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Dim Sizing Technology and Energy of a Unit Semi-Industrial Production of Palm Oil with a Capacity of 0.26 Tonnes of Plans, Costs Per Day in Rural Areas

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ABSTRACT

The industrial processing of fresh fruit bunches of oil palm remains an important activity in rural areas, but it is often associated with low productivity, loss of oil, important, and difficult working conditions. This study proposes the design of a unit semi-industrial production of palm oil suited to a rural environment and with a nominal capacity of treatment of 0.26 tonnes of fresh fruit bunches per day.

The design is made from material balances and energy of the process including the receipt of the plans, sterilization, stalking, digesting, pressing, clarification and storage. The hourly capacity retention is 32 kg/h for a duration of operation 8 h/j. A safety margin of 20% to 30% leads to retain a nominal capacity of major equipment of approximately 40kg/h.

On the basis of an extraction rate of 19-20 %, the daily production of oil is estimated at 260 kg/d, or about 289 L/j depending on the density used for the oil. The need for process water is estimated to be about 780L/j. power consumption indicative is of the order of 5 kWh/d with reference to a specific consumption of 18 kWh/t of plans. The steam system is sized for approximately30 to 40 kg/h of steam, with recovery and energy recovery of fiber and nuts when this is technically possible.

The design proposed is an intermediate configuration between the handcrafted processes and the large oil mills industry. It aims to improve the regularity of the treatment, the yield of extraction and the quality of the oil, while maintaining a technology compatible with the constraints of a rural environment.

KEYWORDS: *palm oil, palm oil, sizing, semi-industrial, 5 tons/day, material balance, energy balance, rural, extraction.*

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1. INTRODUCTION

The oil palm is an important source of raw materials for the production of vegetable oil in the tropical regions. In rural areas, however, the processing of fresh fruit bunches is still largely carried out with equipment artisanal or semi-mechanized.

The traditional operations typically include the cooking of the fruit, the beating, kneading, pressing and clarification. The studies conducted in West Africa show that small units use different configurations of the digesters, hydraulic presses or screw presses.

The use of a sterilization controlled steam was a significant improvement compared to the simple cooking water. The literature points out that the sterilization facilitates the detachment of the fruit, the better the subsequent operations of extraction and contributes to the limited enzymatic reactions responsible for the increase of free fatty acids.

For a small unit rural, the difficulty is to determine an ability that is sufficiently large to promote the local production while remaining compatible with the resources available.

The present work thus focuses on the design of a unit semi-industrial capable of handling 0.26 ton of plans charges by day

2. MATERIALS AND METHODS

2.1. Methodological approach

The study is based on an approach combining process engineering, the techno-economic analysis and assessment of constraints to the rural areas.

The approach includes the following steps:

a) characterization of the raw material;
b) estimate of the amount of plans available;
c) definition of the capacity of the processing;
d) development of the block diagram of the processing;
e) selection of equipment;
f) sizing preliminary;
g) estimation of energy needs and water;
h) identification of by-products;
i) analysis of costs;
j) estimate of revenue;
k) assessment of the profitability.

2.2. Raw material

The main raw material is made up of fresh fruit bunches of oil palm. Their quality directly affects the performance of extraction and the quality of the oil.

The main parameters to consider are:

a) the degree of maturity of the plans;
b) the average mass of the plans;
c) the oil content of the fruit;
d) the time between the harvesting and processing;
e) the conditions of transport and storage.

An effective organization should transform the plans as soon as possible after harvest.

2.3. The palm oil and the production of crude palm oil

2.3.1. General information on the oil palm

The oil palm tree, scientifically called Elaeis guineensis, belongs to the family of Arecaceae. It is a plant monocot tropical mainly cultivated for its fruits that are high in fat.

The palm tree produces plans that consist of numerous fruits arranged around a central axis. At maturity, these fruits contain a large amount of oil. Two main fractions can be obtained: crude palm oil, mainly extracted from the pulp, and palm kernel oil derived from the kernel of the kernel [1].

The production depends on several factors, including variety, the age of the plantation, the climatic conditions, cultivation practices and the degree of maturity of the plans. The treatment should be carried out in a relatively short period of time after the harvest in order to limit the degradation of the quality.



