RS Global Journals

Scholarly Publisher
RS Global Sp. z O.O.
ISNI: 0000 0004 8495 2390

Dolna 17, Warsaw, Poland 00-773
Tel: +48 226 0 227 03
Email: editorial_office@rsglobal.pl

JOURNAL	World Science
p-ISSN	2413-1032
e-ISSN	2414-6404
PUBLISHER	RS Global Sp. z O.O., Poland

ARTICLE TITLE	RESULTS OF EXPERIMENTS ON BUCKWHEAT PEELING WITH A DISK HULLER
AUTHOR(S)	Amartuvshin Oidov, Munkhbat Mendbayar, Gangantogos Yadamsuren, Battugs Sukhee
ARTICLE INFO	Amartuvshin Oidov, Munkhbat Mendbayar, Gangantogos Yadamsuren, Battugs Sukhee. (2024) Results of Experiments on Buckwheat Peeling with a Disk Huller. *World Science*. 2(84). doi: 10.31435/rsglobal_ws/30062024/8175
DOI	https://doi.org/10.31435/rsglobal_ws/30062024/8175
RECEIVED	18 April 2024
ACCEPTED	14 June 2024
PUBLISHED	19 June 2024

RESULTS OF EXPERIMENTS ON BUCKWHEAT PEELING WITH A DISK HULLER

Amartuvshin Oidov
Doctorant, School of Engineering and Technology, Mongolian University of Life Sciences Ulaanbaatar, Mongolia
ORCID ID: 0009-0007-3696-6228

Munkhbat Mendbayar
Ph.D School of Applied sciences, Mongolian University of Life Sciences Ulaanbaatar, Mongolia
ORCID ID: 0009-0000-0087-681X

Gangantogos Yadamsuren
Doctorant, School of Applied Sciences, Mongolian University of Life Sciences, Ulaanbaatar Mongolia
ORCID ID: 0000-0002-4428-7344

Battugs Sukhee
Ph.D., Professor, School of Applied Sciences, Mongolian University of Life Sciences, Ulaanbaatar Mongolia
ORCID ID: 0009-0005-6479-0018

DOI: https://doi.org/10.31435/rsglobal_ws/30062024/8175

ARTICLE INFO

Received: 18 April 2024
Accepted: 14 June 2024
Published: 19 June 2024

KEYWORDS

Peeling Equipment, Factors, Experimental Design, Optimal Value.

ABSTRACT

In order to implement the government's "Food Supply, Security and Nutrition" national program, carry out scientific theory and technical research on the process of dehulling, which is the main step in the production technology of certain types of rice imported from abroad (such as buckwheat). there is a necessity.

The year-on-year increase in the yield and import of rare types of rice has increased the demand and need for valuable products used for food, feed, and hygiene purposes, and companies and organizations are interested in selling them to foreign markets. Between 2018 and 2022, primary processing was carried out in Estonia, Japan, Korea, Russia, and China, and buckwheat worth 2972 thousand US dollars was exported. If we study the demands of the enterprises and citizens engaged in agricultural production, our research review shows that there is a need for rice cleaning and peeling equipment suitable for the conditions of our country.

Therefore, experiments are carried out on buckwheat with disk huller using the three-factor rototable designing method, and after finding the mathematical model, the results of determining the optimal values of the technological parameters are presented.

Citation: Amartuvshin Oidov, Munkhbat Mendbayar, Gangantogos Yadamsuren, Battugs Sukhee. (2024) Results of Experiments on Buckwheat Peeling with a Disk Huller. *World Science.* 2(84). doi: 10.31435/rsglobal_ws/30062024/8175

Introduction.

There is a need to fractionate the grain by geometric size in order to include it in the peeling and polishing process after grain harvesting and in the process of scarification to prepare the seed for planting. This requirement applies to squeeze-rub-tap peeling machines. For example, buckwheat is separated into 6 fractions using a broom with holes of Ø 4.5-4.2-4.0-3.8-3.6-3.3 mm, and peeling is carried out in 6 parallel lines. Therefore, in order to investigate whether it is possible to reduce the number of 6 parallel lines used in the process of peeling technology, we conducted a gas test of a disc or disk huller device, which is a type of peeling machine with the action of compression-carrying-rubbing.

