ESTUDO PARA IMPLEMENTAÇÃO DE UMA UNIDADE PRODUTIVA DE AZEITE EM PÓ

STUDY FOR IMPLEMENTING A UNIT FOR PRODUCTION OF POWDERED OLIVE OIL

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Resumo

O presente trabalho teve por objetivo fazer um estudo para a implementação de uma unidade industrial para produção de azeite em pó. Para a produção deste produto, que se destina ao mercado da cozinha *gourmet*, recorre-se à maltodextrina, a qual permite a obtenção das pequenas esferas (microgotas) de azeite.

Para o cumprimento do objetivo, foram avaliadas todas as etapas que constituem o processo produtivo, desde a produção de azeite até ao produto final sob a forma de pó a fim de poder a partir delas estabelecer todas as etapas necessários ao projeto final, e que envolvem: definição das instalações e equipamentos, implantação fabril e ainda breves considerações sobre os efluentes e resíduos gerados.

Palavras-chave: projeto, indústria, azeite, implantação.

Abstract

This work aimed to make a study for the implementation of an industrial unit for production of olive oil powder. For obtaining this product, which is designed for the gourmet kitchen market, is used the maltodextrin, which allows obtaining the small spheres (micro-droplets) of olive oil.

To fulfil the proposed objective, were evaluated all steps that constitute the production process, including the olive oil production and then the transformation into the final

product, i.e., in the form of powder. In this way, it will allow establishing all the steps necessary for the final project, which involve: definition of premises and equipment, layout and also some brief considerations regarding the effluents and wastes generated.

Keywords: design, industry, layout, olive oil.

1. Introduction

Virgin olive oil (VOO) is unique among the vegetable oils because it is obtained from the olive fruit (*Olea Europea* L.) by solely mechanical means, and therefore avoiding any other treatments. As a result, it contains many polar compounds that otherwise would typically be eliminated from the other vegetable oils during the various stages of refining. Among these compounds stand volatile compounds, aliphatic and triterpenic alcohols, sterols, and several antioxidants, which are contribute for its many health effects (Capriotti et al., 2014).

Olive oil has been a key staple of the Mediterranean Diet for centuries (Santosa et al., 2013). The health benefits of olive oil are attributed to various components identified, that include from monounsaturated fatty acids to specific types of polyphenols.

Olive oil has been documented in several scientific publications as having many benefits for the human health. In addition to bolstering the immune system and helping to protect against viruses, olive oil has also been found to be effective in fighting against diseases such as: cancer, heart disease, oxidative stress, blood pressure, diabetes, obesity, rheumatoid arthritis or osteoporosis (Brownlee, 2005; Estruch et al., 2013; Martínez-González & Sánchez-Villegas, 2004; Pérez-Jiménez et al., 2007; Saija & Uccella, 2000; Tuck & Hayball, 2002).

Maltodextrins have the same general formula as amylose but are of shorter chain length. Maltodextrin is a polysaccharide composed of chains of glucose molecules, being a complex carbohydrate rapidly absorbed by the body. 100 g of maltodextrin provide 350 calories(Udomrati & Gohtani, 2014).

Maltodextrin is a non-sweet sugar to which can be attributed multiple flavours, and subsequently it is commonly incorporated into many commercial beverages such as sports drinks and beer, as well as many processed foods (Kendig et al., 2014). Maltodextrins are widely used in industry due to their non-toxicity and low price. They are used as thickening agents in food processing, and as binding agents in pharmaceuticals (Udomrati & Gohtani, 2014).

Maltodextrin is obtained by partial hydrolysis of corn, wheat, potato or tapioca starch. It presents a slightly sweet taste and has no associated odour. It dissolves readily in water absorbing a generous amount of olive oil, hence turning it into powder.

2. Characterization of the company

The company will be implemented in a ground of approximately 6.000 m^2, including the facilities (a building of 2.700 m^2) and 3.000 m^2 of outdoor area for loading and unloading, as well as parking areas.

This company's main activity is the production and marketing of virgin olive oil sold in bottles of 0.75 L as well as powdered olive oil, marketed in glass containers with 100 g (jars). The distribution will be carried out at national level with adequate transportation to maintain the final product quality.

The company will work from Monday to Friday, from 8:30 to 18:00 hours with a lunch break alternated by turns.

It is estimated that the company will employ 16 people, including the management, accountant, receptionist, food engineer and workers in the production line. From those, 5 workers will be hired in part-time, since the olive oil production is seasonal.

