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Research of the Effect of Factors on the Process of Separation of Shadow Seeds from the Peel

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ABSTRACT

The research illustrates that soybeans are a non-traditional raw material in the oil industry in Uzbekistan. To date, the country has grown 16,000 tons of soybeans. Soybeans contain 24-45% protein, 17-22% fat, 20-32% carbohydrates, 1-2% lycitin, vitamins D, B and E. The weight of 1000 pieces is 140-200 g. Soybeans from the seeds are used to make flour, oil, protein and lysine. 89-92% of soybean seeds are kernels, 6-9% are husks and 2-2.5% are apricots. The data show that the development and creation of energy and resource-saving equipment for the processing of locally grown soybean seeds is of great importance. This article presents the results of an experimental study of the process of separating the bark of the locally grown variety "Universal". Mathematical planning of the experiment was performed. An experimental device has been developed. Experiments were conducted. As a result of mathematical and statistical processing of experimental results, a generalized empirical equation of the separation coefficient was obtained: the angle of inclination of the blade, the initial moisture of the seeds, the speed of rotation of the drum, the speed of air flow, the initial consumption of the product. The generalized empirical equation obtained is used to determine the optimal processing methods for separating the local soybean seed from the husk.

Keywords: local shadow, factors, knife, drum, air flow, experiment, laboratory device, generalized equation, separation coefficient

1. Introduction

Cultivated soybean (Latin. Glycine max) is an annual herbaceous plant, a type of soybean (Glycine) of the legume family. Cultural shade is widespread in more than 60 countries on all continents, with an annual production capacity of 359 million tons [1]. In the territory of the Republic of Uzbekistan from the local soybean seeds are grown the following varieties: "Ilkhom", "Universal" and "Sultan" [3]. A distinctive feature of cultivated seeds is the high content of protein and fat. The protein content in the seeds of the above soybean varieties varies by 40.5% and the fat content by 20%. Soybeans contain about 8% of husk and only 0.6-0.7% of fat, a lot of cellulose in the husk, as well as a high amount of pigment, gum and wax [8].

The technological process of soy processing includes the following stages: reception, purification of mixtures and storage of soybean seeds; peeling the shadow; extruding; squeezing the oil out of the soybean husk; purification of soybean oil by sedimentation and filtration; cooling and grinding the soybean husk to obtain a semi-oil-

free soybean meal; extruding soy flour to obtain soy protein. The scientific literature contains detailed information on various techniques and technologies for processing soybean seeds, as well as methods and devices for crushing and peeling. However, the high energy and resource consumption of these devices does not meet today's demand. Therefore, it is important to develop new energy resource-saving devices for crushing soybean seeds and separating the husk.

2. Materials and methods

This article is an experimental study of the process of crushing and separating the soybean variety grown locally. For this purpose, the object of research was the local soybean variety "Universal" harvested in 2021. For the mathematical description of the experimental results obtained, the method of planning a multifactorial experiment proposed by M. Protodyakonov was used [9]. The limits of variability of the influencing factors were selected based on the analysis of the results of preliminary experiments to study the process of separation of soybean seeds from the husk.

The acceptance of the influencing factors and the values of their values in the range of 5 is given in Table 1.

Table1. Influencing factors and degree of their change

№	Influencing factors	change interval				
		1	2	3	4	5
1	Slope angle of the blade,φ (grad.),	30	45	60	75	90
2	Initial humidity W (%)	12	14	16	18	20
3	Drum rotation speed, v_b (rot/min)	500	750	1000	1250	1500
4	Air flow rate, v_h (m/s)	1	2	3	4	5
5	Primary product consumption G (kg/s)	0.01	0.015	0.02	0.025	0.03

Source: [Compiled by the authors].

The separation coefficient Ka was defined as the sought objective functions. In our case, if the number of factors is equal to five in the implementation of the 5 × 5 experimental plan, [9] 25 experiments need to change the factors at five levels.

3. Results The matrix and experimental results are presented in Table 2. The separation coefficient K_a was obtained as the sought function.

Experimental results.

