

## EQUIPMENT AND TECHNOLOGIES USED IN WALNUT PROCESSING

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**Abstract:** Walnut is a species that can be grown in a temperate climate, has a fruit with a high content of essential nutrients, vitamins, proteins, carbohydrates and amino acids, necessary to maintain human health and can be consumed both fresh and after processing or maturation. In order to obtain the walnut kernel for direct consumption, the walnut must pass through a whole processing flux. After harvesting, which can be done both manually or using mechanized means, the walnut kernel must be cleaned of both the green coating and the shell. First apply the process of washing and cleaning of impurities and green peel, calibration of nuts, then enter the process of splitting walnuts, separating them, sizing walnut kernels into fractions, cleaning the core of dust and various foreign particles. The last steps can be, drying, packing or storing them depending on how we intend to preserve the nuts (with box or just the core) and market requirements.

**Keywords:** walnut processing, optical separation technologies

### 1. INTRODUCTION

A deep processing of each part of the walnut should be considered in order to accomplish the high value-added use of the walnut fruit. Before walnuts enter the sphere of heavy processing and consumption, they must first undergo preliminary processing. The sophisticated degree of technical equipment required can aid in determining the grade of walnut goods (Pycia *et al.*, 2019; Zhao *et al.* 2020; Gupta *et al.* 2019).

Walnut has an old history of growing and harvesting in Romania, being considered among the important European nut producers. The fruits are a source of energy, vitamins and antioxidants necessary for maintaining the health of the human body for long periods of time. Medical research has concluded that regular consumption of walnut kernels has important effects in preventing or treating several diseases, and they can also be included into various nutritional diets (Soto–Maldonado *et al.*, 2019; Yang *et al.*, 2019).

Some of the walnut kernel characteristics: rich in Phosphorus, but also in other minerals (Sodium, Potassium, Iron, Zinc or Iodine), rich in essential elements and vitamins, being an excellent source of natural fiber. They are frequently used in cosmetics for making regenerating skin creams or conditioners. Walnut is a very popular ingredient in the traditional cuisine, being used to prepare tasty desserts, (green walnut jam, green walnut liqueur, oil, etc. (Chen *et al.*, 2018; Verde *et al.*, 2021; Uğurlu *et al.*, 2020).

A walnut plantation is starting to produce fruits with a good yield, depending on the variety, after 5–6 years from planting.

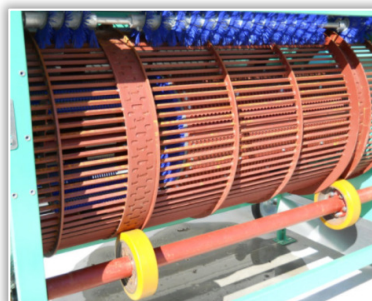
The harvesting of nuts and their processing is a very important activity. Mechanized walnut harvesting has developed modern equipment and machinery either towed, worn or self-propelled shaking. The collection and processing phases were introduced into equipment: cleaning, washing, calibration, breaking, sorting, drying, packaging, storage, in many construction variants using advanced technologies.

### 2. MATERIALS AND METHODS

An equipment for peeling and washing freshly picked walnuts is shown in Figure 1 a). This model is produced by AMB Rousset and is a fast cleaning machine that removes the green peel from the nuts and washes them at the same time. It is equipped with two concentric drums that rotate in opposite directions, being driven by electric motors. As can be seen in Figure 1 b) the device is also provided with a set of brushes that helps to better clean the nuts from impurities found on the uneven surface of the nuts. A low-pressure jet is used for this washing process and if necessary, they are rinsed with a high-pressure jet. It is a robust machine that can peel up to 300 kg of nuts per hour.



a)

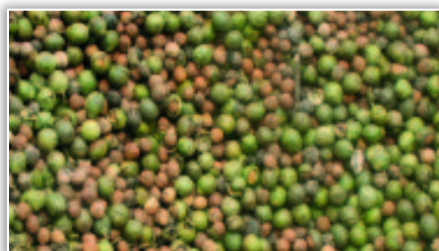


b)