Fig. 2.1: oil Palm (Elaeisguineensis), is the main species grown for the production of crude palm oil [2]

2.3.1. Structure of the fruit of the palm tree

The fruit of the oil palm is the major raw material used for the production of crude palm oil. They are grouped in clusters called regimes, of which the weight generally varies between 10 and 30 kg, depending on the variety, the age of the palm tree and the growing conditions. Each plan can contain between 1 000 and 3 000 fruit, of ovoid shape, and color ranging from red-orange to dark red at maturity. Each fruit is made up of four main parts:

- the flavedo, which corresponds to the outer shell of the fruit;
- the mesocarp, fleshy part that is rich in crude palm oil;
- the endocarp, also called shell, which protects the seed;
- the palm kernel (almond), located on the inside of the shell, used for the production of palm kernel oil.

The quality of the fruit directly influences the efficiency of oil extraction. The plans must be harvested at their optimum maturity, characterized by the detachment of the natural first-fruits. A harvest early or late leads to a

decrease in performance, as well as a degradation of the quality of the oil obtained. For this reason, the fruits are usually routed to the oil immediately after harvest in order to limit the phenomena of fermentation and the increase in the acidity of the oil [3].

From the genetic point of view, there are three main types of fruit:

- Dura, characterized by a thick shell and a small proportion of pulp;
- Pisifera, devoid of the hull, but not very productive;
- Tenera, hybrid resulting from the cross between the previous two.

Thanks to its thin shell and its mesocarp abundant, the type Tenera is today the most widely cultivated in commercial plantations because of its excellent performance in oil (figure 2.2).

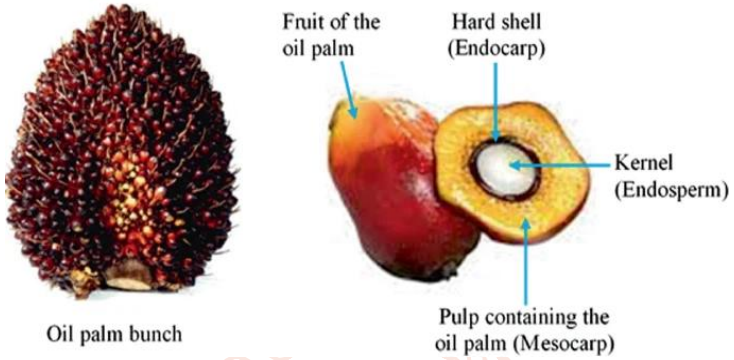


***Fig. 2. 2*: Structure of the fruit of the oil palm and diet of fresh fruits [4]**

2.3.2. Crude palm oil

1° Definition

Crude palm oil (BPH), also called *Crude Palm Oil (CPO)*, is a vegetable oil extracted from the mesocarp of the fruit of the oil palm (*Elaeis guineensis*). It is obtained after sterilization operations, digestion, pressing and clarification of the plans of palm. In the natural state, the oil has a reddish-orange color due to its richness in carotenoids, including β-carotene and α-carotene. It is the main product resulting from the processing of palm fruit oil and represents a major raw material for many industries [5].

2° Composition of crude palm oil

Crude palm oil is composed mainly of triglycerides, which represent approximately 95% to 98% of its composition. The 2 remaining 5% is made up of minor compounds that play an important role in its nutritional properties, physico-chemical and technological.

The main fatty acids present in the crude palm oil are palmitic acid (C16:0), oleic acid (C18:1), linoleic acid (C18:2) and stearic acid (C18:0). This combination of saturated and unsaturated fatty acids gives the oil a good thermal and oxidative stability, which makes it suitable for industrial processes and food applications(Table 2.1).

In addition to triglycerides, crude palm oil contains minor compounds such as carotenoids, which are responsible for its coloring, red-orange, tocopherols and tocotrienols (vitamin E), phytosterols, phospholipids, as well as low amounts of free fatty acids, the content of which depends on the conditions of harvesting, transport and processing of the fruit. These compounds contribute to the nutritional value of the oil as well as its resistance to oxidation.

Table 2.1. The main constituents of the average crude palm oil [6]

Components	Containing Approximately
Triglycerides	95%, 98%
palmitic Acid (C16:0)	40 to 45 %
oleic Acid (C18:1)	39 to 45 %
linoleic Acid (C18:2)	8% to 12%
stearic Acid (C18:0)	4 to 5 %
Carotenoids	500 to 700 mg/kg
Tocopherols and tocotrienols	600 1 000 mg/kg

3° Properties of crude palm oil

Crude palm oil has properties of physical, chemical and nutritional properties that explain its use in many industrial sectors. At room temperature, it has a consistency of semi-solid**,** resulting from the balance between

saturated and unsaturated fatty acids. Its density generally ranges between 0.89 and 0.92 level**,** while its melting point ranges from 33 to 39 °C, depending on its composition (Table 2.2).

