

Extraction of Natural Cellulose from Soybean Dregs and Its Utilization in Food^{*}

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Abstract The fresh soybean dregs were used as materials in the study. Four factors affecting the content of natural cellulose were tested with right angle experiment. Those factors are caustic strength, temperature, time and the amount of used enzymes. The optimum conditions for extracting soybean dregs were established. Soybean dregs natural was made through extracting, caustic treatment, hydrolyzation, drying and superpulverization. The production rate was 85%. The content of cellulose was 80% in the product. At the same time, a series of soybean cellulose food was made from soybean dregs natural cellulose.

Key words Natural cellulose ; Soybean dregs; Hydrolyzation.

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In recent years, comprehensive utilization of soybean by-product was focus in our country. Soybean oligopeptides, protein, oligosaccharides, and so on were made with soybean meal. But, the research in comprehensive utilization of soybean dregs are very few. Soybean dregs contain a lot of natural cellulose, the functions of which are releasing poison, keeping out of incontinence of the faeces, reducing blood fat, eliminating cancer, and so forth.

So functional natural cellulose was made of soybean dregs. On the one hand, the matter which the prepared soybean dregs came across in the processing of soybean was resolved. On the other hand, new cellulose produce with very wide market and high fashion will be added up. So, the study on "Extraction of Soybean Dregs Natural Cellulose and Its Research on Food" had been conducted during the period of 1996-2000.

1 Materials and Methods

1.1 Materials:

Fresh tofu (local product)

Trypsin (Difco company 2-4 item/mg); 250)

Caustic (A, R)

1.2 Analysis methods

Protein content; analysed through GB5009.5-85

Fat content ; analysed through GB5009.6-85

Water content ; analysed through GB5009.3-85

Ash content ; analysed through GB5009.4-85

Cellulose content ; analysed through GB5009.10-85

Bacteria level content ; analysed through GB4789, 2, 3, 4, 5, 10, 11-94

Harmful elements; analysed through Atomic Fluorescent Analysis

2 Results and Discussion

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2.1 Conditions and methods for extraction of soybean dregs natural cellulose

2.1.1 Processing techniques

Soybean dregs→water clean→homogenize→caustic treatment→hydrolyzation→separation→wet cellulose→drying→pulverizing→cellulose.

2.1.2 Extraction methods

After the new soybean dregs were removed trash through water cleaning , they were homogenized through cracking according to 5.5% of material weigh (w/w) added 5% caustic solvents, hotted, kept up temperature. Then conditioning pH value with caustic and trypsin of 0.3% of material weigh (w/w) was added up, keeping up temperature, hydrolyzing in some temperature, separating by separated machine, recovering filercake, drying in 80—85℃, cracking, screening through 70 pore, making of product of soybean dregs natural cellulose.

2.2 The research and achievement for extraction of soybean dregs natural cellulose

2.2.1 Selecting of the factor levels of the right angle experiment for extraction of the meal natural cellulose

Soybean dregs contain protein and fat .Protein affect the pure of production. The production send out strange taste owing to fat oxidation. So both of them should be got out in the preparing of extraction in order to improve production qualify. For selecting the condition we used caustic and trypsin hydrolyzation; the amount of used trypsin, caustic extraction and so on were studied. We selected caustic strength (A) 3%—5%, temperature of caustic extraction (B) 40—80℃, time of caustic extraction (C) 40—80 min, trypsin strength (D) 0.3%—0.5%, acted as the factor levels of the right angle experiment .

2.2.2 The right angle experiment for extraction of the meal natural cellulose

We analysed the content of the product through four factors and three levels, with the method of L9(3⁴) the right angle experiment , on the basis of right angle experiment to plan the conditions of experimental number in

Table 1 The analysis of the right angle experiment L9(3⁴)

| Experimental number | Factors | | | | Cellulose (%) |
|---------------------|------------------|---------------------|----------------|------------------------------------|---------------|
| | A Caustic (%) | B Temperature(℃) | C Time(min) | D The amount of used enzymes(%) | |
| 1 | 3 | 40 | 40 | 0.3 | |
| 2 | 3 | 60 | 60 | 0.4 | |
| 3 | 3 | 80 | 80 | 0.5 | |
| 4 | 4 | 40 | 60 | 0.5 | |
| 5 | 4 | 60 | 80 | 0.3 | 72.32 |
| 6 | 4 | 80 | 40 | 0.4 | 70.55 |
| 7 | 5 | 40 | 80 | 0.4 | 71.63 |
| 8 | 5 | 60 | 40 | 0.5 | 74.48 |
| 9 | 5 | 80 | 60 | 0.3 | 76.17 |
| K1 | 214.51 | 223.44 | 221.23 | 228.34 | 75.86 |
| K2 | 226.51 | 219.77 | 224.87 | 223.05 | 76.64 |
| K3 | 229.53 | 227.33 | 224.44 | 219.16 | 73.05 |
| K2 | 71.50 | 74.48 | 73.74 | 76.11 | 79.84 |
| K3 | 75.50 | 73.26 | 74.96 | 74.35 | |
| K3 | 76.51 | 75.78 | 74.81 | 73.05 | |
| R | 50.1 | 2.52 | 1.22 | 3.06 | |

