IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 16, Issue 2 Ser. II (February. 2023), PP 07-11
www.iosrjournals.org

Study on Mechanical Properties of Maize Kernel

HuabiaoLi[1], Qinghao He[1], Duanxin Li[1], Lin Niu[1], Ce Zhang[1], Duanyang Geng[1]
[1](*School of Agricultural And Food Engineering, Shandong University of Technology, Zibo 255000, China.)*

Abstract: *The static pressure damage test was carried out on the main corn varieties Zhengdan 985 and Xianyu 335 in the Huang-Huai-Hai area using a universal tension-compression testing machine controlled by a computer, and the static pressure rupture time of the belly, top and side surfaces of the corn kernels was measured. The mechanical properties of corn kernels were analyzed, and the effects of different varieties, moisture content, and pressure-applied parts on the static pressure damage characteristics of corn kernels were analyzed. The test results showed that the moisture content and the compression position had a significant impact on the static pressure damage characteristics of corn kernels. The test results are of great significance for further research on the mechanical properties and damage mechanism of corn kernels and the design of new corn threshers.*

Key Word*: kernels; pressure; mechanical properties; thresher.*

Date of Submission: 12-02-2023 Date of Acceptance: 24-02-2023

I. Introduction

Corn is one of the most important grains in the world. my country's annual corn planting area is 24 million hm2, second only to the United States, ranking second in the world. Corn is also the largest grain crop in the Huang-Huai-Hai region, ranking first among all crops in terms of planting area and total output[1]. Corn is not only an important food crop but also a high-quality feed for livestock and poultry. At present, corn used as feed is about 75% to 80% of the total amount of corn[2-5]. It can be seen that the level of corn production not only plays a very important role in my country's food supply but also in the development of animal husbandry. The quality of corn kernels has an important impact on its yield[6-9].

The impact, compression (extrusion) and shearing of mechanical threshing cause damage to corn kernels, which seriously affects the yield of corn[10-13]. Therefore, this paper advances the research on the mechanical properties of corn kernels, and provides a more scientific and comprehensive theoretical basis for the research on related equipment such as corn harvesting, drying, threshing, processing, storage and transportation, and quality appraisal.

II. Material And Methods

Test materials and instruments:

The experimental corns were Zhengdan 985 and Xianyu 335, the main corn varieties grown in the Huanghuaihai region, and their main physical characteristics are shown in Table 1.

Test equipment: electric blast drying oven, electronic digital display vernier caliper, universal material testing machine. Auxiliary tools include: marker pens, fixtures, trays, gloves, labels, etc.

Table 1 : Physical Properties of Corn Kernel.

Varieties	Length/mm	Width/mm	Thickness/mm
Zhengdan 985	13.14	8.69	4.26
Xianyu 335	13.89	9.57	4.71

Experiment method:

In this experiment, Zhengdan 985 and Xianyu 335 varieties were used. The microcomputer-controlled electronic compression testing machine was used to measure the static pressure rupture peaks of the ventral surface, top surface and side surface of corn kernels. For each variety, 4 different water samples were taken, and 50 corn kernels of similar size and shape were selected for testing, the peak value was recorded, and the average value was taken.

