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INNOVATIVE SUPPLY SYSTEM DESIGNED FOR GRAPE SEED SEPARATION EQUIPMENTS FROM WINEMAKING BY-PRODUCTS

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Abstract: *Grape seed separation equipment from winemaking has gained great importance at this time as it can be successfully integrated into the technologies of superior harvesting, technology that according to the new intelligence specializations is in the Smart Industry domain, respectively in the 4.0 Industry and Bioeconomy subdomain. Due to these research directions, and the fact that the winemaking industry occupies an important place in the Romanian and European economy, the development of innovative technologies in this field is opportune and necessary, especially if we take into account the new scientific discoveries in the field of food and phytopharmaceutical breach.*

Keywords*: Innovative supply system, grape seed separation, marc processing, PAM's.*

1. Introduction

In favour of the circular economy approach is mentioned the next arguments: to achieve a sustainable world does not involve to change product quality and consumers purchasing power; doesn't require loss of revenues or extra costs for manufacturers and other economic agents. But the circular economy focuses on areas such as design thinking, systems thinking, product life extension, and recycling, in order to achieve models that are economically and environmentally sustainable, idea supported by most researchers and experts in the field of economy.
Based on the circular economy principles, the study of feedback-rich (non-linear) systems are similar to particularly living systems [1] and its practical applications to economic systems evolved incorporating different features and contributions from a variety of concepts sharing the idea of closed loops. Some of the relevant theoretical influences are cradle to cradle, laws of ecology, looped and performance economy, regenerative design, industrial ecology, biomimicry and blue economy. [2]
The marc capitalization technology used by the wine producers are mainly used to obtain bio-fuels but, due to latest research in Phyto-pharmaceutic field revealed that the fresh mark can be used also as an important source of oxidants and valuable compounds for the human health, and in many other related fields (animal and fish feeding, soil bio-nutrients, etc.). Taking in to consideration that wine industry is present on all continents, the technical and environmental potential and impact has a great impact, for this reason the regenerative systems "is a must", because the resource input are the wine waste, emission, and energy leakage are minimized by slowing, closing, and narrowing energy and material loops.
The means to achieve circular economy, respectively "long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, recycling, and upcycling" [2], is in contrast to linear economy which has a production model like 'take, make, dispose'. [1].
In 2017 in order to provide guidance to organizations that implement circular economy strategies, the British Standards Institution (BSI) developed and launched the first circular economy standard "BS 8001:2017 Framework for implementing the principles of the circular economy in organizations. Guide". BS 8001:2017 standard, intend to align the far-reaching ambitions of the CE with established business routines at the organizational level. It contains a comprehensive list of CE terms and definitions, describes the core CE principles, and presents a flexible management framework for implementing CE strategies in organizations. Circular economy monitoring and assessment is given, but it missing the consensus yet on a set of central circular economy performance indicators applicable to organizations and individual products.

This fact is generated maybe, because there are not yet implemented this system and the environmental polices strong enough to stimulate and reward the participants, or because the sanctions and fines have no impact on the phenomenon generators enough to stop and mitigate the contaminated sites.
Wine trade between the EU and third countries excels, with exports reaching the level of 6,7 billion euro, in 2010, almost a quarter of European exporters of agricultural products. Economically speaking, European production plays a strategic role, having in to consideration the fact that in 2016, the wine market turnover reached 377 million euro and it is estimated that in 2017 to be 385 million euro, reaching the highest level in recent years. The Romanian market place in the big wine producers in the world is placed on 13-th position, next to Portugal (6,6 mhl), Hungary (2,9 mhl) and Austria (2,4 mhl), and is among the few European countries that have registered an increase compared to 2016. According to KeysFin analyses, after more than 10 years of changes and reorganization, wine sector business has come close to maturity. [3]
If we apply the concept of circular economy in Romania, the innovative technology to capitalize marc is perfect integrable and can create a valuable chain reaction, Fig. 1, and in the main beneficiary is the human being for the food product (wine, grape seed flour and oil) and phytopharmaceutical. [4]

