Optimization of Soybean Press Cake Treatments and Processing

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Summary

This paper presents some results given by a systemic study of methods used in soybeans press cake treatment and processing. The influence of raw materials on soybean pressing system and the parameters of extrusion process are analyzed. Principally, the experiments confirm the influences of heat process parameters in case of soybean press cakes production using classic solutions and microwave energy. These experiments start up by manufacturing soybean press cake in industrial conditions at "S.C. International romoster srl" – Dudestii Vechi, Timis County.

For ensuring the best conditions, the experimental stand included an extruder, a system for toasting the soybeans press cake, a system for parameters' control and the system for ensuring the processing of water.

The following possibilities were analyzed: (1) Soybeans press cake obtained by the classical method without toasting at pressure of extrusion $p_1 = 75$ kgf cm^{-2} and flow $Q_1 = 800$ kg h^{-1}; (2) Soybeans press cake obtained at pressure of extrusion head $p_2 = 85$ kgf cm^{-2} and flow $Q_2 = 600$ kg h^{-1}; (3) Soybeans press cake obtained at pressure of extrusion head $p_3 = 95$ kgf cm^{-2} and flow $Q_3 = 300$ kg h^{-1};

Using this application we tested a new method for treatment and studied the special systems which can be applied in industrial practice at "S.C. International romoster srl" – Dudestii Vechi, Timis County. During the testings and researches the variation of electrical permeability was observed. Differences between theoretical equation and practical results in calculus and energy measurement in the workspace were noticed.

Key words

raw materials, ureasic activity, optimization, treatment, microwave

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Introduction

Usually fat raw materials are used for obtaining vegetable oil, both by chemical technologies, usually under heat, or mechanically, by cold pressing. Cold-pressed edible oils make a particularly beneficial contribution to healthy nutrition due to the big amount of vitamins and trace elements preserved throughout the process.

As raw material for oil production sunflower seeds, linseed, corn seed germs, soybean seeds and other special seed types are used. Soybean press cake is a by-product of cold press oil production. It is made from extruders using short technological process. The most important use of press cake is as animal feed. Soybeans contain not only high quality protein, but are also a rich source of energy due to their oil content. Dehulled soybean meal is preferred by many poultry nutritionists over the 44% protein soybean meal.

The advantages of dehulled soybean meal include a higher level of balanced protein, lower fiber level and a higher energy level. Since dehulled soybean meal is a more dense protein source, the level of cereal grain in the ration may be increased, resulting in a more energy dense ration. Extra energy in broiler rations stimulates weight gains and decreases feed required per unit gain.

Improper oilseed processing damages amino acids, rendering the proteins biologically unavailable. A serious deficiency in most composition tables is that authors do not take into consideration that the oilseed may be damaged by improper processing. Research by Polacco et al. (1976) and Palacios et al. (2004) showed that the mean apparent digestibility of nitrogen and most amino acids at the end of the small intestine for young chicks and pigs is similar for 44 % and dehulled soybean meal. These studies support earlier studies where soybean meals produced with different heat treatments, ranging from underheating to overheating, had similar ileal and fecal digestibility of crude protein, digestible energy and lysine digestibility (Kukhtin et al., 1997).

For soybean press cake, the most important indicator of anti-nutritional factor destruction is the urease enzime content and activity, which the nutritionists measure by comparing it with other effects: bacitracin and flavomicin (Bergaoui et al., 1980).

The study starts at researches level concerning urease activity in the gastrointestinal tract of rabbits (Crociani et al.,1986), or in lambs (Marini et al., 2004). Urease values, measured by pH rise in an ammonia solution, are 2.0 for raw soybean. The US feed industry demands urease values from 0.05 to 0.2 pH to avoid risks in properly processed soybean meal. Soybean meal with the lowest level of trypsin inhibitors and urease values is best utilized in fish diets.

The objective of this paper has been to determine an optimum system for heat treatment for soybean meal, using microwave energy respecting the condition restriction presented.

Material and methods

Principally, the experiments confirm the influences of heat process parameters, in the case of soybean press cakes production using microwave energy and compare the results with the classic situation. These experiments start up by manufacturing soybean press cake in industrial conditions at “International romoster production” – Dudestii Vechi, Timis County.

The schematic presentation of extrusion system used in obtaining of soybean press cake that was the first part of operations is presented in Figure 1. For ensuring the best conditions, the experimental stand includes an extruder 1, a system for toasting the soybeans press cake 2, a system for parameters’ control 3 and the system for ensuring the processing of water 4.

The following possibilities were analyzed:

— Soybeans press cake obtained by the classical method, without toasting, at pressure of extrusion $p_1 = 75$ kgf cm^{-2} and flow $Q_1 = 800$ kg h^{-1};
— Soybeans press cake obtained at pressure of extrusion head $p_2 = 85$ kgf cm^{-2} and flow $Q_2 = 600$ kg h^{-1};
— Soybeans press cake obtained at pressure of extrusion head $p_3 = 95$ kgf cm^{-2} and flow $Q_3 = 300$ kg h^{-1};

After that, experiments continued by heating process for soybeans press cake obtained in industrial condition.

The stand for heating process analyzing was made in the laboratory for feed analyses, Department of Mechanical Technology, Mechanical Engineering Faculty, “Politehnica”

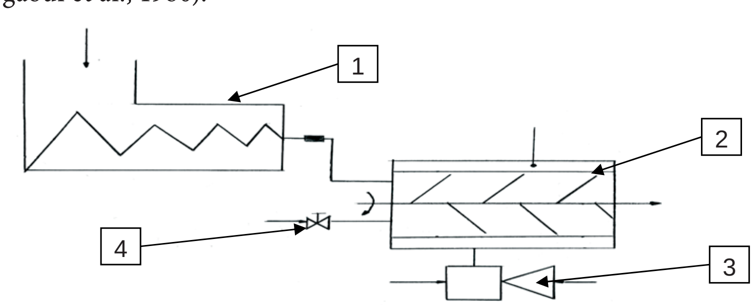

Figure 1.
Schematic presentation of the extrusion system used in experiments

University of Timisoara, financed by a research grant from the National Council for Academic Scientific Research, in 2002 (Tucu et al., 2003).

