

THE NEED TO DEVELOP A WALNUT-BREAKING DEVICE FOR SMALL WALNUT FARMS

DANIELA DRĂGHICESCU¹, OANA CORINA GHERGAN¹, IASMINA IOSIM^{*2}

¹*Politehnica University of Timișoara, Romania, Faculty of Mechanics;*

²*Banat University of Agricultural Sciences and Veterinary Medicine, "King Michael I of Romania", Timișoara, Romania, Faculty of Management and Rural Tourism.*

*Corresponding author's e-mail: iasminaiosim@yahoo.com

Abstract: *In recent years, in Romania, but especially in the western part of the country, it has been found that long-term development in rural areas is absolutely necessary. The need for sustainable agriculture is also an important help from an economic point of view for the future. The Western area of Romania has a huge potential in the development of small farm businesses, in accessing European Funds, but also in attracting domestic and foreign investors. This potential also refers to the development of walnut crops, and, related to their processing, by creating new processing lines, modern equipments. The major objective of this paper was to discover specific characteristics of some Romanian walnut varieties, before and after the breaking, in order to conceive later a constructive solution of a machine that can be used by small walnut farms. Given the importance of choosing the walnut varieties, they will be observed visually, numbered, measured on all outer sides, with the help of a callipers beam, after which they will be broken. The results will be processed, in order to obtain data necessary for the development of a machine adapted to the needs of small farmers. The trend of the future shows an urgent need to replace physical work, with high-performance, automated machines and equipment. This need comes precisely because of the growing acute shortage of qualified staff. Data accessed through agricultural management systems can be processed to obtain customized solutions for small and medium farms.*

Key words: *Romanian walnuts sorts, precision agriculture, small and medium farming, sustainable development*

INTRODUCTION

More than two decades ago, Romania was among the first walnut-producing countries in Europe, with a production of over 40 thousand tons. In the interwar period, Romania was in the top three in the production of nuts in the world. It should be mentioned that until the beginning of the 20th century, walnut formed forests and extensive plantations in most counties of the country. Over time, the pursuit of walnut wood, but also the systematization and territorial organization determined, in the years of the communist regime, by the collectivization of agriculture, led to the cutting of many trees. Currently, attempts are being made to restore the walnut areas in the context in which more and more investors are interested in investing in this culture [21].

It is also a beneficial crop for preventing landslides. The walnuts on the slopes have a root reinforcement that strongly encloses the soil, having the same efficiency as that of a dam of 7 cubic meters of concrete, say the specialists. The tree is of medium height and elastic. It has a large annual biomass production, which makes it a good source of fuelwood and lumber. Walnuts can reach an age of 50 years, but they should not be over 30 years old to ensure its growth and quality. The minimum height for walnut trees is 5 meters, with an angle of 16-18 degrees (or 40-44 centimetres), depending on the variety [20].

However, walnut cultivation is a tempting business today, with low investment and high profits. The investment pays off two years after the plantation bears fruit.

The Western Region has an area of 32,034 km² (13.4% of the country's surface) and is composed of 42 cities (of which 12 municipalities) and 276 communes (318 administrative-territorial units), grouped in four counties: Arad, Caraș-Severin, Hunedoara

and Timiș. The region includes the province of Banat, a historical Romanian province with an even earlier economic development compared to other provinces in the country. The population of the Western Region is characterized by cultural diversity, the Romanian communities coexisting with the Hungarian, German, Romany and Serbian ones [16, 18, 19].

The fields in which the West Region has a high development potential are research-development-innovation, the West Region having a university tradition of over 80 years, services and tourism, the latter gaining increasing importance at the level of the region. It is well known that in the European Union organic products are highly valued in general, and walnuts are sought after for their special qualities. Walnuts are considered an ecological product highly sought after for export, along with demier and berries. According to the estimates of the Department for Foreign Trade, in 2007 the value of the export of ecological products will exceed 100 million euros, registering a significant increase compared to 2006, when a value of 75 million euros was registered. Representatives of MIMMCPL (Ministry of SMEs, Trade and Liberal Professions) say At present, the estimated volume of the market is located at 30-40% of world walnut production, and for the future it is estimated an increase in walnut production for export up to at 50% [4, 17].

