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Assessment of Some Physical and Mechanical Properties of *Ecballium Elaterium* (L.) Seeds Grown in Natural Environment

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ABSTRACT: In this study, Several essential physical and mechanical properties of the seeds of the Ecballium elaterium (L.) plant, which grows naturally in Balıkesir province of Turkey and has some medicinal properties, were determined for product processing and similar processes. All properties were evaluated at different moisture states ranging from 11.48% to 22%, and the changes of these properties according to moisture were observed. At an initial moisture content of 11.48%, Ecballium seeds had a length of 4.72 mm, a width of 2.85 mm, a thickness of 2.09 mm, an arithmetic mean diameter of 3.22 mm, a geometric mean diameter of 3.04 mm, a sphericity of 64.45%, and a thousand grain weight of 13.61 g. As a result of measurements conducted on Ecballium seed re-wetted to moisture levels between 11.48% and 22%, it was observed that its bulk density decreased from 501.00 kg m^{-3} to 468.5 kg m^{-3} its true density decreased from 965.67 kg m^{-3} to 870 kg m^{-3} its projected area increased from 10.60 mm^2 to 11.51 mm^2, its rupture strength decreased from 5.08 N/mm^{-2} to 2.98 N/mm^{-2}, and its terminal velocity increased from 2.69 m s^{-1} to 3.06 m s^{-1}.

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KEYWORDS: Ecballium, physical properties, image processing, moisture content, mechanical properties

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INTRODUCTION

Ecballium elaterium (L.) A. Rich. (Cucurbitaceae) is a perennial wild plant with semi-aquatic, hairy leaves and stems that has therapeutic properties against a wide variety of diseases, abundant in our country and the Mediterranean region. (Attard and Scicluna-Spiteri, 2001; Sağlam Yılmaz andAkyıldız, 2018; Touihri et al., 2019; Aydoğmuş-Öztürk, 2021)

Ecballium elaterium (L.) A. Rich.; is a herbaceous plant with a recumbent stem and its flowers are light yellow. Fruits; It is oval, stalked and drooping when mature (Christodoulakis et al., 2011; Ekici et al., 1998; Sağlam Yılmaz andAkyıldız, 2018; Bozdoğangil, 1996).

Ecballium elaterium (L.) A. Rich. grows indoors, in woodlands, mountainous areas, plateaus, slopes, grasslands, meadows, pastures, roadsides, shrubs, maquis, rocky, stony, gravelly, arid slopes, steppes, swamps, wetlands, fields, cultivated areas, It grows in salty areas, river banks, lake shores, coastal dunes and shrubs and high mountain areas. When the fruit of the plant matures, it breaks off from where it is attached to the stem due to the effect of internal pressure, and the plant sprays its seeds to long distances. (Sağlam Yılmaz and Akyıldız, 2018).

Ecballium elaterium (L.) A. Rich. is of particular interest due to the continued use of its fruit extracts in various medicinal systems within the Mediterranean region (Rust et al., 2003; Uslu et al., 2006; Touihri et al., 2019).

The plant has been esteemed as a valuable medicinal resource since ancient times, utilized in treating a wide array of ailments including sinusitis, hepatitis, fever, rheumatism, cancer, liver disorders, hemorrhoids, earaches and uroclepsy. Additionally, its antimalarial, antimicrobial, analgesic, anti-inflammatory, anti-jaundice, and antiproliferative properties have been identified (Touihri-Barakati et al., 2016; Tizio et al., 2012; Abbassi et al., 2014).

Considering the natural growth environment, this product offers the potential for medicinal production without the use of environmentally harmful elements such as chemical fertilizers and pesticides. Additionally, its cultivation does not contribute to exhaust gas emissions from agricultural machinery. Therefore, choosing this product instead of cultivated plants can make significant contributions to the protection of the environment. Technical aspects such as length, thickness, width, breaking strength and surface area are important considerations for biological materials such as Ecballium seed.

