International Journal of Agriculture, Environment and Food Sciences

JAEFS

e-ISSN : 2618-5946

DOI: 10.31015/jaefs.2019.4.8

www.jaefs.com

Research Article

Int J Agric Environ Food Sci 3(4):245-249 (2019)

Determination of the friction force and energy for Karacadağ local rice cultivars for different surfaces

Resat Esgici[1,*]

[1]Bismil Vocational High School, Dicle University, Diyarbakır, Turkey

[*]Corresponding Author: resgici@dicle.edu.tr

Abstract

The friction properties of grain products are one of the important parameters that are considered in the design of transport, transmission and storage structures and equipment. In addition, the friction force and coefficients on different surfaces are important in the selection of the power supply required for such design of structures and in the calculation of their actual dimensions. These are the common materials used for handling and processing of grains and construction of storage and drying bins. In this study, the static friction force and static friction energy were measured on 4 different material surfaces (rubber, chrome, galvanized sheet and PVC) and 3 different moisture contents (9.30%, 18.50% and 29.00%) for Karacadağ Beyaz and Karacadağ Karakılçık local rice varieties. The pulling of the grain box on the surface and the friction forces and energy were measured at a constant speed of 20 mms^{-1} with Llyod tester having a capacity of 2500 N. There was no significant difference between the varieties in terms of frictional force and friction energy ($p > 0.05$). However, the effect of surface material and grain moisture content was found to be very important ($p < 0.01$). As the moisture content of the grain increased, the static friction force and friction energy values increased. The highest values were obtained in PVC and rubber material with a moisture content of 29.00%, the lowest value was obtained in chromium material and 9.30% moisture content.

Keywords: Rice, Friction force, Friction energy, Friction surface

Introduction

The friction values of grain products are among the important physico-mechanical properties that should be known for the design of the machines used in the sowing, planting, harvesting and post-harvesting processing of agricultural products as well as for the selection of the working parameters. Moreover, it also plays an important role in determining the conveyance, transportation and storage properties of agricultural products. Friction preserves its importance for determining the vertical loads on the lateral surfaces of bins and similar storage structures and between the material and lateral surfaces in pneumatic conveying as well as for the pressing and cutting operations of agricultural products (Beyhan et al., 1999; Sabahoglu and Ozturk., 1996; Guzel et al.,1996; Alayunt, 2000; Colak and Sacilik., 2002; Sessiz., 2005). Knowledge of the friction characteristics of various grain products at different surface materials and moisture contents is important for selecting the machine that will be designed or produced or the selection of the power source for the facility and calculating its actual dimensions.

Rice cultivation can be carried out in many provinces and especially those in the Marmara and Black Sea regions in Turkey which has a significant importance with regard to rice production and consumption in the world. Hence, the level of rice harvest and post-harvest drying, storage and processing facilities continues to increase every year. Southeastern Anatolia is another region where rice is produced in Turkey. Şanlıurfa, Diyarbakır and Mardin are among the provinces in the region with high rice cultivation. The geography located in between these three provinces is known as the Karacadağ region. Rice cultivation in this region is carried out mostly in natural and rocky areas where machines cannot be used and the use of machinery is limited in contrast with other regions of Turkey.

Cite this article as:
Esgici, R. (2019). Determination of the friction force and energy for Karacadağ local rice cultivars for different surfaces. Int. J. Agric. Environ. Food Sci., 3(4), 245-249
DOI: https://dx.doi.org/10.31015/jaefs.2019.4.8
Received: 22 September 2019 **Accepted:** 05 December 2019 **Published:** 24 December 2019
Year: 2019 **Volume:** 3 **Issue:** 4 (December) **Pages:** 245-249
Available online at : http://www.jaefs.com - http://dergipark.gov.tr/jaefs

The use of chemical pesticides and fertilizers is limited. Thus, rice with a higher quality with regard to human health can be produced in this region. That is why; local varieties are mostly preferred and consumed in the region (Esgici et al., 2016).