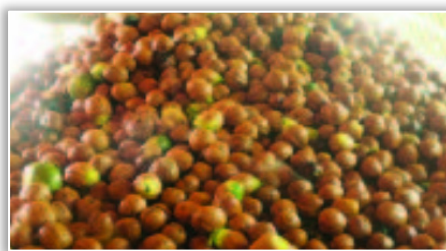
Figure 1. Walnut cleaner L 28 type a) General view, b) Exterior drum cleaning view  
(<https://www.amb-rousset.com/produit/laveuse-ecaleuse-2-m-l28/>)

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In figure 2 a) can be observed the nuts harvested with impurities and green peel, which as seen remains stuck on the nut, while in figure 2 b) the same nuts after passing through the cleaning machine named L28.



a)



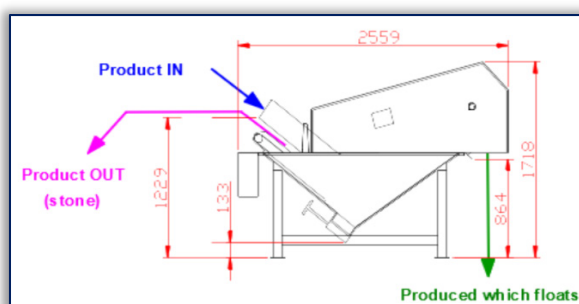
b)

Figure 2. Harvested nuts a) Before cleaning with equipment L28, b) After cleaning with the equipment L28 (<https://www.amb-rousset.com/produit/laveuse-ecaleuse-2-m-l28/>)

The separator of impurities (especially stones), BAP equipment depicted in figures 3 a) and b) can be placed after the collector or after a pre-washing or cleaning device. This equipment uses water (a tank deep enough so that heavier nuts do not get lost) to make a separation of the base material, from other impurities of similar size lumps, stones, green shells, etc.



a)



b)

Figure 3. BAP impurity separator, a) Overview, b) BAP separator sketch

([https://www.amb-rousset.com/wp-content/uploads/2021/03/BAP-AUD-L05-009198\\_0E.pdf](https://www.amb-rousset.com/wp-content/uploads/2021/03/BAP-AUD-L05-009198_0E.pdf))

CA3 equipment (figure 4 a), is a special smaller model of a nutcracker. The technical characteristics and the component parts of this machine are the following: supply tank has a capacity of 300 liters, anti-lock system for foreign bodies, electric motor powered at 380 V, electronic speed variator. The overall dimensions are: 1.52 x 0.80 x 1.70 m and the weight of the case is 212 kg. Walnuts can be broken without calibration. It is a robust machine and has a capacity of 50 to 70 kg / h depending on the size of the nuts. With the help of the speed variator the working capacity of the CA3 machine can be increased up to 100 kg / h.

For a separation and sorting of the working core in dimensions in line with the nutcracker, a separation and sorting equipment is also installed, as in figure 5 b). For smaller production capacities can use the nut crushing machine, model CA1, figure 4 b), which has a capacity of 15 to 30 kg / h depending on the size of the nuts. This model breaks one nut per cycle, while the CA3 model breaks 3 nuts per cycle, see figure 5a), (<https://www.cub-e.ro/procesare-nuci/>).

The model of nutcracker shown in Figure 4 a) may be combined with a walnut kernel sorting and separation plant, which makes the separation on the basis of air pressure, depending on the weight of the

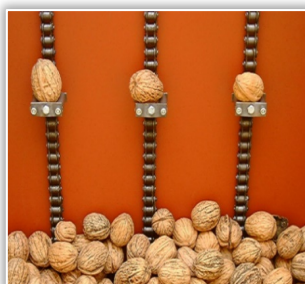


a)

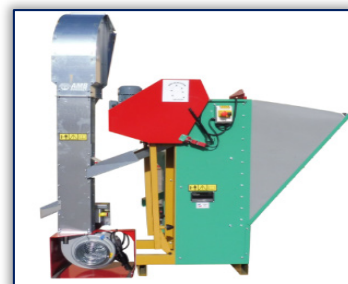


b)

Figure 4. Nutcracker a) model CA3 b) model CA1 (<https://www.amb-rousset.com/produit/casseuse-junior-ca3/>)



a)



b)

Figure 5. a) Model CA3 with breaking 3 nuts per cycle, b) Nut sorting and separation equipment (<https://www.amb-rousset.com/produit/casseuse-junior-ca3/>)



processed material, (Figure 5 b) . This nutcracker is mainly used for hard-to-clean nuts, and the separation is performed on the basis of air pressure, depending on the weight of the processed material.