The purpose of this research work is to find the optimal value of the main influencing technological parameters and determine the results by using the appropriate rototable designing method of the experiment designing center in the numerical data of the buckweat peeling test with a disk huller.

Experimental design.

From the sample of buckwheat, one hundred pieces were counted and the material to be peeled was selected. After that, their geometrical dimensions were individually measured, mathematical statistical processing was performed on the numerical data, and the working distance of the plate peeler was selected by the 3 sigma rule. The degree of peeling (K_x) was determined depending on three factors, such as the speed of rotation of the rotor of the peeling device (ω), the moisture of peeling seeds (w), and the grain size of seeds (z). The test black box is shown below (Fig. 1).

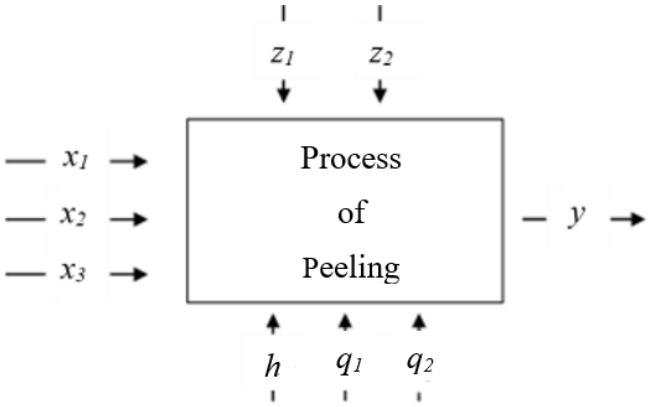

Figure 1. Black box for planned testing.

Of this:

Controlled factors:

x_1 – the speed of rotation of the rotor of the peeling device - ω , [r/min];

x_2 – the moisture of peeling seeds – w, [%] ;

x_3 – the grain size of seeds – z, [μm];

Controllable but unmanaged factors:

h – the size of the gap between the stationary and rotating discs;

q_1 – degree of purity of husked rice;

q_2 – the temperature of the husked rice;

Unmanaged factors:

$z1$ – ambient air temperature,

$z2$ – ambient air humidity.

The experimental plan consists of a three-factored (n = 3) factorial design with five levels.

Levels of variation and codes of the independent variables of x1, x2, and x3 for the degree of peeling are presented in Table 1.

Table 1. Levels and codes of the independent variables of ω, w and *z*.

		1.68	-1	0	1	1.68	Δ
The speed of rotation of the rotor of the peeling device - ω , [r/min]	x_1	864	1000	1200	1400	1536	200
The moisture of peeling seeds – w, [%]	x_2	8.64	10	12	14	15.36	2
The grain size of seeds – *z*, [μm]	x_3	23.2	30	40	50	56.8	10

Table 2. Real and coded values for independent variables Speed of rotation of the rotor of the peeling device (x1), Moisture of peeling seeds (x2), and Grain size of seeds (x3) the degree of peeling (y).

№	ω , [r/min]	w, [%]	z, [μm]	ω , [r/min]	w, [%]	z, [μm]	K_x
	x_1	x_2	x_3	x_1	x_2	x_3	y
1	1	1	1	1400	14	50	75
2	1	1	-1	1400	14	30	62
3	1	-1	1	1400	10	50	65
4	1	-1	-1	1400	10	30	63
5	-1	1	1	1000	14	50	65
6	-1	1	-1	1000	14	30	58
7	-1	-1	1	1000	10	50	60
8	-1	-1	-1	1000	10	30	57
9	1.68	0	0	1536	12	40	58
10	-1.68	0	0	864	12	40	61
11	0	1.68	0	1200	15.36	40	57
12	0	-1.68	0	1200	8.64	40	55
13	0	0	1.68	1200	12	56.8	65
14	0	0	-1.68	1200	12	23.2	61
15	0	0	0	1200	12	40	69
16	0	0	0	1200	12	40	68
17	0	0	0	1200	12	40	67
18	0	0	0	1200	12	40	65
19	0	0	0	1200	12	40	78
20	0	0	0	1200	12	40	66

Optimization parameters:

y – the degree of peeling, K_x, ($K_x \rightarrow 100\%$);

The degree of peeling: $K_x = \frac{n_1 - n_2}{n_1}$.

