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conference paper

A New Technology for Olive Oil Manufacture

Nova tehnologija za proizvodnju maslinovog ulja

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Summary

The traditional system for continous processing of olive fruits by means of centrifugal extractors requires the addition of warm water and the olive paste is separated into three phases: oil, vegetable water and olive residue. The disadvantages of this process include great consumption of warm water, rinsing out of valuable components (especially natural antioxidants) and pollution of environment because of considerable amounts of waste water. Therefore, a new decanter was designed to separate the olive paste in two parts: olive oil as one phase and the cake, together with the vegetable water, as the other phase. The new »integrated« system enables simple switching from the 2-phase to the 3-phase or vice versa. The results of the comparison of this two procedures are discussed.

Sažetak

Tradicionalni sustav za kontinuiranu preradu maslina s pomoću centrifugalnih ekstraktora zahtijeva dodatak tople vode, a maslinovo se tijesto razdvaja u tri faze: ulje, vegetabilnu vodu i kominu. Nedostaci tog postupka ogledaju se u velikom utrošku tople vode, ispiranju vrijednih sastojaka iz ulja (posebice antioksidanasa) te onečišćenju okoliša ispuštanjem znatnih količina otpadnih voda. Zbog toga je proizveden novi dekanter u kojem se maslinovo tijesto razdvaja na dva dijela: maslinovo ulje kao jednu, a kominu pomiješanu zajedno s vegetabilnom vodom, kao drugu fazu. Novi »integrirani« sustav omogućuje lako prebacivanje s dvofazne na trofaznu ekstrakciju ili obratno. U radu se raspravlja o rezultatima usporedbe ovih dvaju postupaka.

Introduction

Virgin olive oil is a product of a high nutritional and biological value *(1,2)*. Therefore it is increasingly used in contemporary diet. Significant shifts towards its consumption have been achieved in the great world markets (USA, Canada, Australia, Japan), traditional consumers of other fats *(3)*.

Positive trends in the manufacture and consumption of genuine olive oils in the world are a result of adequate policies and activities undertaken on the basis of the International Agreement on Olive Oil, in which the objectives for the improvement of quality are placed in the foreground, especially concerning the manufacture of the »extra virgin oil«.

The characteristics of the composition, the nutritional value and organoleptic properties of olive oil depend on the factors involved in the primary production: pedoclimatic conditions of the growing of olives, assortment, agricultural machinery, the degree of ripeness and the manner of harvesting *(4,5)*, as well as the technological procedures of olive processing *(6)*.

By advancing the processing technology it is attempted to increase the oil yields, to upgrade the quality and economy of the manufacture and to protect the environment from pollution *(7,8)*.

Continuous olive oil extraction by centrifugation

Pressing in batch presses was the first method commonly used for olive fruit processing and olive oil manufacture. A great variety of presses for olive pulp are found on the market, but they are all based on the same operating principle, giving two products: water-oil suspension and olive residue. The shortcomings of such machines are: batch operation with high labour costs, low rated capacity and high wear of filtration supports *(9)*.

Although the improvement of the machines is considerably with a view to cutting down the operating costs, the present trend is towards continuous centrifugation.

The first industrial plants for continuous olive processing by means of centrifugal extractors with a horizontal shaft – decanter were used in the 1963/64 season *(10)*. These »traditional« plants incorporate a decanter which separates the olive paste into three parts (phases): oil, vegetable water and the solid part – olive residue (cake, pomace, husk). In order to make this decanter work properly it is necessary to dilute the paste with an adequate amount of warm water (Fig. 1). The unfavourable effects of the operation of the 3-phase decanter include great consumption of warm water, rinsing out of nutri-

