CONSIDERATIONS ON THE TECHNOLOGIES FOR SEPARATING FRUIT SEEDS WITH APPLICATIONS ON THE SEPARATION OF SEA-BUCKTHORN PULP FROM SEEDS

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ABSTRACT

Sea-buckthorn is a shrub fruit whose benefits have been known since antiquity. The whole plant is considered medicinal by specialists in the field, but the most active part is the sea-buckthorn fruit because it has a beneficial effect on the entire human body and more recently on animal breeding. A high-value by-product is sea-buckthorn oil, which is currently gaining traders' attention at international level and which is obtained from both fruit and pomace resulting from the extraction of juice (shells and seeds). This paper presents some representative technolo-gies and installations used for fruit processing in general, technologies that will be the basis for the realization by INMA Bucharest of a technical equipment for separating sea-buckthorn pulp from the seeds.

INTRODUCTION

Current global trends to replace synthetically obtained food and therapeutic products with similar extracts from fruits and plants put fruit trees in a favourable light.

A series of remarkable characteristics of these fruit species, exceptional precocity, high productive potential, ability to capitalize on a wide range of soil types, nutrient richness of fruit, leaves and shoots are arguments for accelerating the development of well-known fruit-bearing shrub crops and of the valuable ones from the spontaneous flora *(Mörsel T. et all., 2013).*

Sea-buckthorn is considered one of the most valuable species of fruit-bearing shrubs in the spontaneous flora. The fields of application are extremely wide, obtaining spectacular effects in human and veterinary medicine, animal husbandry, cosmetics, agriculture, microbiology, food industry, forestry *(Li T. et all., 2003).*

Research conducted in the country and abroad has shown that sea-buckthorn leaves, fruit and shoots contain a number of biologically active substances with an essential role in regulating metabolism (*Beveridge T.H.L. et all., 2004).* Sea-buckthorn fruit are appreciated as natural multivitamins because they are rich in the main vitamins (A, B1, B6, C, E, F, K, P).

Due to its extraordinary qualities and properties, sea-buckthorn that grows in Romania stands out as one of the most valuable plants for medicinal and food use worldwide.

The article presents some representative technologies and installations used for processing fruit in general, technologies that will be the basis for the realization by INMA Bucharest of technical equipment for separating sea-buckthorn pulp from seeds.

MATERIAL AND METHOD

The initial technological operation in the primary processing of fruit arranged in clusters, for example grapes, is the crushing of the berries and the separation of the rachis (rachis removal). Partial or total rachis removal must be applied depending on the specific conditions of the harvested product.

Rachis removal equipment (Fig. 1) consists of a rotating perforated cylinder (1), inside of which rotates, in the opposite direction, a shaft with vanes (2) helically arranged, which has the role of detaching the berries from the rachis projecting them towards the walls of the cylinder. The crushed berries pass through the holes of the perforated cylinder which have a diameter of 20÷30 mm, and the separated rachises are evacuated by their axial movement at the end of the cylinder with the help of evacuation vanes (3).

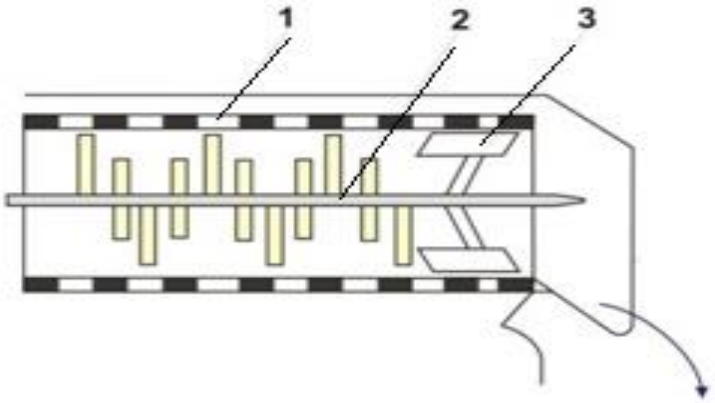

Figure 1. Constructive scheme of rachis removal equipment
1-rotating perforated cylinder; 2-shaft with vanes; 3- evacuation vanes

When studying the constructive solutions of rachis removal equipment, one can see a great variety of the constructive and kinematic parameters, but from a technological point of view, it is more rational to arrange the vanes on a helical surface. Roller crushers use as active parts two or more grooved cylinders (rollers) which, rotating towards each other, catch the berries and compress them, causing the skin to crack.

