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

ARTICLE TITLE	RESULTS OF DETERMINING THE HARDNESS OF THE SEED COAT OF GRAINS GROWN IN MONGOLIA
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ARTICLE INFO	Orkhon Lkhvasvren, Amartuvshin Oidov, Ganbat Balsan, Gangantogos Yadamsuren, Battugs Sukhee. (2023) Results of Determining the Hardness of the Seed Coat of Grains Grown in Mongolia. *World Science*. 4(82). doi: 10.31435/rsglobal_ws/30122023/8067
DOI	https://doi.org/10.31435/rsglobal_ws/30122023/8067
RECEIVED	22 September 2023
ACCEPTED	30 October 2023
PUBLISHED	03 November 2023
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RESULTS OF DETERMINING THE HARDNESS OF THE SEED COAT OF GRAINS GROWN IN MONGOLIA

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DOI: https://doi.org/10.31435/rsglobal_ws/30122023/8067

ARTICLE INFO

Received: 22 September 2023
Accepted: 30 October 2023
Published: 03 November 2023

KEYWORDS
Hardness, Statistical Analysis, Seed Coat, Moisture

ABSTRACT
The objectives of the long-term development policy of Mongolia "VISION-2050" include scientific and knowledge-based development of agricultural production with the sight of sustainable development, the ability to transform knowledge into practice, the introduction of advanced technologies and innovations, the extension of agricultural raw materials and products in a foreign market, suspending the import of certain types of raw materials and products, and increasing exports.
In order to determine the hardness of grain seeds, carried out 3-5 repeated experiments and measurements on the laboratory equipment for each grain grade after considering the different levels of moisture and made mathematical and statistical analysis on data of collected samples and processed experiment results.

Citation: Orkhon Lkhvasvren, Amartuvshin Oidov, Ganbat Balsan, *Gangantogos Yadamsuren,* Battugs Sukhee. (2023) Results of Determining the Hardness of the Seed Coat of Grains Grown in Mongolia. *World Science.* 4(82). doi: 10.31435/rsglobal_ws/30122023/8067

BASIK OF RESEARCH WORK.

As the development of the countries of the world accelerates, the issue of food supply and food security of the population has become more urgent. National programs are being implemented throughout Mongolia to develop agricultural production and sales network, to fully meet the needs of staple food products domestically, and to support the production of import-substituting and export-oriented products.

In recent years, the annual increase in grain yield and import indicates the interest and need of small machinery for hulling grain suitable for the conditions of our country for individuals and enterprises engaged in production in this field.

The purpose of this research work is to test the hardness of grain seeds depending on its moisture in laboratory conditions, and to determine the results by applying mathematical statistical analysis methods on the numerical data extracted.

RESEARCH MATERIALS AND METHODS.

The experiment will be carried out according to the method of determining the hardness of the seed coat of grains. [4, 5, 6].

The relationship between grain moisture and the hardness of the seed coat is considered a linear and curvilinear relationship.

The mathematical statistical processing is performed on the sample data and quantitative indicators are determined [1].

Grain materials and equipment used for the experiment:

• Laboratory equipment for determining grain hardness (Figure 1);
• Grain moisture meter. (Figure 2. WILE55. Finland);
• Digital microscope. (Figure 3. DM-1000S. China).