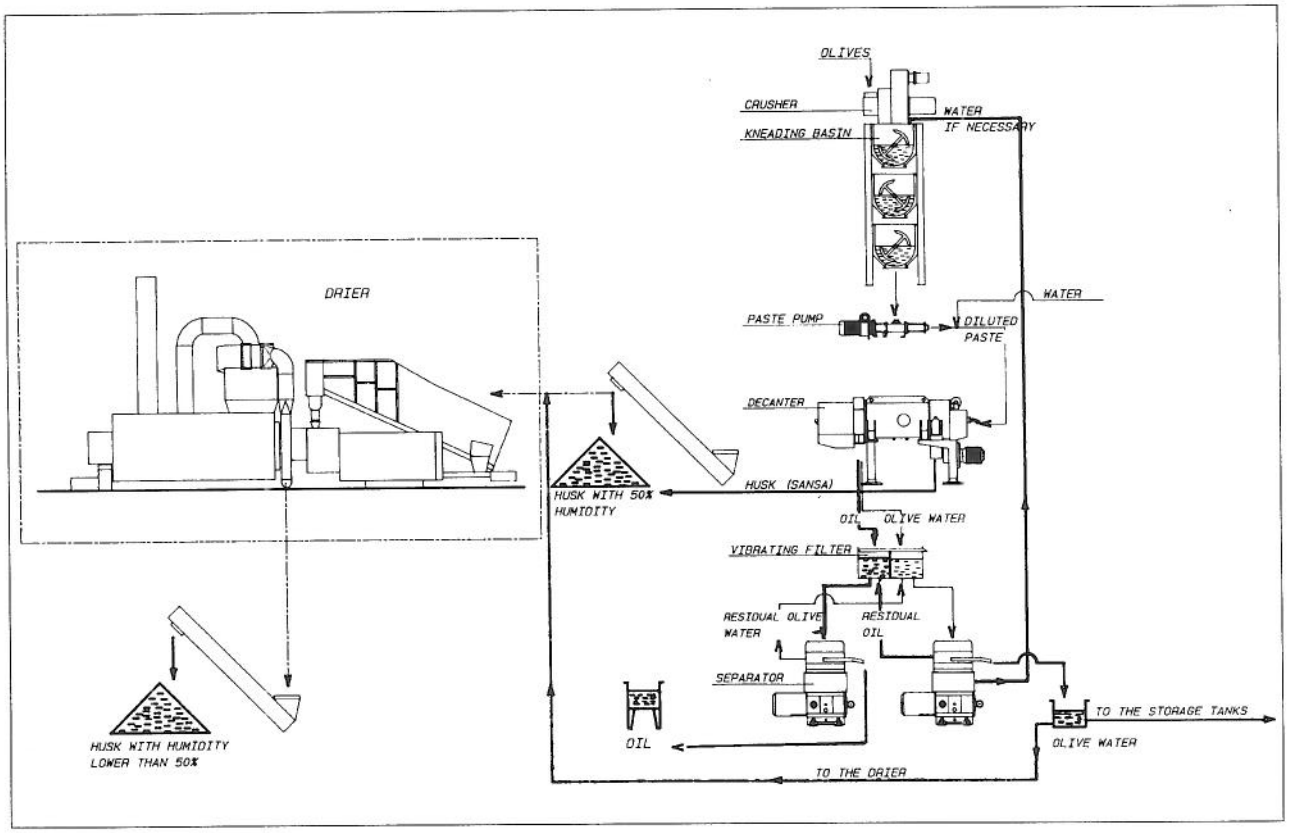

Fig. 1. Scheme of PIERALISI continuous three-phase installation
Slika 1. Shema PIERALISI centrifugalne ekstrakcije s tri faze