The number, dimensions and distance between the rollers change the processing capacity (productivity), and the shape of the rollers, the profile and the orientation of the grooves influence the quality of the work process performed (Ștefănescu I., 2010).

Lately, there is a tendency to pass from cylindrical rollers with grooves to profiled ones (Fig. 2).

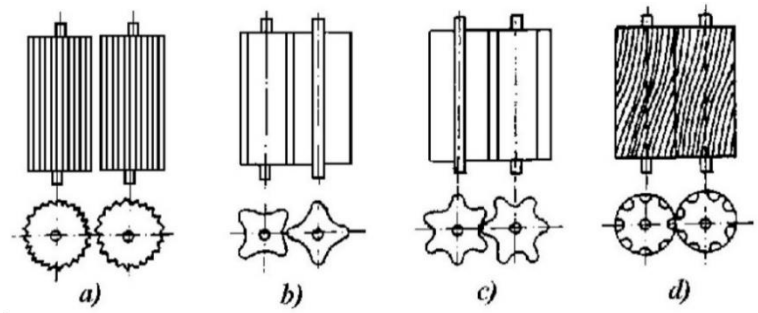

Figure 2. Constructive variants of rollers

a- cylindrical rollers, b,c,d- profiled rollers with 4 and 8 grooves

The diameter of roller D for entraining the largest berries with a diameter d is determined according to the relation:

$$D = \frac{d\cos\propto - \delta}{1 - \cos\propto} \quad (1)$$

where:

δ - is the distance between the rollers (m), which must be greater than the size of the grape seeds.

The angle ∝ reaches the maximum value if δ = 0.

By introducing δ = 0 and ∝ = φ, the minimum diameter of the roller is obtained:

$$D_{min} = \frac{d\cos\varphi}{1 - \cos\varphi} \quad (2)$$

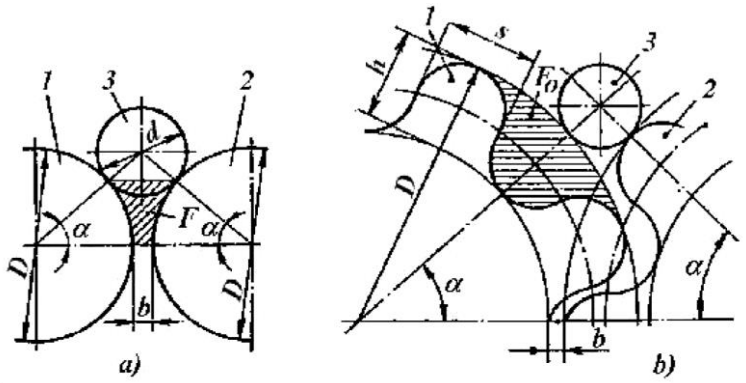

Figure 3. The scheme of drawing the grapes between the rollers of the crusher: a –flat rollers; b - profiled rollers. 1;2 - rollers; 3 –berry

The productivity of the crusher-rachis removal equipment is determined according to the relation:

$$Q_z = u_m\, \delta\, l\, \rho\, K_u \quad (3)$$

where:

u_m- is the average speed of movement of the product through the space between the rollers, (m/s)

(or the peripheral speed of the rollers);

δ - distance (clearance) between rollers, (m);

l - roller length, (m);

ρ - bulk density of fruit, (kg/m^3);

K_u - correction coefficient taking into account the uneven product supply of the rollers, filling of the space between the rollers (Ku = 0,7 - 0,8).

The relation for determining productivity can also take the following form:

$$Q_z = \frac{\pi D n m}{60} \pi\, l\, \rho\, K_u \quad (4)$$

where:

D is roller diameter, (m);

n_m – rollers' average speed, (rot/min).

$$n_m = \frac{n1 + n2}{2} \quad (5)$$

where:

n_1, n_2 - represent rollers' speed;

δ, ρ, l, K_u - have the meaning presented above.