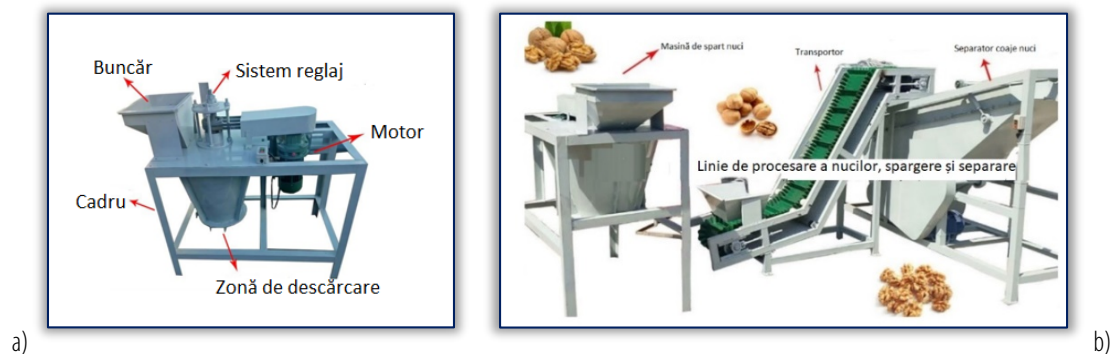


Figure 6. a) Nutcracker, b) Nut processing line by breaking and separating

(<http://ro.rxgoldenmachine.com/nut-processing-machine/walnut-cracking-machine.html>)

In figure 6 a) is presented a nutcracker that has as main parts a robust frame, a hopper, a unloading funnel, a drive motor and an adjustment system. The nut processing line, figure 6 b) has in its composition a nut crushing machine, a conveyor and a separation and sorting installation. This machine can clean and select other products from the category of walnuts besides walnuts. (<http://ro.rxgoldenmachine.com/nut-processing-machine/walnut-cracking-machine.html>)

The GRK–300 nutcracker as seen in Figure 7 a), is equipped with a transporting frame on wheels for easy handling. It can be powered on request by 220V or 380 V mains. The drive motor has the power of 0.75 KW, so there is a low power consumption. The transmission from the engine is made with the help of a V-belt. The principle of cracking is depicted in figure 7, this model having a productivity of up to 300 kg / hour.



Figure 7. GRK 300 nutcracker a) General view, b) Power supply system, c) Overview broken walnuts (<https://tmagro.com.ua/>)

The GRK 300 nutcracker model can also be adapted to work with hazelnuts as a raw material. When the material to be selected is based on hazelnuts the productivity of the GRK 300 machine can reach up to 200 kg per hour. The weight of the machine is 60 kg, and the overall dimensions, length / width / height are 611/440/905 mm ( <https://tmagro.com.ua/p/1140290850-orehokol-grk-300.html>).

Another model of sorting and separation equipment is SEP 800 that can be seen in Figure 8 a). This device separates the core from the shell by ventilation. It removes about 30% of the walnut shells and processes from 50 to about 200 kg / h (as seen in See figure 8 b). The turbine is driven by a three-phase electric motor, having 380V. The overall dimensions are: length 0.87 m, width 0.64 m, height 2.36 m. The weight of the equipment is 80 kg.