The financial management and the management of human resources with be assured by the general manager of the company. On the other hand, the food engineer will be responsible for the production management and quality. The accountant will deal with management of stocks and orders (to buy raw materials and sell the final product).

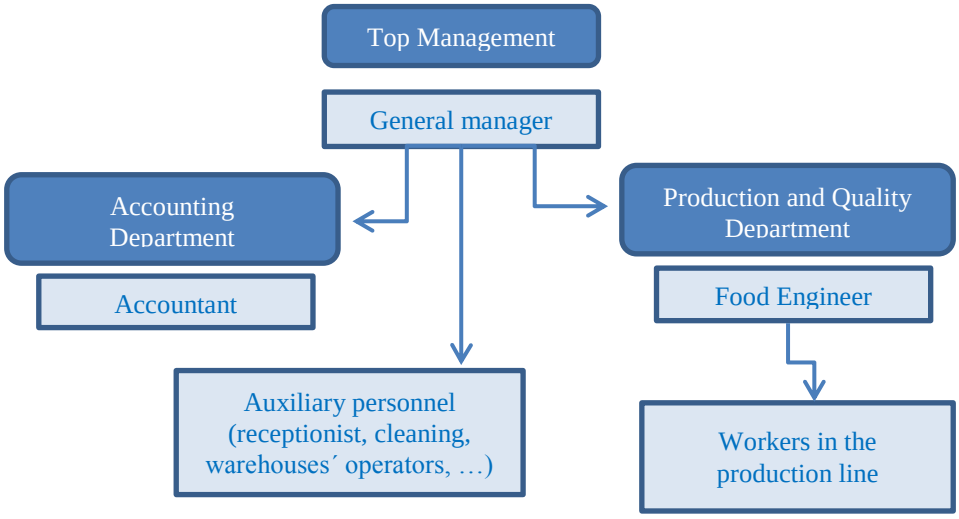

Figure 1. Organogram of the company.

3. Process operations

The process follows the steps indicated in Figure 2, and described in the present section more in detail.

3.1. Preparation of the raw material

To obtain a quality olive oil it must be made after whole unbroken, healthy and ripe olives. Upon entering the mill the olives are classified according to the variety, its provenance regarding soil or tree, the sanitary state, or whether they suffered any action of pathogens, so as to be worked separately by class. For each class, the olives are ventilated so that air currents separate the leaves which accompany them, and then they further submitted to washing with water. At this stage, a sample is collected for laboratory analysis, and then follows weighing, sorting and storage, having in mind that the olives are separated into batches according to quality. The olive oil must be processed no later than 24 hours following reception, to obtain a high quality product.

3.2. Trituration of the olives and preparation of the paste

The milling operation consists of pressing the olives so as to form a paste. The olive paste is prepared by using metal hammers mills, and subsequently is heated in a thermal mixer to increase the extraction yield, facilitating the separation of the oil.

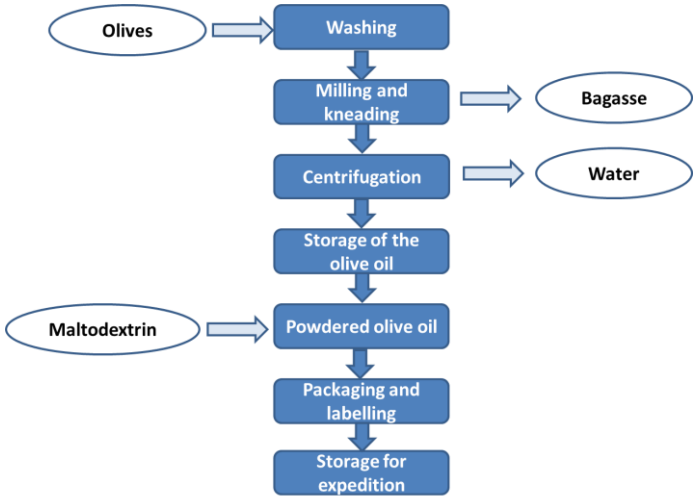

Figure 2. Processing operations for obtaining of powdered olive oil.

3.3. Extraction of the oil

When the paste is conveniently kneaded and heated, it proceeds to extraction, a process of separation of the solid phase (the bagasse) from the liquid phase (containing oil and water). This extraction operation is performed by centrifugation in a continuous two phase system.