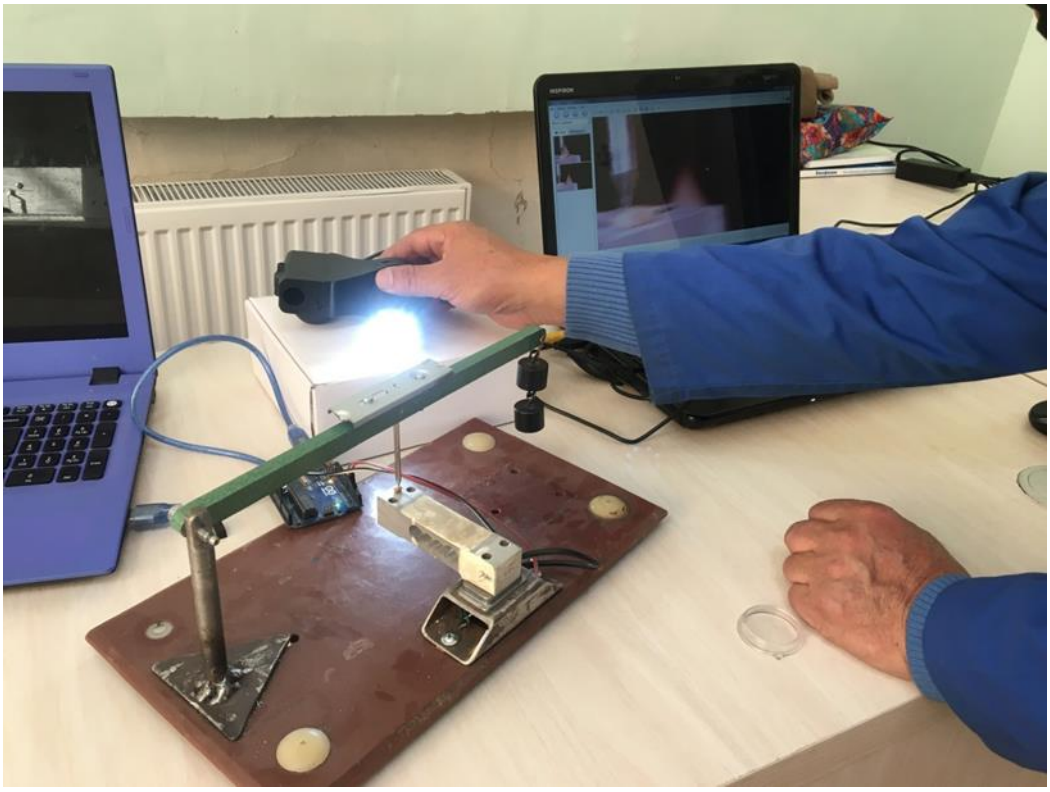

Figure 1. Experimental and measurement processes during determination of seed hardness.

Figure 2. Moisture meter. *Figure 3. Microscope.*

RESULT OF THE RESEARCH.

Table 1. shows the results of experiments and measurements that determine the hardness of seeds in relation to the moisture.

Using STATISTICA 21 software, obtained following results of mathematical and statistical analysis of numerical data of collected samples from experimental testing and measuring of grain seed hardness and moisture.

Here, it can be seen that the numerical data of the breaking force of grain hull experiment for each grain corp obeys the normal distribution law with the Kolmogorov-Smirnov Dn-criterion.

Including:

Moisture: $K - Sd = D_n = ax|F_n(x) - F(x)| = 0.13389 < D_{10,0,05} = 0.40925$.

Buckwheat: $K - Sd = D_n = max|F_n(x) - F(x)| = 0.11685 < D_{10,0,05} = 0.40925$.

Wheat: $K - Sd = D_n = max|F_n(x) - F(x)| = 0.15352 < D_{10,0,05} = 0.40925.$

Barley: $K - Sd = D_n = max|F_n(x) - F(x)| = 0.13138 < D_{10,0,05} = 0.40925.$

Oat: $K - Sd = D_n = max|F_n(x) - F(x)| = 0.22364 < D_{10,0,05} = 0.40925.$

According to the results of the regression analysis of the relationship between the breaking force of grain hull and moisture, the coefficients of determination are $R^2 = 0.98 - 0.99$, which indicates that breaking force of grain hull strongly depends on moisture with 98-99%. (Tables 2-5).

From the result of dispersion analysis, according to Fisher's exact test $F_{experiment} = (38.74 - 384.57) > F_{theory}(2,7,0.05) = 19.35$, the curvilinear form of the regression curve is plausible and consistent with a probability of 0.95%.

From the figure, the hardness of the seed coat depending on its moisture can be illustrated (Figure 4).

Table 1. Relationship between seed hardness and moisture, determined as a result of experimental measurements / Amounts are defined as average values of data.

Moisture, %	Wheat, H/mm ^{2}	Barley, H/mm ^{2}	Buckwheat, H/mm ^{2}	Oats, H/mm ^{2}
12.5	78.4	58.8	53.9	40.18
14.5	58.8	51.94	41.16	37.24
15.5	51.94	49.98	38.22	34.3
16	50.96	45.08	36.26	24.5
17	49	43.12	34.3	21.56
18	44.1	36.26	31.36	20.58
19	39.2	33.32	29.4	18.62
20	36.26	29.4	22.54	17.64
23.5	27.44	19.6	19.6	15.68
23.7	23.52	17.64	17.64	14.7

Table 2. Results of coefficient analysis of curvilinear regression equation between wheat hardness and moisture.

N=10	Regression Summary for Dependent Variable: Wheat, H/mm^2 R= .989592 R^2= .979293 Adjusted R^2= .973376 F(2,7)=165.53 p<.00005 Std.Error of estimate: 2.5953					
	b*	Std.Err. of b*	b	Std. Err. of b	t(7)	p-value
Intercept			211.53	22.655	9.337	0.0000
Moisture, W,%	-3.305	0.5777	-14.31	2.501	-5.722	0.0007
W^2	2.351	0.5777	0.27	0.067	4.020	0.0047

Table 3. Results of coefficient analysis of curvilinear regression equation between barley hardness and moisture.

N=10	Regression Summary for Dependent Variable: Barley, H/mm^2 R= .99548035 R^2= .99098113 Adjusted R^2= .98840431 F(2,7)=384.58 p<.00000 Std.Error of estimate: 1.4783					
	b*	Std.Err. of b*	b	Std. Err. of b	t(7)	p-value
Intercept			121.47	12.904	9.413	0.00000
Moisture, W,%	-1.479	0.3813	-5.53	1.425	-3.880	0.0061
W^2	0.487	0.3813	0.05	0.038	1.277	0.2422

Table 4. The results of the coefficient analysis of the curvilinear regression equation between buckwheat hardness and moisture.