Fig. 1. An example of wine technological process combined with marc capitalization technology respecting the principle of circular economy [4]

2. Innovative technology to capitalize grape marc

Due to research and development activities developed within the project ‘Research regarding the developing of innovative technology to recovery of secondary products from viticulture’ financed in 2018 the INMA has develop several technologies to recover the vineyard by-products, namely the

marc fraction, taking in to consideration the technological aspect of agroecosystem sustainability and ecological aspects of waste recycling. [4, 5]
Usually, the wine technologic yield is an important indicator that represents the ratio between the total grapes mass and must quantity, which usually is influence by grape pomace mechanical properties, from this point on, the by-product capitalization technology must be deployed, in order to achieve a good separation and maximize profits. The values of this indicator it was evaluated at 50 % (wine presses) and 90 % (continuous presses), in some technical papers this indicator variants between 75 ÷ 80 % yield if it is considerate the type and position of the pressing actuation system, the lower value is for vertical hydraulic systems and the upper value for horizontal mechanical or pneumatic presses. [6]
The technology presented in Fig. 2, incorporates a marc complex processing process that can be easily adapted in accordance of the marc quality (marc type: suit or fermented marc). For this reason, the technologic flow incorporates a succession of machines and equipment's dedicated to separate, wash, dry and select the processed material.

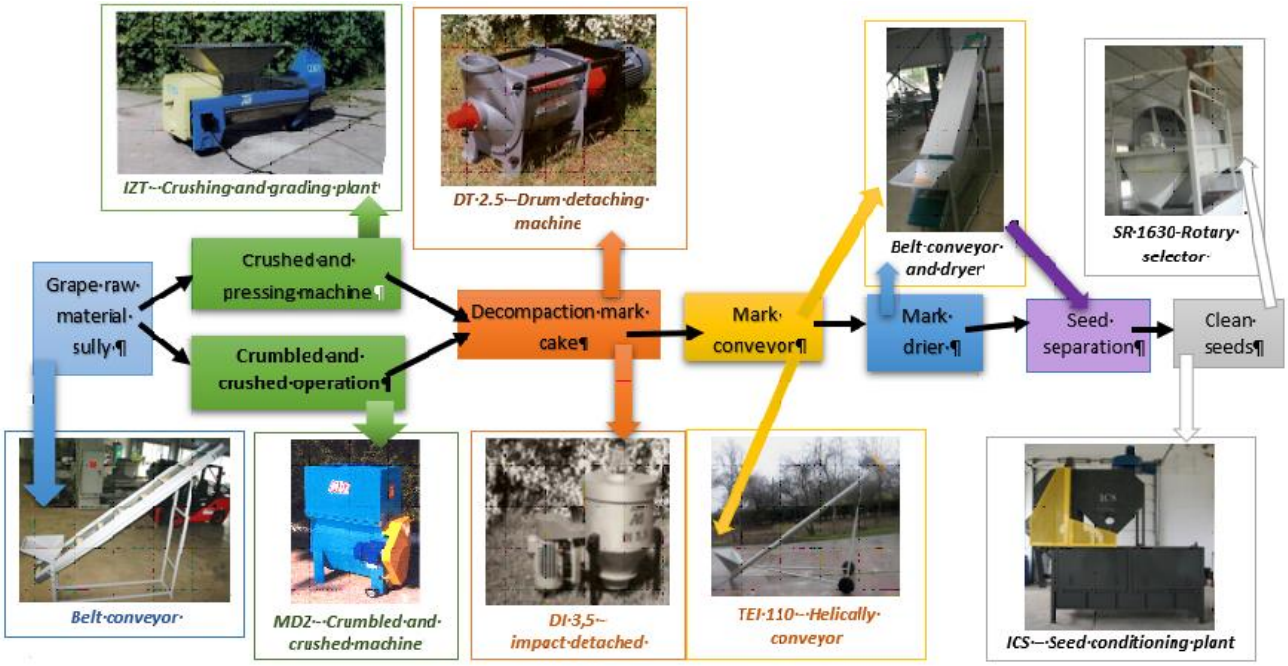

Fig. 2. INMA grape marc capitalization technology [5]