The two phase centrifugation system contributes to the reduction of the waiting time until the olive is processed and has had a very positive impact on improving the quality of the oil obtained. It has also contributed to a substantial decrease of the environmental impact caused by effluents from mills, as in the case of these systems there is no production of high impact contaminated waters, the effluent being merely the result of water used for washing the olives and equipment.

3.4. Storage of the olive oil

The olive oil obtained is stored in tanks at a temperature between 15 and 18° C and under low light, for preservation of the organoleptic and health properties until further processing.

3.5. Transformation into powdered olive oil

The process of transformation of the liquid olive oil into the powdered form involves the measurement of the adequate quantities of olive oil and maltodextrin, the mixing of the two components and the control of the processing conditions so as to obtain the ideal particle size (Guiné et al., 2012) (Figure 3). The final product is than packed and labelled and stored under appropriate temperature conditions, until further commercialization.

Figure 3. The powdered olive oil.

4. Equipment

In this section is described briefly the equipment that will be needed for the industrial plant. Firstly, it will be focused the equipment for the processing of the olives and extraction of the olive oil and later the equipment for the transformation of the olive oil into powder.

4.1. Production of olive oil

The production of the olive oil will involve first the processing of the olives (cleaning and storage) and then the pressing operation for extraction of the olive oil.

The system for the production of the olive oil will involve centrifugation whereby the oil phase will be separated from the water phase and solids (bagasse).

Deposit for olive: with a capacity of storing 700 kg of olives, is built in electrolytic zinc chromate and has a rot-proof bag made of washable fabric. It contains a system of sliding funnel for emptying at the base. Its dimensions are 1 m^3 and it can be stacked.

Multipurpose cleaning machine: has four main functions: cleaner, stemmer, washing machine and integrated balance. The cleaner has a vibratory sieve through suspension, a tray for expulsion of soil and ventilation for expulsion of the leaves. It works by regulating air pressure and has a power of 4.75 Hp. The stemmer aims at the separation of the waste and it power is 1.0 Hp. The washer makes the disposal of waste by decantation through a double wash cycle including pneumatic washing. In the integrated balance the weighing capacity is continuous. This device has a height of 3.9 m and a length of 4.5 m.

Hopper: aims to carry the olives for the storage containers and still has the function of removing the leaves that have not been removed in the previous step. The dimensions are: height 0.5 m and length 2.5 m.

Hammer mill: olives are transferred to the hammer mills that grind the olives into thin slurry. The above facility is 5.7 m length, 1.27 m width and 2.15 m height.

Beater: the mass produced earlier will stay in this equipment for about two hours, in automatic movement through a screw that will produce a slow continuous beat, followed by a gentle heat that helps the oil droplets to unite into larger droplets. Dimensions: 1.45 m long, 1.5 m wide and 0.95 m high.

Horizontal centrifuge: this equipment separates the solid phase from the liquid phase. The solid phase will be in a thick slurry state and is sent to the storage silo which is outside the factory. The liquid phase contains oil together with some water and suspended solids (small olive particles). Dimensions: 4 m long and 1.5 m wide.

Vertical centrifuge: after separation of the oil this is purified to remove particles that may persist. This process is accomplished with the aid of hot water at low temperatures. This equipment's dimensions are: length 1.6 m, width 1,13 m and 2 m in height.

Storage silos: the purified olive oil is stored into stainless steel tanks. Also the bagasse will be stored in a silo until its recollection by a proper accompany.

4.2.Transformation into powdered olive oil

Storage silo for maltodextrin: the maltotextrin will be stored until its usage in stainless steel silos.

Mixer: it consists of a dual-axis industrial mixer. It is robust and highly efficient. The mixture of the olive oil with the maltodextrin is ready in 3 to 15 minutes. The shafts rotate at the same speed but in opposite directions. Dimensions: length 1.124 m, width 1.10 m and height 0.72 m.

Filling and labelling machine: is equipped with a linear piston volumetric dosing for filling. It allows easy disassembly and quick cleaning of dryers and valves. Some of its characteristics include a feeding mat, a bottle stop device by a pneumatic/electric system, controller for the presence of flasks, pressure volumetric filling by pneumatic cylinders. Moreover, it labels the bottles automatically. Size: 4 m long, 0.70 m wide and 1.45 m high.

5. Layout

Plant layout corresponds to the most effective physical arrangement, either existing or in plans of industrial facilities. It deals with the arrangement of machines, processing equipment and service departments to achieve greatest co-ordination and efficiency of the so called 4 M's (Men, Materials, Machines and Methods) in a plant.