A schematic presentation of this stand is described in Figure 2. This stand includes: 1- generator for microwave signal, 2- emission room, 3- transmitter, 4- accord circuit, 5- antenna, 6- detector, 7- signal amplifier, and 8- measuring piece. On this stand the influences of the work final temperature and the increase of treatment temperature in time upon ureasic activities were studied.

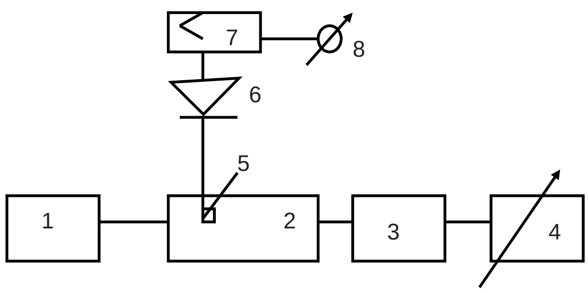

Figure 2.
Schematic presentation of the stand for microwave heating

All chemical analyses were made in the laboratory for chemical analyses, Faculty for Chemical Engineering, "Politehnica" University.

Results and discussion

Table 1, 2, and 3 present the experimental results for ureasic activities, U [mgN/min/g] at different final toasting temperatures [^{0}C] and duration of increase [s].

After the graphic representation of dependences, interesting conclusions were drawn. For example, Figure 3 presents the dependence between urease activity U, and time of heating, for final toaster temperature 120^{0}C.

During the testing and experiments the variation of electrical permeability determined in different conditions of raw materials, temperatures and electric power was observed. Because of electrical permeability variation, there can be observed differences between the theoretical equation and practical results in calculus and energy measurement in the workspace.

That means it changes the dielectric capacity of soybean press cake according to temperature rise. Also, an important influence on product temperature is determined by the radiation room type. For this reason, different wave guides are used, all in the group of rectangle profile guides, with form and dimension presented in Figure 4. In experimental activities dimensions "A" and "B" were modified.

Table 1. Results at 120 ^{0}C

No.Det.	Time (s)	U (mgN/min/g)
1.	120	0.0462
2.	240	0.0443
3.	360	0.0433
4.	480	0.0425
5.	600	0.0423

Table 2. Results at 125 ^{0}C

No.Det	Time (s)	U (mgN/min/g)
1.	120	0.0451
2.	240	0.0439
3.	360	0.0424
4.	480	0.0415
5.	600	0.0409

Table 3. Results at 130 ^{0}C

No.Det	Time (s)	U (mgN/min/g)
1.	120	0.0424
2.	240	0.0412
3.	360	0.0401
4.	480	0.0390
5.	600	0.0383

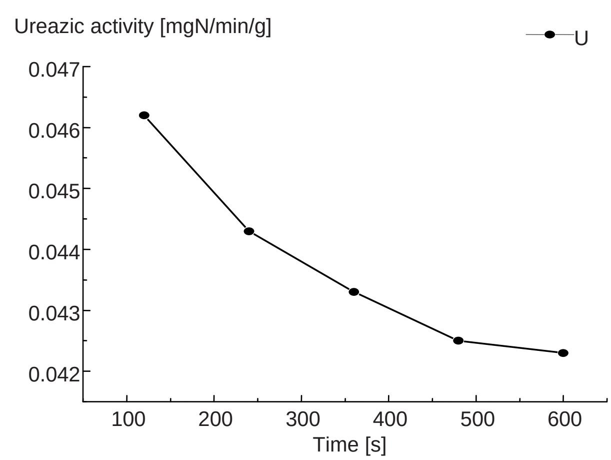

Figure 3. Graphic representation of the relationship between ureasic activity and time of heating

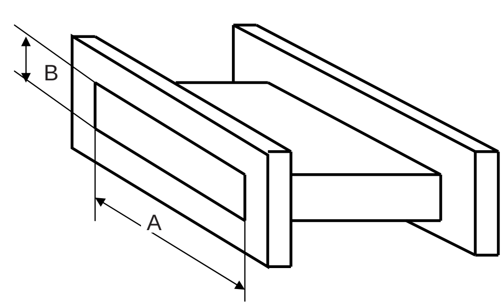

Figure 4. Form and main dimensions of the wave guide

Conclusion

For optimization of the treatment process for soybean press cake production using microwave heating it is necessary to consider significant variation of dielectric permeability with temperature and product humidity.

Influences of the raw materials quality and the extrusion process are minimal. Technically, it means that introduction of new circuits for adapting the power emitted by magnetron to the temperature and humidity of product as raw materials is necessary.

Based on calculus and the Smith diagram, a new mathematical model for dialectical permeability, ε' and ε'' and angle tangent for dielectrically losses, tg δ, was proposed (Tucu et al., 2000).

$$\varepsilon' = \frac{Y_V + \left(\frac{\lambda_g}{\lambda_C}\right)^2}{1 + \left(\frac{\lambda_g}{\lambda_C}\right)^2}, \quad \varepsilon'' = \frac{Y_K}{1 + \left(\frac{\lambda_g}{\lambda_C}\right)} \qquad tg\delta = \frac{\varepsilon'}{\varepsilon''}$$

The results of these researches indicated that the system for heating treatment for soybean is a priority of our future research.

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