In here presented technological flow are integrated two decompaction equipment's: the DI 3.5 - impact detacher (model with vertical detaching active element positioned parallel with the power source) and DT 2.5 - marc detacher (model with horizontal detaching element positioned in line with the power source). The transportation operation can be successfully used systems that cannot be gripped, allowing the grape pulp and juice to be entirely collected and transported without leakage, from this technologic point of view it can fit the belt conveyor (with or without scraper) and horizontal or oblique spiral conveyors.
The modern transportation systems are fitted with hot/cold air ventilation systems that can provide the proper operating mode, but also to dry the marc in accordance with a certain humidity regime and in this way, the technologic line gauge is diminished. [7]
Depending by the wine technology and the by-product type, respectively sweet (fresh and unfermented) or fermented (resulting in fermentation of the bush). In the case of sweet marc, the diffusion juice must be immediately processed. For obtaining quality grape seed oil and the following procedure is recommended to fulfil: I- seed drying to a maximum temperature of 110 [^{0}C]; II – to reach the conservation humidity of 10 ÷ 12 %; III - assuring sterile conservations conditions to inhibit the growth of lactic bacteria and molds.

Here in presented technologies are made in a logical order to ensure the development of a technological grape seed separation from peels, in accordance with specific processes of secondary material, in order to obtain the finished products grape seeds, peels and cod, which can be later capitalized in order to obtain new products.

3 Innovative supply system designed for grape seed separation equipments

Grape marc capitalization technology can be optimized and shorten if are implemented to innovative solutions on top of SR1630 rotary selector or ICS seed conditioning plant, respective an adjustable capacity hopper powered with PAM's [8] and a separation system of frape seeds from marc [9]. These technical solutions can be implemented also in the mobile or modulated technologies that can be developed nowadays, trends that nowadays are more often encountered, due the fact of equipment interchangeability and technologies adaptation to the processor needs.

3.1. The adjustable capacity hopper powered with PAM's

In practical applications, there are known different companies that manufacture seed/cereal separation and calibration plants with fixed capacity feeding hoppers such as: ROMILL and Eurobagging from the Czech Republic, Murska from Slovenia, Martiney and Staneck from Argentina, etc. Some of them can be also trailed plants and are also equipped with fixed capacity feed hoppers, designed to provide raw material requirements for maximum plant operating capacity but also to be in line with transport norms on public roads.

The drawbacks of these fixed capacity feeding hoppers consist of:

- large gauge and do not fall under the public transport regulations;
- difficult to adapted and mounted on high and low-capacity aggregates;
- decreasing the plant working autonomy if it is adjusted to work at maximum capacity - increasing the hopper feeding time especially when are used front loaders;
- increasing fuel consumption when the hopper is powered by front loaders;
- interruption of the plant continuous workflow especially in the maximum capacity case- respectively, when the processor wants to make the technological process more efficient, or when the plant works in hard field and weather conditions.

The technical problem solved by the technical solution presented in Fig.3 and 4, consists in providing an adjustable capacity hopper provided with fluid artificial muscles, known in speciality literature as PAM's, which can be easy adapted and used in all types of plants (trailed, steady or modular) configurated to process seeds or cereals and also provide a continuous flow in maximum working capacity, so to comply with the legal framework for road transport on public roads and to meet the requirements of grain producers and processors in terms of yield and working conditions of the flattening process.

According to the invention, the adjustable storage hopper provided with artificial fluid muscle, consists of the protective casing *1* made of composite material, which is mounted on the frame not shown in the Fig.3 and 4.

