Extraction of N-Compounds of Rapeseed Meal in Relation to pH and Temperature

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ABSTRACT

Nitrogen compounds were extracted from defatted rapeseed meal with 0-0.1 N aqueous sodium hydroxide or hydrochloric acid. Extractions were carried out for 30 min in water bath at 20, 40, 60, 80 or 100 C. Samples were centrifuged and concentrations of nitrogen and pH were measured. The highest extractability of N-compounds (more than 80% of total N) was at pH 9.5-10 and 30-45 C. The lowest extractability (20-25% of total N) was at pH 6.5-8, and 80-100 C, the region of heat denaturation, and at pH 3.8-4 at 20 C (35% of total N).

INTRODUCTION

In recent years, a considerable amount of scientific and technological research was done in several countries on the utilization of specially processed low fat oil seed meals for developing processed foods based on isolated plant proteins. Up to now the main source of protein isolates used for this purpose has been soybean and peanut meal.

In countries of North and Central Europe, e.g., France, Germany, Poland and Sweden, the main oilseed source is rapeseed. Rapeseed meal containing ca. 37% of proteins is produced on a large scale by the oil industry of these countries.

The amino acid composition of rapeseed protein indicates that the rapeseed meal may be a good source of an edible protein (1). Rapeseed protein isolate is rich in lysine (6-7%) and sulfur amino acids (4-5%). Therefore this isolate could be very useful as a supplement in mixture with other, e.g., cereal, proteins. The protein nutritive value expressed as chemical score (CS) EAA Index, or NPU is similar to soybean protein known as one of the best plant proteins (2,3).

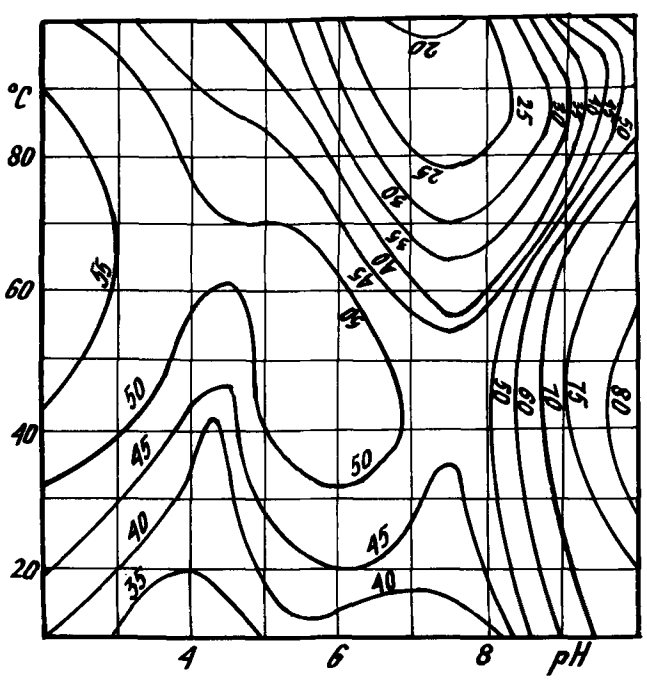

FIG. 1. Extractability of N-compounds as a function of pH and temperature of extraction. The numbers over the contour lines represent the level of extractability of N-compounds in per cent of total nitrogen of extracted meal.

The technique of isolation of rapeseed protein could be based on the method used for soybean. High productivity of this process depends on the knowledge of the main properties of rapeseed proteins. Unfortunately there is rather little data in the literature. Pokorny et al. (4) found that addition of 10 ml 0.3% NaOH/1 g of rapeseed meal and coagulation at pH 4 gave high efficiency and good quality of isolated protein. The results of Finlayson (5,6) provided more information concerning the characteristics of rapeseed proteins.

In this work we studied the extractability of nitrogen compounds of rapeseed, as a function of pH and temperature, to obtain basic data for effective isolation of rapeseed proteins.

MATERIALS AND METHODS

Preparation of Oil-Free Rapeseed Meal

Ground rapeseed was extracted for 8 hr with hexane in a laboratory Soxhlet extractor. Oil-free meal was air-dried overnight at room temperature and then dried additionally under low pressure (1 mm Hg) at 40 C for 4 hr.

Extraction of Rapeseed N-Compounds

10 g of oil-free rapeseed meal was blended with 200 ml of NaOH or HCl solution in a concentration up to 0.1 N. Then samples were transferred into round bottom flasks and heated under reflux for 30 min in a water bath at constant temperature (20, 40, 60, 80 or 100 C) with continuous stirring. After cooling under tap water the samples were centrifuged at 2000 rpm for 20 min.

Nitrogen in the supernatants was determined by the Kjeldahl method and the pH was measured with a pH meter.

RESULTS AND DISCUSSION

The extractability of N-compounds expressed in per cent of total nitrogen of defatted meal is shown in Figure 1. The coordinates, pH and temperature, of given levels of extractability were established by inter- and extrapolation of the experimental data. The contour lines shown in Figure 1 connect points of the same extractability. Four characteristic regions of influence of pH and temperature on extractability of the nitrogen compounds of rapeseed meal are apparent:

The first is the range of pH 2-3.8. The highest extraction in this region is 55-60% at 60-80 C. Maximum extraction is at 65 C and decreases above and below this temperature. Extraction decreases with increasing pH.

The second is the range of pH 3.8-5.5. The minimum extraction is about 35% at pH 3.8 at 20 C. Extraction increases with increasing temperature to about 50% at 65 C. Raising the temperature above 65 C, to 100 C, decreases extraction to 35-40%.

The third is the range of pH 5.5-7.5. Increasing the temperature to 50 C increases extraction from 40-52% but thereafter extraction decreases to 20-25% at 100 C. In the

pH range of 6-8, 80-100 C is the region of heat denaturation of protein. The contour line of 45% extraction at 20-40 C in the range of pH 7-8 indicates the presence of a small protein fraction with minimum solubility at pH 7.5.

The fourth is the range of pH 7.5-10. Increasing the pH from 7.5 to 10 and the temperature to 40-45 C increases extraction to 80-85%. Maximum extraction is at pH 9.5-10 and 35-40 C. Further increase in temperature reduces extractability because of heat denaturation.

From a technological point of view there are two regions suitable for protein extraction. The first is limited by coordinates pH 9.5-10, temp 30-45 C, where nitrogen extraction is highest, more than 80%, and the temperature of extraction is below that of heat coagulation of proteins. The second region is limited by coordinates pH 2, temp 65±10C but extraction is much less effective as the maximum extraction is only 55-60%. The lowest extraction of nitrogen is at pH 7-8 and 80-100 C, a region of heat denaturation of proteins. These conditions could be used in preparation of meat-like products from rapeseed meal. But for isolation of undenaturated proteins from rapeseed meal extraction at pH 9.5-10 at 30-45 C and precipitation at pH 3.9 at 20 C or below seems the most useful.

ACKNOWLEDGMENT

Mrs. E. Pioterczak gave technical assistance.

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[Received October 8, 1970]