

QUALITY ASSURANCE OF SOYBEAN PRODUCTS FROM FARMERS FIELD TO COMPLETE FEED

OSIGURANJE KAKVOĆE SOJINIH PROIZVODA OD POLJA PROIZVOĐAČA DO GOTOVE KRME

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Professional paper - Stručni članak
UDC: 636.086.72.087.26
Received - primljeno: 20 june - lipanj 1997.

SUMMARY

To assure consumers farmers and feed industry safe, healthy soybean products of high nutritional value, a strict quality control in the whole chain from the farmer field to complete feed is needed.

As an example in tables 3 and 4 the quality control scheme and quality criteria applied for the production of fullfat soya in our own company are shown.

A number of quality parameters has to be controlled at different stages of the production process. It is very important that everybody involved in the process takes his own responsibility and up his own quality assurance system International standards can be a good help but have to be applied in specific circumstances. Good managing practice, prevention of problems and good collaboration with preceeding links in the chain will be more effective and less expensive than intensive control afterwards.

A wide spectrum of analysis techniques and methods are available for quality control nowadays. Standardisation and harmonisation would be of great value for producers and consumers and in the interest of all partners in the chain.

1. INTRODUCTION

In animal feeds soybean products are well appreciated ingredients. Although the inclusion levels will vary and depend on price and availability, it is quite common that a certain percentage of soybeanmeal or fullfat soya is included in the ration.

As is the case with all natural feed ingredients the quality of soybean products will vary and may have a remarkable influence on the quality of the complete feed fed to the animals. Therefore

effective quality control during harvest, transport, storage and processing is very important.

In this paper a review will be given of the main quality aspects of soybean products in relation to animal feeding and the effects of processing on product quality. Also recommendations are given regarding methods for efficient quality control and for a systematic and effective quality assurance.

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2. AIMS OF QUALITY ASSURANCE

A systematic quality control of feed ingredients and of compound feeds is necessary for different reasons. The most important are:

a. to know the real composition and nutritional value of products for feeding animals

b. to assure that products are not hazardous for health of animals and people handling and consuming them

c. to avoid undesired pollution of the environment

d. to control the effects of storage, transport and processing.

Nowadays more and more companies have implemented an integrated quality management system with all these aspects in it. An increasing number of feed companies is ISO 9001 or 9002 certified assuring their clients that products delivered meet the specifications agreed. Others work with a quality system based on the specific standards for Good Managing Practice (GMP) in the feed industry.

It is more and more accepted that good quality management means more than frequent analysis of feed samples in the laboratory. To assure the consumer a safe and healthy product effective quality management in the whole chain of production is a must.

3. QUALITY ASPECTS

Several quality aspects are of importance when soybeans and soybean products are used for animal feeding. The most important will be mentioned here.

Chemical composition

The chemical composition of a feedstuff is directly related with its nutritional value. For the production of high quality animal feed it is a must to have the correct information regarding the level of nutrients in the ingredients.

As far as soybeans and soybean products are concerned especially protein and oil content are

important to know for a good assesment of the nutritional value of the product.

The amino acid profile of the protein may vary in relation to the origin of the product. In the CVB table used in the Netherlands the lysin level in US soybean products is f. e. 6.4 g/16 g N and for soybean products from South America this level is 6.1 g/16 g N.

The moisture level is of importance for the keepability of the product and the fibre content for its digestibility by poultry and pigs.

Controlling the ash content of products may sometimes also be advisable. Sometimes high levels are found due to the addition of high percentages of free - flowers or even calcium carbonate.

It is clear that feed manufacturers like to receive not only safe and healthy ingredients but also products with the chemical composition that is as constant as possible. Farmers, trade and the processing industry should recognize this and try to produce products of constant quality.

Anti - nutritional substances

Besides the chemical composition the presence and level of undesired admixtures and substances in soyproducts should also be controlled.

Sometimes rather high percentages of toxic weed seeds as e. g. *Datura stramonium* or *D. ferox*, *Crotalaria* and even *Castorbeans* may occur. In some countries there is also a control on the presence of *Ambrosia* seeds in soybeans or soybean products to prevent the entry of this plant that emits allergenic pollens.