The mobile hopper *2* is provided with a sieve *16* that has a number running slides *17,* on which the rollers *3 are* mounted on the hopper walls *4,* and in this way is generated a sliding motion on vertically direction. The mobile hopper has a certain number of holes through which are passing the stainless-steel cables *5,* that lift the mobile hopper *2*, by means of the fixed rollers *6,* mounted on the fixed hopper *4*.

The cables *5* are coupled to fork element *7* of the rotation levers *8,* which pass through the rotation elements *9*, that are fixed to the support *10,* welded to the fixed hopper *4*. The opposed ends of the levers are provided with the eyelet coupling elements *11*, which assure the connection of the artificial fluid muscles *13* mounted on the side walls of the fixed hopper *4*.

Using the coupling elements *7*, mounted on the fixed hopper *4*, provide the connections with elements *11* of PAM's*,* which are connected to the fluid control and command system *14*. The threaded levers *8* allow the movement of the mobile hopper *2* so that the PAM's raise it to the desired height.

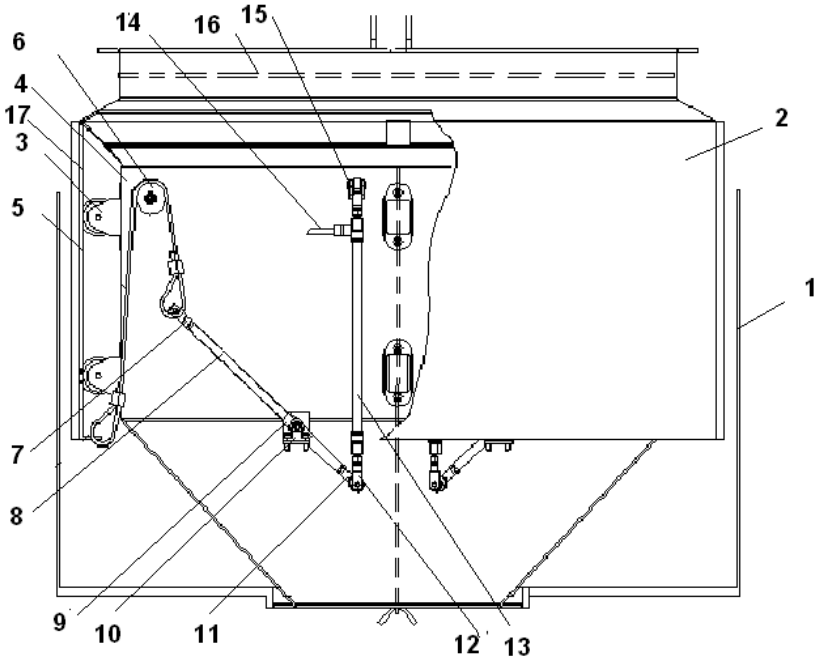

Fig. 3. Adjustable capacity hopper powered with PAM's: position retracted (disconnected from the fluid power system) [8]