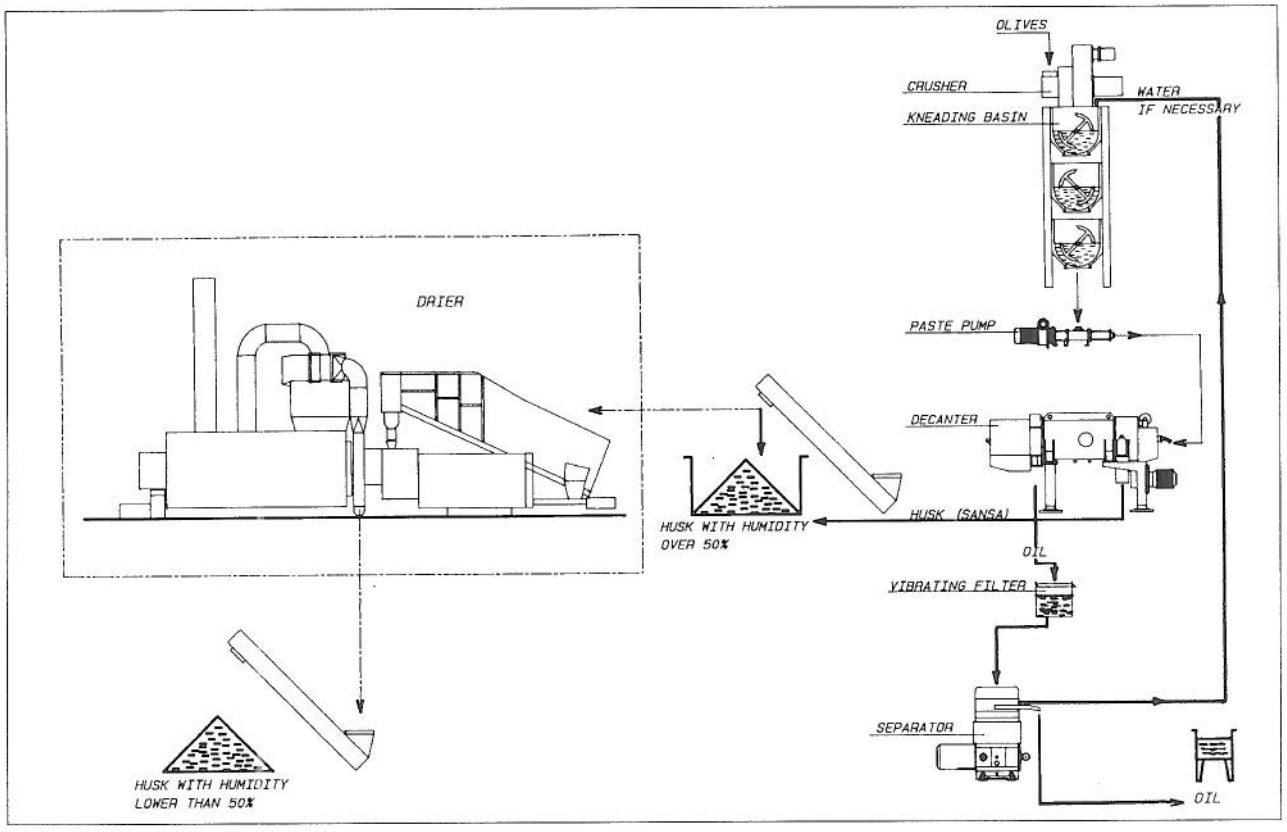

Fig. 2. Scheme of PIERALISI continuous two-phase installation
Slika 2. Shema PIERALISI centrifugalne ekstrakcije s dvije faze