To date, there have been scarce studies conducted on the physical and mechanical properties of *Ecballium elaterium* (L.) seeds. Due to the increasing importance of *Ecballium elaterium* (L.) seeds, there is a need to develop machines to be used in processes such as harvesting and processing the seeds. Therefore, the physical properties of Ecballium seeds must be well known to avoid the seed from being damaged and to obtain appropriate treatments. The objective of this investigation is to investigate several physical properties of *Ecballium elaterium* (L.) seeds grown in the natural environment of Balıkesir province in Turkey, focusing on their variation with humidity levels.

MATERIALS AND METHOD

The research utilized seeds of *Ecballium elaterium* (L.) A. Rich, gathered from Balıkesir, Turkey, in 2023. Fruit specimens were gathered from Balıkesir, Turkey, in 2023, following which seeds were extracted from the fruits and prepared for experimentation. Total seeds weights are 1000 grams. They were maintained in chilled containers for delivery to the laboratory. The leftover the material was packaged into a 2000 ml glass vessel and kept chilled till it was ready for use. To get rid of any external objects, like branches, dust, leaves, and premature or damaged fruits, the seeds were purified. After taking a sufficient amount of sample from the product to determine its moisture, the left material was placed in hermetic glass containers and stored in chilled storage until utilization. A hundred seeds were randomly selected for each measurement. Before initiating the test, the needed amount of seeds was left to reach room temperature

The seeds' initial moisture level was identified using a standardized procedure (USDA, 1970), revealing a moisture level of 11.48% (d.b.). The quantified volume of distilled water was introduced to the seeds, completely blended, and then enclosed in polyethylene bags To achieve the targeted moisture contents. The samples were refrigerated at 278K for 7 days to ensure a uniform moisture level (Deshpande et al. 1993; Çarman 1996; Konak et al. 2002). All physical characteristics of the seeds were assessed across moisture contents of 11.48%, 14%, 16%, 18%, and 20%, as well as 22% d.b., with three replicates conducted at each level.

To ascertain the dimensions of the seeds, Ten sets of samples, each comprising 100 seeds have been chosen randomly. From each set, thirty seeds were chosen, and an electronic micrometer was used to measure each seed's length, width, and thickness with an accuracy of 0.01 mm.

The following formula was used to calculate the seeds' geometric mean diameter (Dp) and arithmetic mean diameter (Da), as per Mohsenin's (1986) description:

$$Dp = (LWT)^{1/3} \quad (1)$$

$$Da = \frac{L+W+T}{3} \quad (2)$$

where W stands for width, T for thickness, and L for length. The degree of sphericity (ϕ) has the following expression, according to Mohsenin (1986):

$$\phi = \frac{(LWT)^{1/3}}{L} 100 \quad (3)$$

Image processing techniques were used to quantify the projected area of a seed. A digital camera, a computer with 2.4 GHz processor and FIJI software were used for this measurement. Seeds were placed on white background. A calibration plate was placed near seeds and pictures of seeds were taken from 30 cm height with a leveled 16 MP camera. Then, images were processed and projected areas were determined.

A hectolitre weight tester calibrated in kilograms per hectolitre was employed to gauge the bulk density, as outlined by Deshpande et al. (1993). The masses of the seed weights were ascertained using an electronic balance with an accuracy of 0.001 grams.

Toluene (C_7H_8) was preferred over water due to its lower absorbability by seeds, as noted in the studies by Sitkei (1976), Mohsenin (1970), and Haciseferogullari et al. (2005). The porosity of the bulk was designated using the relationship described by Mohsenin (1970) and Thompson and Isaacs (1967).

$$\varepsilon = \left(\frac{\rho_t - \rho_b}{\rho_t}\right) 100 \quad (4)$$

where ρ_b is the bulk density and ρ_t is the true density.

The seeds' terminal velocities were calculated utilizing an air column. An electronic anemometer with a precision of 0.1 m s^{-1} was used to measure the air velocity close to the site of the suspended seed after a seed was discharged into the airflow from the top end of the air column (Joshi et al. 1993). The system for measuring terminal velocity was specified in Figure 1.

