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The Effect of Wetting Corn Grain on its Physico-Mechanical Properties.

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Vliyaniya uvlazhneniya zerna kukuruzy na yego fiziko-mekhanicheskiye svoystva

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TRANSLATION

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Values of disintegrating force are given for various types and hybrids of corn, and also work of disintegrating 1 kg of grain depending on the degree of wetting, setting time, and water temperature.

The effect of moisture on the mechanical damage to corn grain during threshing has been described (1, 2, 3,4). It has been established that with increase of moisture from 16. 0 to 27. 0% the quantity of disintegrated grain and also cracks in its endosperm decrease. However, there is little said in the references about changes in this of the physical-mechanical properties of corn grain. Meanwhile, knowing the regularity of their changes in relationship to wetting method, the optimum condition can be established for processing corn grain into flour and groats. It is known that it is capable of strong absorption of moisture, which reduces the binding strength of the seed to the endosperm a' and reduces the hardness of the latter. At the same time the plastic properties of all parts of the grain increase, which increases their resistance to deterioation (5).

The absorption of moisture and its penetration into the grain depends on the temperature of the water, the physical-mechanical properties of the grain as a whole, and its anatomy. In connection with this the absorption of moisture is not uniform, and consequently, also not uniform are the physical-mechanical changes. Wetting grain leads to strengthening of the capsule and reduction in strength of the endosperm, consequently to reduction of overall grain hardness (5, 6, 7).

Considering the variation in endosperm structure and especially in the distribution of corniform and farinaceous substances in various types of corn - odontoid and granular, types and hybrids of yellow corn of the 1961 harvest were studied: Granular-Vornonezhskaya 76 with average grain size: length - 8. 6, width - 7. 6, thickness - 4. 7 mn; semi-odontoid - OD-27: length - 10. 0, width - 8. 0, thickness - 5. 6 mm; odontoid - BIR-42: length - 9. 0, width - 8. 1, thickness - 3. 9 mm. A form with initial moisture 13. 5% was wet at 20, 40, and 80°C, set aside at 20 2°C for 40 min, 3, 4, 8 and 24 hours, leading it to 15, 5, 16. 5 and 17. 5 (± 0. 5) moisture.

Disrupting forces of pressure and tearing under static stress was determined in an MP-0. 05 machine, produced by the Ivanovskij Plant of GZIP and fitted by us for testing corn grain. Allowable error, 1% of the measured load; scale of deformation recording on diagram apparatus 5:1; rate of loading form, 30 mm/min. After laying aside, the grain was placed with tweezers on the corresponding die--frames of the machine for pressing or tearing, and the deteriorating forces were determined for the length, width, and thickness of the grain. To determine the corresponding units of surface, grains were sliced on a microtome, recorded on a recording apparatus, and then the area was found by planimeter. The appearance of the first fissures were counted as deterioration, which was fixed by diagramatci apparatus and visually. Experiments for each situation were repeated eight times, the five figures closest to each other were selected, and the average arithmetical data carried to the table.

Work on impact destruction of 1 kg of corn grain was determined on a laboratory ram impact machine type U-1 (Rozhkov system) (8). Basic lot parameters: weight 0. 2 kg, base area 0. 7cm^2, upper fall limit 50 cm.

The resulting forms were sorted on a laboratory seive. Collection from the screens with round holes 9, 8, and 7 mm in diameter were weighted and the resulting fractions calculated in percents. The average form was taken from each fraction, and from it several sets of 50 grains each. The grains were shattered, releasing the hammer over various intervals of height. In each group the number and increase of destroyed grains was counted in pieces and percentage. From the result of each fraction the specific work was calculated, necessary for the destruction of the grain of the given fraction, and the total specific work represented the work to destroy 1 kg of corn grain. The results obtained for varying moisture are given in Table 1.