Even though it is such an important product, significant quality and quantity losses take place during the harvesting, transportation, drying, storage and factory processing stages. Hence, the design of transportation, conveyance and storage structures for rice is important for reducing product losses and operational costs. One of the physical-mechanical properties of grainy products is the friction property that is displayed when the product is moved on the surface of materials used in transportation-conveyance and storage structures. That is why, the friction characteristics of the agricultural products should be taken into consideration when selecting or designing equipment for harvest, transportation, storage and drying. The material slides on the material surface during the loading and unloading processes when transporting and conveying agricultural products. Sliding depends on the product content and surface material.

Knowledge of friction characteristics for various grain products on different surface materials and moisture contents is important for the selection of the power source and the calculation of the actual dimensions (Sabahoglu and Ozturk., 1996; Guzel et al.,1996; Caliskan and Vursavus., 2009). In addition, friction force between the material and the lateral surface plays an important role in pneumatic conveying.

In this study, 4 different surface materials were used for the Karacadağ Beyaz and Karacadağ Karakılçık local rice varieties cultivated in the Diyarbakır province and its environs for determining the friction force and friction energy for three different moisture contents and the relationships between them were examined.

Materials and Methods

Plant characteristics and measurement devices

Karacadağ Beyaz and Karacadağ Karakılçık rice varieties were used in the present study as plant material (Figure 1). Both varieties were obtained in 2018 from the production areas of an active producer in the city of Diyarbakır. The rice samples acquired from harvester storage during harvesting were transferred over to the Agricultural Machines and Technologies laboratory where experiments were conducted. Grain moisture contents were determined in accordance with the ASABAE (2008) standards with oven drying method at 103◦C for 24 hours (Figure 1). The trials were carried out for three different moisture values. The moisture contents of the grains obtained from the harvester storage during harvesting were taken into consideration during the first trials (29.00 %). The grains with high moisture content acquired during harvesting were left to wait for 5 days in the laboratory to decrease the grain moisture for the second moisture experiments. During this time frame, the moisture content decreased down to about 19.00 % and experiments were carried out at this moisture content. Rice grains were left to natural drying in the laboratory for 10 days for the third moisture experiments after which the experiments were carried out when the moisture content decreased by about 9.30 %.

Figure 1. Rice varieties used (Karacadağ Beyaz on the left, Karacadağ Karakılçık on the right).

Friction Characteristics

Static friction force has a greater value in comparison with the dynamic friction force. Since the higher value of static friction force or coefficient is taken into consideration for power selection and for the design of other agricultural equipment and structures, static friction force and static friction energy were measured during the present study.

The measurements were carried out on 4 different surface materials (galvanized sheet, PVC, Chrome and Rubber) and at three different moisture content values 9.30 %, 18.50 % and 29.00 %). A Lloyd plus brand test device with a measurement capacity of 2500 N and a special test setup shown in Figure 2 were used for pulling of the rice grains on the material and the measurement of the friction force and friction energy. This setup is comprised of three units. These are; product cup, friction surface and data measurement setup. The product box has dimensions of 250 x 250 x 90 mm3 with the lower part of the box containing the rice seeds left open and a setup with rails and wheels was placed underneath the box in order to avoid contact between the sides of the box and the surface. The weight of the box used in the experiment was 1.9 kg (19 N) and 1.00 kg (10 N) of rice grains were added inside for the trials. Therefore, the normal force was taken as 2.9 kg (29 N) for all trials.

The friction data of the tests were recorded automatically by the device as force-time graphs. The pulling operation was carried out with a constant speed of 20 mms^{-1} at a distance of 50 cm. The highest force value measured by the device when the box first started its movement was taken into consideration as static friction force. The average of 50 measurements recorded by the device was calculated as one repetition (Sessiz et al., 2018; Esgici et al., 2018). Figure 3 presents a typical force-time change graph.

Statistical analysis

SPSS 14 statistical package software was used for statistical analyses and comparisons. GLM model was applied for multiple variance analysis. Differences between the averages were determined according to TUKEY test results.