On the chemical level, the crude palm oil is characterized by a good stability to oxidation due to its richness in natural antioxidants, including carotenoids and the compounds of vitamin E. This stability allows it to withstand the heat treatment and it can be used in various industrial applications.

From the nutritional point of view, the crude palm oil is an important source of provitamin A (carotenoids) and vitamin E**,** in the form of tocopherols and tocotrienols. However, the quality of this oil is influenced by the rate of free fatty acids, which increases when the fruits are stored for too long before their transformation. In order to preserve its organoleptic properties and nutritional plans, palm must be processed quickly after harvesting [7].

Table 2.2: Main properties of the crude palm oil

Property	Value indicative
Color	Red orange
physical State at 25 °C	Semi-solid
Density (40 °C)	0.89 to 0.92 by
melting Point	33 to 39 °C
Main antioxidants	Carotenoids, tocopherols, tocotrienols
Main uses	in food Industry, cosmetics, pharmaceuticals, soap making, biofuels

2.3.3. Products and sub-products

The transformation of regimes of oil palm into crude palm oil and implements a main raw material and generate multiple products and by-products recovered [8]. The proper management of these different streams helps to improve the technical performance, economic and environmental production units (Table 2.3).

The main raw material used in the manufacturing process is made up of fresh fruit bunches (*Fresh Fruit Bunches* – FFB) from the oil palm (*Elaeis guineensis*). The plans are harvested at optimum ripeness to ensure a high-yield oil and a good quality of the final product. In normal conditions, culture, palm oil is the oil crop the most productive in the world, with an average production of more than 3.5 tonnes of oil per hectare per year, of which about 2 to 3 tonnes of crude palm oil and nearly 300 kg of palm kernel oil.

1° main Products

The transformation plan oil palm achieves two main products:

- **Crude palm oil (Crude Palm Oil – CPO):** extracted from the mesocarp (pulp) of the fruit, it is the main product of the processing unit. After refining, it is suitable for industries of food, cosmetics, pharmaceuticals and energy.
- **Palm kernel oil (Palm Kernel Oil (PKO):** obtained from the kernel (palm kernel) contained in the nuts after the crushing and extraction. This oil is mainly used in the industries of cosmetics, pharmaceuticals, chemical, and in the manufacture of soaps and detergents.

2° Sub-products gems

In addition to the oils produced, the process generates several by-products that could be valued:

- Plans empty (Empty Fruit Bunches – EFB): used as a soil amendment, as raw material for composting or fuel biomass.
- Palm Fibres: used as a fuel in the boiler to produce the steam necessary for the processing operations.
- Shells of palm oil: used as a source of renewable energy in industrial boilers or as a fuel in some installations.
- Meal kernel: residue obtained after extraction of palm kernel oil, rich in protein and used in animal feed.
- Liquid effluent of palm oil mills (Palm Oil Mill Effluent POME): waste water from the process of transformation. After treatment, especially for anaerobic digestion, these effluents may be used for biogas production, thus contributing to the reduction of the environmental impact of the production units.

Table 2.3: raw Materials, products and by-products of the transformation plan palm *oil*

Category	Elements	Main uses
raw	fresh fruit bunches (FFB)	Production of crude palm oil
main Product	crude palm Oil (CPO)	Industry food, cosmetic, pharmaceutical
main Product	of palm-kernel Oil (PKO)	Soap making, cosmetics, detergents
by-product	Diets empty (EFB)	Compost, biomass

by-product	Fiber	Fuel boiler
by-product of	Cockles	energy Production
by-product	Meal, palm kernel	animal Feed
by-product	Effluent (POME)	biogas Production after treatment