Also the admixture of other foreign substances as pieces of glass, stones and sand, metal objects and other undesired materials have to be controlled.

In raw unprocessed soybeans a number of anti - nutritional substances is present: trypsin - inhibitors, lectins, saponins, lypoxigenase, phytate etc.

Fortunately most of them can be inactivated by heat treatment. It is necessary to have a good control on the effects of processing and to assure

that the anti - nutritional substances have been inactivated.

Digestibility and energy value

For quality evaluation of soybean products not only proper inactivation of the anti - nutritional substances is necessary, but also the digestibility and the corresponding energy value should be under control.

As far as protein and amino acids are concerned one should be aware of possible overheating of products. Overheating will cause so called Maillard reactions resulting in a decrease of protein and amino acids digestibility.

It is very important that conditions regarding temperature, time and moisture during the heating proces are chosen so that negative influences of

the processing on the nutritional value of the product is avoided as much as possible.

In case soybeans or soybeanmeal is processed to produce a product with a high level of undegradable protein for ruminants it should also be avoided that the digestibility of the protein in the intestine is too decreased. Testing the in - vitro digestibility may be advisable to control this.

For fullfat soyproducts a direct relation exists between the oil availability and the energy value for the animal. Several experiments have shown this. The oil availability is strongly influenced by the physical or mechanical treatment of the product resulting in a disrapture of the oil containing cells. To increase the oil availability different treatments are applied such as grinding, flaking, pelletizing, extrusion, expanding etc. In table 1 an example is given of the effect of flaking on the fat digestibility and energy value of fullfat soya.

Table 1. Effect of flaking on fat digestibility and metabolizable energy of fullfat soya for chickens

Tablica 1. Djelovanje pahuljičanja na probavljivost masnoća i metaboličku energiju punomasne soje za piliće

Product - Proizvod	Feed - Krma	Fat digestibility Probavljivost masnoće (%)	Metabolizable energy Metabolička energija (MJ/kg Dm)
Soyax toasted soybeans - Tostirana soja	brašno - meal	78	14.52
Soyax toasted soybeans - Tostirana soja	pelete - pellets	83	14.73
Soyax toasted and flaked soybeans Tostirana i pahuljičasta soja	brašno - meal	83	15.02
Soyax toasted and flaked soybeans Tostirana i pahuljičasta soja	pelete - pellets	90	15.27

Physical structure

For bulk - handling the physical structure of feed ingredients is very important. With unprocessed soybeans and with soybeanmeal there is in practice almost no problem but with fullfat soya with a relative high oil content sometimes there are. Fullfat soya in meal - form or with a relative fine structure has a bad flowability and can cause big problems during transport and storage. Therefore, if the product is not well pelletized, a coarse structure is advisable.

To achieve this soybeans are not finely ground but only cracked by a roller - mill. To check the result of the cracking and the adjustment of the mill sievefractions of the product should frequently be determined.

To avoid sticking of products in the silo it may be advisable to add a small amount of a free - flower. The amount added should be controlled regularly by determination of the ash content.

Pelletizing fullfat soyproducts is rather difficult; it is not easy to get a pellet of good hardness. Type of pelletizer, moisture level of the product and quality

of added binding agents are important factors for the final pellet quality.

To prevent the sticking of fullfat soya in the silo it is advisable not to store the product for a long time in the same silo but to transfer it to another silo from time to time. This should be done if the product has to be stored for a longer period.

Homogeneity

If soyproducts are not finely ground and/or pelletized but if they are in a more coarse structure, there may be some mixing during transport and storage. If this is the case hulls are separated from the other parts of the beans and a significant difference of quality between the different parts in the same load or lot is the result. Also taking representative samples becomes difficult. Pelletizing the products, also those with a more coarse structure, will prevent this. By pelletizing the hulls more or less stick to the other parts of the bean and demixing is prevented.

