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PERFORMANT EQUIPMENTS DESIGNED FOR GRAPE MARC SEEDS SEPARATION AND CALIBRATION FOR SUPPERIOR CAPITALIZATION IN FOOD AND PHYTOPHARMACEUTICAL INDUSTRY

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Abstract: One of the most important process operations from wining by-products capitalization, it is the grape seed recovery from grape marc. In this paper are presented a series of processes and performing equipments which are integrated in well-known seed separation and calibration technological flows that can be successfully used in the grape seed selection line. Due to their working principle, these equipments lead to high quality seeds material, which can guarantee the food and phyto-pharmaceuticals production to meet the most demanding requirements of the interested consumers.
Keywords: grape seeds, sieves, seed separation, calibration

1. INTRODUCTION

The cleaning and selection operations of cereals and other crop seeds, have a purpose to grow the agricultural products qualitative indices according to their destination and physic-mechanical properties. Usually the seeds and cereals that are meant to get through the processing lines, firstly must be eliminated the impurities (mineral formations, weeds and vegetal parts) and calibrated. Those operations usually are designed in accordance with the type of seeding material and cereals, the mechano-pneumatic separation system that is provide with smaller and smaller mesh sivels, but also by the number of passing. This combination usually can be found on all performing equipments which operating on the gravitational and aerodynamic principle, the material that passes through the sieve mesh is known as sifted (fine sort) and the other refusal (roughly sort). The mechanic screening equipments are provided with several sieves whereby the elimination of impurities and seeds calibration in several dimensions. In scientific and technical documentation those equipments are classified as:

- Shape and dimension calibration equipments;
- Aerodynamic properties calibration equipments;
- Combined separation equipments (dimension and aerodynamic criteria);
- Volumic mass separation equipments (known also as specific mass);
- Color separation equipments.

The right seed separation process is applied taking in to consideration the initial product purity, the type and the nature of the impurities, compared to the basic seed properties, as well as the destination of the final product (short- or long-term storage, consumption, industrialization, marketing, sowing material, etc.). In technical literature those equipments are divided in two categories taking in to consideration the sieve form:

- Equipments with plane sieves;
- Equipments with cylindrical sieves.

Due a proper technologic analyse of the cleaning and calibration equipments designed for seeds and cereals, was concluded that those equipments can be used also in winery by-products, respectively fresh grape marc processing, applying small changes regarding the cinematic conditions and some technologic adaptations in order to obtain grape seeds (Voicu Gh, at all, 1995; Costin I., 1988).

Taking in to consideration the percentage of by-products (marc, yeast and stone of wine) obtained from wine making process, that in some cases is evaluate at 18 ÷20 %, and the estimations that the rate grape seeds in the marc is 18 ÷ 25% (the rest is liquid remains and 55÷65 % peels), this process is profitable, only if significant quantities are collected from major wine manufacturers. In the world, grape marc processing is made entirely, mainly grape seeds - to obtain oil and peels for the food industry and natural dyes. The marc separation process is very important because every component has a specific composition and post processing technology.

As example, the grape seed post-processing technology imply drying in order to rich at a certain humidity that assure good storage on optimal conditions for a certain period of time (maximum 3 months). Sometimes the drying methods are naturally (sun exposure or attics) or enclosures with controlled environment – drying installations. In some cases, the oil

extraction from grape seeds (that have an oil content of 8-12 %) can be made by pressing (mechanical processing) or by solvent (chemical processing). According to scientific studies made by known research centres in the food and phyto-pharmaceutical industry, stated that grape seed oil meets all the qualities of a food oil (light yellow colour, pleasant taste, a great content of E vitamin and low concentration of bad cholesterol). In order to obtain good grape seed oil [11], must be respected the below technologic requirements:

- # seed separation must be made from fresh marc (sweet marc);
- # seed drying can be made for a temperature of maximum 110 [^{0}C];
- # seed mass humidity during the storage must be 11÷12 %.

In Figure1, is presented the diagram of an innovative technology to process fresh marc made from INMA Bucharest and incorporates three main phases:

- # phase I - components coarse separation of the non-homogeneous mixture;
- # phase II - dry mass obtained;
- # phase III - components fine or final separation from non-homogeneous mixture.

