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PRINCIPLES OF THE TECHNOLOGY FOR OBTAINING COTTONSEED PROTEIN

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The principles of obtaining protein isolates with given properties from cottonseed meal are considered.

The achievements of practically all directions of modern science are finding wide use in solving problems of human nutrition and the feeding of animals. Cottonseed meal is used as a source of fodder protein in the feedstuffs industry, but the sphere of its use in agriculture is limited [1]. In order to create a modern technology for obtaining "cottonseed protein" we have made use of the achievements of various fields of science, and, in the first place, the chemistry of protein molecules [2]. The experience of world science has been widely used in the analysis of a set of strategies for investigating the technology of obtaining cottonseed proteins. The main feature of the majority of literature sources is the isolation of proteins with acceptable biological properties (biological value). In future, the problem of creating new types of products from them will be solved. Thus, the final result will be attained in two stages: 1) isolating biologically valuable protein; and 2) imparting to the protein product the required set of given properties. We have solved this problem in one stage, the problem having become as follows: it is necessary to create a technique that would permit protein products with a high biological value and a given set of physicochemical properties (functional properties) to be obtained directly. The technology of obtaining protein products should include in a single scheme three main features: economy—biological value—functional properties. The creation of such a technology is possible only on the basis of fundamental investigations in the field of the main protein components of cotton seeds.

For protein isolates of cotton seeds the most important point connected with biological value is the absence (or an acceptable level) of the toxic pigment gossypol [3]. Free (not bound by a covalent bound) gossypol presents the greatest danger for the animal organism. The oils and fats industry of Uzbekistan is based mainly on the prepressing method of obtaining oil and meal. The technology for the production of such meal includes the conversion of gossypol into the bound state (primarily by binding with proteins, peptides, and amino acids).

The presence of bound gossypol in proteins considerably changes their properties, including their biological value. The digestibility of the protein is diminished and so, consequently, is its assimilability in the animal organism. Readily assimilable proteins are necessary for certain categories of animals (for example, young calves). The fractionation of various protein components of the meal has shown that the amount of gossypol bound with the proteins depends on their amino acid composition and structure. In view of this, the primary task in the technology of obtaining cottonseed proteins is the fraction of proteins containing different amounts of gossypol.

The first studies on the extractability of cottonseed proteins as a function of the pH were carried out by Fontaine [4]. It was shown that the extractability of protein nitrogen depends essentially on the pH of the medium and the level of phytates. In an acid medium in the presence of phytates the proteins are extracted in low yield, although this problem can be solved by first extracting the phytates at pH 4.8-5.0 [4]. Unfortunately, in this paper the problem of gossypol in the proteins is not considered.

Our investigations have shown that the solubility of gossypol-containing proteins changes substantially in the presence of low concentrations of phytates at acid pH values [5]. It is just this fact that enables one to obtain protein isolates with a limited amount of gossypol from cottonseed meal by acid extraction (after elimination of the phytates) [6]. It is possible to use

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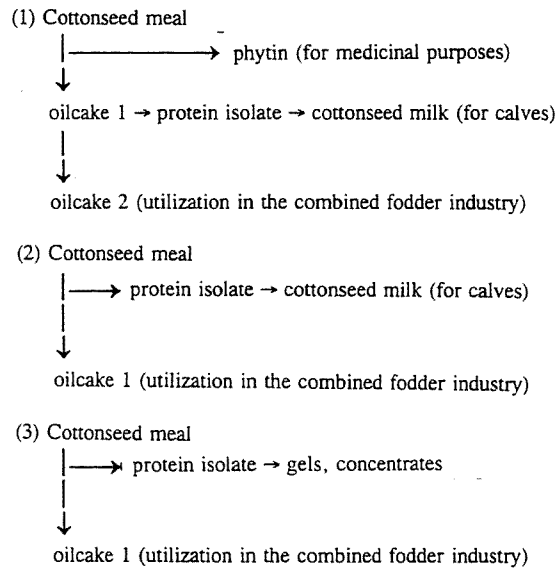
differences in the solubilities of gossypol-containing proteins at alkaline pH values with the same effect [7]. In the latter case, the pH of the extractant must be strictly controlled, since with an increase in the yield of protein its gossypol content rises sharply. Thus, in light of the fact that it is mainly the prepressing method of obtaining meal that is used in the Uzbekistan industry, it can be stated that one of the methods for expanding the sphere of use of cotton seeds is the fractionation of proteins with different gossypol contents.