It should be noted that the indicated relations are only applicable if the material is crushed into pieces that do not contain liquid.

The technological operation of removing the seeds from the fruits is performed in order to capitalize them as raw material for the production of jams and natural juices.

The installation for stone removal from fruits – ISS, developed as an experimental model by INMA Bucharest, can be used for extracting stones of small (cherries, sour cherries and small plums) and large (large plums, apricots and peaches) fruits. The operating principle of the installation for stone removal based on cutting the fruit to the stone and removing it whole by using a rubber drum, followed by collecting the stoneless

fruit and recovering the fruit juice, resulting from the stone removing process. (Fig.4)

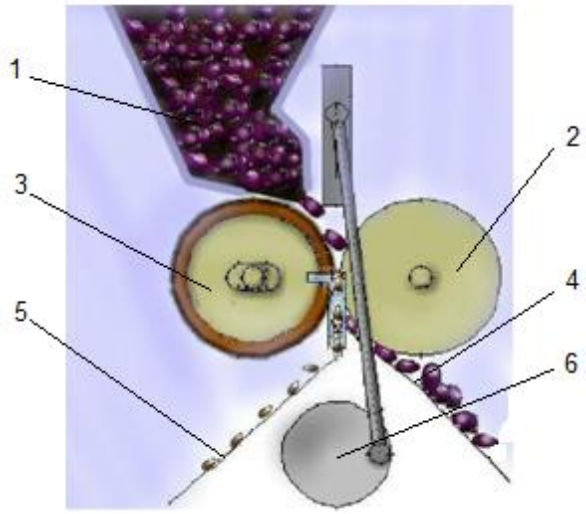

Figure 4. The operating principle of the installation for stone removal ISS, Q=300÷400kg/h; P=1.5 kW. *1.-feed hopper; 2-profiled drum; 3-rubber drum; 4-pulp discharger hopper; 5-stone discharge hopper; 6-counterweight*

The demand for natural and untreated fruit products is continuously increasing. Consumers attach great importance to high quality. Cloudy apple juice, for instance, should have a light colour and a clear and stable turbidity. Production should be fast and continuous in order to prevent the product as far as possible from getting a brown colour. These requirements can best be met by using a combination consisting of a belt press followed by a disc stack centrifuge (figure 5).

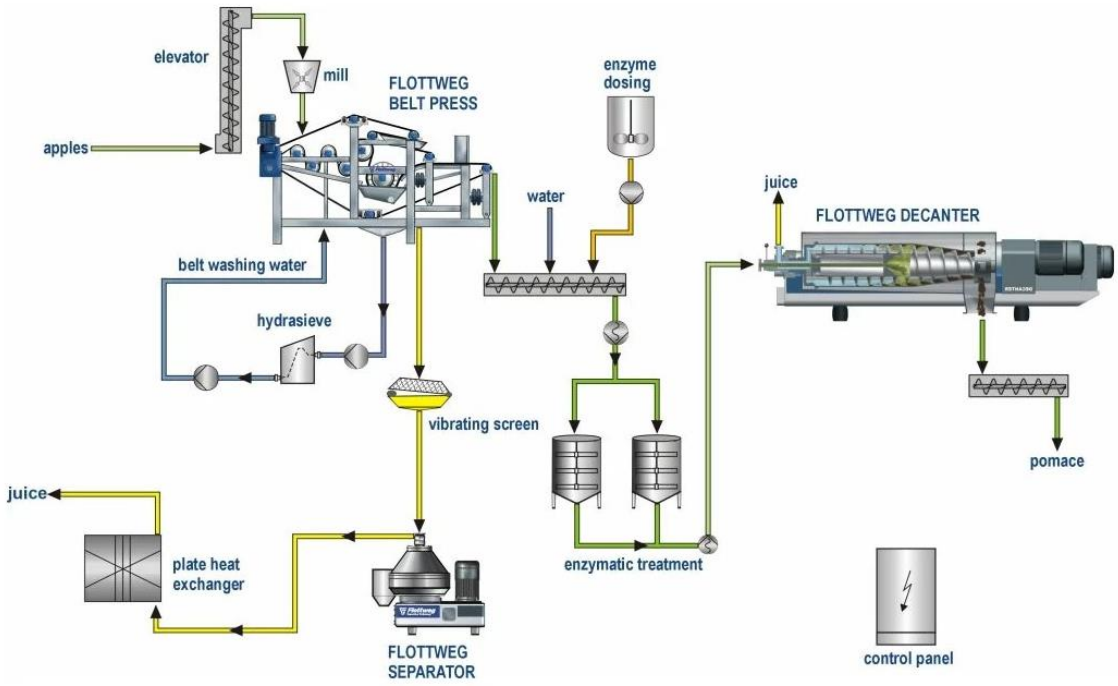

Figure 5. Technology for the production of cloudy apple juice [7]