All these phases can be interconnected by transport interphasic operations that will be monitored through a Command and Control Unit – UCC.

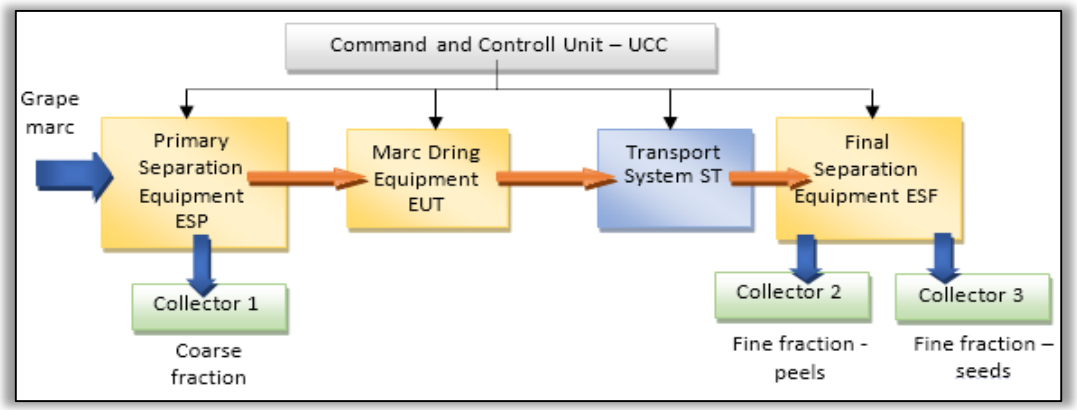


Figure 1 - Diagram of an innovative technology to process fresh marc (Milea D., 2018)

The grape seed cleaning and calibration equipments can be implemented in 1th and 3th phase, usually in current practical applications, in phase 1th are used cylindrical sieve cleaning equipments and in 3th phase, when the material has a lower humidity, are used plane or circular sieves. The UCC has the role to control and commands the marc technologic processing in accordance with grape variety, typo-dimensions of grape seeds and material destination (food or phyto-pharmaceutic industry).

2. MATERIAL AND METHOD

In this part will be presented most representative equipments used in the grape seed processing used in marc capitalization by the most representative companies.

— Seed separation and calibration with cylindrical sieve equipment's.

In technical applications these equipments have specific design and can made several operations, as:

- ≡ seed separation, this operation the equipment is provided with different kind of sieves and meshes, placed on different configuration relative to the rotation centre axis. From this point of view, here will be presented the next models:
  - # the sieve with different mesh sectors, that is used in multiple operations as: first se to eliminate the small impurities, the next sectors to separate the sieved material in categories and the last mesh for large impurity elimination (see Figure 2);
  - # the coaxial sieves diametral dispose sieves, this equipments are designed to separate and calibrate the seeds and its gauge to be smaller, (see Figure 3);
- ≡ coarse processing, this operation is achieved in the case in which the rotary sieves have the same mash in order to eliminate the coarse impurities from the marc composition, directed them to the collector opening and the sieving mass is formed form small impurities peels and seeds (see Figure 4 and 5);
- ≡ seed calibration (seed separation).

In Figure 2 is presented the technologic scheme of a seed separation and calibrating equipment that uses an multi mesh cylindrical sieve and the material flow, which can be adjusted by sieve axis inclination compared to horizontal position (this angle usually is 3 ÷ 5 ^{0}). Also, in this figure are presented its main components and the fractions that can be obtained during its operation. The raw material is supplied from inlet funnel *1*, reaches the rotary sieve work area *8*, which is provided with meshes *9*.