Oil Quality

It is our practical experience that deterioration of the oil quality caused by fat - oxidation in soya-beanproducts seldom occurs. Under normal storage conditions regarding temperature and humidity special measurements are not necessary. Only if the product has to be stored for a longer period and under extreme circumstances the addition of an anti - oxidant may be advisable. Heating fullfat soya to inactivate the anti - nutritional substances has the advantage that fat - oxidizing enzymes lipoxidase and lipoxygenase are also eliminated.

Microbiological Quality

Directly after the heating process to inactivate the antinutritional substances no viable microbes

are present in the processed soybean products. However, soya and especially fullfat soya is an excellent substrate for mold and bacterial growth and post - contamination after the heating can easily occur.

Therefore special care should be taken to prevent this. In respect to this attention should be paid to the moisture level of the product, the prevention of water water condensation in silo's and bins, the temperature during storage a regular cleaning of processing and transport machinery and of storage facilities etc.

Nowadays great importance is attached to the prevention of Salmonella contamination of feedstuffs. Especially fullfat soya is one of the products that may be susceptible to this if it is not properly processed and handled.

Circumstances during processing such as high temperatures and high moisture levels, are ideal for Salmonella growth and contamination of products. During recent years the processing industry has taken a number of measures in order to prevent Salmonella contamination of the soyaproducts that are manufactured. Frequent cleaning and decontamination of the installation, isolation of coolers and dryers to prevent water condensation and sticking of product to the installation and adding preservatives to the products are some of them.

At loading there should be a very strict control of cleanness of trucks and vessels.

By intensive sampling and analysis on microbiological parameters the hygienic status production and storage facilities should be continuously under control. By these measures the frequency of Salmonella contamination of products can be decreased significantly.

Genetically modified products

Recently there has been a lot of discussion about the so called GMO soybeans or also called the Round Up soybeans. The genetic structure of

this soybean has been modified so that it is resistant to the herbicide glyphosate, the main component of the Monsanto herbicide Round Up. Although it has been proved that there is no health risk when consuming GMO soybean products, some people remain strongly against any genetic engineering and manipulation of plants. It can be expected that for this category of consumers a separate small market for non - GMO soybeans and soybean products will remain. Processing non - GMO soybeans and producing guaranteed non - GMO products will need a very strict control of cleanness of transport, storage and processing facilities. With the actual analysis methods it is possible to detect one GMO soybean in a sample of 10000 beans!

4. QUALITY CONTROL METHODS

In order to assure the client the quality and specifications that were agreed, an intensive quality control and frequent analysis of raw materials and end products is necessary. Several methods and techniques are available and can be applied.

For good comparison of results it is very important that the analysis methods used are the same or at least give the same results. Often there are discussions about differences regarding analysis results due to the application of different analysis methods.

For example not comparable figures for oil and fibre due to differences in sample preparation as the fineness of milling pre extraction of oil etc.

To avoid these problems the application of standardized analysis methods is advisable and also a regular exchange of samples between laboratories to compare results.

It is clear that also the sampling itself is a very critical point. Even when this is done automatically. People in charge of quality control should always be aware that only the analysis of a representative sample can give useful information.

For the quality control one can make use of visual, physical or chemical methods.

Visual inspection

To control the quality of soybeans and their products a systematic visual inspection is very helpful.

By visual inspection it is possible to determine the amount of undesired admixture, the percentage of damaged soybeans, discoloured beans etc.

All you need are your eyes, may be a small microscope and well trained people. Besides this it may be advisable to build up a collection of small samples of foreign materials, damaged soybeans weed seeds etc that may be present in soybeans or soybean products. For a systematic control the US grades and grades requirements can be also helpful (table 2).

Physical parameters

Some physical parameters can give a good indication of the quality of products especially regarding their handling properties. For example the hardness of pellets of a pelletized product and the physical structure as indicated by its sieve analysis. To avoid problems during transport and storage frequent control of these aspects is advisable. This is especially the case with fullfat soyproducts.

Chemical Analysis

Chemical analysis can be done by conventional wetchemistry in a well equipped laboratory. The application of NIRS, Near Infra Red Spectroscopy, analysis is a good alternative. This analysis technique offers the possibility to have the chemical composition figures of raw materials available before production processes start.