It is certain that the adequacy of layout greatly affects the efficiency of subsequent operations, and is a major determinant of productivity. Once the site of the plant has been decided, the next important problem before the management of the

enterprise is to plan suitable layout for the plant. Only in this way will be possible to assure the best potential integration of all elements affecting production.

Figure 4 shows the layout of the industrial plant. The software used to produce the layout was Corel DRAW Graphics Suite X6, version 64-bits.

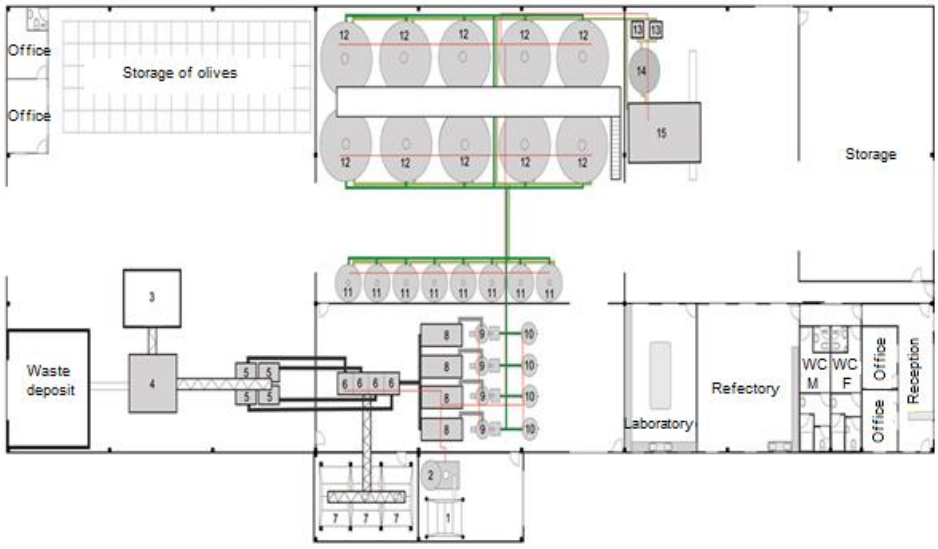

Figure 4. Layout of the industrial plant for production of powdered olive oil. 1: pallet silo, 2: boiler, 3: olives silo, 4: machine for treating the olives, 5: hammer mill, 6: beater, 7: bagasse silo, 8: horizontal centrifuge, 9: vertical centrifuge, 10: measurement tank (200 L), 11: storage tank (5000 L), 12: storage tank (20000 L), 13: industrial beater, 14:storage silo for the olive oil powder, 15: line for filling and labelling.

The facilities include the production areas, offices to support the production and management, a reception, warehouses for storage of raw-materials and finals products, auxiliary facilities, such as sanitary installations and a refectory. Also a laboratory for the quality control of all products and raw materials is included.

6. Effluents and wastes

During the process of extracting oil by using exclusively physical processes large quantities of wastewater are necessarily produced. This results from the washing of the olives prior to extraction and some water that is added to facilitate emulsion. This waste water originated in the plants for production of olive oil has been identified as an environmental problem (Rana et al., 2003).

Olive mill waste contains a high quantity of phenols that might be potentially dangerous for the environment as well as for the human health. Furthermore, the fermentation and digestion processes that take place in the waste release an unknown quantity of polluting gases into the atmosphere (Pérez et al., 2009).

Olive oil production results in a large volume of hazardous organic waste material. It has been assessed that every 100 kg of olives generate 35–45 kg of olive solid waste depending greatly on the methods used for the extraction of the oil (Killi et al., 2014). This waste contains some important environmental toxins that can pollute water bodies and are harmful to soil microbial communities and plant growth (Asfi et al., 2012).

The present industrial plant for production of powdered olive oil uses a tank with a capacity of 49000 litters for storing the waste water. The main solid waste generated in the preparation of olive oil, the olive pomace, is stored in a silo, which will then be handled and transported by a company for valorisation.

There has been increasing focus on the possibilities of the re-use and recycling of the wastes from olive oil production as an agricultural 'green-waste' in the manufacture of organic bulking agents, fertilisers and mulches (Alburquerque et al., 2007; Altieri & Esposito, 2010; Arvanitoyannis and Kassaveti, 2007; Buono et al., 2011; Martínez-Blanco et al., 2011; Saadi et al., 2007).

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