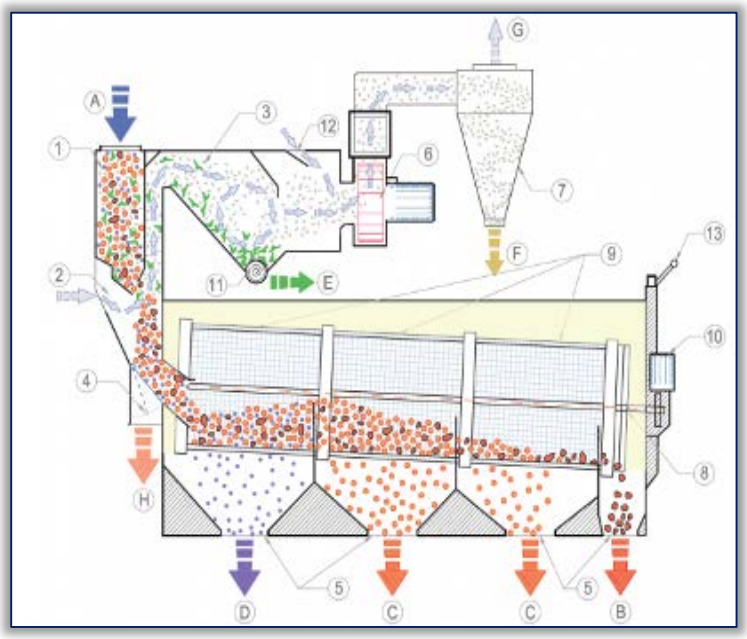


Figure 2 - Technologic scheme of a seed separation and calibrating equipment with cylindrical sieve [7]: 1-supply funnel; 2–air inlet opening; 3–aspiration chamber; 4-by-pass falp;5 – outlet opening; 6 – fan; 7–separation cyclone; 8-rotary sieve; 9-metalic meshes; 10-sieve power engine; 11-light impurities outlet conveyor; 12–air flow flap;13-sieve inclination; A–raw material; B–large impurities; C–seed calibration; D–small impurities; E-light impurities; F-dust and small particles; G-air evacuation; H-seeds pre-cleaned by aspiration.

The separation process is made using sieves made from perforated sheets with round or rectangular holes. Cylindrical separators are less widespread than plane separators, due to their lower working capacity. Compared to site planes, the cylindrical separators have a quiet operation mode because, they do not have balancing masses and the construction of the hollowing system is simpler.

In Figure 3 is presented a performing cereal/seed selector model Kongskilde KDC 4000 designed for grate capacity plants, begin from 14 to 40 [t/h].

The coares processing equipments have usually simpler structure, see Figure 5, and are embedded in large industrial technologies and sometimes in small scale for small scale processing – small producers, Figure 4.

The model presented in Figure 6, is specially designed for grape sweet marc, respectively for high humidity seeds, designed with rotary sieve on which are placed helical inner groves and axial pallets with the purpose to provide product advance and rummage it during the working process.

Figure 3 - Kongskilde KDC 4000m selector, Danemark [8]

Figure 4 - Plant for separating grape seed with sieve [19]

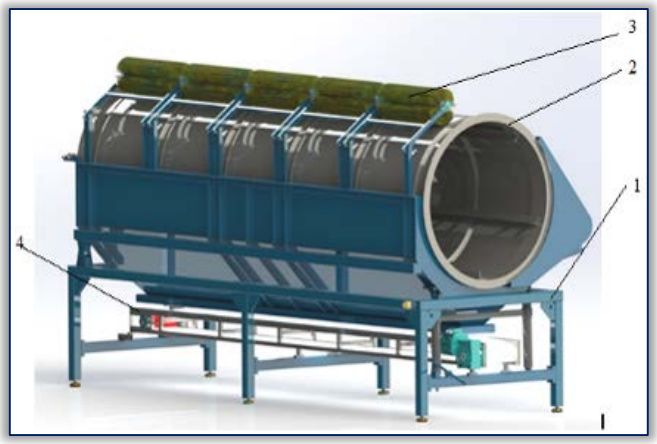


Figure 5 - Onmak Makina grape seed separator, Turchi [21]
1 – Metalic frame; 2 – Rotary cylindrical sieve; 3 –exterior rotary brush; 4 – rubber belt conveyor

Figure 6 - Rotary circular sieves and their cleaning systems: a – rollers cleaning system, b – circular brushing system

To avoid the cylindrical sieve perforations clogging must be used a cleaning system that usually is provided with rollers or brushes, so that the wet seed separation process to be efficient and uninterrupted, Figure 6.a and b. The sieved material can be transported to the next machine in the stream, by a rubber belt or helical conveyor, Figure 4, 5 and 7.