Table 2. U.S. standards for soybeans
Tablica 2. SAD standardi za sojino zrno

Soybeans - Sojino zrno				
§ 810.1604 - Grades and Grade Requirements - § 810.1604 Ocjene i uvjeti za ocjene				
Grading Factors - Čimbenici ocjenjivanja	Grades U.S. Nos. – Stupnjevi ocjene SAD broj			
	1	2	3	4
Minimum limits of: - Minimalne granice od:				
Test weight lbs/bu - Težina testiranja lbs/bu	56.0	54.0	52.0	49.0
Maximum percent limits of: - Maksimalne granice postotka od:				
Damaged kernels: - Oštećenje jezgre:				
Heat (part of total) - Srž (dio ukupnog)	0.2	0.5	1.0	3.0
Total - Ukupno	2.0	3.0	5.0	8.0
Foreign material - Strani materijal	1.0	2.0	3.0	5.0
Splits - Raspukline (kalanja)	10.0	20.0	30.0	40.0
Soybeans of other colors 1/ - Soja drugih boja 1/	1.0	2.0	5.0	10.0
Maximum count limits of: - Maksimalne granice brojenja:				
Other materials - Drugi materijali				
Animal filth - Životinjska prljavština	9	9	9	9
Castor beans - Zrna u prahu	1	1	1	1
Crotalaria seeds - Sjemenke Crotalarije	2	2	2	2
Glass - Staklo	0	0	0	0
Stones 2/ - Kamenčići 2/	3	3	3	3
Unknown foreign substance - Nepoznate strane tvari	3	3	3	3
Total 3/ - Ukupno 3/	10	10	10	10
U.S. Sample grade - SAD uzorak ocjene				
Soybeans that: - Soja koja:				
(a) Do not meet the requirements for U. S. Nos. 1, 2, 3, 4; or - Neodgovara uvjetima SAD br. 1, 2, 3, 4, ili				
(b) Have a musty, sour, or commercially objectionable foreign odor (except garlic odor); or – Imaju pljesniv, kiseo ili komercijalno nepoželjan strani miris (osim mirisa češnjaka), ili				
(c) Are heating or of distinctly low quality - Pregrijana ili su izrazito niske kakvoće.				
1) Disregard for Mixed soybeans - Neobaziranje na miješanu soju				
2) In addition to the maximum count limit, stones must exceed 0.1 percent of the sample weight - Osim ograničenja maksimalnog broja, kamenčići moraju prelaziti 0.1 posto težine uzorka				
3) Includes any combination of animal filth, castor beans, crotalaria seeds, glass, stones, and unknown foreign substances. The weight of stones is not applicable for total other material - Uključuje svaku kombinaciju životinjske nečistoće, zrna u prahu, sjemenke crotalarije, staklo, kamenčiće i nepoznate strane tvari. Težina kamenčića ne uključuje se za ukupne druge materijale.				

Table 3. Quality control fullfat soya SCHOUTEN products.

Tablica 3. Kontrola kakvoće punomasne soje proizvoda SCHOUTEN

Product Proizvod	Control point Mjesto kontrole	Sampling by Uzorak uzeo	Analysis by Analizirao	Type of analysis Vrsta analize	Frequency Učestalost
Soybeans Sojino zrno	Seaport Morska luka	Superintendent Nadglednik	Superintendent Nadglednik	Visual - Vizualno	Per barge Po teretu
			Nutrilab - Laboratorij	Nirs admixture	Per barge Po teretu
Soybeans Sojino zrno	Storage silo Silos	Automatic sampler Automatski birač	Operators Tehničar	Visual - Vizualno	Per barge Po teretu
Soybeans Sojino zrno	Entrance plant Ulaz u tvornicu	Operators Tehničar	Operators plant lab. Tehničar laboratorija tvornice	Visual moisture Vizualna vlaga	Per hour Na sat
Soyax	After cooler Poslije hlađenja	Automatic sampler Automatski birač	Plant lab. Tvornički laboratorij	Visual moisture urease – activity Vizualna vlaga aktivnost ureaze	Per 45 mton Na 45 m.tona
Soyax	After cooler Poslije hlađenja	Automatic sampler Automatski birač	Nutrilab - Laboratorij	NIRS urease - activity sieve- analysis NIRS aktivnost ureaze – analiza prosijavanjem	Per day Na dan
Soyax	After cooler Poslije hlađenja	Automatic sampler Automatski birač	Nutrilab - Laboratorij	TIA, PDI	Per week Na tjedan

Table 4. Quality criteria soybeans and soyax.