The creation of a modern technology for obtaining cottonseed proteins taking functional properties into acount has required the performance of investigations in the field of physiology during the seed-ripening process [8, 9] and also a study of all levels of the organization of the main protein component of cotton seeds [10-13]. It must be mentioned that this relates to molecules with an extremely complex structure [14-16] that changes under various conditions, the mechanism of these changes also being very complex. It is precisely these changes that determine the physicochemical properties of the protein isolates [17]. In light of the results of structural investigations, studies have been made of the main functional properties of the cottonseed proteins: solubility, emulsifying properties, and gel formation (texturation) [18-21]. The results obtained have been made the basis of fundamentally new technologies of obtaining cottonseed proteins for animal husbandry. The following problems have been solved: 1) the extraction from the meals of the protein with the greatest value from the biological point of view; 2) the creation from this the form of protein additive necesary for a given type of animal; 3) the production of a depleted oilcake (after the extraction of the protein) with increased biological value (through the partial detoxication of the meal); and 4) the utilization of the waste waters for the production of fodder yeast. As a rule, the solutions have consisted of unified technological schemes.

Below we give a scheme for obtaining a series of products from cottonseed protein isolates for feeding those animals the ration of which includes a considerable amount of natural food products (calves from the suckling stage to the age of three months, fur-bearing animals, domestic dogs, cats, laboratory rats, etc.).



The proposed technologies will permit an additive to be obtained in the necessary form (emulsions, substitutes for meat and fish concentrates, gels, etc.) while the physical properties of these products can be varied according to requirements. All the proposed protein products have been created from a single protein with the following amino acid composition (g/100 g of protein, without taking tryptophan and cysteine into account):

Aspartic acid	8.8	Methionine	0.7 (2.2)
Threonine	3.3 (2.8)	Isoleucine	3.8 (4.2)
Serine	3.9	Tyrosine	2.1 (2.8)
Glutamic acid	21.0	Phenylalanine	6.3 (2.8)
Proline	3.6	Histidine	2.9
Glycine	4.8	Lysine	2.4 (4.2)
Alanine	2.9	Arginine	13.6
Valine	5.4 (4.2)	Leucine	5.1 (4.8)

TABLE 1

Group	Plan (mean numbers)			Experiment		
	No. of animals	Total no. of days	Total increase in weight, metric centners	No. of animals	Total no. of days	Total increase in weight metric centners
1	57	20916	94.1	57	20916	114.0
2	34	12570	56.6	34	12570	69.1

TABLE 2

Type	Dynamics of the change in weight, g			
	July	August	September	October
		Control		
Females	702±7	945±19	1171±10	1268±29
Males	940±18	1633±42	2023±52	2150±180
		Experiment		
		25% replacement of meat concentrate		
Females	680±10	1080±17	1330±21	1405±27
Males	800±35	1520±24	2080±68	2312±58

The figures in parentheses are the levels of essential amino acids in food proteins according to WHO recommendations. The gossypol levels in the finished additive were (%): bound — 0.06%; free — 0.004%. Ash — 5.5%.

The level of gossypol in the finished product depends on the final form of the protein additive, and, as a rule, the level of free gossypol in it is an order of magnitude lower than in the initial meal.

The processing of cottonseed meal significantly changes the biological value of products based on it, this having been determined with the aid of infusoria by a standard procedure [22].

Sample	Biological value, %
1. Cows' milk, dried	100.0
2. Cottonseed meal, prepressed	25.4
3. Cottonseed protein additive	48.2
4. Cottonseed oilcake after chemical processing	40.9

As can be seen, the processing of cottonseed meal not only gives a protein additive with a high biological value but also raises the biological value of the residual oilcake even though the protein content of the latter is low. This is achieved through partial detoxification and the elimination of the most active antifeedant substances (phytates).

All types of protein fodder additives have been manufactured by the Kokand MZhK [Oils and Fats Combine] (Republic of Uzbekistan) and have undergone extensive trials. Below we give the results of the use of cottonseed protein additives for feeding calves up to the age of three months (Fergana Province, Engels collective farm, Table 1) and mink (Tashkent Province, 1991, Table 2).

Cottonseed milk was used in 30% substitution of whole milk for the weaning of calves. During the feeding period the calves developed normally. The daily increase in weight was at the level of the control.

It must be mentioned that the protein additive can be produced in three forms: fresh (time of storage 1-2 days), fresh preserved (time of storage several months), and dry powder (time of storage several months). The time of storage depends on the conditions of storage. The biological value of the product is practically independent of the form of storage.

The problem of the utilization of nontraditional sources of proteins is determined mainly by the features of each source. The world level of investigations in the area of the technology of cotton seeds as a source of food and fodder proteins at the present time determines the possibility of expanding the field of use of the products of the processing of cottonseed meal in animal husbandry. The nutritional advantages of this source and the protein products based on it will apparently find their solution in the future.

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