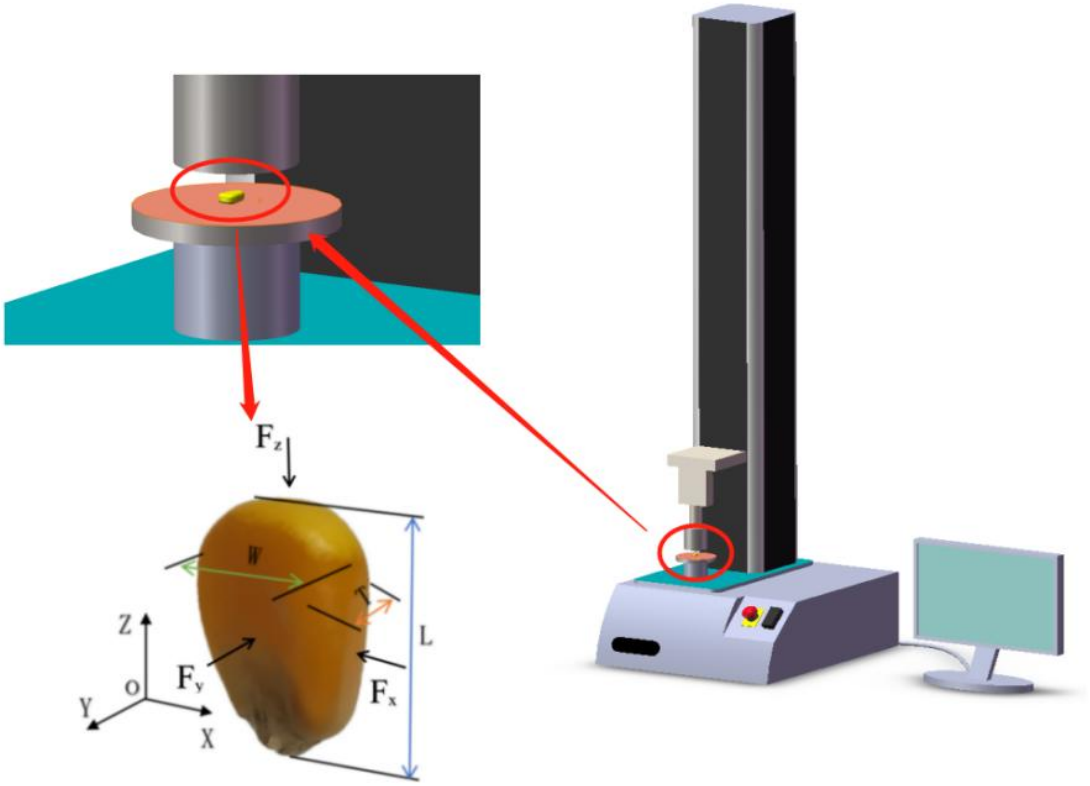

Figure 1. Schematic diagram of corn compression test.

Statistical analysis

Data was analyzed using Origin version 2021.

III. Result

In the test, the corn kernels of Zhengdan 985 and Xianyu 335. 1 were subjected to 30 times of static pressure loading tests of horizontal placement, vertical placement and side placement under four different water contents. Read the peak value, record it, and take the average value. The test results are shown in Table 2.

Table 2: Static pressure damage test of corn kernels.

Varieties	Moisture content/%	Horizontal pressure value/N	Vertical pressure value/N	Sidepressure value/N
Zhengdan 985	15.8	336.1	170.1	220.5
	17.5	315.4	159.5	208.6
	19.6	310.6	146.9	183.5
	22.1	298.1	130.5	167.4
Xianyu 335	16.8	244.5	166.8	159.5
	18.6	238.6	148.5	143.5
	20.7	224.7	136.4	132.5
	22.9	209.5	122.1	99.5

Note: The results in the table are the average of 50 tests.

Static pressure loading analysis of corn kernels at different water contents

As shown in Figure 2 and Figure 3, Zhengdan 958 and Xianyu 335 have different water contents and pressure values at the same time. It can be seen from the figure that the moisture content has a significant effect on the compression cracking peak of corn kernels. No matter which compression surface of corn kernels, the

pressure value decreases with the increase of moisture content, especially the pressure values of the side and top surface show a significant downward trend. When the deformation of corn kernels is the same, the lower the moisture content of the kernels, the greater the load it can bear. Analyze the reason: mainly because the lower the moisture content of the corn kernel, the greater the strength and hardness of the kernel, and the stronger the ability to resist cracking, so the greater the load that the corn kernel can bear.

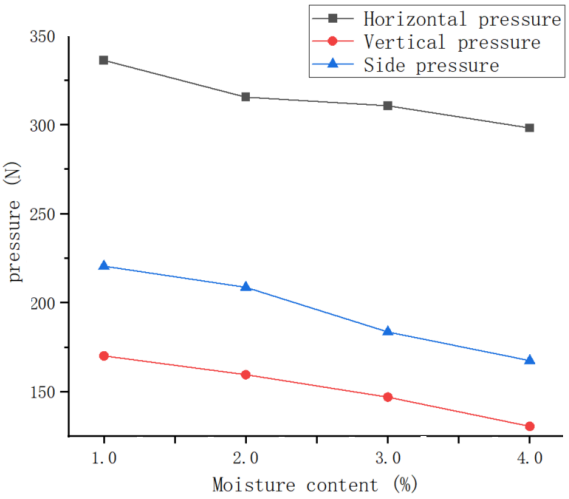

Figure 2. Zhengdan958 Pressure value at different moisture content.

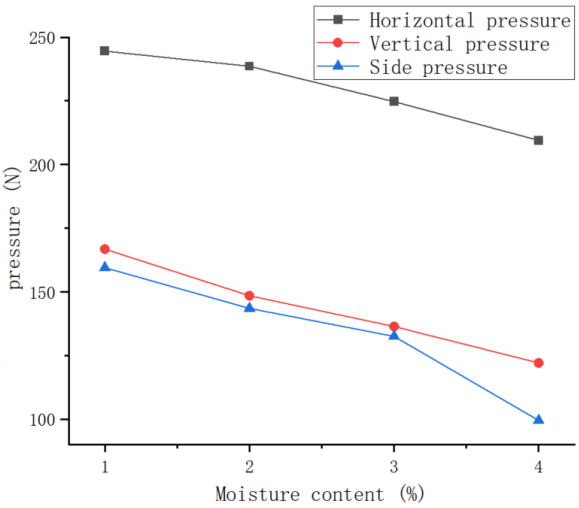

Figure 3. Xianyu335 Pressure value at different moisture content

Analysis of Static Pressure Loading on Different Compression Parts of Corn Kernel