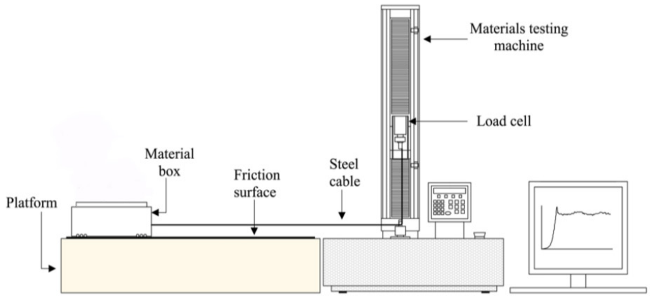

Figure 2. The setup and material test device used for determining the friction characteristics.

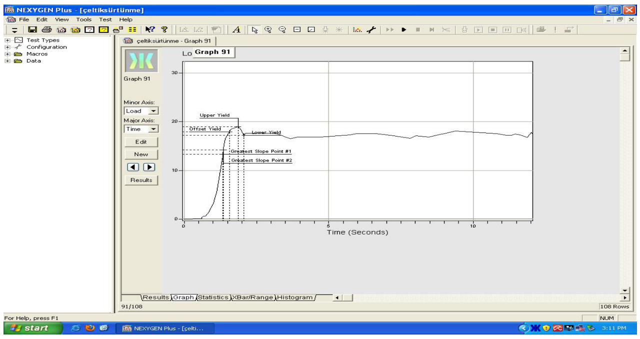

Figure 3. Typical force-time change graph.

Results and Discussion

The average values obtained for the friction force for both varieties are presented in Table 1. The difference between the varieties with regard to static friction force was observed to be statistically insignificant as a result of the variance analyses carried out. However, these values were relatively higher numerically for the Karacadağ Karakılçık variety (Table 1). The average values of both varieties are presented in Figure 3. As can be seen in Table 1 and Figure 4, the average static friction force values for both varieties increased on all surface materials with the increase of the grain moisture content. The difference between the moisture content was observed to be statistically significant. According to Guzel et al. (1996), friction force depends on the type and roughness type of the surfaces in friction. Therefore, friction force and energy increased with increasing moisture since the rice grain surfaces are rough and awned resulting in sliding on the material rather than rolling. According to Ozturk and Sabahoglu (1994) friction coefficients increase with increasing moisture content. Because the increase of friction force also corresponds to the increase in friction coefficients since the normal force remains constant. The highest values for both varieties were observed respectively in materials of PVC, rubber with smooth surface, galvanized sheet and chromium). While the lowest static force was obtained in chrome material with 11.77 N, the highest value was obtained as 30.30 N for 29.00 % grain moisture content in the Karacadağ Karakılçık variety and PVC material. PVC has similar surface characteristics with rubber material but is rougher. Hence, it has displayed a greater resistance in the opposite direction against normal movement. This was due to the adherence characteristics between the two surfaces as the grains slide on the surface as well as the awned structure of the grains. This was put forth by Ozturk and Sabahoglu (1994) as an increase in the friction resistance due to the fluid of the material transferring onto the surface material as agricultural products pass from the same surface repeatedly. Moreover, temperature increases at the interface as the product passes from the surface. Friction force increases since the increase in the contact time between the surfaces has an impact on adhesion and surface wear.

Data for the friction energy are presented in Table 1 and Figure 5. The difference between the varieties with regard to friction energy was observed to be statistically insignificant. However, as was the case for static friction force, friction energy on all surfaces increased with increasing moisture content in both varieties. The lowest friction energy was obtained as 2.061 Nm at a moisture content ratio of 9.30 % for the Beyaz variety on chrome surface material, whereas the highest value was obtained as 7.053 Nm at a moisture content ratio of 29.00 % for the Karakılçık variety on PVC material. While the PVC material and rubber with smooth surface displayed similar characteristics, chrome and galvanized sheet materials also displayed similar characteristics (Table 1). Since the difference between the two varieties was observed to be statistically insignificant, the average values for the two varieties are presented in Figure 5. As can be seen from the graph, increase in grain moisture content increased the friction energy (Nm) for all surfaces. This increase was observed to be statistically significant for all surfaces. The highest values were obtained for rubber and PVC materials. The lowest values were determined for chrome and galvanized sheet material with smoother friction surfaces. As can be observed, the structure of the friction surface, moisture content and the awn characteristics of the grain had an impact on friction energy. A similar result was also expressed by Ozturk and Sabahoglu (1994), Colak and Sacilik (2002), Guzel et al. (1996).