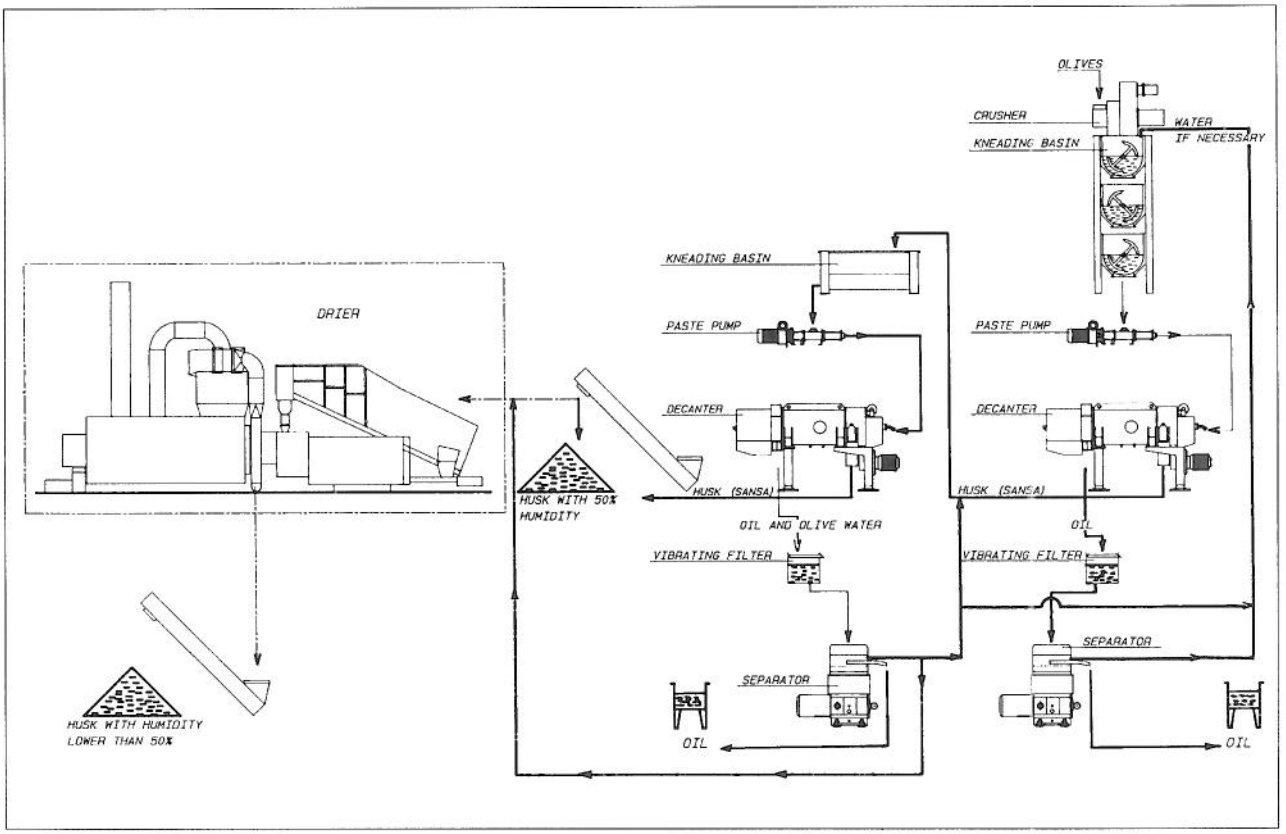

Fig. 3. Scheme of PIERALISI continuous two-phase installation with double processing
Slika 3. Shema PIERALISI centrifugalne ekstrakcije s dvije faze uz dvostruku separaciju

tive components from the oil (especially natural antioxidants) and the pollution of environment – by draining considerable quantities of waste water.

In order to avoid the above mentioned drawbacks of the centrifugal 3-phase extraction, a new decanter was designed for operation without the addition of warm water, while the olive paste (of natural composition) is separated into two parts *(11)*: the oil is separated as a separate phase and the cake (husk) together with the vegetable water as the other phase (Fig. 2).

The new decanter is designed so as to work in 2 or 3 phases, depending on the specific requirements of the olive oil manufactured. Switching from the 2-phase system to the traditional 3-phase method or vice versa can be achieved in about 30 minutes, without disassembling the major parts of the apparatus (Fig. 3).

The technological process up to the preparation of the paste is identical for the plants with the »traditional« and the new decanter. It comprises the following processes: removal of leaves and other impurities from the fruits, washing, crushing (hammer crusher or grind-stone crusher) and the preparation of the paste in the system of mixers.