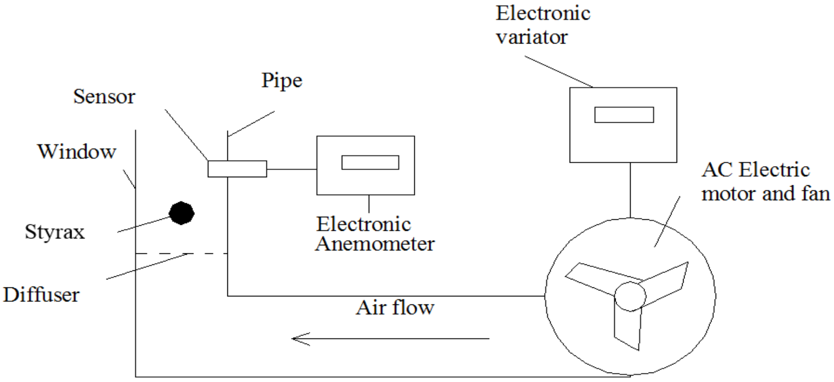

Figure 1. Terminal velocity measurement system

The device for testing biological materials devised by Aydin and Öğüt (1992) was utilized to ascertain the rupture strength of the *Ecballium elaterium* (L.) seeds, as illustrated in Figure 2. The device comprises of a stable upper platform and a movable bottom platform, a data acquisition system (comprising a dynamometer, amplifier, and XY recorder) and a driving unit (which includes an AC electric motor and electronic variator). The seeds were positioned on the movable bottom platform and compressed against a stable probe (with a diameter of 2.2 mm). With a minimum resolution of 0.01 N, a force dynamometer and a data collecting system were utilized to ascertain the rupture strength of the seed. The trial was carried out at a loading velocity of 50 millimeters per minute.

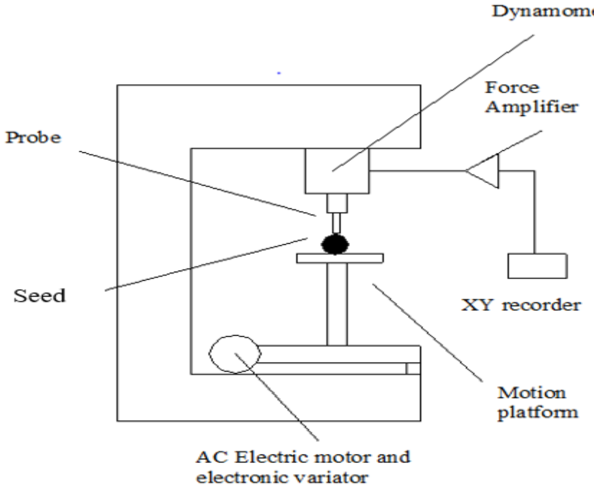

Figure 2. Biological material testing system

RESULTS AND DISCUSSION

Geometric characteristics *of Ecballium elaterium (L.)*seeds

Geometric characteristics of *Ecballium elaterium* (L.) at initial moisture level (11.48%) are listed in Table 1. The sphericity, length, width, thickness, arithmetic mean diameter, geometric mean diameter and thousand grain weight of Ecballium ranged from 13.61 to 15.4 g, 4.72 to 5.02 mm, 2.85 to 3.06 mm, 2.09 to 2.27 mm, 3.22 to 3.45 mm, 3.04 to 3.26 mm, and 64.03 to 65.06%, in that order. The relationship between the average seed dimensions can be described by the following general expression at 11.48% (d.b.) moisture content:

L=1.656xW=2.258xT=1.553x GMD=1.466AMD=0.73x Ø

Table 1. Geometric characteristics of *Ecballium elaterium (L.)*

Properties	Values
Thousand grain weight (g)	13.61±0.026
Length (mm)	4.72±0.20
Witdth (mm)	2.85±0.23
Tickness (mm)	2.09±0.13
Geometric mean diameter (mm)	3.04±0.14
Arithmetic mean diameter	3.22±0.14
Sphericity (%)	64.45±2.67

Correlation coefficients (Table 2) show that the Length/AMD and ratios of the seeds at 11.48% (d.b.) moisture content were determined to be quite significant, while the Length/Width, Length/Thickness, Length/GMD and Length/Sphericity ratios were not determined to be significant. Similar outcomes were observed by Demir et al. (2002) for hackberry and Haciseferogullari et al. (2005). This shows that length and arithmetic mean diameter are closely linked.

