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A Research on the Effect of Position, Variety and Storage Period of Onion on Punching

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Abstract: In this study, punching force, stress, and energy of Yalova 12 and Banko onion varieties were examined. These varieties are grown in Bursa region and having an important place for exporting in our country. The effects of storage (right after harvest and after one month of storage) and the position of onion (radial and axial) along with the variety of onion were examined for punching the onions. According to the results, the variety had no effects on punching, but the position of onion was found important statistically. It was found that axial punching requires more force, stress and energy than radial punching.

Key words: Onion, punching, mechanical properties

Introduction

The knowledge of physical properties of agricultural productions has a great importance on designing and proper usage of agricultural machineries, and conservation of the quality. Onion is sent to the market right after harvest or stored for later use. To minimize the quality lost during storage, the mechanical behaviour of onion should be known and necessary precautions should be taken for preventing the damage. According to the research, the storage time effects onion as; first its texture gets soften, then onion sprouts and gets rotten due to the vigor loss finally the quality of the onion lessens as a result of combinations of these effects. (Mavi *et al*., 1996; Sağsöz *et al*., 1999).

Different behaviour effects can be observed from the agricultural products under axial load. These effects are called "Mechanical Properties". The deformation occurs on the material due to the load. In the force versus deformation graphics, first biological material yields and then rupturing occurs with cracking or breakage of the material. After this point large deformations occur with small force. At this point load carrying capacity of the material is maximum (Alayunt, 2000; Kara, 1988; Mohsenin, 1986 and Turgut, 1994).

In this study, the effects of variety and position of the onion and the storage time on the punching force, stress, and energy were investigated.

Materials and Methods

Two varieties; Yalova 12 and Banko, which are grown in Bursa region for mainly exporting, were used in the experiment. Before laboratory tests, onions were numbered, weighed, and its volume and dimensions were measured for physical properties. Some of the physical properties of these two onion varieties were given in Table 1.

Onions were punched either axial or lateral until penetration. (Fig. 1). Punching was made with a plunger having a diameter of 8 mm with a constant speed of 25 mm/min at the load-displacement device (Çakir *et al*., 2000).

Applied load was measured by HBM-Q3 model load cell with 5 kN capacity and at them same time the downwards displacement (axial deflection) was measured with HBM-W100 model LVDT. Both instruments were connected to the computer with an AD card to record each test output.

Experiments were made at the periods of right after harvest and after one month of storage. Onions were stored in the fridge during one month of storage. Stored onions were left 24 hours outside before the test to make them reach the equilibrium temperature of the laboratory. It has been considered that the direction of the punching, either axial or lateral, could be important since inside structure of the onion is in wrapped layers.

Table 1: Some physical properties of Yalova 12 and Banko onion varieties onions

Variety	Yalova 12	Banko
Volume (cm^3)	298.16	70.5
Weight (g)	270.42	63.84
Moisture (%)	88	94
Shape Index	0.89 (rounded)	1.1 (rounded)

Fig. 1: Onions were punched axial and radial

The applied load and the axial displacement were measured and recorded by the computer. Then the punching stress and energy were calculated as follows;

$$\sigma = \frac{F}{A} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1$$

σ = Punching stress (kPa)
F = Punching force (kN)
A = Cross sectional area of the puncher (m^2)

By trapezoidal rule (Burden and Faires, 1989)

$$U = \frac{\sum (x_1 - x_0)\,(F(x_0) + F(x_1))}{2} \quad \ldots\ldots\ldots\ldots\ldots\ldots 2$$

U = Punching energy (Ncm)
x_0 = First displacement (cm)
x_1 = Second displacement (cm)

The data were given in Table 2. For statistical analysis, the

Table 2: Data gathered from the effect of variety, position and the storage time of onions on punching force and energy

Period	Onion	Position	Punching Force (N)	Deformation (cm)	Energy (Ncm)
Right after harvest	Yalova 12	Radial	136.75	0.058	3.79
			203.56	0.088	8.82
			87.60	0.092	3.68
		Axial	119.49	0.156	6.19
			214.45	0.154	15.93
			118.21	0.08	4.13
		Radial	87.31	0.052	2.07
			99.67	0.07	3.35
	Banko		139.79	0.088	5.55
		Axial	273.40	0.224	31.54
			150.78	0.115	6.39
			178.15	0.125	9.56
One month of storage	Yalova 12	Radial	72.10	0.065	2.77
			28.35	0.048	0.73
			190.02	0.141	4.04
		Axial	160.98	0.185	16.48
			211.01	0.116	7.76
			175.30	0.177	6.24
		Radial	136.26	0.101	3.30
			106.14	0.092	3.96
	Banko		116.35	0.124	2.82
		Axial	98.98	0.085	4.49
			126.75	0.289	0.77
			105.85	0.193	8.03