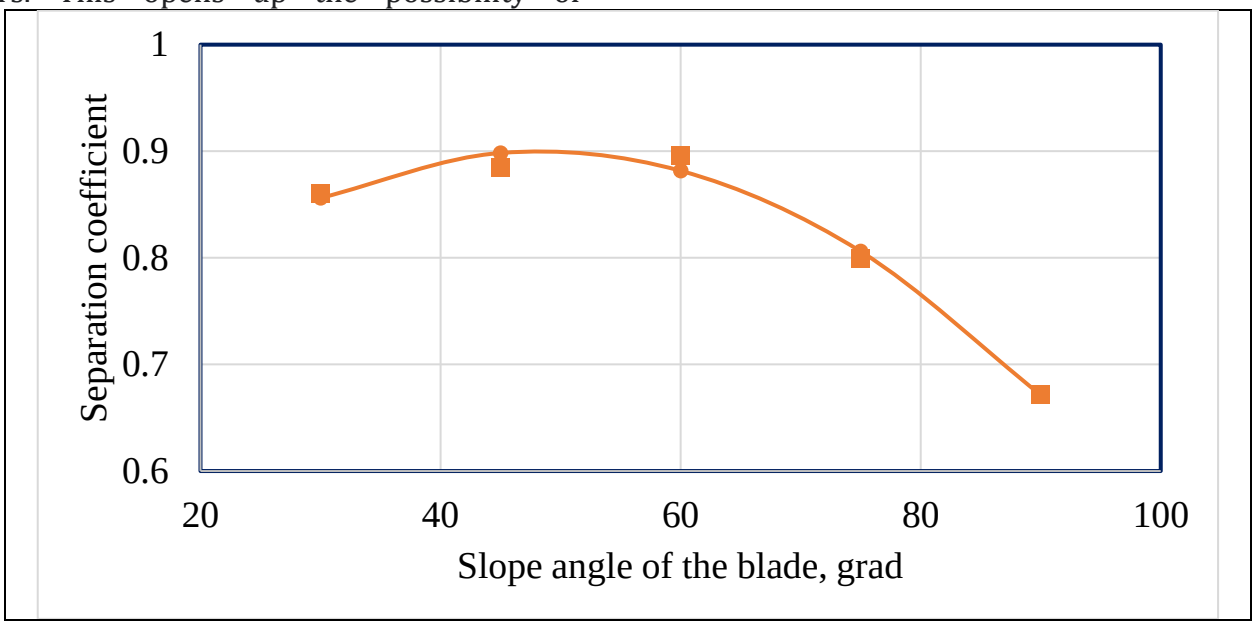
Table 2

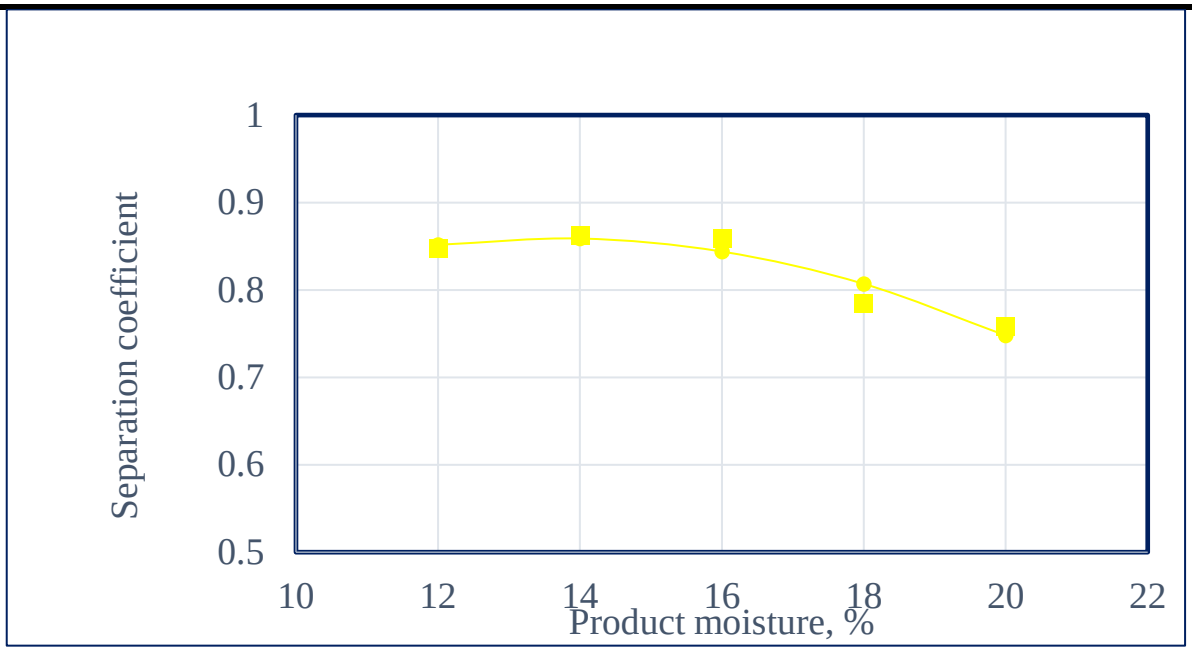
№ experience	φ (grad.),	W (%)	v_b (rot/min)	v_h (m/s)	G (kg/s)	K_a
1	30	12	500	1	0.01	0,83
2	30	16	1000	3	0,02	0,86
3	30	14	750	2	0,015	0,96
4	30	20	1500	5	0,03	0,82
5	30	18	1250	4	0,025	0,83
6	60	12	100	2	0,03	0,92
7	60	16	750	5	0,025	0,90
8	60	14	1500	4	0,01	0,92
9	60	20	1250	1	0,02	0,87
10	60	18	500	3	0,015	0,88