Table 2. The correlation coefficients of *Ecballium elaterium* (L.) seeds

Particulars	Ratio	Degrees of freedom	Correlation coefficient
Length/Width	1.656	28	0,251
Length/Thickness	2.258	28	0.293
Length/GMD,	1.553	28	0.548
Length/AMD	1.466	28	0.699**
Length/Sphericity	0.73	28	-0.367

**significant at 1% level

Bulk and true density

The bulk density values of *Ecballium elaterium* (L.) seeds at various moisture levels ranged from 501.00 to 468.5 kg/m³ (Figure 3). The true density of Ecballium across different moisture levels varied between 965.67 and 870 kg/m³. Ecballium's density was found to be affected by moisture level, and when moisture level got higher, bulk and real density both decreased. The moisture level and density were shown to be negatively correlated.

This is due to the lower volumetric expansion in which the fruit is under moisture and under increasing mass. Baryeh (2001) reported a similar tendency for bambara groundnut, and Pradhan et al. (2009) likewise identified a negative linear association between bulk and actual density and moisture content for jatropha fruit.

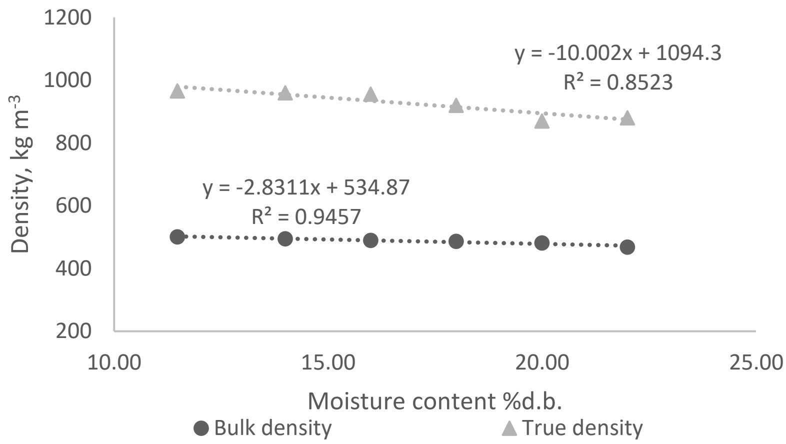

Figure 3. Moisture content-induced changes in the bulk and true density of *Ecballium elaterium* (L.) seeds

Porosity

The porosity of *Ecballium elaterium (L.)* seeds exhibited variations ranging from 44.64% to 48.72% across different moisture levels (Figure 4). İt was observed that the porosity of *Ecballium* did not exhibit a consistent trend with increasing moisture level. Despite a slight decrease associated with an increase in moisture level, it has been concluded that the porosity of *Ecballium* does not exhibit a consistent alteration with rising moisture levels.

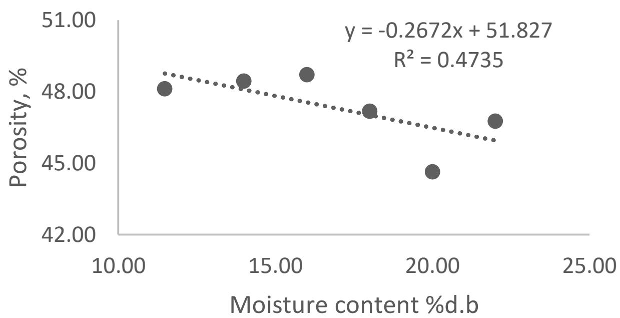

Figure 4. The fluctuation of *Ecballium elaterium* (L.) seed's porosity in response to changes in moisture content

Projected area

The projected area of *Ecballium elaterium* (L.) exhibited variations ranging from 10.60 to 11.51 mm^2 across different moisture levels (Figure 5). Moisture content elevation has led to an augmentation in the projected area. As the moisture content increases from 11.48% to 22%, the projected area experienced a 9% increase. Similar patterns were documented for numerous other seeds (Ayman et al., 2010; Unal et al., 2008; Aghkhani et al., 2012).