The need for long-term development in rural areas is essential. In recent years, in Romania, a country that has experienced massive emigration in the last 20 years, but especially in the western part of the country, it has been found that long-term development in rural areas is absolutely necessary. The need for sustainable agriculture is also an important help from an economic point of view for the future. The Western region has a huge potential in the development of small farm businesses, in accessing European funds, but also to attract domestic and foreign investors. This potential also refers to the development of walnut cultivation [19].

Nowadays, precision agriculture also means the application of high technologies such as automation, robotics and computing in agriculture and, especially in this case, mechanised agriculture [1, 8].

MATERIALS AND METHODS

In Romania, in the Western area, walnut cultivation is very important for the development of smaller farms, for local production largely for economic development of rural areas. The main feature of walnut cultivation in our country is that a large amount of walnut production is obtained from trees grown on their own roots, spread in different ecological conditions. Therefore, walnut production is still fluctuating quantitatively and qualitatively. Foods, including nuts (*Juglans regia* L.), have a complex chemical composition and are determined by a number of parameters, which must be taken into account when calculating processes and apparatus and their completion. Existing methods of assessing the quality of production are often subjective, far from perfect. The actual physical properties of food products are not always taken into account when designing machines and appliances. For the scientific substantiation of the appreciation of these properties in different fields of food technique and technology, it is necessary to systematize the data regarding the structural-mechanical characteristics of the products [2, 3, 5, 15].

Despite these facts, there are many biotypes from which productive types can be selected for the reconstruction of a modern walnut crop and to meet the objectives of growers and the needs of consumers. According to the needs of small farmers, it is necessary to evaluate the Romanian varieties of cultivated walnuts, both according to their external dimensions in order to be able to make a suitable and reliable machine for

breaking walnuts. According to the national strategy for growing walnuts, new walnut cultivation is chosen following specific objectives such as:

- large size (12-19g), spherical or ovoid shape, yellow or cream in color, adequate strength, seam thickness and suture, easy core extraction with a core percentage of more than 50% for nuts;

- good size, light color, high organoleptic quality, high nutritional value (fat 50%, protein 16%), for the core;

- late bud break, cold resistance, heat tolerance, low or medium vigor, lateral fruiting, high and constant productivity, early bearing, early ripening time (15-20 September), resistance or tolerance to key diseases of walnuts (anthracnose and walnut blight), resistance to key pests of walnuts (*Cydia* sp.).

Since 1996, the Vâlcea Fruit Research Station and the Faculty of Horticulture of the University of Agronomic Sciences of Craiova have a joint research program to improve the assortment of nuts for the southwest of our country by selection in the local population of nuts and controlled hybridization [7].

As a result of these general efforts, from 1990 to the present, a number of 10 new walnut cultivars and 2 walnut rootstocks with higher agronomic performance have been obtained, mainly by selection in walnut populations [16]. The Romanian walnut assortment now includes 22 varieties and 2 rootstocks from *Juglans regia* L., and approximately 30 more elite selections are being evaluated in the experimental fields of the Fruit Research Institute, another approximately 30 at the Research Station of Fruits from Geoagiu, 20 elite selections at the Vâlcea fruit research station and many other selections at the Iași and Târgu Jiu fruit research stations. Since 1992, special attention has been paid to prospecting, evaluation and conservation of germplasm, as a determining condition for the success of our national walnut growing program, the Romanian walnut germplasm fund, which now includes 215 accessions including: 6 species, 168 Romanian genotypes and 41 foreign genotypes[5].

Studies about the walnuts were also made in papers like [2], [3], [12], [15]. Regarding walnuts cracking, researchers from all-over the world have made different tests and the results have been presented in papers like [5], [9], [10], [11].

An evaluation of a number of 5 Romanian varieties is considered, for choosing the best variant, as a variety both in terms of culture, production, soil resistance in the West, to generate significant yields for small farms from rural areas. We are looking for solutions for the development of this business, both by attracting European funds but also from our own funds. To choose the right varieties, a dimensional evaluation of the fruit was made, by measuring a number of 5 varieties that correspond to the climate and can be adapted to the area. The size, mass of the nut, the color of the core, and the productivity that can be obtained were evaluated. Five different types of Romanian nuts were selected for the experiment.

Varieties used:

- (1) Sibisel 525 - pos. I, figure 1,
- (2) Germisara - pos. II, figure 1,
- (3) Cyprian - pos. III, figure 1,
- (4), (5) Varieties Metis - IV and V, figure 1.