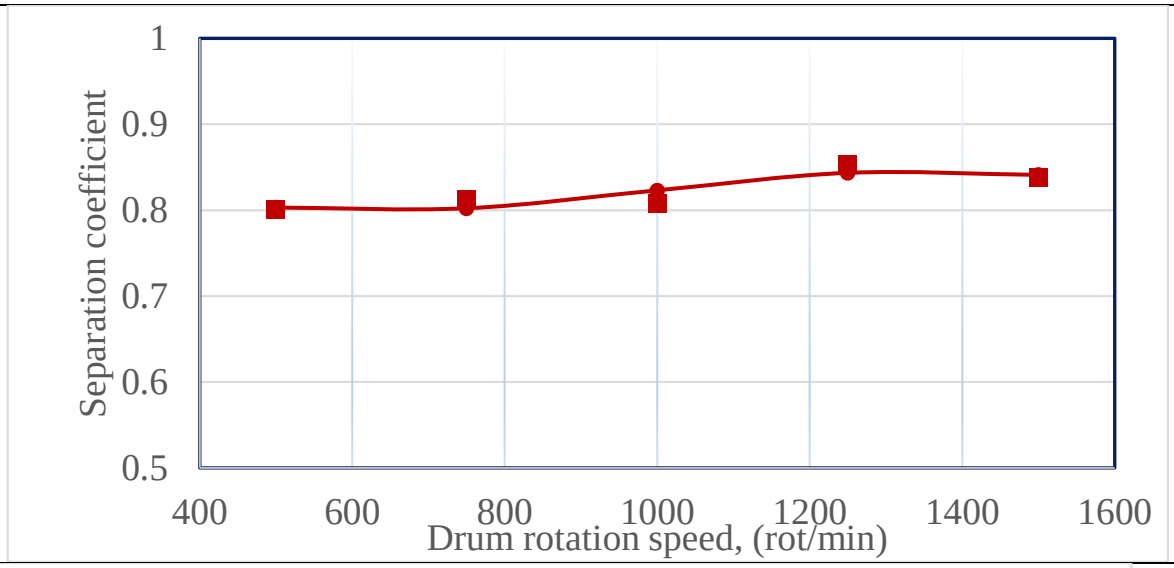
№ experience	φ (grad.),	W (%)	v_b (rot/min)	v_h (m/s)	G (kg/s)	K_a
11	45	12	750	4	0,02	0,9
12	45	16	1500	1	0,015	0,925
13	45	14	1250	3	0,03	0,94
14	45	20	500	2	0,025	0,82
15	45	18	1000	5	0,01	0,84
16	90	12	1500	3	0,025	0,748
17	90	16	1250	2	0,01	0,78
18	90	14	500	5	0,02	0,65
19	90	20	1000	4	0,015	0,58
20	90	18	750	1	0,03	0,6
21	75	12	1250	5	0,02	0,84
22	75	16	500	4	0,03	0,83
23	75	14	1000	1	0,025	0,84
24	75	20	750	3	0,01	0,70
25	75	18	1500	2	0,015	0,78