As shown in Figure 4 and Figure 5, the pressure values at different parts of Zhengdan 958 and Xianyu 335. The results show that, from the overall trend of the histogram, we can see that the relationship between the peak values of static pressure rupture at different parts of the corn kernels of the two varieties at different moisture contents is: horizontal pressure rupture value>side pressure rupture value> Put the pressure rupture value on the vertical side. This is because the crushing peak of corn kernels is mainly related to two factors: the compressed area and the compressed part. The larger the compression area, the stronger the ability to withstand and resist cracking, and the greater the peak value of cracking.

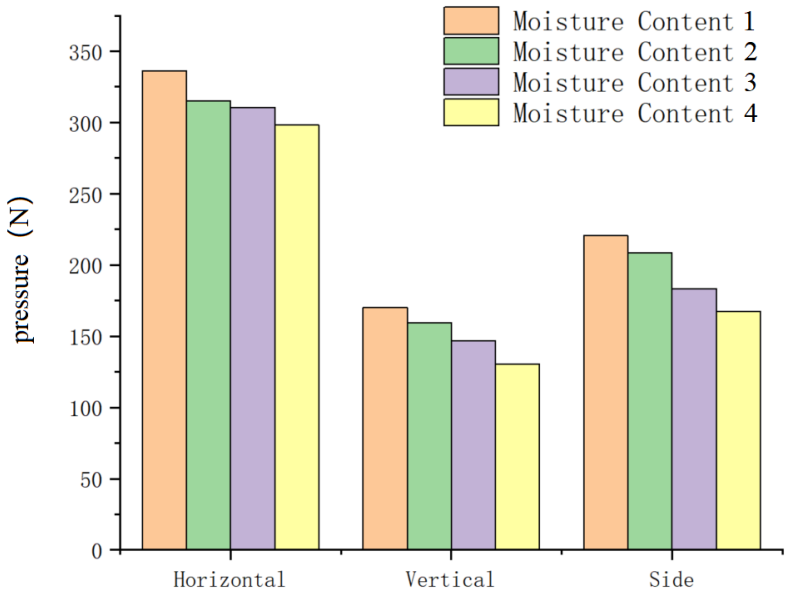

Figure 4. Zhengdan958 Pressure value of different placement methods.

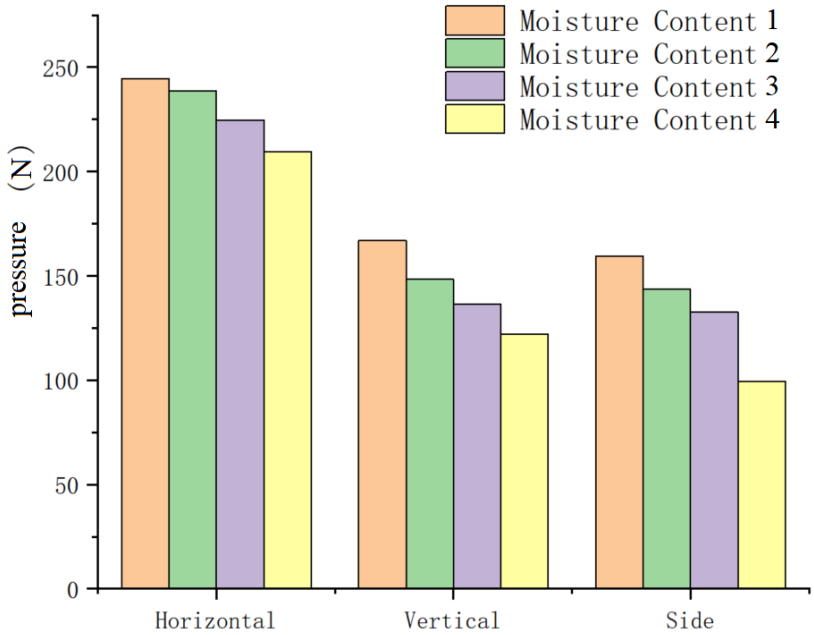

Figure 5. Xianyu335 Pressure value of different placement methods.

The reason for the maximum pressure rupture value when laying flat is that when the corn grains are placed horizontally, the pressure surface is the ventral surface, and the ventral surface bears the largest force area, which is much larger than that placed sideways and vertically. The pressure rupture value of the side surface is basically similar to the pressure rupture value of the top surface, and fluctuates when the moisture content is different. When the water content is 16%~18%, the side pressure rupture value is greater than the top pressure rupture value.