Figure 1. Five Romanian walnut varieties

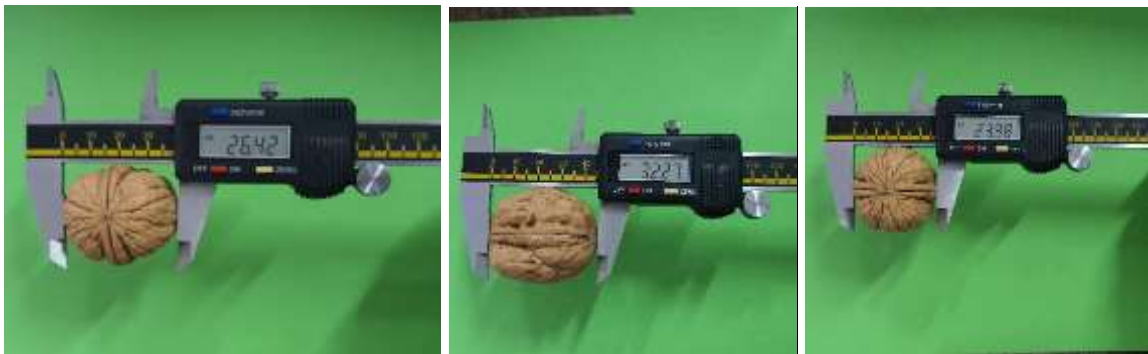


Figure 2. Specimen of measured fruit

Ten pieces of each of the five varieties were used in this experiment. The walnuts were measured (figure 2), in three rectangular directions: the length (L), the maximum diameter (D) measured in the largest section, and the diameter on rectangular direction, (d). Also, the walnuts were weighed individually for each variety, in order to obtain concrete data about these varieties.

After they were cracked, using an equipment designed especially for walnut cracking, it was counted for each walnut how many pieces of peel resulted from the breakage. The obtained results were statistically processed with the help of Microsoft Excel in order to obtain the necessary conclusive data, to design such a walnut-breaking machine. The relationship between the number of pieces obtained after the breaking process and the average of the initial dimensions of the walnut fruit, namely (arithmetic, geometric and square average), could qualify the process. The arithmetic (A), geometric (GA) and square (SQA) values of the walnut dimensions are very close. After accounting was completed, the values were recorded into a table.

The data will need to determine whether these varieties are productive for the soil in the western part of the country and also the climate in the area. High productivity is important as an economic factor. Rural development on this segment of agriculture bringing a great economic contribution to the area [4]. The peel resulting from the breaking of the walnuts can be used later, for example as we can see in some papers that refer to the pyrolysis process [6, 14], or by other methods of valorisation [13].

RESEARCH RESULTS

For the recorded values, statistical analysis was performed with Microsoft Excel, where the standard deviation, mean deviation, and variance was calculated (see Table 1). Also, the average, geometric average, square average were calculated for the three dimensions (L, d, D).

Table 1

Walnuts and broken parts characteristics

No.	L [mm]	d [mm]	D [mm]	Weight [g]	A [mm]	AG [mm]	SQA [mm]	Pieces on sample
I (1)	32.80	28.95	30.30	10.28	30.68	30.66	30.64	10.50
II (2)	40.36	29.61	29.76	9.86	33.25	33.05	32.89	13.63
III (3)	35.58	29.87	31.77	11.81	32.41	32.36	32.32	15.43
IV (4)	41.98	33.28	32.02	11.19	35.76	35.62	35.50	13.73
V (5)	32.16	29.11	29.96	10.25	30.41	30.40	30.38	9.93