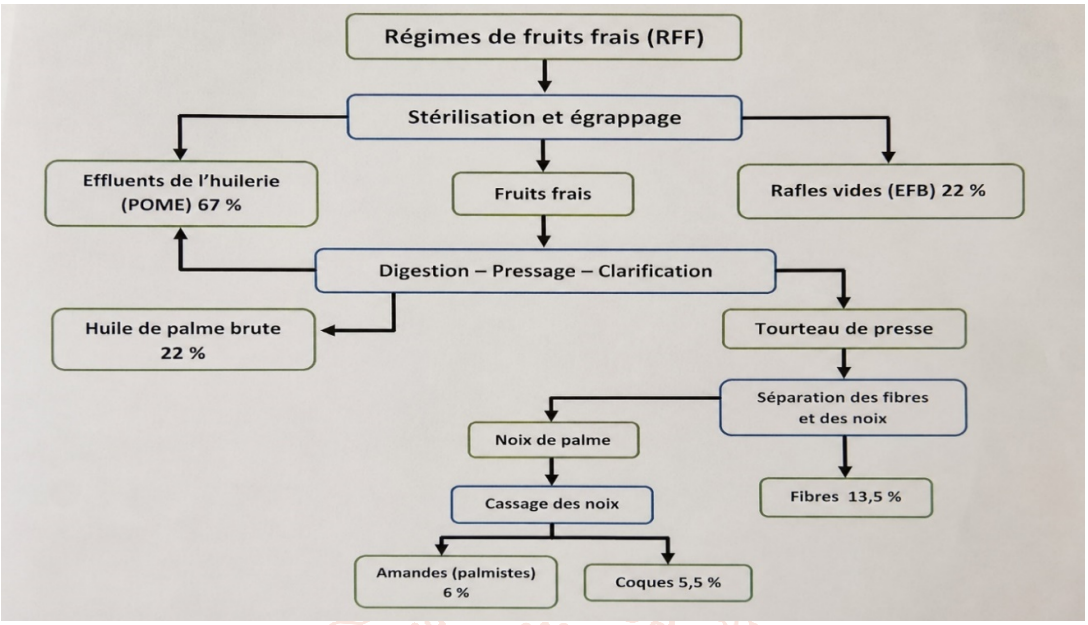


Figure 2.3: block Diagram of the chain overall production of crude palm oil from fresh fruit bunches.

3° Equipment used

The traditional process primarily uses simple equipment, manufactured locally and easily accessible to rural communities (figure 2.4). The main equipment are:

- a machete to the stalking of the plans;
- a metal drum of about 200 litres used in the cooking of the fruit;
- a traditional fireplace, three-stone, or an improved stove powered wood;
- a tray of banco intended for the mixing of cooked fruit;
- the baskets large meshes used for the separation of the fibers, and nuts; and
- from gourds, bowls and strainers used in thescooping, to the filtration and storage of the oil.



(a)



(b)

Figure 2.4: traditional Process of transformation

4° Advantages of the traditional process

The traditional process has several advantages, including in rural areas, where financial resources and industrial infrastructure are limited. It requires an initial investment is relatively small, the equipment is simple, inexpensive, and locally made. It mainly uses wood as a source of energy, fuel is generally available in the areas of production.

Moreover, this method is easily controlled by the local populations and does not require skills specific techniques. In some regions, it also allows us to obtain an oil crafted of quality appreciated by consumers, including the red oil in the traditional way.

5° Boundaries of the traditional process

Despite its simplicity, the traditional method has several limitations, which reduce its efficiency. The yield of extraction remains relatively low compared to the processes, semi-industrial and industrial due to the loss of oil during different operations.

In addition, the work of transformation are particularly painful, especially during the kneading manual of the fruit. The hygienic conditions are often insufficient, which may cause variability in the quality of the oil produced. Finally, the production capacity is still limited, which makes this method unsuitable for commercial production on a large scale. Table 2.4 brings into view the synthesis of the traditional process of transformation

Table 2.4: Overview of the traditional process of transformation

Recap	Criterion	Description
1	Level of mechanization	Very low
2	power Source	- Wood
3	Investment	Low
4	Workforce	Important
5	Extraction	Low
6	Quality of the oil	Variable
7	production Capacity	Low
8	Area of use of	family Farms and village

2.4. Process semi-industrial processing

2.4.1. Process Description

The process semi-industrial [9] and [10] is an evolution of the traditional process through the introduction of mechanical equipment to help improve the performance of the extraction, the quality of the oil produced and the production capacity. This process is particularly adapted to small and medium-sized processing units, in particular in developing countries where industrial investments remain limited.

The transformation begins with the reception of fresh fruit bunches (Fresh Fruit Bunches – FFB), followed by sterilization with steam. This operation allows you to soften the fruit, to facilitate detachment of the raids and inactivate the enzymes responsible for the increase of free fatty acids [11].