When the moisture content of the corn kernels of the two varieties is greater than 21%, the deformation of the corn kernels during compression is relatively large, just like in the test, a small number of such phenomena were found; At high moisture, the pressure peaks of lateral compression are significantly smaller, which is one reason why threshing is not suitable at higher moisture contents[14-16].

IV. Conclusion

When corn kernels are statically compressed, no matter which surface of the grain, the pressure value decreases with the increase of water content; the lower the water content of the grain, the greater the load it bears when the grain is damaged.

When maize kernels are statically compressed, under an appropriate water content (16%-20%), the relationship between the peak value of static pressure damage in different parts is horizontal pressurevalue>side pressure value >vertical pressurevalue.

References

[1]. National Bureau of statistics of the people's Republic of China. China Statistical Yearbook[M]. Beijing: China Statistics Press, 2019.

[2]. Cui Tao, Fan Chenlong, Zhang Dongxing, et al. Analysis on the Research Progress of Maize Mechanized Harvesting Technology [J]. Journal of Agricultural Machinery, 2019, 50(v.50): 1-13.

[3]. Xu Haigang, Zhang Chunxiang, Sun Yancheng, et al. Effects of different threshing methods on corn kernel damage [J]. Journal of Shandong University of Technology (Natural Science Edition), 2022, 36(2): 18-23.

[4]. Hu Biyou, Li Yaoming. Finite element simulation analysis of ear collision of corn grain threshing [J]. Agricultural Equipment Technology, 2018, 44(v.44;No.206): 4-7.

[5]. Yin Xuebo, Ming Bo, Hou Junfeng, et al. Grain position effect analysis of corn grain structure characteristics based on X-ray μCT technology [J]. Journal of Agricultural Engineering, 2021, 37(7): 8-14.

[6]. Qiu Qingyu, Gou Kanglin, Luo Huizhong, et al. Design and experiment of flexible threshing device for corn with low feed amount [J]. Journal of Anhui Agricultural University, 2021, 48(5): 857-864.

[7]. Geng Duanyang, Tan Delei, Yu Xingrui, et al. Design and experiment of threshing components of corn flexible threshing drum [J]. Journal of Jilin University (Engineering Science Edition), 2020, 50(5): 1923-1933.

[8]. Li Xinping, Gao Lianxing, Ma Fuli. Finite element analysis of mechanical properties of corn seeds [J]. Journal of Agricultural Machinery, 2007, (10): 64-67, 72.

[9]. Li Xinping, Xiong Shi, Geng Lingxin, et al. Effect of moisture content on the anti-compression characteristics of corn ears [J]. Journal of Agricultural Engineering, 2018, 34(2): 25-31.

[10]. Zhang Tao, Li Ping, Zhang Ying, et al. Analysis of Research Progress on Maize Harvesting Mechanical Damage [J]. Agricultural Technology and Equipment, 2021, (1): 27-29.

[11]. Zhang Li, Zhang Jiwang, Zhou Wei, et al. Correlation analysis between grain bulk density and physical properties of maize at different grain positions [J]. Maize Science, 2015, 23(2): 64-68.

[12]. Yang Jinzhong, Zhang Hongsheng, Li Nana, et al. Dimensional analysis of corn ear growth characteristics [J]. Maize Science, 2013, 21(4): 148-152.

[13]. Cai Chaojie, Chen Zhi, Han Zengde, et al. Research on the relationship between biomechanical properties and threshing performance of seed corn [J]. Agricultural Mechanization Research, 2017, 39(4): 192-196.

[14]. Li Lulu, Xie Ruizhi, Fan Panpan, et al. Study on the dehydration characteristics of Zhengdan 958 and Xianyu 335 grains_Li Lulu[J]. Maize Science, 2016, 24(2): 57-61, 71.

[15]. Chai Zongwen, Wang Keru, Guo Yinqiao, et al. Current Situation of Maize Mechanical Grain Harvesting Quality and Its Relationship with Moisture Content_Chai Zongwen[J]. Chinese Agricultural Sciences, 2017, 50(11): 2036-2043.

[16]. Wang Keru, Li Lulu, Guo Yinqiao, et al. Effects of different mechanical operations on corn kernel harvest quality_Wang Keru [J]. Maize Science, 2016, 24(1): 114-116. [8] Li Xinping, Xiong Shi, Geng Lingxin, et al. Effect of Moisture Content on Corn Ear Compression Resistance [J]. Journal of Agricultural Engineering, 2018, 34(2): 25-31.

HuabiaoLi, et. al. "Study on Mechanical Properties of Maize Kernel." *IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)*, 16(2), 2023, pp. 07-11.