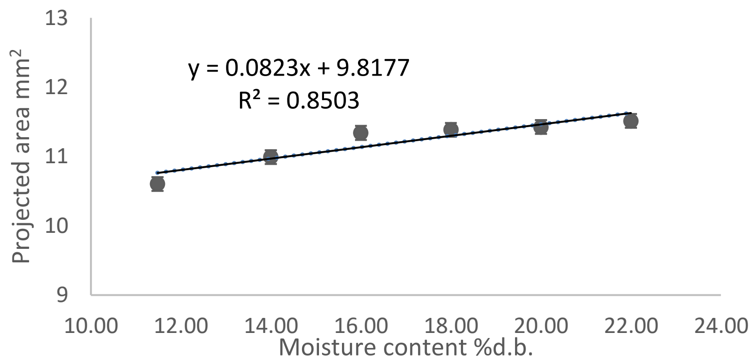

Figure 5. Differences in the projected area of Ecballium seeds according to its level of moisture.

Rupture strength

The rupture strength values of *Ecballium elaterium* (L.) are depicted in Figure 6. The rupture strength of *Ecballium* was found 5.08 to 2.98 N mm^{-2}. The rupture strength increases in low moisture contents. *Ecballium's* rupture strengths show a linear correlation with moisture content. Higher moisture content likely led to lower rupture forces, as the seeds tended to become very soft under such conditions. Nyorere and Uguru (2018) and Ekinci et al. (2010) reported similar results.

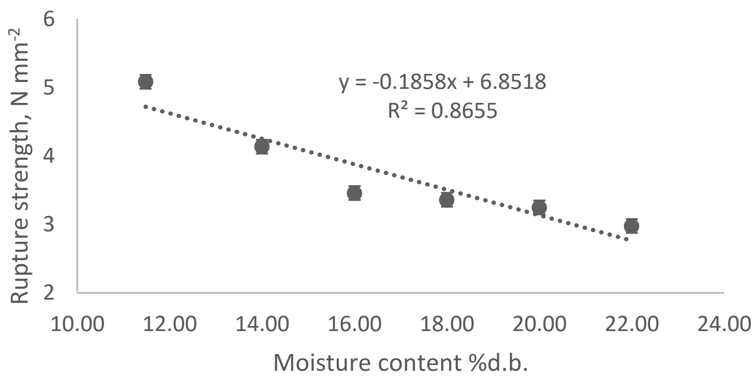

Figure 6. The rupture strength of Ecballium elaterium (L.) seeds varies with changes in moisture content

Terminal velocity

The terminal velocity of *Ecballium elaterium* (L.) seeds varies across different moisture levels, ranging from 2.69 to 3.06 m/s (Figure 6). It was found that the terminal velocity increased linearly with the moisture content. With a 92% increase in moisture content, an average 14% increase in terminal velocity was seen. Several researchers (Kural and Çarman, 1997; Aydin, 2003) reported similar findings.

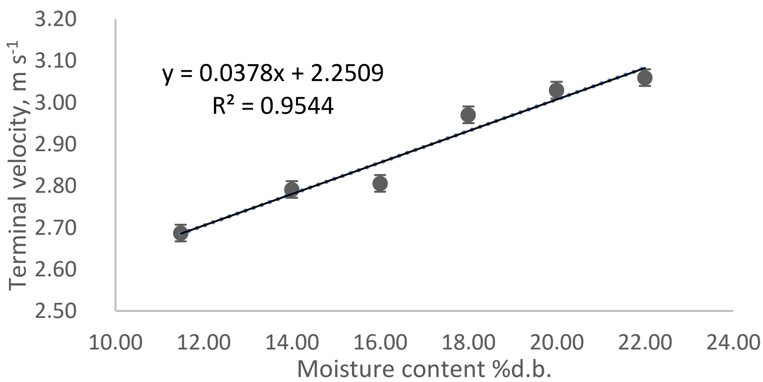

Figure 6. Changes in the terminal velocity of *Ecballium elaterium* (L.) seeds with varying moisture level

CONCLUSIONS

Based on the findings of this study, several physical properties of *Ecballium elaterium* (L.) seed, commonly grown in Türkiye, were determined due to their importance in agricultural machinery.