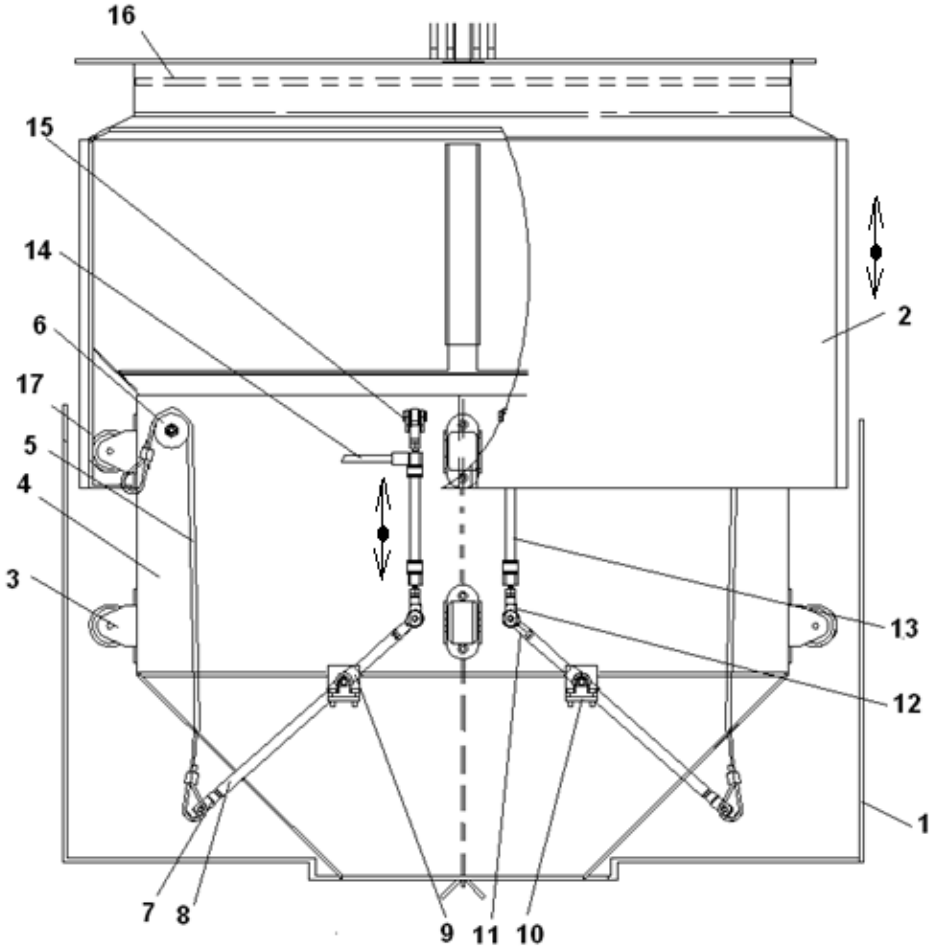

Fig. 4. Adjustable capacity hopper powered with PAM's: position extended - connected to the fluid power system [8]

This system presents the next advantage:

1. easily adapted and powered by fluidic systems, respectively by air compress generator but also by hydraulic groups. Mainly those supply systems can be easily configurated and implemented on an industrial hall, bur also connected at mobile fluidic systems with which the tractors are fitted.
2. increases the working autonomy of cereal/seeds pre-processing plants operating at full capacity, by reducing the hopper feeding time when are used front loaders;
3. lowering fuel/energy consumption when the plant is supplied by front loaders;
4. ensures the storage and processing of harvested grains/seeds directly on field when the plants are supplied directly from agricultural combines;
5. ensures a raw material continuous flow in the plants when it is adjusted to work at maximum capacity, fact that leads to high efficiency of the technological process, especially when the plants work in the field and the changing weather conditions;
6. increase the implementation grade on large powers and gauges aggregates;
7. increase the hopper adaptability to the maximum working capacities of the cereals/seed's processing plants;
8. provide the necessary gauge for the trailed cereals/seed's processing plants to comply with the public transport regulations;
9. increases the machinery field of seed processing due to their adaptability to the requirements of cereal/seed farmers and processors;
10. provide the technologic performance to the highest standards form the fluid actuations systems, respectively 4.0 industrial command and control systems that can be used on smart agriculture industry.

3.2. The separation system of frape seeds from marc

This by-product supplying system designed for marc decompaction has the role to separate the mark fractions (grape peels and seeds) in small pieces that enter in SR1630 rotary selector or ICS seed conditioning plant.

The material undergoes a grinding and decompaction process, subsequently facilitating substantially the working process of seed separations machines.

The current state of the art, are known similar plants produced by companies such as: ALLGAIER Process Technology - USA, Florapower GmbH & Co. KG. KG - Germany, Anyang Best Company Machinery Co., Ltd. - China; Lavrin -Ukraine, ONMAK MAKINA - Turkey, installations that process marc with classic sieve systems.

