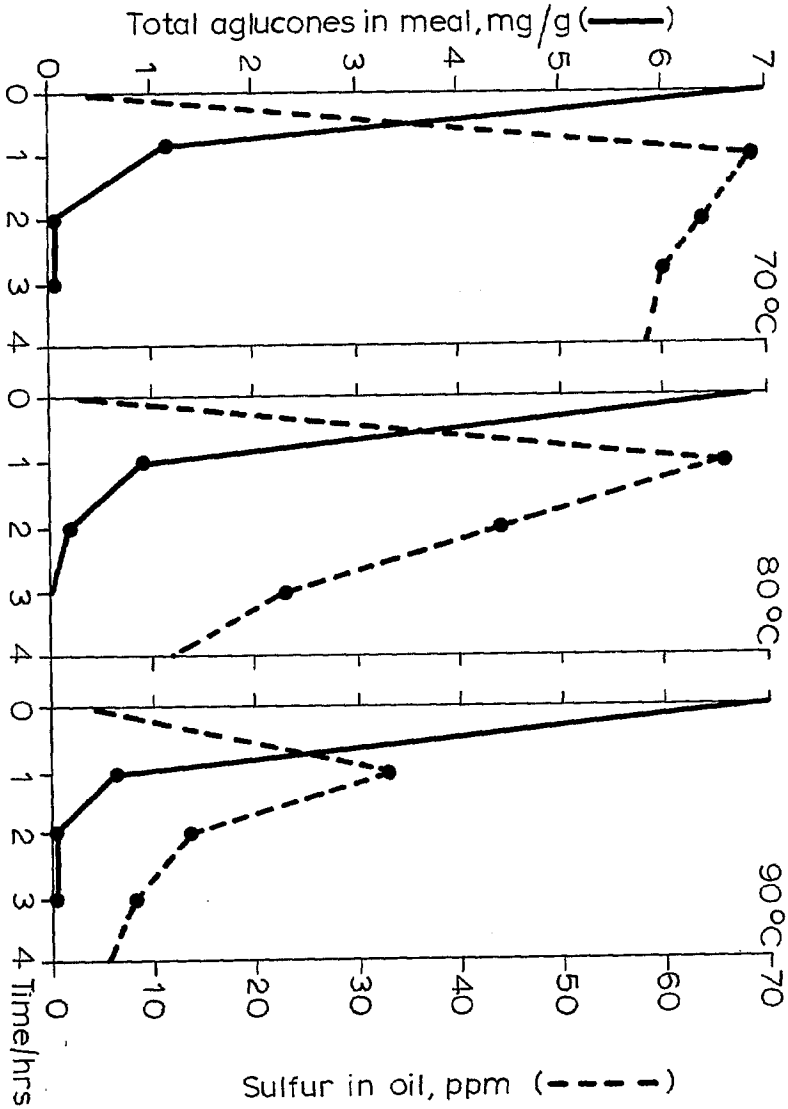


Figure 2: The content of aglucones in Skrzeszowicki rapeseed meal during the bath extraction (90°C, pH 9)

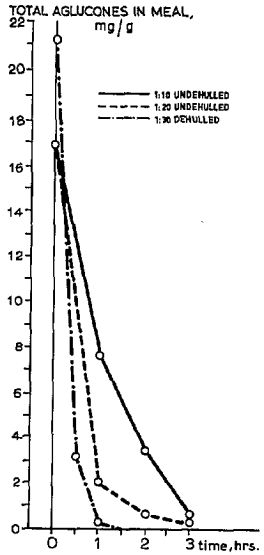
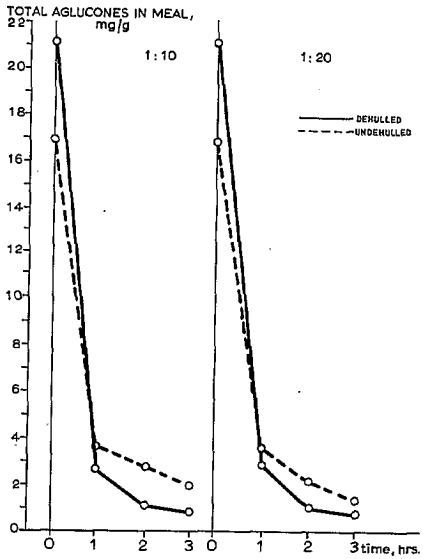


Figure 3: The content of aglucones in Skrzeszowicki rapeseed meal during the continuous extraction (90°C, pH 9)



Continuous extraction methods were investigated as a means of reducing the solvent volumes and diffusion time required to detoxify rapeseed of the "Skrzeszowicki" variety. The seed to solvent ratios in these experiments which were conducted at 90°C, were 1:10 and 1:20 during a 3 hours extraction period (Fig. 3).

As in the previous experiment, most glucosinolates were removed from the seeds during the first hour of extraction, averaging about 78 % in undehulled seeds, and 8 % higher in dehulled rapeseed. The lengthening of the time of extraction caused a further decrease of glucosinolates with no noticeable difference between samples extracted at seed to solution ratios of 1:10 and 1:20.

On the basis of these results it is concluded that more complete removal of glucosinolates is achieved by bath diffusion extraction, but the consumption of water is relatively high in this process. A noticeable decrease in extraction time can be obtained by conducting the extraction with dehulled seeds.

Besides the problem of the removal of glucosinolates from rapeseed, which seems to be almost solved, there is the problem of hulling. The hull may be removed from the seed at various steps, namely:

1. Before DE, thus shortening the time of extraction. In this case the losses of dry solids are higher.
2. After DE, which means that the mucilageous substances connecting the hulls with the meat are washed away during extraction causing easy removal of the hulls.
3. After DE, and after oil extraction, the process of removing the hulls on a technical scale has not yet been solved, and this problem is the subject of research in many laboratories.

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