Table 2 The physical and chemical examination of soybean dregs natural cellulose (%)

| Sample | Protein | Fat | Water | Ash | The total cellulose |
|----------------------------|---------|------|-------|-----|---------------------|
| Soybean dregs cellulose | 1.42 | 0.4 | 3.0 | 2.5 | 79.5 |
| Soybean dregs (dry weight) | 1.0 | 18.0 | 3.5 | 2.9 | 50.0 |

Table 3 The bacteria level in soybean dregs natural cellulose

| The kinds of bacterium | Level |
|------------------------------|----------------|
| The number of total bacteria | 20 item/ g |
| Coliform bacteria | < 30 item/100g |
| Malignant bacteria | None |

the plan table and to make the experiment for extraction of the meal natural cellulose.

Table 4 The harmful elements in soybean dregs natural cellulose (mg/kg)

| Sample | Pb | Hg | As |
|---------------------------------|-------|-------|-------|
| Soybean dregs natural cellulose | 0.210 | 0.003 | 0.050 |
| Soybean dregs (dry weight) | 0.280 | 0.005 | 0.090 |

From the result of the right angle experiment, the main and minor order of every factor in conditions was $A > D > B > C$. The excellent level in every factor was caustic strength 5%, temperature 80 °C, time 60 min, and used trypsin 0.3%. Through the optimum condition as checking experiment produce of 80% cellulose content was made.

3 The physical and chemical examination of the produce

The extracted natural cellulose extracted through caustic extraction, hydrolyzation, etc., conditions contained very lower protein and fat. It showed the high pure of natural cellulose and the content of natural cellulose was obviously higher that of raw material.

3.1 The organoleptic properties in produce

The soybean dregs natural cellulose are milk white, finely meal, no strange taste, extrusion across water, but insoluble in water.

3.2 The bacteria level in produce

The bacteria level in soybean dregs natural cellulose accorded with the related rules of food additives. The results appeared in Table 3.

3.3 The harmful elements in produce

The results analysed through Atomic Fluorescent Analysis appeared in Table 4. The content of the harmful elements, such as Pb, Hg, As, and so forth accorded with the related rule of food additives in soybean dregs natural cellulose produce.

4 The using of soybean dregs natural cellulose on food

The extracted soybean dregs natural cellulose were used as materials. The research was made in added amount and conditions for extraction of cellulose food. According to

50%—60% in material adding some starch, dextrin, a bit elements, etc., cellulose extrusion food was made, shapes were pole, shape, beads, soft, sharp.

The cellulose paper was white, with a certain soft character and can be eaten. The cellulose pill was a smooth, dust white pill shape with a certain sharp, extrusion across water. The cellulose solvent shape beautifully and ate easy.

5 Results

5.1 The new soybean dregs were used as materials in the paper.

The research established the conditions for extracting soybean dregs natural cellulose with right angle experiment L9(3⁴). Soybean dregs natural cellulose was made through caustic treatment, hydrolyzation, drying and superpulverization. The production rate was 85%.

5.2 The content of soybean dregs natural cellulose was 79.5% in this condition, its colour was good, pelleted mean, low fat, low protein. The content of the harmful elements, the bacteria level and other physical and chemical examination accorded with the related rule of food additives. So, the soybean dregs natural cellulose is an good food additives.

5.3 The soybean dregs natural cellulose were used as materials. The research was made in the recipe of soybean dregs natural cellulose and the method of extraction through science adding. The food of soybean dregs cellulose, the cellulose paper, the cellulose pill and so on, were made. Soybean dregs cellulose was used in food industry preliminarily.

5.4 The research result showed that the condition was simple, low expense, small source, little industry pollution, easy use, etc.

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豆渣膳食纤维制备及其在食品中的应用

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摘要 以新鲜豆渣为原料, 通过L9(3⁴)正交实验设计方法, 就影响膳食纤维含量的碱浓度、温度、时间和酶用量四项因素进行了实验。研究确立了制备豆渣纤维的最佳工艺条件。利用本工艺, 湿豆渣经浸泡、碱处理、酶解、干燥和超微粉碎等程序, 即得到豆渣膳食纤维, 工艺产率为85%, 产品纤维素含量是80%, 本文还以豆渣膳食纤维为原料研制出大豆纤维系列食品。

关键词 膳食纤维; 豆渣; 酶解

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