Another modular constructive solution from this type of equipments is presented in Figure 7, in which the circular sieve is supplied from a belt conveyor that is positioned under an upper supply funnel, and the seeds are collected from another two belt conveyors positioned to transport the processed material to silage packing bags.

Figure 7 - OPTION rotary sieve installation for separating grape seed from marc, Italy [9]

— Seed separation and calibration with plan sieve equipments

A plane sieve equipment is working as is represented in Figure8, which works according a combined working principle, separation by seed size and aerodynamic characteristics. The main components of this equipment are:

an aspiration chamber with two air supplying ducts (provider with air flow control mechanisms and with light impurities evacuation);
two frames with hanging plane sieves of the machine frame through elastic blades;
a steady plain sieve;
an eccentric mechanism for the frames action;
a series of gutters and funnels for evacuating the products resulting from the working process.

Cleaning the plane mashes in this case is done with linear brushes.

In Figure 9 is presented a smaller gauge seed separator/calibrating equipment which the mobile plane sieves are powerd by two motovibrating electric engines placed on each lateral sieve side. Also the equipment is provaided with light impurity aspiration chanel. The sieve frame is positioned on four shock elastic elements (helicaly springs or ribber buffers).

The active separation surfaces discharge is made by a rubber ball special configuring system placed under it. The equipment constructive simplicity results from: the sites action mode; lack of lubrication points and through the rapid sieves change. In this way provides, easy accessibility and easy adjustments that ultimately lead to reduced maintenance and exploitation costs.

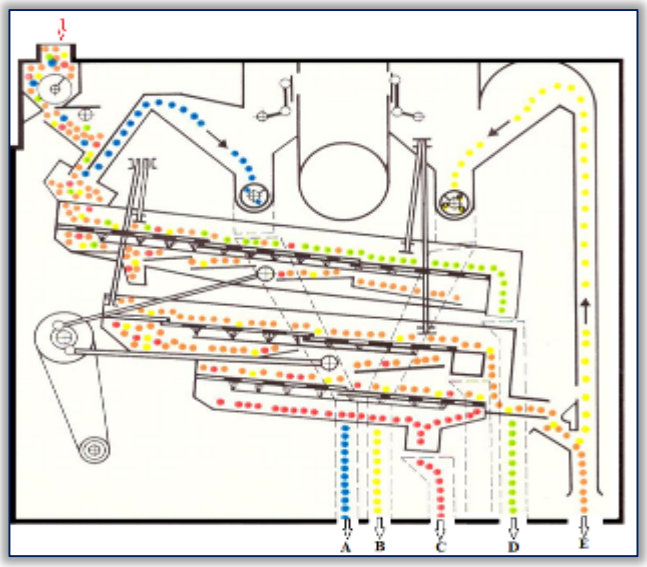


Figure 8 - Technologic scheme of a seed separation and calibrating equipment with plane sieves [17]
A–preliminary aspirator & discharge; B–final aspirator & discharge; C–lower sieve & discharge; D–upper sieve & discharge; E–processed product.

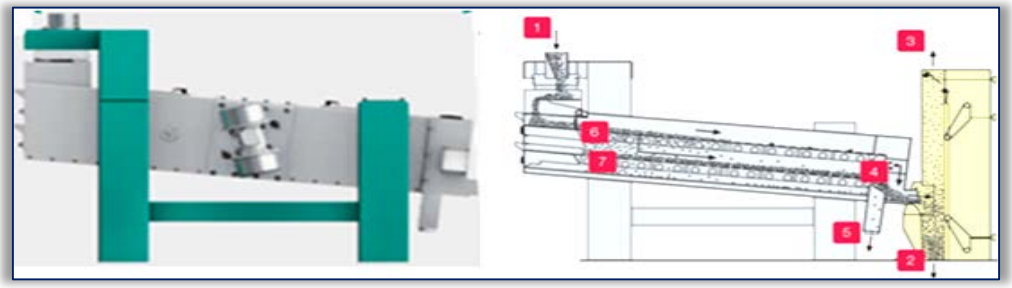
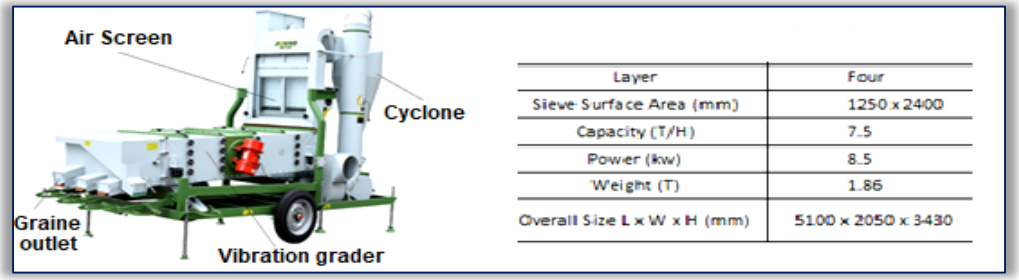