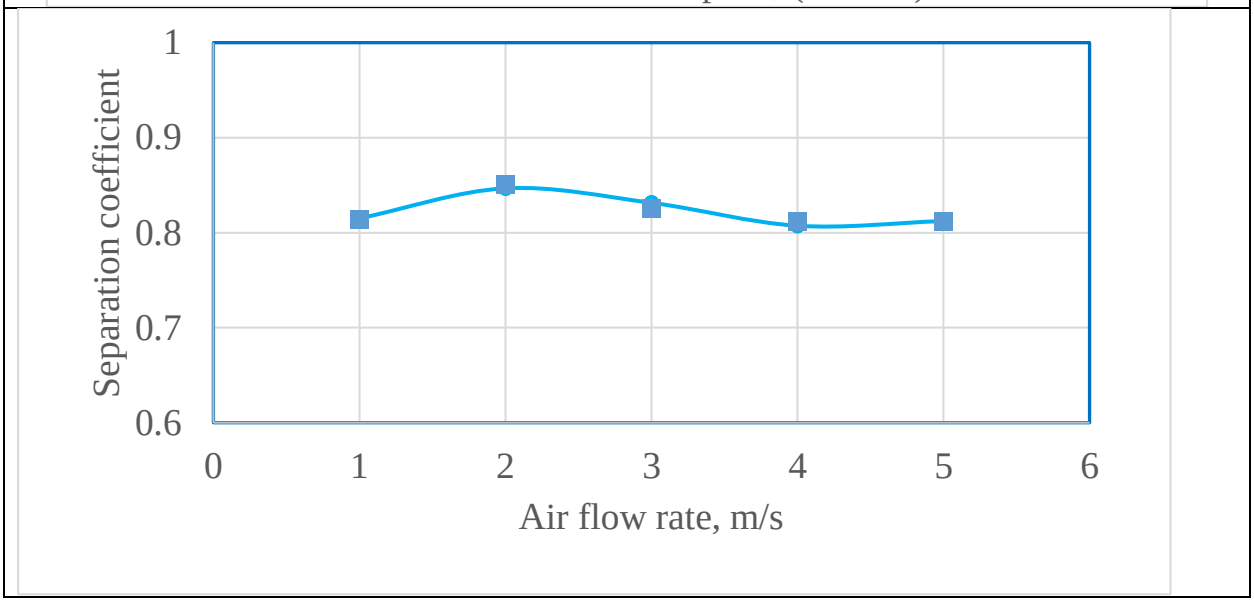
Source: [Compiled by the authors].

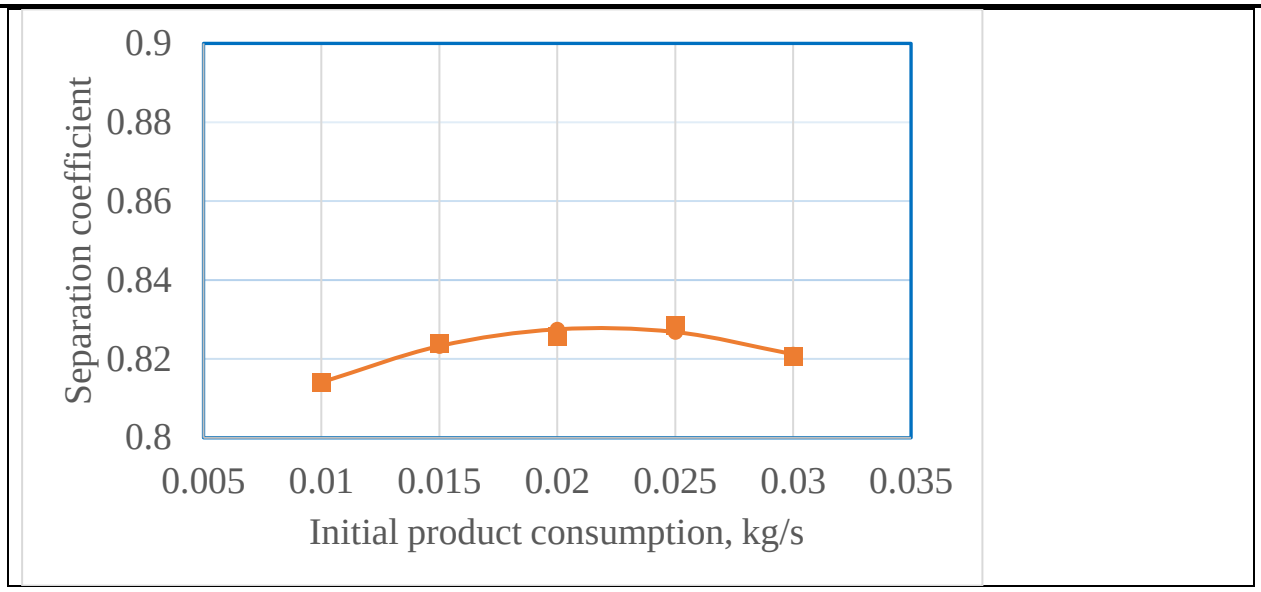
The structure of the matrix is such that during all experiments, each level of any factor meets each level of all other factors once, so that each level of each factor is set as many times as it is accepted in the experiments. This achieves the average effect of any factor, viz. The same effect is achieved with an infinite number of experiments with random variation of all factors. This opens up the possibility of applying mathematical statistical methods and saves on the number of experiments. [9]. Empirical formulas were obtained to describe the dependence of the separation coefficient on the angle of inclination of the blade, the initial moisture content of the seeds, the number of revolutions of the drum, the air flow rate and the consumption of the initial product.