Of this:

n_1 − number of seeds with a hard shell before processing, pieces;

n_2 − number of seeds with a hard shell after processing, pieces.

Grain materials and equipment used for the experiment:

- Buckwheat sort: Zemlyachkii;
- Grain moisture measurer (WILE55. Finland), (Fig. 5 (a));
- Tachometer (Fig. 5 (b));
- Electron balance. (JJ-200. [0.01gr]. China), (Fig. 5 (c));

Micrometer, caliper (Fig. 5 (d)).

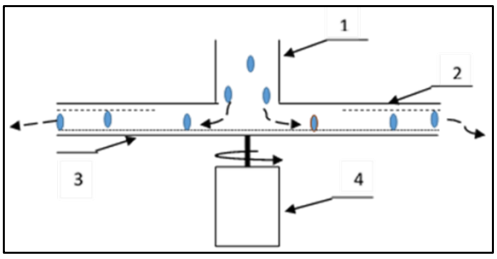

Figure 2. Technological scheme of a disk huller:
mouth for making peeling material, 2- stationary parts for pumping,
3- movable parts for tapping-rubbing, 4- engine.

When the grain is made through the hollow mouth of the shaft of the 1-immovable disk, 3-it is husked in the action of compression-squeezing-rubbing while moving accelerated by centrifugal force on the rotating disk.Grain peeling takes place between the stationary 2-disc on a horizontal parallel plane and the 3-rotating disc with an abrasive surface (Fig. 2).

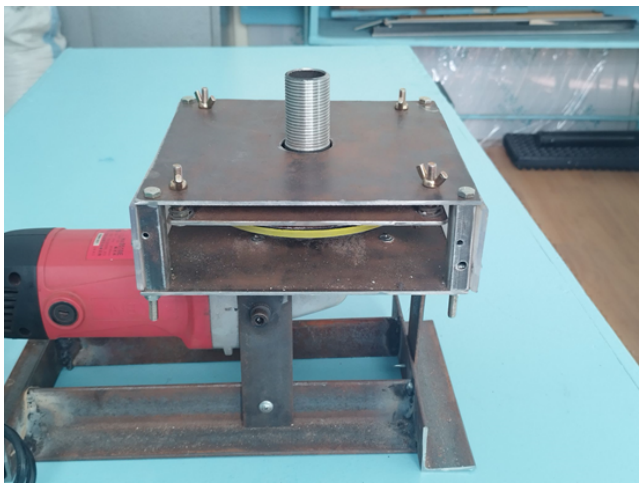

Figure 3. Test disk huller equipment.

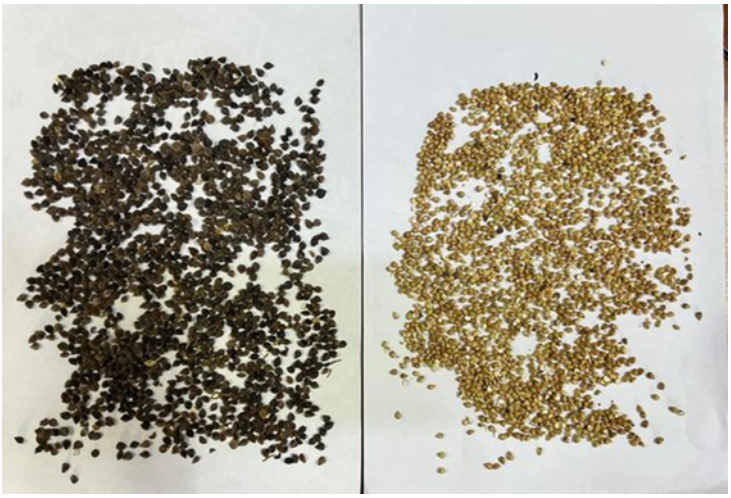

Figure 4. Appearance of peeled buckwheat.