Figure 9 - MTRC 100/200 separator made by Bühler [10]: 1-row material feed; 2-product discharge; 3-light impurities outlet; 4–side material discharge (large grain, cords straw, etc.); 5– fine waste descharge (broken seeds, sand, etc.); 6–coarse sieve; 7–sand sieve.



Layer	Four
Sieve Surface Area (mm)	1250 x 2400
Capacity (T/H)	7.5
Power (kw)	8.5
Weight (T)	1.86
Overall Size L x W x H (mm)	5100 x 2050 x 3430

Figure 10 - Air Screen Cleaner 5XFS-7.5C Julite Machinery, China [15]

Figure 11 - DOUBLE Gravity Table Cleaner 5XFZ-40Z, Julite Machinery, China [16]

In order to support the small producers of cereal seeds, technical plants and other types of agricultural crops, the equipment and machinery for seed cleaning and calibration, have developed advanced mobile equipments, Figure 10 and 11, which performs simultaneous processing operations that combine several cleaning and calibration processes such as: in air currents - after aerodynamic qualities; with sieves – after seeds shape and size and special surfaces – after their specific weight, (Bracacescu C., et all, 2017).

— The seed cleaning and calibration using gravitational equipments

Usually this equipments are working with different components density from seed mass, this method is used both for cleaning and for calibration in different fractions, that are different not only by some physical properties but also by certain physiological and productivity characteristics. In practice, segregation after specific mass is done today with gravitometric sortators called densimetric or gravitational tables.

The gravitational separator is mainly made from: support frame; one or several fans (to generate upper air flow lines) placed on an aspiration chamber; a special calibration table that allows to pass the air lines and to be orientate on two perpendicular directions and an eccentrically driving mechanism that generates an oscillation motion at a certain frequency from a pre-establish working field, according to operational technologic requirements imposed by the finite products quality, (Bucurescu N, at all, 1992).

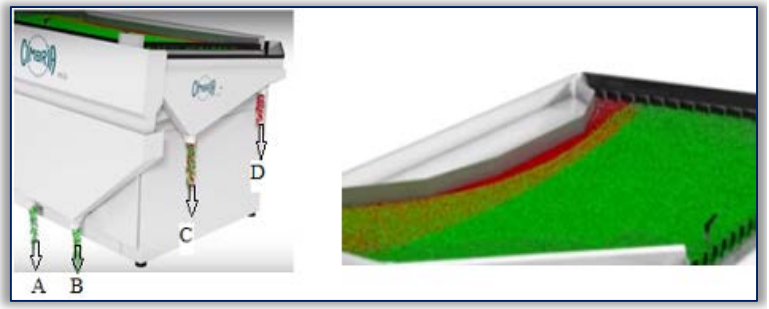


Figure 12 - Working principle of gravitational separators [14]: A and B – habey fractions; C – mixt fractions; D – light fractions

The gravitational equipment working principle is presented in Figure12, the seed/cereal mass is in continuous gravitational and vibrating movement, fact that arrange them in a thin layer on upper table surface. The upward currents, generated by the fans, order their disposal in accordance with their mass, so they have elements are on the button and the lighter ones on the exterior, this effect is increased also by the table vibratory motion that decrease the friction coefficient. In accordance with table inclination the lighter particles are collected in the lower part and the have ones in the upper part. In Figure12 and 13 can be seen two models of gravitational separators with different supply systems and configuration.