The new Pieralisi integrated system with the 2-phase decanter (Fig. 4) was first used in manufacture in 1992/93.

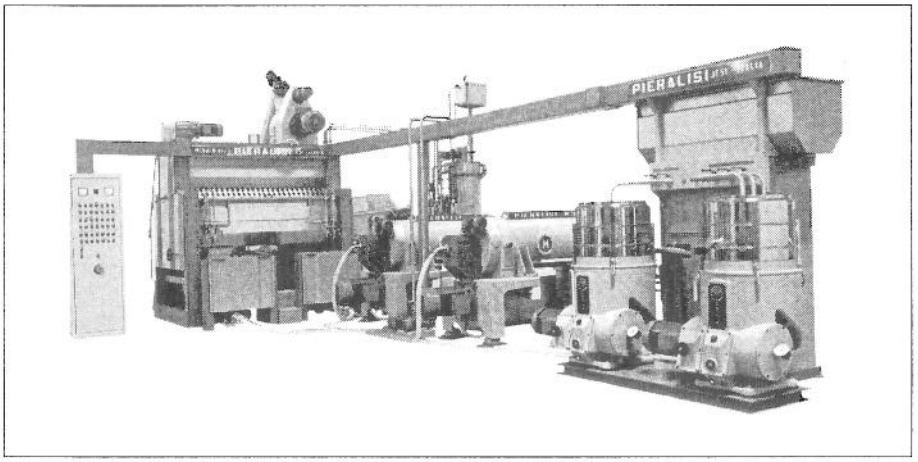

Fig. 4. Modern PIERALISI plant for centrifugal extraction of olive oil
Slika 4. Suvremeno postrojenje PIERALISI za centrifugalnu ekstrakciju maslinova ulja

Comparison of 2-phase and 3-phase extraction

Over the last two years numerous experiments have been made to examine the advantages of the integrated continuous oil extraction system over the »traditional« 3--phase system. In order to present the results objectively,

we shall discuss the experimental work of renowned experts from the specialized institutes in Italy, namely Istituto Meccanica Agraria, Universita di Bari and Istituto Sperimentale per la Elaiotecnica, Pescara *(12,13)*.

Experiments were carried out in an oil mill in the olive growing area of the region of Puglia, on Pieralisi plants with a MAJOR 2 decanter (in the 1992/93 season). The processed olive fruits were of Ogliarola salentina and Cellina di Nardo variety. The analyses of the olive fruits, the cake and vegetable water, and those of oil samples were performed according to the methods officially prescribed in Italy *(14)*.

Tables 1 and 2 show the average results of the major technological indicators and quality properties of the oil obtained.

Data in Table 1 show that the average oil yield by centrifugal 2-phase extraction was 86.20 % while the yield on 3-phase extraction was 85.70 %.

Table 1. Results obtained by centrifugal 2-phase and 3-phase extractions *(12,13)*
Tablica 1. Rezultati rada centrifugalne ekstrakcije s dvije i tri faze *(12,13)*

Measurements	Centrifugal extraction	
	2-phase	3-phase
OIL YIELD*/ %	86.20	85.70
OLIVE CAKE (HUSK)		
Quantity / (kg/100 kg of olives)	74.60	55.05
w (water) / %	60.75	53.85
w (oil) / %	4.01	3.58
w (oil) / (kg/100 kg of olives)	2.99	1.97
VEGETABLE WATER		
Quantity / (L/100 kg of olives)	–	90.00
m (oil) / (g per L of water)	–	16.25
w (oil) / (kg/100 kg of olives)	–	1.46
TOTAL OIL IN BY-PRODUCTS (kg/100 kg of olives)	2.99	3.43

* percentage of oil produced in comparison to the amount of oil in the olive fruits

Satisfactory results were obtained also with respect to the residual oil in the by-products of the process. The cake on 2-phase extraction contained 4.01 % of oil (an equivalent of 2.99 kg of oil per 100 kg of olives) and on 3-phase extraction 3.58 % (an equivalent of 1.97 kg per 100 kg of olives). Residual oil in the waste water was negligible or nil on the 2-phase operation (water consumption was only 4-7 L per 100 kg of olives). The waste water on 3-phase extraction contained 1.46 kg of oil/100 kg of olives.