Separation coefficient
1
0.9
0.8
0.7
0.6
0.5
10
12
14
16
18
20
22
Product moisture, %


Separation coefficient
1
0.9
0.8
0.7
0.6
0.5
400
600
800
1000
1200
1400
1600
Drum rotation speed, (rot/min)


Separation coefficient
1
0.9
0.8
0.7
0.6
0
1
2
3
4
5
6
Air flow rate, m/s



The following empirical equations were obtained for the separation coefficient of these graphs:
Separation coefficient for K_a:
For the angle of inclination of the blade $K_\varphi = -0.00013x^2+0.013x+0.59$
For the initial humidity of the product; $K_W = -0.003x^2+0.075x+0.345$
For drum rotation speed $K_v = -236.79\cdot10^{-12}x^3+706.28\cdot10^{-9}x^2-604.97\cdot10^{-6}x+958.56\cdot10^{-3}$;
For the airflow velocity, $K_y=6.33\cdot10^{-3}x^3-61.44\cdot10^{-3}x^2+171.62\cdot10^{-3}x+698.56\cdot10^{-3}$;
For the initial product consumption. $K_G = -98.86x^2+4.31x+0.78$
The general equation describing the process for the separation coefficient is:

$$K = \frac{(-0.0001\varphi^2 + 0.013\varphi + 0.59)(-0.003W^2 + 0.075W + 0.345)(-98.86G^2 + 4.31G + 0.78)}{0{,}82^4((-3\cdot10^{-12}v^3 + 706\cdot10^{-9}v^2 - 605\cdot10^{-6}v + 0{,}1)(6.3\cdot10^{-3}y^3 - 6.1y^2 + 0{,}2y + 0{,}7)} \quad (1)$$

4..Discussion

Based on the obtained empirical equation, it is recommended in the process of separating soybean seeds from the husk. It can be seen from the graphs that for the maximum separation of soybean seeds from the husk, the blade was found to be 450 from the product drop point and the separation coefficient decreased with increasing slope angle. The second influencing factor is the maximum amount of separation coefficient when the moisture content of the product reaches 14%. As the moisture content of the products increased, the separation coefficient decreased. When the rotational speed of the drum is 1250 rpm, the separation coefficient is reached at a high level. As the number of revolutions of the drum increases, the separation coefficient decreases. When separating lightning, a high value of air flow velocity of 2 m / s can be seen, the maximum value of the separation coefficient can be seen at this value, but an increase or decrease in air velocity above this value will cause a decrease in the separation coefficient. If the consumption of the product is given in the amount of 0.025 kg / sec, the separation coefficient will have a maximum value. As the consumption of the product increases, the separation coefficient decreases.7

5. Conclusion

The generalized empirical equation obtained (1) and the output index in the range of variation of the influencing factors studied in the process of separating the local soybean from the husk can be determined with sufficient accuracy. The obtained equation is used to determine the degree of influence on the final result (slope angle of the blade, initial moisture of the seed, drum rotation frequency, air flow rate, product consumption) required to optimize the process of separation from the shade.

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