Table 1

Type or Hybrid	Moisture, %	Shattering force, n/cm² compression in L	H	W	shear in W	Work of shattering 1 kg of grain, joules
Voronezhskaya 76	13.4	442.8	570.0	695.5	204.0	566.0
	15.7	375.7	415.9	687.7	184.4	644.5
	16.6	358.0	359.0	675.9	163.8	655.3
	17.4	331.6	339.4	565.0	149.1	668.0
OD-27	13.2	395.3	396.3	650.4	205.0	549.4
	15.3	397.3	383.6	622.9	200.1	609.2
	16.2	328.6	327.6	615.1	165.8	630.8
	17.2	321.8	280.5	524.8	146.0	670.0
VIR-42	13.4	780.9	582.7	802.5	207.0	570.9
	15.3	708.3	509.1	785.8	200.1	629.8
	16.4	663.2	482.6	764.2	182.5	667.1
	17.5	621.9	432.6	686.7	185.4	701.4

Table 2

Type or Hybrid	Water temp., °C.	Shattering force, n/cm² Compression in L	H	W	shear in W	Work of shattering 1 kg of grain, joules
Voronezhskaya 76	20	359.0	296.3	691.6	176.6	655.3
	40	348.3	364.9	682.8	163.8	668.1
	80	326.7	356.1	675.9	122.6	676.9
OD-27	20	329.6	327.7	615.1	166.8	630.8
	40	314.9	325.7	563.1	132.4	651.4
	80	310.0	317.8	403.2	127.5	706.3
VIR-42	20	663.2	482.7	725.9	182.5	667.1
	40	632.7	479.7	719.0	175.6	685.7
	80	541.5	470.9	706.3	168.7	734.8

For all types wetted at 20°C and set aside for 3 hours, with moisture increase the resistance of grain to shattering decreases. In shearing, the destruction force is significantly less than under pressure. The work of shattering 1 kg of grain with increased moisture increases, which explains the increase in its elasticity.

Shattering force and the work of shattering odontoid corn similar conditions is greater than for granular and semi-odontoid, which is explained by the different content and distribution of corniculate and farinaceous endosperm. Change of solidity of wetted corn relative to water temperature during constant wetting of all types at 16.5-0.5% and 3 hour setting time is shown in Table 2. All types with initial temperature of 20°C. were wet by the usual method.

Comparing the values of hardness of the types and hybrids of corn studied, we establish that with increase of water temperature the hardness of grains increases. The effect of time is shown in Table 3. Experiments were conducted with samples brought to 16.5-0.5% moisture in water at 20°C.

From the table we see that the resistance of corn grain to the destructive force of pressure is fairly high for 0.6 hours setting, where all moisture from the grain surface is dispersed in the capsule, and as a rule decreases up to 4 hours, after which the resistance of the grain again increases; likewise the destructive force for 1 kg of corn changes. Shattering force and destructive work also is greater for odontoid corn.

Table 3

Type or Hybrid	Setting Time hrs.	Shattering force, n/cm² compression in L	H	W	shear in W	Work of shattering 1 kg of grain, joules
Voronezhskaya 76	0.6	462.0	491.5	702.4	166.8	719.1
	3	394.4	463.0	615.1	164.8	655,3
	4	370.8	463.0	617.0	206.0	638.6
	8	464.0	516.0	675.9	196.2	684.7
	24	428.7	535.6	690.6	208.0	710.2
OD-27	0.6	381.6	349.2	642.6	168.7	669.2
	3	328.6	327.6	587.6	166.8	630.8
	4	333.5	315.9	609.2	159.9	610.2
	8	365.9	419.9	615.1	164.8	622.9
	24	420.8	407.1	644.5	211.9	669.2
VIR-42	0.6	690.6	527.8	793.6	186.4	735.7
	3	663.2	481.7	725.9	182.5	667.0
	4	663.2	494.4	760.3	223.7	710.2
	8	737.7	485.6	765.2	220.7	738.7
	24	680.8	544.5	774.0	263.9	756.4

CONCLUSIONS

1. The resistance of corn grain to static and dynamic load depends on the degree of wetting, temperature of the grains and setting time.

2. The physical-mechanical properties of corn grain can be changed by increasing or reducing the moisture content in it.

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