Tablica 4. Kriteriji kakvoće soje i soyaxa

Product - Proizvod	Quality aspect - Kakvoća	Value - Vrijednost
Soybeans - Sojino zrno	boja - color	Yellow/brown - Žutosmeda
	Smell - Miris	Neutral - Neutralan
	Admixture - Dodatak	max. 2%
	Datura spec.	max. 0.1%
	Castorbeans - Zrna u prahu	Free - Slobodna
Soyax	Moisture - Vlaga	max. 13.0%
	Urease - activity Aktivnost ureaze	max. 0.30 mg N per g/min.
	Tripsin inhibition activity - Inhibicijska aktivnost tripsina	max. 3.0 mg/g
	PDI	min. 15
	NSI	min.20
	Sieve analysis Analiza prosijavanja	min 30% > 3.75 mm max 40% > 3.75 mm

For a quick and easy control of the quality of end products the nirs technique is also an interesting possibility. For soybeans and soybeanproducts reliable calibrations are available

nowadays and many feed manufacturers are making use of it. A regular validation of the system and controlling with the results of wet - chemical analyses is advisable.

For moisture determination other quick and accurate analysis methods are also available nowadays that can be successfully applied.

Several analysis methods are available for controlling if the heat treatment of soybeans and soybean products was done in a proper way to mention:

- determination of urease - activity
- determination of trypsin inhibition activity (TIA)
- Cresol Red Tests
- determination of Protein Dispersibility Index (PDI)
- determination of Nitrogen Solubility Index (NSI).

Oil availability in relation to the digestibility for animals in processed fullfat soybean products can be controlled by determination of the extractibility of the oil.

An excellent review of all kinds of tests and analyses available for controlling the quality of soybeans and soybean products is given by Dr Tobor Matrai in "Guidelines in Quality Control for Fullfat Soybean Meal" published by the American

Soybean Association and the United Soybean Board.

Microbiological Analyses

For soybean products used for animal nutrition control of the presence of Salmonella is the most important regarding the microbiological quality controls. This is especially the case if the compound feed in which the soybean products are included as an ingredient are not heat treated e. g. during pelleting. In soybeans processing plants frequent control of the whole installation on the presence of Salmonella is advisable. Especially the critical points should be sampled.

Besides the classical method for Salmonella determination which takes at least 5 days, nowadays methods are also available that give results in a shorter period. However they are not always as reliable as the classical method. Nevertheless, much research is done in the development of new quick tests for microbiological quality control and it may be expected that in future it will be possible to deliver controlled and guaranteed Salmonella free products.

SAŽETAK

Kako bi se osigurali potrošačima, farmerima i prehrambenoj industriji sigurni, zdravi proizvodi soje visoke hranidbene vrijednosti potrebna je stroga kontrola u čitavom lancu od polja farmera do dovršene krme.

Kao primjer na tablicama 3 i 4 prikazan je plan kontrole kakvoće i kriteriji kakvoće primijenjenih u proizvodnji punomasne soje u našem poduzeću.

Potrebno je kontrolirati stanoviti broj parametara na raznim stadijima proizvodnog procesa. Vrlo je važno da svatko uključen u taj proces preuzme vlastitu odgovornost i postavi svoj vlastiti sustav za osiguranje kakvoće. Međutim standardi mogu biti od pomoći ali ih treba primijeniti u posebnim okolnostima. Dobra praksa upravljanja, sprječavanje problema i dobra suradnja s prethodnim vezama u lancu bit će djelotvorniji i jeftiniji od kasnije intenzivne kontrole.

Danas postoji široki spektar postupaka analize i metoda za kontrolu kakvoće. Standardizacija i harmonizacija bili bi dragocjeni proizvođačima i potrošačima i u interesu svih partnera u lancu.