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THE PRECIPITATION OF ISOLATED COTTON-PLANT PROTEIN

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The search for additional sources of protein to make up its deficiency in feeding regions is an urgent problem. A promising source of protein is formed by cotton seeds and cottonseed meal. The quality and quantity of the protein obtained from the meal depends on the conditions of its extraction, precipitation, and drying. As is well known, the most acceptable methods of separating protein from an extract on the industrial scale is its precipitation at the isoelectric point.

The isoelectric points of protein substances are not constant magnitudes and depend largely on the conditions of extraction, i.e., on the amount and nature of the accompanying substances present in the extract. We have studied the precipitation of protein from an extract obtained by treating cottonseed meal with a 5% solution of NH_4Cl at pH 5.7-6.0 [1].

In all the experiments we used meal from the Kokand Oils and Fats Combine. The protein was extracted at room temperature, and clarified extract was used. To determine the optimum medium for the precipitation of the protein we performed a series of experiments on a large laboratory apparatus. In each experiment, 20 liters of protein extract was placed in a precipitating vessel and, under the same conditions, the protein was precipitated by varying the pH of the extract with added 10% hydrochloric acid. The protein precipitate was separated off on a centrifuge and was washed with water, and was then defatted.

The results of the experiments are given below

pH of the precipitate	1	2	2,5	3	3,5	4	4,5	5
Yield of protein on the weight of the initial meal, %	13,5	14,3	14,45	14,55	14,57	14,14	8,1	—

The maximum precipitation of the protein is observed at pH 3-3.5 (90% of the dissolved protein substances is precipitated), which does not correspond with the isoelectric point of cottonseed protein obtained by extraction in an alkaline medium, which is 4.2 [2, 3]. Furthermore, the protein obtained by extraction in an alkaline medium sharply changes its solubility with a fall in the pH, and at pH 1.5 and below the precipitated protein dissolves completely, which was not observed in our experiment.

The cause of the sharp change in the solubility of the protein at low pH values of the medium is the presence of phytin in the extracted protein obtained on extraction in a weak alkaline medium [4]. Experiments to determine the dependence of the protein-precipitating process on the nature of the acid have shown that the yield of protein does not depend on this factor. Hydrochloric acid is used in practice in the food industry and is more economical for the precipitation of protein.

We used for precipitation a 10% solution of hydrochloric acid, as in the method for precipitating soya protein [5].

We also studied the influence of the temperature and the time of coagulation on the precipitation of protein, for which, in each experiment, 20 liters of extract was placed in the precipitating vessel and the protein was precipitated under similar conditions but with variation in the temperature of the extract:

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Precipitation temperature, °C	10	20	30	40	50	60	70
Yield of protein on the weight of the initial meal, %	14,31	14,5	14,62	15,31	15,7	16,2	16,3

With a rise in the temperature, denaturation of the protein leads to an increase in the yield. However, it must be borne in mind that with a rise in the temperature the size of the precipitate increases and it becomes more resistant to breakdown, which does not permit the extraction of NH_4Cl and other ballast substances present in the protein precipitate by washing it with water. After a single washing, the protein precipitated at 20-25°C contained about 0.1% of NH_4Cl, and the protein precipitated at 60-70°C contained 0.5%.

On the industrial scale, the slight increase in the yield of protein obtained by raising the temperature of its precipitation, which is connected with an increase in the consumption of water and also with an additional operation (repeated washing), is undesirable in the economic aspect. Numerous experiments to determine the time of coagulation and the rate of stirring in the precipitation of the protein have shown that the rate of stirring has no influence on the yield of protein within the range of stirrer speeds from 60 to 200 rpm. With a rise in the time of coagulation, the yield of protein rises insignificantly. Thus, the yields of protein when the precipitate was allowed to from for 1 min and for 12 h were, respectively, 14.5 and 14.8% of the weight of the initial meal.

EXPERIMENTAL

Extraction of the Meal. A reactor was charged with 20 kg of comminuted industrial meal, and 200 liters of 5% NH_4Cl solution was added. Extraction was carried out for 20 min at room temperature with the stirrer working (60 rpm). The extract was separated from the exhausted meal in a NOGSh-325-N centrifuge and was clarified in a SGO-100 × 750 supercentrifuge.

Precipitation of the Protein. A vessel with a stainless-steel stirrer (precipitator) was charged with 160 liters of clarified protein extract and, with the stirrer working (50-90 rpm), a 10% solution of HCl was added in a stream until the pH of the protein suspension was 3-3.5, which was checked by a remote-reading pH-meter.

Separation and Washing of the Protein. The protein suspension was separated on a SGO-100 × 750 centrifuge (at a rotor speed of 7500 rpm), and the protein fraction (70% moisture content) was sent for washing, for which purpose the paste was diluted with 10% of its amount of water in an apparatus with a stirrer and was passed through a hydromill. The comminuted protein suspension was fed to a VF B-025 vacuum filter where, on separation, the suspension was washed additionally with water (in a continuous flow).

Drying of the Protein. The protein concentrate after separation on the vacuum drum filter was diluted with water to a 10% protein content and after milling it was fed to a "Angidro" spray tower. The yield of protein was 3.62 kg or 14.5% of the weight of the initial meal.

SUMMARY

The optimum condition for the precipitation of the protein from an extract obtained by treating cottonseed meal with 5% NH_4Cl is its precipitation at room temperature with 10% HCl at pH 3-3.5.

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