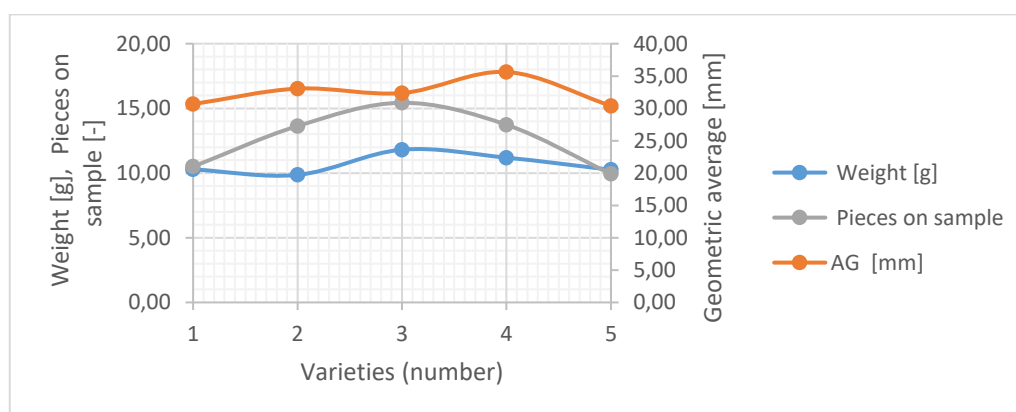


Figure 3. Comparison between geometric mean, weight and number of pieces obtained after breaking for the five varieties

In order to conclude, an attempt was made to make a correlation between the average number of pieces of peel obtained after breaking and the average of the three dimensions (using the geometric mean), together with the average weight. The comparison is presented in figure 3. The result was obtained the sixth-degree polynomial and according to resulting graphs for each variety of walnuts a linear trend is observed.

CONCLUSIONS

The aim of this research was to obtain data to help develop new equipments for small walnut farms.

We can consider as a conclusion that the bigger walnuts are easier to break, and the number of pieces in which they break are smaller compared to the smaller nuts. The results will be integrated into a larger study complemented by influences of temperature, humidity, and walnut variety conditions.

The study shows that the most suitable varieties in order to obtain a suitable solution to build a walnut-cracker, which will be used by small farmers in western Romania, are Cipryan and Germisara. Their productivity is high, well-formed fruit and compact kernel, diseases resistant and weather-resistant varieties. The resulting kernel from the breaking of the two varieties was much more compact.

It is also necessary to use other data evaluation programs in order to obtain a better evaluation of the data obtained in table 1.

According to the results obtained from the research study, it is found that the varieties are vigorous and suitable for the development of rural areas in Western Romania.

- The fruits have a beautifully formed rind with fruit that is easy to extract after breaking,
- It is foreseen in the future development of technologies for harvesting walnuts, by vibration shaking,
- Development in the direction of technology,
- One of the most important tasks of modern technology is the creation of autonomous machines that do not require constant attention, with low maintenance and administration needs
- At present, Romanian walnuts are one of the most productive in Europe and can be produced by small farms with medium or low capital investment.
- Walnut cultivation is intensively studied in Western Europe, and European countries especially fully exploit their potential.
- The design of the nutcracker must take into account many important parameters in the design process. That is very important the geometric, mechanical, and economic.
- Depending on the resulting parameters, it is necessary to adapt a mechanical or automatic adjustment to the future machine to be designed

Nowadays, precision agriculture also means the application of high technologies, the transition from classical mechanization to machine automation, especially in this case, so that the human presence is replaced by them. Given the increasingly precarious situations, the labour force is less and less, tends to automate and robotize work equipment. Increasing labour costs and declining availability, high seasonal labour, high-quality agricultural products and reducing pollution from agricultural activities generate automation needs.

REFERENCES

- [1]. **BODIN F., MNERIE D., TUCU D., NAGY V.**, 2017, Elements to optimize of the educational and formative management of engineers specialized for jobs in the agriculture's mechanization. *Actual Tasks on Agricultural Engineering-Zagreb* 45, 623-629
- [2]. **BUJDOSO G., CSEKE K.**, 2021, The Persian (English) walnut (*Juglans regia* L.) assortment of Hungary: Nut characteristics and origin, *Scientia Horticulturae*, Volume 283, 110035, ISSN 0304-4238
- [3]. **CERIT I., SARICAM A., DEMIRKOL O., UNVER H., SAKAR E., COSANSU S.**, 2017, Comparative study of functional properties of eight walnut (*Juglansregia* L.) genotypes, *Food Science and Technology*. 37(3), 472-477.
- [4]. **CRISAN G.C., TUCU D., BOBOESCU R.**, 2017, Improvement of safe & healthy work systems in agricultural SME's. *Actual Tasks on Agricultural Engineering-Zagreb* 45, 657-663.
- [5]. **DRAGHICESCU D., TUCU D., GHERGAN O.C., IUSCO A.**, "Nuts varieties influence on walnut breaking and peeling process", *Actual Tasks Onagricultural Engineering. Proceedings, Book Series: Actual Tasks on Agricultural Engineering-Zagreb*, vol. 47, pp. 419-427, March 2019, ISSN: 1848-4425
- [6]. **FILIPOVICI A., TUCU D., BIALOWIEC A., BUKOWSKI P., CRISAN G.C., LICA S., PULKA J., DYJAKON A., DEBOWSKI M.**, 2017, Effect of Temperature and Heating Rate on the Char Yield in Sorghum and Straw Slow Pyrolysis. *REVISTA DE CHIMIE* 68, 3, 576-580
- [7]. **GACEU L., TUCU D., MNERIE D., OPREA O.B.**, 2016, LabView tool for infrared monitoring the quality of vegetables drying process. *Actual Tasks on Agricultural Engineering-Zagreb* 44, 311-320