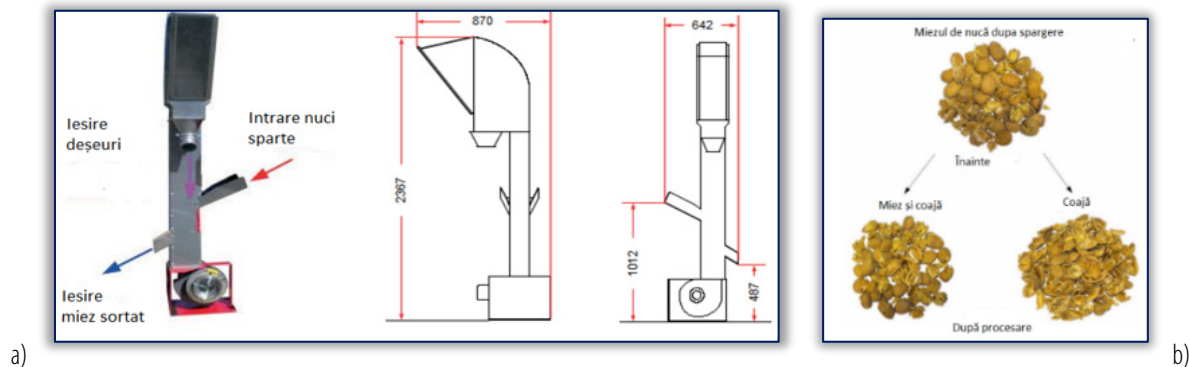


Figure 8. SEP 800 sorting and separating equipment a) General view and sketch with overall dimensions, b) Walnut kernel before and after processing, (<https://www.amb-rousset.com/produit/separateur-pneumatique-800/>)

In figure 8 a) is presented 6SXL optical sorter, which can select fresh nuts, dried nuts, almonds, hazelnuts, chestnuts, olives, cherries, etc. It has a very high sorting accuracy because it contains outlet nozzles every 5 mm, the viewing of defects is performed from 0.02 mm, and the chambers are located both above and below the product.

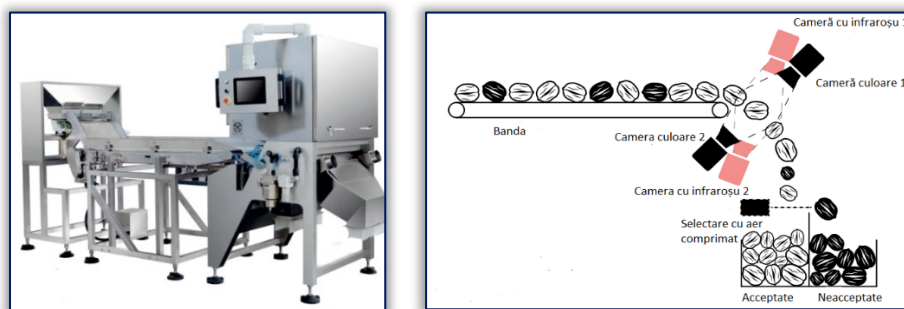


Figure 9. 6SXL optical sorter a) General view, b) Schematic of the operating principle, (<https://www.amb-rousset.com/wp-content/>)

The cleaning chambers used in this separator are protected from dust and moisture. The lighting is done with LEDs that guarantee up to 100,000 hours of operation. The feed hopper is simple with a vibrating gutter that prevents the material from stopping. The power supply is made at 220 V and a compressed air source is also needed. It is mounted on rollers or frames so that the whole assembly can be easily moved. Depending on the product to be sorted, the optical cameras are adjusted for certain configurations, they have an advanced technology that develops a very good sorting quality. Infrared cameras have a very advanced technology that allows certain materials to stand out to be selected.

From this category of optical selectors type 6 SXL we find the following models, according to table no. 1.