The fruit sterilized are then directed to a destemmer mechanics, where the fruits are separated from the stalks. The fruits are then fed into a digester mechanics, which ensures that the brewing and the crushing of the pulp in order to prepare for the extraction of oil.

The extraction is performed using a mechanical press, screw that separates the crude oil from the mixture of fiber and nuts. The oil obtained is then subjected to a clarification, in order to eliminate the water, solid impurities and suspended solids. Finally, the oil is dried and then stored in tanks prior to its packaging or shipping.

2.4.2. Equipment used

A unit semi-industrial production of crude palm oil is composed of a set of facilities that provide different unit operations of processing of fresh fruit bunches. The main equipment are the following:

- Table or the receiving dock: designed to receive, control, and temporarily store the fresh fruit bunches (FFB) prior to their introduction in the transformation process.
- Steam sterilizer: used to cook the plans of the palm under the action of the steam to soften the fruit, to inactivate the enzymes responsible for the increase of free fatty acids and facilitate the operations of stalking and extraction.
- Destemmer mechanical: equipment for the mechanical separation of the fruit of the raids after sterilization.
- Digester mechanical: vessel equipped with a stirring system that ensures the mixing and crushing of the pulp to promote the release of oil prior to pressing.
- Screw press: a machine designed to extract the oil contained in the mesocarp by mechanical compression. It separates the crude oil from the mixture of fiber and nuts.
- Clarifier: used for removing solid impurities, suspended solids and a portion of the water contained in the crude oil to improve its quality.
- Dryer or evaporator: helps reduce the water content of residual oil clarified in order to improve its stability and its conservation.

- Storage tanks: water tanks meant to keep the crude palm oil before packaging or shipping.
- Steam boiler: ensures the production of steam required for the sterilization operations and, depending on the facility, certain processes of heating.
- Generator: provides the electrical energy necessary for the operation of the equipment when the power grid is non-existent or insufficient.

2.4.3. Rated capacity of the unit

The nominal capacity is the most important from which will be scaled to different production equipment. It corresponds to the amount of fresh fruit bunches that the unit shall be capable of processing during a given period of time.

His determination will take into account mainly the availability of the raw materials, the level of production desired, and operating conditions of the unit. As stated in the first chapter, the production capacity is the reference for the design of the sterilizer, the digester, the press, clarifier, and other equipment.

It will be expressed in the form:

$$Q = \frac{M}{t}$$

With :

- Q: *is the ability of processing ;*
- M: *mass of material to be treated ;*
- t: *operating time.*

3. PRESENTATION, ANALYSIS AND INTERPRETATION OF THE RESULTS

3.1. Energy balance

The energy balance allows to determine the energy needs required for the operation of the unit semi-industrial. The requirements are primarily made up of the thermal energy required for sterilization, and heating, as well as the electrical energy necessary for the operation of motorized equipment.
The processing capacity retention of 2 000 kg of RFF per day, or 2 tons/day, specific consumption expressed per tonne of RFF are used to determine the daily needs.

3.1.1. Thermal requirements

The thermal energy is mainly required for sterilization or cooking fruits and maintaining the temperature during certain operations of the process.

For a small mechanized unit using a screw press, the FAO indicates a fuel consumption of the order of 146 kg of wood per ton of RFF.

For 2 tons of RFF per day:

$$M_{wood} - 2 \times 146$$
$$\boxed{M_{wood} = 292\ kg/d}$$

The thermal demand per day is estimated at approximately 292 kg of wood per day when the timber is selected as the fuel.

However, in our unit, a part of the fibers and other solid residues, can also be used as fuel. The FAO indicates that the residues of processing may be used to provide the necessary thermal energy for the process.

Thus, in the final design, the choice of fuel should be specified according to the local availability and energy recovery of by-products.

3.1.2. Electrical requirements

The electrical energy is used mainly to cause the motorized equipment, such as:

- the destemmer;
- the digester;
- the press;
- the pumps;
- the system of clarification;
- the dryer;
- the auxiliary equipment.

FAO provides, for a unit semi-continuous comprising a digester and a screw press, a power consumption of the order of 2 to 3 kWh per tonne of RFF treated.