The total residual oil in by-products amounted to 2.99 kg/100 kg of olives on 2-phase extraction and 3.43 kg/ /100 kg of olives on 3-phase extraction. Consequently, the 2-phase extraction resulted in a positive difference of 0.44 kg of oil/100 kg of olives.

The moisture content of the cake (60.75 %) in 2-phase extraction was not significantly higher in comparison to the 3-phase operation (53.85 %).

Analytical data in Table 2 show that the centrifugal 2-phase extraction yields an oil with considerably higher

Table 2. Characteristics of the oil obtained by centrifugal 2-phase and 3-phase extractions *(12,13)*
Tablica 2. Svojstva ulja dobivenog centrifugalnom ekstrakcijom u dvije i tri faze *(12,13)*

Measurements	Centrifugal extraction	
	2-phase	3-phase
FFA / (% oleic acid)	1.07	1.04
Peroxide value / (mmol O_2/kg of oil)	5.03	5.35
Polyphenols total*	111.00	72.00
o-diphenols**	132.00	58.00
Stability / h***	7.25	4.15
w (chlorophylls) / (mg/kg)	2.80	2.65
K_{232}	1.965	1.952
K_{270}	0.145	0.128
Organoleptic assessment	6.80	6.80

* expressed as mg galic acid per L of oil
** expressed as mg caffeic acid per L of oil
*** Rancimat method

content of total polyphenols and o-diphenols, which are important natural antioxidants. These values are 35 to 65 % higher compared with those of the 3-phase extraction. Thus, the positive indicators of the oil oxidative stability are evident. The stability indicator is by 43 % higher in the oil produced by 2-phase extraction. Comparative values of other indicators do not show any significant divergences.

The experimental results described give good ground for conclusion that the centrifugal 2-phase extraction offers a better oil yield. This is a consequence of the facts that the new decanter efficiently separates oil from the solid phase and that no warm water is required for the dilution of the paste prior to centrifuging, and thus no oil/water emulsion is formed.

The 2-phase extraction leaves the cake with an increased amount of water, depending on the degree of moisture of the olivee fruits and the ratio of olive stones/pulp. The cake can be sent to a solvent extraction plant or be dried to a required moisture level in a drier (see Figs. 1–3) with low-calorie fuel (olive cake and other waste products), also produced by the Pieralisi company *(15)*.

In order to reduce the amount of water in the cake and obtain a better oil yield, it is useful (with larger quantities of raw material) to employ additional plants for the »second processing« of olive paste (see Fig. 3). The application of this treatment reduces the water level in the cake to 50 %, and the yield of oil is raised to 93–97 % *(16)*.

Advantages of Pieralisi 2-phase extraction

The results and advantages of the centrifugal 2-phase extraction have been confirmed over the past two seasons of olive processing in industrial manufacture *(17)*.

The following economic advantages should be mentioned in favour of the centrifugal 2-phase extraction:

- a higher return from the oil manufactured, better yield and high quality;
- reduction of water consumption by at least 30 L/ /100 kg of olives;
- energy consumption (for warm water) decreased by 70 %, and

- waste water reduced to symbolic amounts, thus requiring no significant expenditure for its purification and the protection of the environment from pollution.

The 2-phase extraction system allows the manufacture of an oil of natural composition, with a higher content of antioxidants and corresponding organoleptic properties. Consequently the oil is of a better quality and more stable to oxidation.

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