Table 3: Variance analysis on the effect of variety and position of onion for punching force, stress and energy

Variable	Punching Force		Punching Stress		Punching Energy	
	F	P	F	P	F	P
Variety (B)	0.1659	-	0.3327	-	0.0018	-
Position of the onion (C)	4.8097	0.0434	5.7359	0.0292	6.1574	0.0246
Variety * Position (B x C)	0.0184	-	0.0014	-	0.0540	-
Time (A)	1.3548	0.2615	1.0454	0.3218	1.8275	0.1952
Variety * Time (B x A)	0.6625	-	0.4240	-	1.019	0.3116
Position * Time (C x A)	0.0845	-	0.2210	-	0.4805	-
Variety * Position * Time (BxCxA)	4.9149	0.0415	5.8539	0.0278	2.5028	0.1332

completely randomized test was applied and the analysis of the variance of data was calculated.

Results

The analysis of variance was calculated on the data given in Table 2 using MSTAT statistic program. The effects of variety and position of the onion on the punching force, stress, and energy were examined.

Punching force: Results of the variance analysis and the F tests were given in Table 3. Variety of the onion was found notsignificant for punching the onion. But the position of the onion, punching either radial or axial, was found significant statistically.

Punching stress: The results of the variance analysis of the punchin g stress calculated as punching force divided by the cross sectional-area of the puncher were also given in Table 3. Similar results with punching force were found for punching stress. The variety of the onion and the storage time of the onion were found not significant whereas the position of the onion was significant statistically.

Punching energy: The integration of force-deformation curve until the punching force gives the punching energy of the onion as described in the method (Kara *et al.*,1988). The

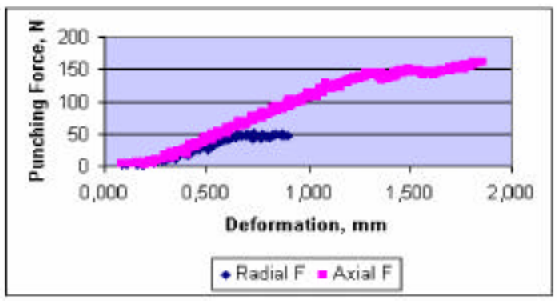

Fig. 2: Punching force as affected by the position of the onion

results of the variance analysis of he calculated energy values by using the Trapezoidal rule, were given in Table 3.

Discussion

According to the results, the position of the onion was found effective on the punching onion. The variety of the onion and the storage time of the onion did not effect the punching parameters. The trend of the punching force and energy according to the position of the onion were given in Figs. 2 and 3. The reason for requiring more punching force in the axial position than radial position could be the wrapping

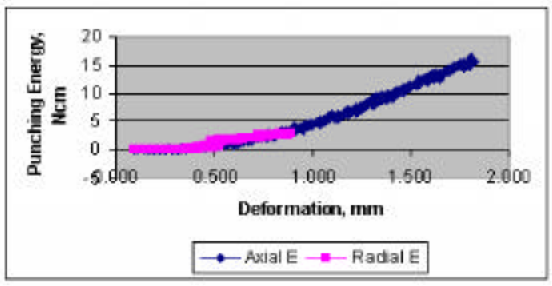

Fig. 3: Punching force energy as affected by the position of the onion

direction of the layers inside of the onion. This also effects the punching energy. Axial punching requires more energy than the radial punching. The punch ing force and energy somewhat dif fers for the onion stored one month comparing the onion right after harvest.

The structure of the onion gets softer after storage which effects the firmness of the onion. Punching forces and energies were 153.6 N, 8.57 Ncm, and 129.8 N, 5.21 Ncm for onion right after harvest and one month storage tim e respectively. Although the storage time effects on the onion is well known fact, storage time was not found significant with $\alpha_{0,05}$ level for punching the onion.

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