(a) *(b)* *(c)* *(d)*

Figure 5. Equipment used for the experiment.

Results.

The results of the matrix of coded and actual values of experimental planning are shown in Table. 2 is shown.

Based on the results of previous experimental work on the material of compression parts, the material is selected under the condition that the elastic coefficient is k≤24 H/mm [1]. This will ensure that the "kernel" does not break.

The moving parts that perform the rubbing-rubbing action are made of abrasive surface material that will generate more dynamic friction force on the grain [2].

When the numerical values of the measurements are checked by the Kolmogorov-Smirnov D_n-criterion, it is proved that they obey the normal distribution law as $K - Sd = D_n = max|F_n(x) - F(x)| = 0.102 < D_{100,05} = 0.13$.

When checking the homogeneity of dispersion by Cochran's G criterion, the calculated value $G_T = 0.157$ satisfies the condition that the table value $G_X = 0.270$ is lower.

Table 3. Results of analysis of curvilinear regression equation between the speed of rotation of the rotor of the peeling device (x_1), Moisture of peeling seeds (x_2), and Grain size of seeds (x_3).

Factor	Regression Summary for Dependent Variable: the degree of peeling, y, % (Spreadsheet 1) R^2= .63133 Adjusted R^2= .29952 3 factors,1 bloks, 20 Runs; MS Residual=24.47062					
	Effect	Std.Err.	b	Std. Err. of b	t(4)	p-value
Intercept	68.692	2.017	68.692	2.017	34.05	0.0000
(1)x1 (L)	2.925	2.678	1.462	1.339	1.092	0.3000
X1 (Q)	-4.829	2.610	-2.414	1.305	-2.850	0.044
(2)x2 (L)	2.691	2.678	1.345	1.339	1.004	0.3338
X2 (Q)	-7.309	2.610	-3.654	1.305	-2.800	0.018
(3)x3 (L)	4.649	2.678	2.324	1.3339	2.735	0.013
X3 (Q)	-2.349	2.610	-1.174	1.305	-0.900	0.389
1L by 2L	0.750	3.497	0.375	1.748	0.214	0.834
1L by 3L	1.250	3.497	0.625	1.748	0.357	0.728
2L by 3L	3.750	3.497	1.875	1.78	1.072	0.308

The probability value F (shown in Table 3) is less than 0.05 which indicates that the model is significant.

The significance of the coefficients of the regression equation is checked by the Student's test, and the correctness of the equation is checked by the Fisher test. The calculated value of the criterion is $F_T = 1.91$, and the condition $F_T < F_X$ ($F_X = 2.25$) is met, so the mathematical model is created as follows.

$$y = 68.692 + 2.324x_3 - 2.414x_1^2 - 3.654x_2^2 \qquad (1)$$

$$\text{The degree of peeling} = 68.692 + 2.324(z) - 2.414(\omega)_1^2 - 3.654(w)_2^2 \qquad (2)$$

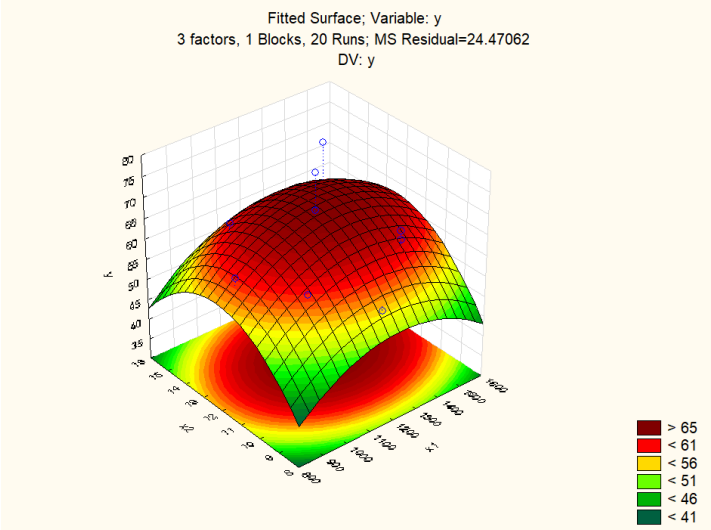

Figure 6. 3-D plots fort the degree of peeling as a speed of rotation of the rotor of the peeling device and moisture of peeling seeds.