Figure 13 - Cimbria Heid gravity separator GA-210, Austria [12]

Figure 14 - Julite Machinery gravity separator – 5XZ-8, China [20]

Although the gravitational equipments can select a wide range of impurities, cannot replace the aspiration equipments known in the technical literature as "tarar" or triora, and usually are placed normally at the end of the technologic line to absorb the finest impurities.

To have the proper results in separation and calibration operations using gravitational equipment, must be fulfil two main conditions: the raw material must be previously selected after granulation (a short dimensional field) and the working parameters must be adjusted accordance with that criteria (as: even material flow; constant air pressure on all active surface, the table working frequency and the inclination angles.

— Seed separation and calibration on vibratory round sieves

The vibratory round sieves are the most popular separation equipments from agriculture and food processing industry. Such equipments and its working principle is shown in Figure 15 and 16.

The raw material is supply on the upper inlet, which is oriented toward sieves outside part to outlet ducts *7*, *8* and *9*. Due to sieve rotation, the sieved material has a helical motion and rising up on sieve due to vibratory and centrifugal forces. The modular frame *11* is placed on the mounting stand *1* via compression springs *15*. Under the oscillations generated by the power engine *2*, the sieves have an oscillatory motion and a rotatory regime set in accordance with raw material weight.

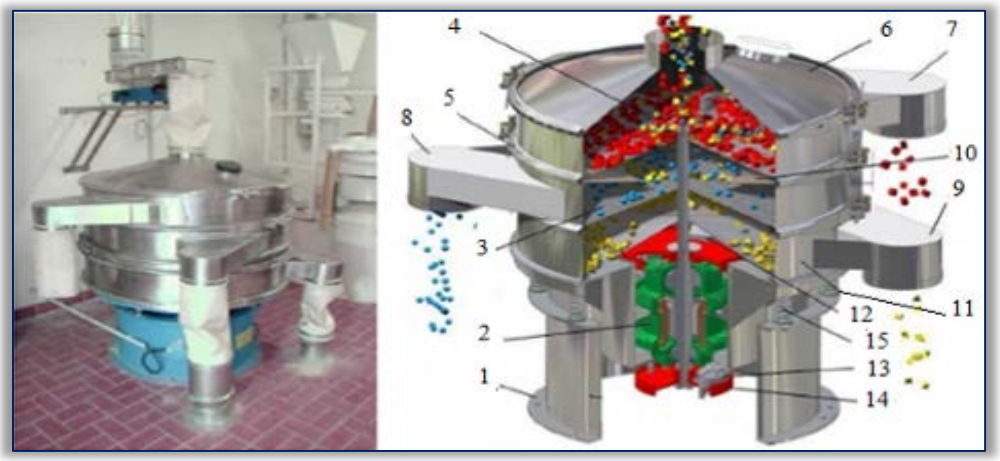


Figure 15 - Sweco equipment with vibratory round sieves LS-18 [18]: a.-general view; b.-working principle diagram, 1- mounting stand; 2.-electric power engine; 3.-round sieve with small mesh; 4.-round sieve with large mesh; 5.-rapid coupling frame; 6.-Upper coverage; 7, 8, 9 – fraction seed outlet ducts; 10.-discharge coverage; 11.- modular frame; 12, 14.–counterweights (adjust vibration amplitude); 13.-sieve inclination angle (displacement speed); 15. Compression springs.

The eccentric counterweights position of the lower and upper shaft of driving motor can generate four working regimes, see Figure16.

Figure 16 - The vibratory- round sives working parameters [18]

The upper counterweight rotation *12* generate vibrations in horizontal plane, fact that influence the seeds are guided to sieve extremity. The weight from bottom *14* generate vertical vibrations and due to inclination mechanism *13* is obtained also a transversal motion. The material speed and trajectory can be adjusted by the operator in order to rich the maximum separation efficiency for any type of granular material (dray or wet, light or heavy, coarse or fine).