Table 1. Change in static friction force and friction energy subject to moisture content and variety.

	Karacadağ Beyaz			Karakılçık		
	Moisture content, %			Moisture content, %		
	9.30	19.00	28.60	9.30	19.00	28.60
Static friction force, N						
Rubber	15.35	18.86	24.48	13.95	15.32	24.72
Chrome	11.77	15.77	20.49	11.86	14.69	21.68
Galvanized sheet	12.65	16.77	23.30	12.83	17.52	24.68
PVC	18.40	22.54	29.20	17.60	21.48	30.30
Static friction force, N						
Rubber	3.094	4.552	5.799	3.303	4.696	5.926
Chrome	2.061	3.429	3.647	2.735	3.337	3.767
Galvanized sheet	2.888	3.297	3.866	2.541	4.413	5.722
PVC	4.454	5.564	6.448	4.478	5.275	7.053

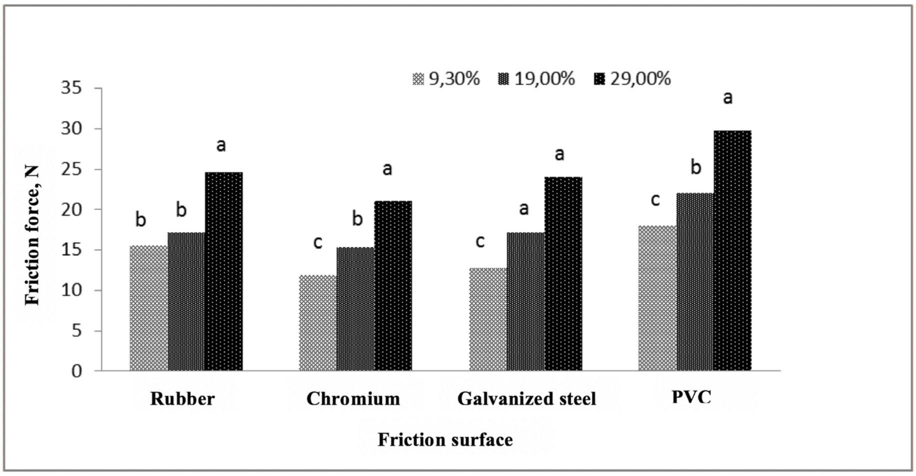

Figure 4. Change in friction force subject to material and moisture content

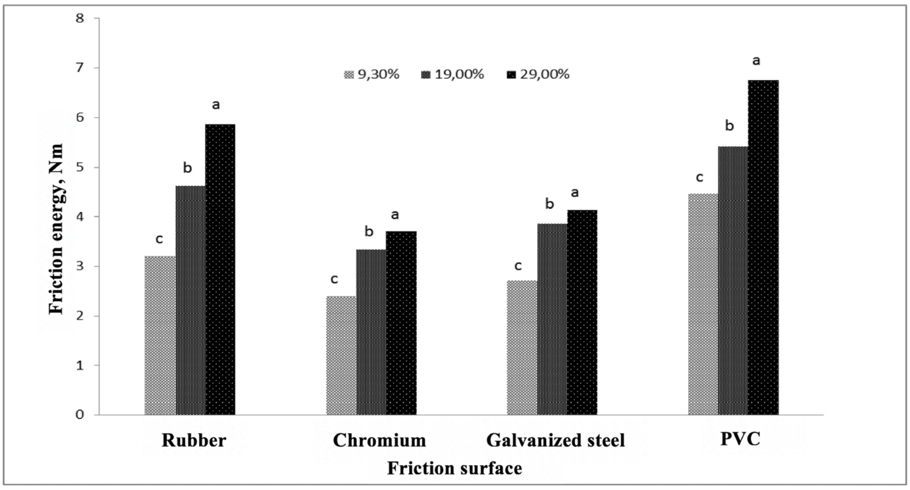

Figure 5. Change in friction energy subject to material and moisture content

Conclusion

The difference with regard to static friction force and friction energy between the varieties was determined to be statistically insignificant as a result of the variance analyses carried out. However, these values were relatively higher for the Karacadağ Karakılçık variety since the awns were larger. The average static friction force and static friction energy values increased with increasing moisture content for both varieties. The highest values for both varieties were observed on PVC, rubber with rough surface, galvanized sheet and chrome materials respectively. The lowest static force was obtained as 11.77 N on the chrome material, whereas the highest value of 30.30 N was obtained at 29.00 % grain moisture content, Karacadağ Karakılçık variety and on PVC material. As was the case for the static friction force, friction energy increased with increasing moisture content for both varieties. The lowest friction energy was obtained as 2.061 Nm at a moisture content of 9.30 % for the Beyaz variety on chrome surface material, whereas the highest value was obtained as 7.053 Nm at a moisture content of 29.00 % for the Karakılçık variety on PVC material.

References

Alayunt, F. (2000). Biological Materials. Ege University, Agriculture Faculty, Textbook, No: 541. İzmir-Turkey.

Beyhan, M. A., Nalbant, M., Tekguler, A. (1994). Determination of coefficient of friction in the grain and husk hazelnuts for different surfaces. Proc. XV. National Congree on Agricultural Mechanization' September 20-22, Antalya, Turkey, 343-352.