Table 1. Technical characteristics for 6XLS type selectors

| Model             | 6SXL – 300  | 6SXL – 600   | 6SXL – 1200   |
|-------------------|---|--|---|
| Size              | Width – 1150  | Width – 1150   | Width – 1750  |
|                   | Length – 2670   | Length – 3500  | Length – 3500   |
|                   | Height – 1860   | Height – 1860  | Height – 1860   |
| Weight            | 750 kg  | 950 kg   | 1200 kg   |
| Flow              | Fresh nuts – 2000kg / h                                     | Fresh nuts – 4000kg / h                                      | Fresh nuts – 8000kg / h                                       |
|                   | Dry – 1500kg / h  | Dry – 3000kg / h   | Dry – 6000kg / h  |
|                   | Core = 400kg / h  | Core = 800kg / h   | Core = 1600kg / h   |
| Electrical source | 220VCA 7,3A   | 220VCA 16A<br>380 VCA 16A                                    | 2x 220VCA 16A<br>380 VCA 16A                                  |
| Compressed air    | Electricity consumption:<br>500l / min 30m <sup>3</sup> / h | Electricity consumption:<br>1000l / min 60m <sup>3</sup> / h | Electricity consumption:<br>2000l / min 120m <sup>3</sup> / h |
|                   | Electrical network: 7bar minim                              | Electrical network: 7bar mini                                | Electrical network: 7bar mini                                 |
|                   | Volume: 150l  | Volume: 300l   | Volume: 600l  |

([https://www.amb-rousset.com/wp-content/uploads/906-FOU-L03-028390\\_OC-1.pdf](https://www.amb-rousset.com/wp-content/uploads/906-FOU-L03-028390_OC-1.pdf))

Various construction solutions can be used to calibrate whole walnuts and walnut kernels. Calibration in both variants is performed by size and with the removal of various impurities (foreign bodies). The most used dimensions of the holes of the calibration sieves are 4mm / 8mm / 18mm, and at the request of the farmer for other dimensions can be also considered (<https://altebo.ro/produse/sita-de-calibrare/>).



Figure 10. Constructive solutions for calibrating nuts and walnut kernels, a) with cylindrical sieve, with flat sieve, c) sorting table

(<https://altebo.ro/produse/calibrator-rotativ/>; <https://altebo.ro/produse/sita-de-calibrare/>; <https://altebo.ro/produse/masa-de-sortare-cu-banda/>) Rotating calibrator consists of a rotating drum, provided with holes of various sizes from the smallest diameter to the largest, Figure 10 a). The whole walnuts inserted in the drum move inside the drum until they meet the hole corresponding to the dimensions through which they will penetrate and thus will have the walnuts of the same size



selected in separate spaces depending on the calibration size. Small nuts will fall into the first holes of the drum while larger and larger nuts will fall into the next or even the last holes. In this process of selecting nuts by size can be calibrated from 4 to 7 sizes. This type of rotary calibrator can also be used for other nut products (<https://altebo.ro/produse/calibrator-rotativ/>).

For the transition from one process to another, for sorting, can be use sorting tables that help to inspect various products such as nuts, apples and many other products. These sorting tables are mobile because they are equipped with wheels that allow movement in different locations. These tables, figure 10 c), are made of high-quality steel sheet, covered with rubber bands and have a width of 400 mm or 800 mm. The length of the selection tables is established according to the need of the process, (<https://altebo.ro/produse/masa-de-sortare-cu-banda/>).

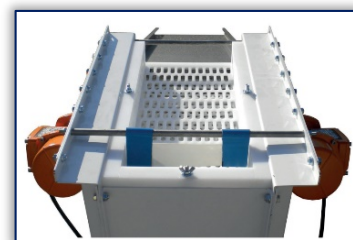
Another model of calibrating machine, C80, is shown in Figure 11 a) and b). This model calibrates the products by the difference in size. The drive is based on vibration with a 0.34 Kw electric motor. The sieve in the image in figure 11 c) has elongated holes with a size of 12/40 mm. The overall dimensions are as follows: length – 1.70 m, width – 0.68 m, height 0.74 m. It has a weight of 220 Kg and a selection capacity from 70 to 100 kg / hour, (<https://www.amb-rousset.com/produit/calibreuse-vibrante-a-cerneaux-c80/>)



a)



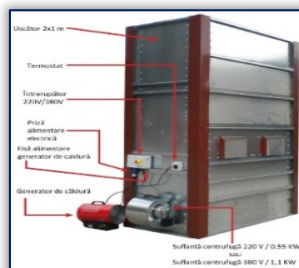
b)