— Equipments to separate the seeds by the colour

Industrial photo-separators are designed to separate the seeds/cereals form other weed seeds, minerals or stains seeds. This separation method uses photoelectric cells that directs each seed in an analyse chamber, sow to be separated from the unwanted ones. In the moment that a seed out of the acceptable field an air current is generated and detached it from

the good ones to another trajectory. This working principle is presented in Figure17. Those equipments have high efficiency and productivity to separate large and heavy seeds/cereals (as: vegetable seeds, cereals, etc.) and also increase the biologic quality and their germination. Those equipments are implemented at the end of seed/cereal processing lines and usually are very expensive.

In Figure18 are presented two models of such of equipments manufactured by Cimbria Company from Austria. The SEA-Chromex separator (see Figure18.a) has RGB sensory module and a LED illumination system, this system has the performance to detect a wide variety of colours and nuances also, at this moment, has the greatest production capacity on the market.

Those equipments integrates the most modern and smart method to process food and no-food industry products, on which the optical systems must detect and eliminate the proper pieces with the same colour but with different nuances (the colour degradation can reflect low quality). Those systems can be easily adjusted due to the calibration systems and programing software, and some are provided with internet connection module to have a long-distance control.

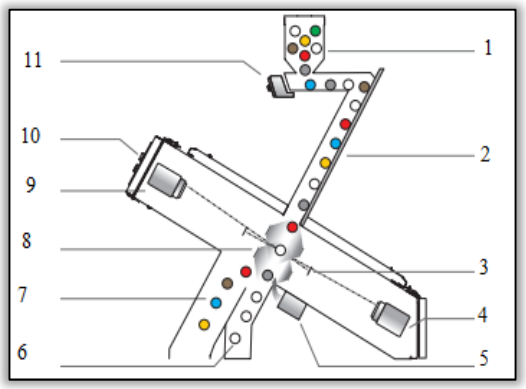


Figure 17 - Seed colour separation working principle [13]: 1.-feed hopper; 2.-sloping ducted; 3.-background plate; 4.-full-color RGB CCD cameras; 5.-air ejectors; 6. -discharged hopper for sorted product; 7.-reject products discharged hopper; 8. -front LED Backlighting; 9. -front CCD camera; 10. -power supply switch; 11.-vibratory feeders

a b

Figure 18 - Cimbria color selector equipments, Austria [13]: a –SEA CHROMEX 5model; b –SEA NEXT 4model.

3. CONCLUSIONS

To capitalise the by-products from wining industry haze a great importance because, in addition to obtain valuable food and pharmaceuticals products, contributes directly to mitigate environmental pollution.

Grape seed oil is one of the most powerful antioxidant oils, helping to maintain blood vessel elasticity and lowering cholesterol levels. Also, it has the role of: protecting the circulatory system, increases the immune system's activity being rich in mineral substances such as copper, selenium, zinc; contains E and F vitamins; antianidins (which have an anti-aging effect 50 times stronger than that of the famous vitamin E) and also is in beauty and cosmetic industry providing a tonic and refreshing effect on skin, ensuring its hydration and elasticity.

The quality of the products obtained from grape seeds depends directly of seed separation process performances.

Acknowledgement

This paper was financed with the support of National Agency for Scientific Research and Innovation, NUCLEU Programme, no. 18N / 16.03.2018, Addendum no. 1/2018, project PN 18/30/02/01 – "Cercetări privind dezvoltarea unei tehnologii inovative de recuperarea produselor secundare din viticultură".

Note: This paper is based on the paper presented at ISB-INMA TEH' 2018 International Symposium (Agricultural and Mechanical Engineering), organized by Politehnica University of Bucharest – Faculty of Biotechnical Systems Engineering (ISB), National Institute of Research-Development for Machines and Installations Designed to Agriculture and Food Industry (INMA) Bucharest, The European Society of Agricultural Engineers (EurAgEng), Society of Agricultural Mechanical Engineers from Romania (SIMAR), National Research & Development Institute For Food Bioresources (IBA), University of Agronomic Sciences and Veterinary Medicine Of Bucharest (UASVMB), Research-Development Institute for Plant Protection (ICDPP), Hydraulics and Pneumatics Research Institute (INOE 2000 IHP), National Institute for Research and Development in Environmental Protection (INCDPM), in Bucharest, ROMANIA, between 01–03 November, 2018.

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ISSN 1584 - 2665 (printed version); ISSN 2601 - 2332 (online); ISSN-L 1584 - 2665