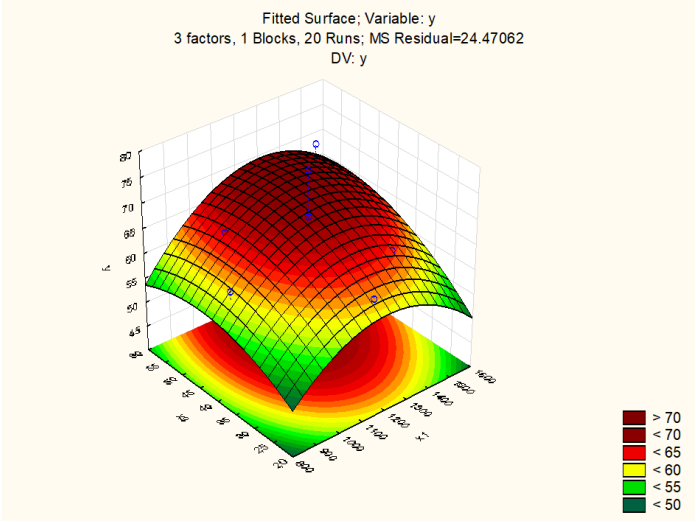

Figure 7. 3-D plots fort the degree of peeling as a speed of rotation of the rotor of the peeling device and the grain size of seeds.

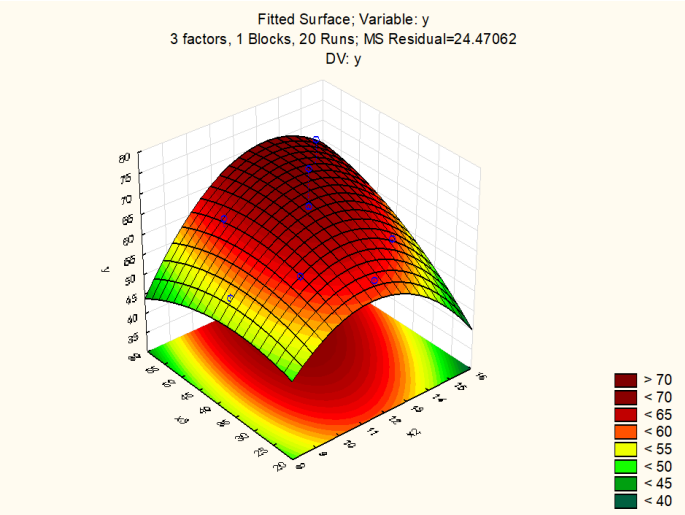

Figure 8. 3-D plots fort the degree of peeling as a moisture of peeling seeds and the grain size of seeds.

Conclusion.

1. The mathematical model of the degree of peeling of buckwheat is as follows. It includes: The degree of peeling $= 68.692 + 2.324(z) - 2.414(\omega)^2 - 3.654(w)^2$

2. Mathematical models show that the degree of peeling will decrease with increasing disc rotation and moisture content for disk huller, with moisture having the greatest effect.

The maximum value of peeling degree is 71.44 % when the speed of rotation of the rotor of the peeling device -1313.06 r/min, the moisture of peeling seeds -13.27%, and the grain size of seeds -56.47μm.

REFERENCES

1. O. Amartuvshin, S. Battogs. The results of experiments determining the deformation limit of triangular rice depending on its moisture content, 2021.
2. O. Amartuvshin, S. Battogs. Results of experiments to determine the dynamic coefficient of internal and external friction of buckwheat, 2022.
3. O.N. Chebotarev, A. Yu. Shazzo. Determination of geometrical parameters of grains, 2005.
4. Gurgenidze Z.J. Determination of parameters and development of construction of a disk installation for grinding sugar beet seeds, 2019.
5. Starostin. I. A. Development of disk grinding device for pre-sowing preparation of sugar beet seeds, 2015.
6. Lukin. A. N. Parameter pneumatic scarifier for pre-sowing seed treatment of perennial legumes. 2013.