The disadvantages of these installations are:

- non-uniform raw material feeding; high loading of the active elements;
- high repair costs due to the frequently malfunctions;
- low plant life time;
- low degree of separation due to the high material losses.

System presented in Fig. 5, consists of a fingered rotor *R* located in the feed tank, the rectangular fingers *D1* can be mounted alternately, inclined in two planes rotated at 45 ^{0}, between which two other sets of straight fingers with the round section *D2* are fixed on the vat *C*.

By applying this solution the equipments present the following advantages:

- uniform marc supply of the separation plant; the marc moisture content is evenly distributed;
- decrease mechanical wear of active parts; - increases the grape seeds separation degree;
- reduce maintenance and repair costs of the plant, and also of increase of equipments lifecycle.

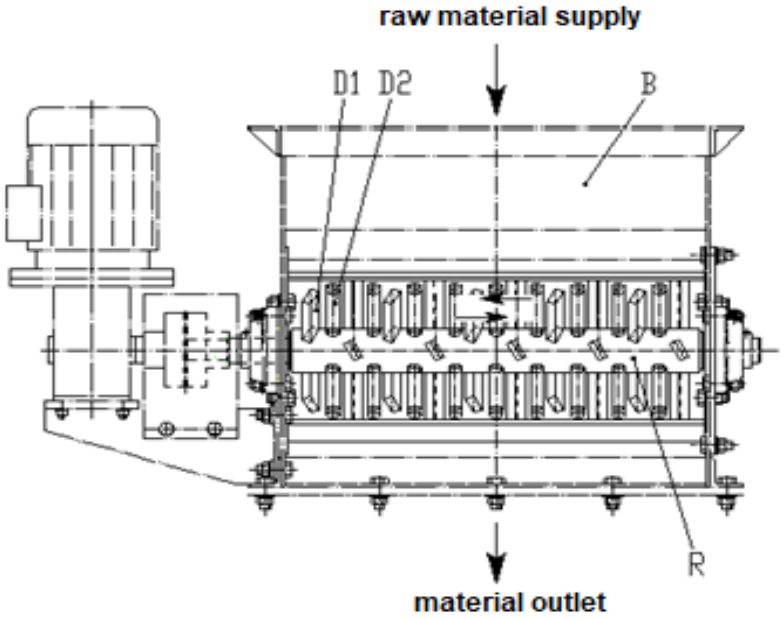

Fig. 5. INMA grape marc capitalization technology [9]

4. Conclusions

In this paperwork is presented one sustainable wine waste management technology, that incorporates different types of equipment's and machines, and some dedicated innovative systems that are perfect integrated in the technologic flow and measure taken to optimise it are adequate in context: of environmental policies; in line with daily grape marc valorisation technologic development, with 4.0 industry and bioeconomy approach from the EU Smart Specialization Strategy.
The INMA innovative technology, can be related also to circular economy approach because respects the arguments:
- achieves a sustainable waste management how does not involve the product quality change and the consumers purchasing power;
- doesn't require loss of revenues or extra costs for manufacturers and other economic agents;
- encourage design thinking, systems thinking, product life extension, and recycling, in order to achieve models that are economically and environmentally sustainable, idea supported by most researchers and experts in the field of economy.
- encourage practical applications to economic systems evolved in incorporating different features and contributions from a variety of concepts sharing the idea of closed loops. (looped and performance economy, regenerative design, industrial ecology, biomimicry and blue economy).
At the end of this paper, are mentioned some of the valuable products that can be obtained from grape marc processing, products that can be found on the market to be commercialized by the most important players are: cosmetic products (face creams, serums and oils, cosmetics, shampoo and conditions, lip-gloss, shaving products, body and massage lotions) and food products (cooking oil, bread and flower, but also the nutritional supplements).

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