

REFRACTOMETRIC METHOD FOR EVALUATION OF SOYBEAN PROTEIN SOLUBILITY

METODĂ REFRACTOMETRICĂ PENTRU EVALUAREA SOLUBILITĂȚII PROTEINEI DIN SOIA

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During the manufacture of soybean meal a quick control is essential, so that simple and rapid methods, to enable an immediate decision to be made, are of value. A simple and rapid method for estimating soybean protein solubility on the basis of changes in the refractive index of dilute potassium hydroxide solution extracts was tested and we found to be highly correlated with the usual protein solubility test in KOH ($r = 0.9382$). Determination of biophysical parameters instead of chemical indices has two great advantages: the methods are nonpolluting since they don't use chemical substances, and the methods are very rapid.

Keywords: soybean meal, KOH protein solubility, refractive index

Introduction

The challenge in soybean meal processing is to apply the optimum amount of heat to produce the most nutritious product. Insufficient heating, or under processing, has a negative effect on the amino acid digestibility because the anti-nutritional factors are not adequately destroyed. When soybeans or soybean meal are exposed to excessive heat treating, or over processing, a reduction in protein quality occurs due both to the destruction of essential amino acids lysine, cystine and methionine and to the reduced digestibility of those not destroyed (Dudley-Cash, 1999).

Most soybean meal is produced today by the solvent extraction process whereby the soybeans are cracked, heated and flaked before the oil is extracted with the solvent hexane. Once the oil has been removed, the flakes are toasted and ground into meal. During this production process, temperature is critical in order to deactivate the anti-nutritional factors naturally present in raw soybeans.

Thermal treatment is the most common method used for reducing protease inhibitor activity to the level that will have no adverse effect in nutrition. Different modes of treatment are in use, such as live steam treating (toasting), heating at different steam pressure, cooking, roasting, dielectric and microwave heating. The

level of residual activity depends on treatment conditions (treatment mode, level of temperature, time of heating) (Rackis, J. J., 1974), initial content of moisture (Fulmer, 1989, Schumacher, 1989), pH conditions and the presence of reducing agents (Sessa, 1986, Friedman, 1989).

However, to maintain optimal nutritional value the meal must not be subjected to excessive heat, as this will denature the protein, making it less soluble and less digestible. Excessive heat or heating time reduces the availability of amino acids due to the Maillard reaction (Del Valle, 2000) and tends to destroy certain amino acids (Shede, 1985).

Soybean meal processors and their customers in the animal feed industry need reliable, rapid and cost-efficient methods to control the quality of their soybean meal. Protein quality of soybean meal depends on two parameters, the reduction of anti-nutritional factors and the optimization of protein digestibility (Parsons, 1991).

During the manufacture of soybean meal a quick control is essential, and only simple methods, which enable an immediate decision to be made, are of value. In this paper the proposed method measures changes in protein solubility during heating of soybean meal by determination of the refractive index of dilute potassium hydroxide extracts of meals. The test seems attractive as a screening test because of simplicity and speed.

Material and Methods

Commercial SBM (crude protein, 43.7 % SBM sample, and 48.63 % dry substance, respectively) was ground to pass the 200 μ sieve. SBM was heated in a forced air oven at 120°C for varying periods of time: 5, 10, 15, 20, 25 and 30 minutes.

The protein solubility was determined according to the procedure of Araba and Dale (Araba, 1990). The KOH protein solubility test is based on the solubility of soybean proteins in a dilute solution of KOH. Protein was determined by the biuret method. The solubility of the protein, expressed as a percentage was calculated by dividing the protein content of the KOH-extracted solution by the protein content of the original soybean sample.

The refractive index of the supernatant solution was determined (at 25°C) with an Abbe refractometer.

The urease assay is based on the pH increase from ammonia released from urea by residual urease enzyme in a soybean meal.

Results and Discussion

A method which can evaluate the over processing of SBM is the KOH protein solubility test, based on the solubility of soybean proteins in a dilute solution of potassium hydroxide.

The results of various analytical procedures made in order to assess the effect of heating time of the meal are given in Table 1

Additional heat treatment decreased KOH protein solubility, and the urease activity index rapidly approached zero. KOH protein solubility remains high, during initial heat treatment (Figure 1). The urease index is useful to determine if the soybean meal has been heated enough to reduce the anti-nutritional factors, but it is not very useful for determining if soybean meal has been over-processed.

The experimental data show a positive relationship ($r = 0.9382$) between the soluble protein and the refractive index (Figure 1).

Table 1.

Effect of heating time on UI, KOH protein solubility and RI

Heating time (min.)	UI	KOH protein solubility %	Refractive index
0	0.03	87.40	1.3380
5	0.02	78.20	1.3378
10	0	71.20	1.3372
15	0	69.95	1.3370
20	0	59.95	1.3340
25	0	58.19	1.3338
30	0	53.20	1.3335

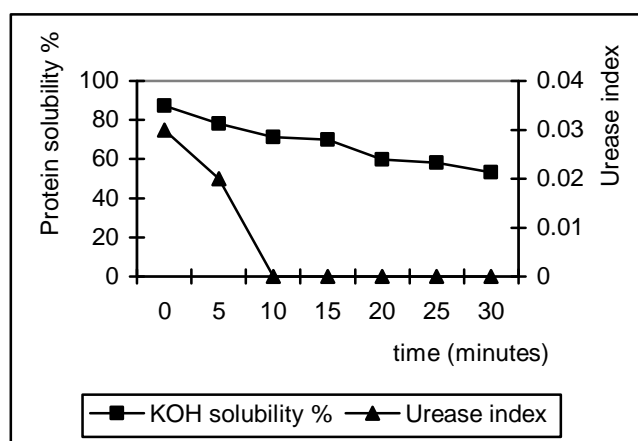


Figure 1. Variation of UI and KOH protein solubility with the heating time

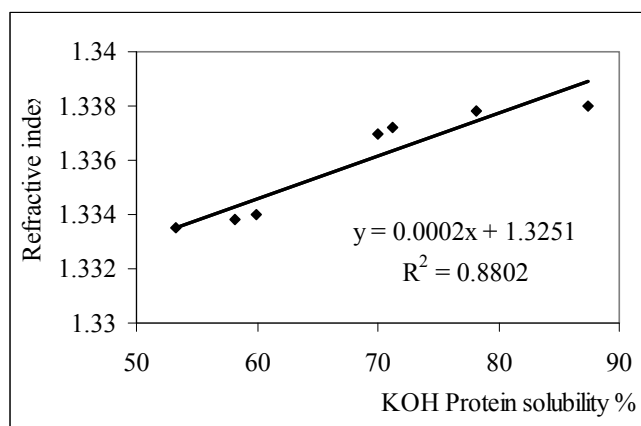


Figure 2. Correlation between refractive index and KOH protein solubility

Conclusions

UI is useful to determine if the soybean meal has been heated enough to reduce the anti-nutritional factors, but it is not very useful for determining if soybean meal has been over-processed.

The refractive index of dilute potassium hydroxide solution extracts was found to be highly correlated with the usual KOH protein solubility test ($r = 0.9382$).

The determination of biophysical parameters instead of chemical indices has two great advantages: first the methods are nonpolluting since they don't use chemical substances, and second these are very rapid methods.

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