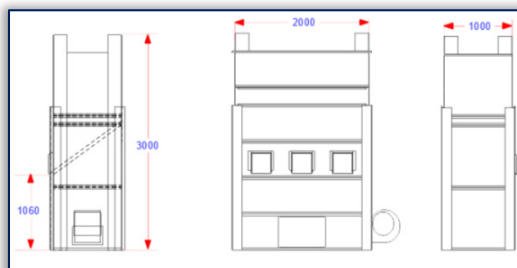
c)

Figure 11. C 80 calibration machine, a) right side view, b) left side view, c) Calibration screen view, (<https://www.amb-rousset.com/produit/calibreuse-vibrante-a-cerneaux-c80/>)

For optimal storage, the nuts can be artificially dried (*Chen et al., 2021*) using a dryer similar to the equipment shown in Figure 12, where there are depicted the main parts of the dryer and an overview of the 2x1m Stage Dryer in Figure b). The dimensions and weight of the dryer are described as follows: length 2 m, width 1 m, height – 3 m, weight – 510 Kg. The total capacity is 1-ton dried nuts.



a)



b)

Figure 12. Walnut dryer model STAGE DRYER 2x1m a) Overview, components, b) Dryer overview, (<https://www.amb-rousset.com/wp-content/>)

### 3. RESULTS

In order to shorten the processing time of walnuts after harvesting, there is a special line for processing walnuts in green shell (figure13). These automated lines consist of green peeling machines, washing, drying them, calibrating them, removing the core from the shell, sorting, packing, storing, etc. depending on how they will be economically fruitful.

Transilvania Nuts, is a company that make complex fluxes for processes nuts. The amount of nuts that can be processed per year is over 5,000 tons. Modern equipment with optical sorting and bichromatic camera is used to identify and remove foreign bodies.

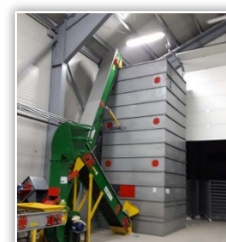
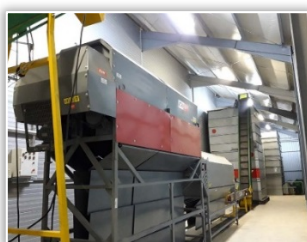


Figure 13. Walnut processing line, (<http://utilajmodern.ro/linie-nuca>)

This optical sorting technology offers a high standard of quality, and the selection efficiency is very high because the accuracy offered by such a state-of-the-art technology is very high. Depending on the color, shape, or other properties, these high-resolution biometric cameras can easily identify and remove foreign bodies found among the walnut kernels.



Figure 14. Walnut processing line, a) Selection of nuts, b) Washing nuts, c) Drying nuts (<https://www.transilvanianuts.ro/tehnologie>)



Figure 15. Walnut kernel processing line a) Walnut kernel grinding, b) Walnut kernel packaging, c) Walnut kernel storage, (<https://www.transilvanianuts.ro/tehnologie>)

After being harvested and consumed, the walnut is selected and processed using various specific machines and equipment, which result in the recovery of walnuts or walnut kernels in very good and quality conditions, as seen in figures 14 and 15 a), b), c), (<https://www.transilvanianuts.ro/tehnologie>).

#### 4. CONCLUSIONS

From an economic point of view, walnuts can be a very profitable business. Walnut stems, nutshell, leaves, and especially the fruit, both in the green state and after ripening can be harvested and will bring a significant profit. If the walnut harvest is well preserved, it can be used after a longer period, which is an advantage compared to other fruits. The maintenance of a relatively light walnut plantation and the high capitalization price, compared to other types of fruit tree plantations, represent the main reasons why the walnut business can be a profitable. Walnuts after baking can be used whole with their shell or just their core, which can be packaged raw in a vacuum, ground or fried. For the harvesting and processing of nuts, various modern technologies and equipment for harvesting and processing nuts have developed on the market. One of the advantages of such machines and processing plants is that they are universal, and they can be adapted to several fruits in the nut family. They are easy to maintain and do not require a large number of employees in order to supervise the official.

#### Acknowledgement

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