At a moisture content of 11.48% (d.b.), the length, width, thickness, arithmetic mean diameter, and geometric mean diameter of *Ecballium elaterium* (L.) seeds were determined to be 4.72 mm, 2.85 mm, 2.09 mm, 3.22 mm, and 3.04 mm, respectively.

The correlation coefficients indicate that the Length/AMD rations of the seeds at 11.48 % (d.b.) moisture content were found highly significant.

Projected area and terminal velocity value of *Ecballium* increased with increased moisture content. Rupture strength of *Ecballium elaterium* (L.) decreased with increasing moisture level.

As the degree of moisture increased, the bulk and true densities of *Ecballium elaterium* (L.) seeds reduced.

The findings of this research could be useful in designing of machinery that can be used in threshing, storage, pneumatic conveying, and other transportation activities, as well as in their optimization.

REFERENCES

1. di Tizio, L.J. uczaj, C.L. Quave, S. Redzic, A. Pieroni, Traditional food and herbal uses of wild plants in the ancient South-Slavic diaspora of Mundimitar/ Montemitro (Southern Italy), J. Ethnobiol. Ethnomed. 8 (2012) 1–10.
2. Aghkhani M, Miraei Ashtiani S, Baradaran Motie J, Abbaspour-Fard M (2012) Physical properties of Christmas Lima bean at different moisture content. Int Agrophys 26(4):341-346
3. Attard, E. G., & Scicluna-Spiteri, A. (2001). Ecballium elaterium: an in vitro source of cucurbitacins. Fitoterapia, 72(1), 46-53.
4. Aydin, C. (2003). Physical properties of almond nut and kernel. Journal of food engineering, 60(3), 315-320.
5. Aydin C, Ögut H (1992) Determination of deformation energy in some biological materials. In National symposium on mechanisation in agriculture, Samsun, Turkey, pp. 254-264
6. Aydoğmuş-Öztürk, F. (2021). Ecballium elaterium'un Farklı Kanser Hücre Hatlarına Karşı Sitotoksik Aktivitesi. Journal of the Institute of Science and Technology, 11(1), 645-653. https://doi.org/10.21597/jist.767550
7. Ayman H, Amer Eissa, Mohamed M A, Moustafa H, Abdul Rahman O. Alghanna. (2010) Moisture dependent physical and mechanical properties of chickpea seeds. Int J Agric & Biol Eng, 2010; 3(4): 70, DOI: 10.3965/j.issn.1934-6344.2010.04.070-083
8. Baryeh EA (2001) Physical properties of bambara groundnuts. Journal of Food Engineering 47:321-326
9. Bozdoğangil, E.E., 1996. Çukurova Bölgesinde Doğal Olarak Bulunan Faydalı Bitkiler Ve Kültür Olanakları Üzerinde Araştırmalar. Çukurova Üniversitesi Fen Bilimleri Enstitüsü Tarla Bitkileri Anabilim Dalı Yüksek Lisans Tezi, Adana
10. Carman K (1996) Some physical properties of lentil seeds. Journal of Agricultural Engineering Research 63(2):87-92
11. Christodoulakis, N. S., Kollia, K., & Fasseas, C. (2011). Leaf structure and histochemistry of Ecballium elaterium (L.) A. Rich.(squirting cucumber). Flora-Morphology, Distribution, Functional Ecology of Plants, 206(3), 191-197. https://doi.org/10.1016/j.flora.2010.06.010
12. Deshpande SD, Bal S, Ojha TP (1993) Physical properties of soybean. Journal of Agricultural Engineering Research 56:89-98
13. Demir F, Doğan H, Özcan M, Haciseferoğullari H (2002) Nutritional and physical properties of hackberry (Celtis australis L.). Journal of Food Engineering 54(3):241-247
14. Ekici, M., Satilmiş, A., Ay, Y. D., Dülger, B., & Yer, H. M. (1998). Ecballium elaterium (L.) meyvelerinin sinüzite karşi kullanimi. Ekoloji, 27, 24-25.
15. Ekinci K, Yilmaz D, Ertekin C (2010) Effects of moisture content and compression positions on mechanical properties of carob pod (Ceratonia siliqua L.). African Journal of Agricultural Research 5(10):1015-1021
16. F. Abbassi, B. Ayari, B. Mhamdi, L. Toumi, Phenolic contents and antimicrobial activity of squirting cucumber (Ecballium elaterium) extracts against foodborne pathogens, Pak. J. Pharm. Sci. 27 (2014) 475–479.
17. Haciseferogullari H, Özcan M, Sonmete MH, Özbek O (2005) Some physical and chemical parameters of wild medlar (Mespilus germanica L.) fruit grown in Turkey. Journal of Food Engineering 69(1):1-7
18. Joshi DC, Das SK, Mukherjee RK (1993) Physical properties ofpumpkin seeds. Journal of Agricultural Engineering Research 54:219-229
19. Konak M, Carman K, Aydin C (2002) PH-Postharvest Technology: Physical properties of chick pea seeds. Biosystems Engineering 82(1):73-78
20. Kural, H., & Carman, K. (1997). Aerodynamic properties of seed crops. In National symposium on mechanisation in agriculture (pp. 615-623). Tokat Turkey.