Caliskan, N., Vursavus, K. (2009). Determining the Physical and Frictional Properties of Washington Navel Orange Fruit Related to Post-Harvest Technology. Journal of Agricultural Machinery Science 5(1),83-92.

Colak, A. and Sacilik, K. (2002). Determination of the Coefficients of Friction of Olive (Olea europaea L.cv. Memecik). Journal of Agricultural Sciences, 8(2), 11-118.

Esgici, R., A. Sessiz, Y. Bayhan. (2016). The Relationship Between the Age of Combine Harvester and Grain Losses for Paddy. International Scientific Journal. Mechanization in Agriculture. S.18-21, ISSN 0861-9638, Sofia-Bulgaria.

Esgici, R., Pekitkan, F.G., Guzel, E., Sessiz, A. (2018). Friction Coefficients For Gundelia Tournefortii Seed on Various Surfaces. XIX. World Congress of CIGR(Commission Internationale du Génie Rural) "Sustainable Life for Children" 22-25 April 2018, Antalya, Turkey.

Guzel, E., Ulger, P., Kayisoglu, B. (1996). Product Processing and Evaluation Technique. Cukurova University, Agriculture Faculty, Textbook, No: 47 Adana-Turkey.

Mohsenin N. N. (1986). Physical Properties of Plant and Animal Materials. Gordon and Breach Science Publishers. New York [CrossRef]

Ozturk, R., Sabahoglu, Y. (1994). Evaluation of methods for determination of friction coefficients of biological materials. 15. National Congree on Agricultural Mechanization, S.353-362. Antalya-Turkey.

Sabahoglu, Y., Ozturk, R. (1996). Determination of Friction Coefficients of Some Wheat Cultivars. 6th. International Congress on Agricultural Mechanization and Energy, Ankara-Turkey.

Sessiz, A. (2005). Physical properties of some green olive cultivars. Proceedings of the International Congress on Mechanization and Energy in Agriculture &27th International Conference of CIGR Section IV: The Efficient Use of Electricity and Renewable Energy Sources in Agriculture, Sep.27-29,2005, İzmir-TURKEY.

Sessiz, A., E. Guzel., Bayhan, Y. (2018). Determination of Cutting Force and Energy in Grape Cane in Some Domestic and Foreign Grape Varieties. Turkish Journal of Agricultural and Natural Sciences. 5(4): 414–423 [CrossRef]

Sessiz, A., Pekitkan, F.G., Esgici, R. (2019). Comparison of Physical and Friction Properties of Local Paddy Varieties in Karacadağ Region. 32. National Congree on Agricultural Mechanization, S.353-362 Canakkale-Turkey

Sessiz, A., Pekitkan, F.G., Esgici, R., Guzel, E. (2018). Determination of Friction Characteristics of Kenger (Gundelia tournefortii) Seeds by Using Regression Technique for Various Surfaces. Journal of Agricultural Machinery Science, 14 (3), 143-148.