- [8]. **GHERGAN O.C., TUCU D., IUSCO A., DRAGHICESCU D., BABANATIS MERCE R.M.**, “Small greenhouse robotized solutions: State of the art and future perspectives”, Actual Tasks On Agricultural Engineering Proceedings, Book Series: Actual Tasks on Agricultural Engineering-Zagreb, vol. 47, pp. 267-276, March 2019, ISSN: 1848-4425;
- [9]. **HOBBS L.J., YAN Z.**, 2008, Cracking the walnut: Using a computer game to impact cognition, emotion, and behavior of highly aggressive fifth grade students, Computers in Human Behavior, Volume 24, Issue 2, Pages 421-438, ISSN 0747-5632
- [10]. **KOYUNCU M.A., EKINCI K., SAVRAN E.**, 2004, Cracking Characteristics of Walnut, Biosystems Engineering, Volume 87, Issue 3, Pages 305-311, ISSN 1537-5110
- [11]. **LUPAȘCO A., ȚARNA R., BERNIC M., TARLEV V., COMAN A.**, 2002, Ruperea cojii nucilor în procesul de zdrobire a lor, Materialele Primului Simpozion Internațional „Biochimie și Biotehnologii în Industria Alimentară”. Chișinău: UTM, pp. 219-221
- [12]. **MAO Y., WANG P., WU Y., HOU L., WANG S.**, 2021, Effects of various radio frequencies on combined drying and disinfestation treatments for in-shell walnuts, LWT, Volume 144, 111246, ISSN 0023-6438
- [13]. **OPREA O.B., GACEU L., TUCU D.**, 2017, Valorisation of winery waste by using GSP (grapeseed powder) as flour substitution in bakery industry. Actual Tasks on Agricultural Engineering-Zagreb 45, 371-376
- [14]. **SHAH M.A., KHAN N.S., KUMAR V., QURASHI A.**, 2021, Pyrolysis of walnut shell residues in a fixed bed reactor: Effects of process parameters on product yields and analysis of products, Journal of Environmental Chemical Engineering, 105564, ISSN 2213-3437
- [15]. **SHAH R.A., BAKSHI P., SHARMA N., JASROTIA A., ITOO H., GUPTA R., SINGH, A.**, 2021, Diversity assessment and selection of superior Persian walnut (*Juglans regia* L.) trees of seedling origin from North-Western Himalayan region, Resources, Environment and Sustainability, Volume 3, 100015, ISSN 2666-9161
- [16]. **TUCU D., HOLLERBACH W.**, 2011, Analyze of opportunities for willow's culture as biomass resources in Banat region. Actual Tasks on Agricultural Engineering-Zagreb 39, 171
- [17]. *** <http://culturanucului.blogspot.com/2015/02/proiect-de-obtinere-finantarii-din.html> Accessed on April 11, 2021
- [18]. *** <http://www.fao.org/3/y5704e/y5704e0p.htm>, Accessed on April 9, 2021
- [19]. *** https://issuu.com/profitulagricol/docs/profitul_agricol_nr_36_2020, Accessed on April 9, 2021
- [20]. *** <https://www.permaculturenews.org/2016/11/23/essential-guide-everything-need-know-growing-walnuts-juglans-regia/>, Accessed on April 10, 2021
- [21]. *** https://www.rri.ro/ro_ro/cultura_nucului_in_romania-2546839, Accessed on April 7, 2021