21. Mohsenin NN (1970) Physical properties of plant and animial materials. Vol. 1. Structure, physical characterisitics and mechanical properties. Physical properties of plant and animial materials. Vol. 1. Structure, physical characterisitics and mechanical properties., 1.
22. Mohsenin NN (1986) Physical properties of plant and animal materials. New York: Gordon and Breach Science Publishers.
23. Nyorere O, Uguru H (2018) Effect of loading rate and moisture content on the fracture resistance of beechwood (Gmelina arborea) seed. Journal of Applied Sciences and Environmental Management 22(10):1609-1613
24. Pradhan RC, Naik SN, Bhatnagar N, Vijay VK (2009) Moisture-dependent physical properties of jatropha fruit. Industrial Crops and Products 29(2-3):341-347
25. Rust, R. W., Vaissière, B. E., & Westrich, P. (2003). Pollinator biodiversity and floral resource use in Ecballium elaterium (Cucurbitaceae), a Mediterranean endemic. Apidologie, 34(1), 29-42.
26. Sağlam Yılmaz, S., & Akyıldız, E. (2018). Acı Kavun (Ecballium elaterium (L.) A. Rich.) Bitkisinde Kallus Kültürü Araştırmaları. Tarım Bilimleri Araştırma Dergisi, 11(2), 15-19.
27. Sitkei G (1976) Mechanics of agricultural materials. Department of woodworking Machines University of Forestry and Wood Science Sopron Hungary. 487 p
28. Thompson RA, Isaacs GW (1967) Porosity determination of grains and seeds with air comparison pycnometer. Transactions of the ASAE 10:693-696
29. Touihri, I., Kallech-Ziri, O., Boulila, A., Fatnassi, S., Marrakchi, N., Luis, J., & Hanchi, B. (2019). Ecballium elaterium (L.) A. Rich. seed oil: Chemical composition and antiproliferative effect on human colonic adenocarcinoma and fibrosarcoma cancer cell lines. Arabian Journal of Chemistry, 12(8), 2347-2355.
30. Touihri-Barakati, I., Kallech-Ziri, O., Boulila, A., Khwaldia, K., Marrakchi, N., Hanchi, B., Hosni, K., & Luis, J. L. (2016). Targetting αvβ3 and α5β1 integrins with Ecballium elaterium (L.) A. Rich. seed oil. Biomedicine & Pharmacotherapy, 84, 1223-1232. https://doi.org/10.1016/j.biopha.2016.10.035
31. Unal H, Isık E, Izli N, Tekin Y (2008) Geometric and Mechanical Properties of Mung Bean (Vigna Radiata L.) Grain: Effect of Moisture. International Journal of Food Properties 11(3):585–599
32. USDA. Official grain standards of the United States. US Department of Agricultural Consumer and Marketing Service Grain Division, 1970, Revised.
33. Uslu, C., Karasen, R. M., Sahin, F., Taysi, S., & Akcay, F. (2006). Effect of aqueous extracts of Ecballium elaterium rich, in the rabbit model of rhinosinusitis. International journal of pediatric otorhinolaryngology, 70(3), 515-518.