The decanter in combination with the belt press is the best solution for the flexible processing of different types of fruits and vegetables. Besides the production of pomaceous fruit juices (such as e.g. apple juice), it is also possible to process berries and other

fruits and vegetables using the same production line.

RESULTS AND DISCUSSIONS

From an economic point of view, we are talking about a 100% use of sea-buckthorn fruit and of what results from pressing them. Sea-buckthorn can be harvested obtaining fresh fruit or 20 cm long fruit-bearing shoots.

These products will go through several mandatory technological links until processing. Sea-buckthorn fruit must be harvested in a well-ripened state, and after harvest either processed quickly or frozen.

In order to develop technologies and installations used for processing sea-buckthorn fruit, INMA has developed a technological flow to separate sea-buckthorn pulp from the seeds (figure 7), based on an ESPS equipment, experimental model, composed of the following main parts: a system that crushes washed sea-buckthorn fruit, in order to improve the separation operations that follow in the workflow, a centrifugal separator that separates the crushed material into two fractions (a fraction consisting of juice and pulp and another fraction consisting of seeds and skins) and another centrifugal separator for separating the seeds from the skins and pulp residues.

The other auxiliary operations can be performed with equipment developed for other types of berries or fruit with small seeds (grapes, blueberries, rosehips, redcurrants, pomegranates, etc.).

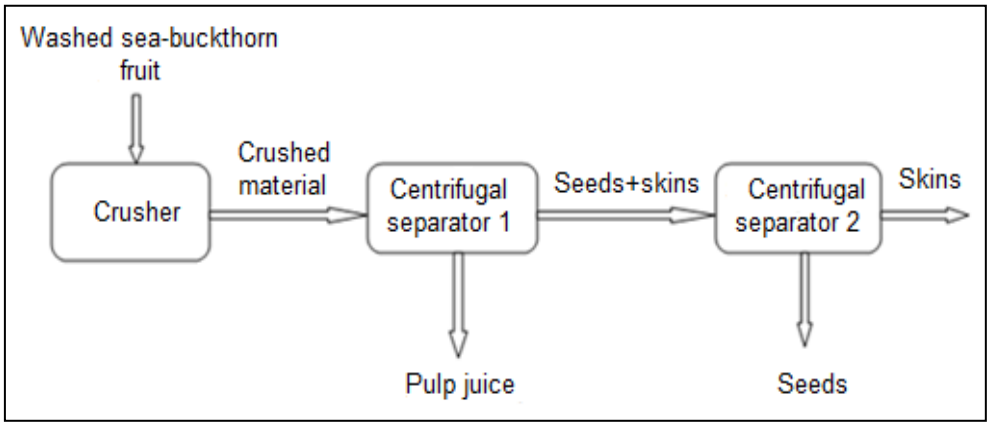

Figure 7. Technological flow diagram of the Technical equipment for separating sea-buckthorn pulp from the seeds –ESPS

It should be noted that the seeds and skins resulting from the extraction of the juice can be dried to 10-l2% moisture, ground and subjected to oil extraction. in sea-buckthorn fruit, the vast majority of the oil is found under the fruit skin, and the oil obtained is more complex, besides the fat-soluble substances in the oil under the skin there are also the lipids and the fat-soluble substances in the seeds.

CONCLUSIONS

Currently there is an increased interest in the development of sea-buckthorn products, for medicinal, therapeutic, cosmetic purposes.

Sea-buckthorn processing technologies start from the need to ensure a technological flow that does not degrade the fruit from a structural point of view, but also from the point of view of nutrient content, which must be maintained to obtain valuable products and by-products.

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