N=10	Regression Summary for Dependent Variable: Buckwheat, H/mm^2 R= .99068459 R^2= .98145596 Adjusted R^2= .97615767 F(2,7)=185.24 p<.00000 Std.Error of estimate: 1.6917					
	b*	Std.Err. of b*	b	Std.Err. of b	t(7)	p-value
Intercept			144.91	14.768	9.812	0.0000
Moisture, W,%	-3.244	0.5467	-9.67	1.630	-5.933	0.0006
W^2	2.287	0.5467	0.18	0.044	4.183	0.0041

Table 5. The results of the coefficient analysis of the curvilinear regression equation between oats hardness and moisture.

N=10	Regression Summary for Dependent Variable: Oat, H/mm^2 R= .95767471 R^2= .91714085 Adjusted R^2= .89346681 F(2,7)=38.740 p<.00016 Std.The error of estimate: 3.0457					
	b*	Std.Err. of b*	b	Std. Err. of b	t(7)	p-value
Intercept			146.70	26.587	5.518	0.0009
Moisture, W,%	-4.480	1.1557	-11.38	2.935	-3.877	0.0061
W^2	3.601	1.1557	0.25	0.079	3.116	0.0169

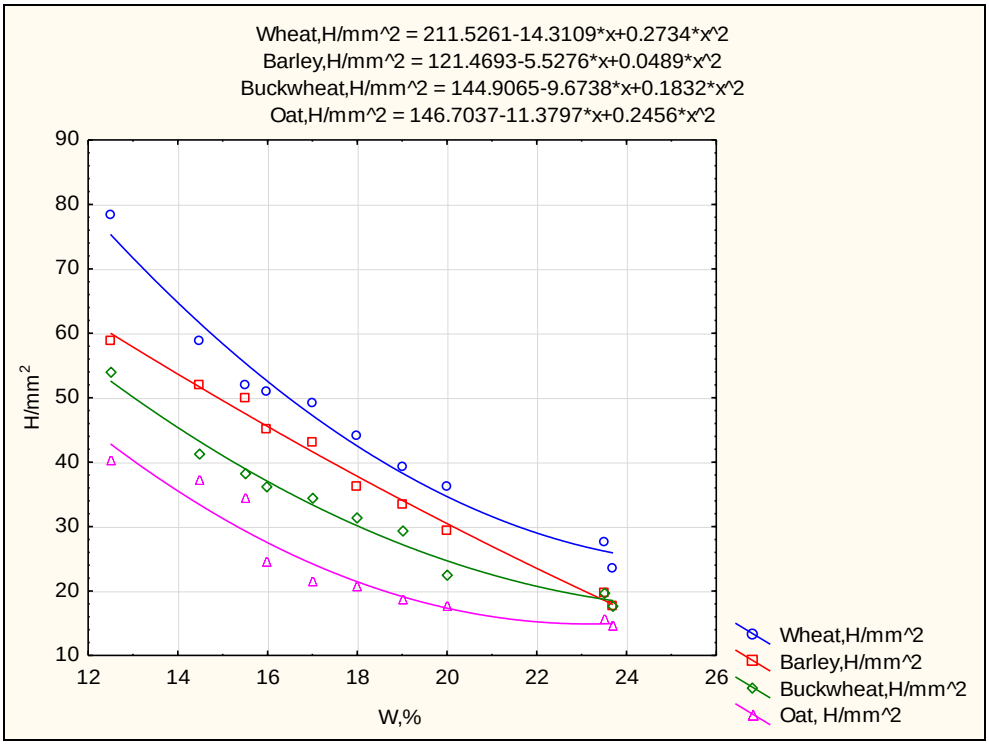

Figure 4. The graph of the relationship between grain moisture and the hardness.

CONCLUSION.

1. According to the results of the correlation analysis made on the relationships between hardness of grain seeds and moisture, it is possible to conduct a regression analysis between seed hardness and moisture because the hardness of the seeds is inversely related to moisture at values between 0.86-0.994.

2. According to the results of the regression analysis, the hardness and moisture of grains have 2nd degree curvilinear dependency and the moisture is inversely related to the hardness strongly.

3. The mathematical model of describing the relations between seed hardness and moisture has the following form.

Here:

- Wheat hardness=211.53-14.31*W+0.27*W ^{2};
- Barley hardness=121.47-5.53*W;
- Buckwheat hardness=144.91-9.67*W+0.18*W ^{2};
- Oats hardness=146.7-11.38*W+0.25*W ^{2}.

4. When seed moisture content of grains increases then the hardness of the grain seed material decreases.

5. It is possible to determine the hardness of the grain seed material at different moisture values using a mathematical model.

6. When the seed moisture content is 12-25%, then hardness of wheat varies between 23.52-78.4 N/mm ^{2}, the hardness of barley is 17.64-58.8 N/mm ^{2}, the hardness of buckwheat is 17.64-53.9 N/mm ^{2} and the hardness of oat is 14.7-40.18 N/mm^2.

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