We adopt the average value of:

$$E_e = 2{,}5\ kWh/t$$

For an output of 2 tons of RFF per day:

$$E_{e,j} = 2 \times 2{,}5$$

$$\boxed{E_{e,j} = 5\ kWh/d}$$

For 300 days of operation per year:

$$E_{e,year} = 5 \times 300$$

$$\boxed{E_{(e,year} - 1\,500\ kWh/year}$$

The need for electrical energy is estimated at 5 kWh/day on the basis of the specific fuel consumption.

3.2. Equipment sizing

The sizing of the equipment is made from the daily capacity retention of 2 000 kg of fresh fruit bunches (RFF) per day, corresponding to a nominal duration of operation of 8 hours per day. The average flow rate of the treatment is therefore:

$$Q = \frac{2\,000}{8} = 250\ kg/h$$

A margin of capacity will be retained when it is necessary to take account of changes in the load, the time of handling, and timely disruptions related to the conduct manual.

3.2.1. The Sterilizer

In the present study, the fresh fruit bunches are entered manually in the sterilizer. The sizing should be done according to the quantity of material that can be charged and discharged by the operators in each cycle.

and the average flow rate as of:

$$Q = 250\ kg/h$$

it retains a nominal load of 250 kg of RFF per cycle.

The sterilizer will, therefore, be designed for a payload of 300 kg per cycle, with a normal charge of operation of 250 kg of RFF per cycle (Table 3.1).

Table 3.1 design of the Sterilizer

Parameter	Value selected
daily Capacity	of 2,000 kg/d
average Flow	of 250 kg/h
normal Load	250 kg/cycle
design Capacity of	300 kg/cycle
Margin of capacity	20 %
Number of design loads	8 loads/j

This configuration is compatible with a unit semi-industrial operation manual, since it does not require an automatic power supply schemes.

3.2.2. Destemmer

The sizing is done on the basis of the rated capacity of the unit. The amount of fresh fruit bunches to deal with on a daily basis is:

$$M_{RFF} = 2\,000\ kg/j$$

For a nominal duration of operation:

$$t = 8\ h/d$$

the average flow rate of processing is:

$$Q = \frac{M_{RFF}}{t}$$

$$Q = \frac{2\,000}{8} = 250\ kg/h$$

The destemmer, therefore, must be able to handle at least 250 kg of diets per hour.

We retain a margin of safety of 20 %:

$$Q_c - Q(1, +020)$$
$$Q_c = 250(1, +020)$$
$$Q_c - 300\ kg/h$$

The design capacity of the destemmer is set to:

$$\boxed{Q_c = 300\ kg/h}$$

The results are given in table 3.2

Table 3.2: design of the Destemmer

Parameter	Value
Amount of RFF	2 000 kg/j
operating Time	8 h/d
nominal Flow rate	250 kg/h
Margin of safety of	20 %
design Capacity of	**300 kg/h**
Power supply	**Manual**

3.2.3. Design of the digester

In the case of this unit, the operation is essentially manual. The filling of the digester, the mixing, the monitoring of the operation and the drain are made by the operators. Therefore, it is not withheld from electric motor for agitation.

The daily capacity of the unit is set to:

$$M_{RFF} = 2\,000\ kg/j$$

For an operating time of 8 hours per day the average flow of processing is:

$$Q = \frac{2\,000}{8}$$
$$Q = 250\ kg/h$$

To account for the variation related to the conduct manual and retain a margin of 20 %, the design flow rate is:

$$Q_c = 250 \times 1{,}20$$
$$Q_c = 300\ kg/h$$

The design of the digester is therefore realized on the basis of a design flow rate of 300 kg/h. The results are given in table 3.3

Table 3.3: design of the digester

Recap	Parameter	Value selected
1	unit Capacity	2 000 kg/j
2	average Flow	of 250 kg/h
3	design Flow rate	300 kg/h
4	digestion Time	30 min
5	Charge per cycle	150 kg
6	bulk density	600 kg/m3
7	Volume occupied	0,25 m3
8	filling Rate	70 %
9	calculated Volume	0,357 m3
10	**Volume retained**	**400 L**
11	Diameter proposed	0.75 m
12	proposed Height	of 0.90 m
13	Mixing	**Manual**
14	Power supply	**Not required**

Thus, the digester chosen is a tank of approximately 400 litres, designed to accommodate approximately 150 kg of fruit per cycle and can be operated without motorization. This choice is consistent with the character of a semi-industrial unit and, especially, with the choice of an operating mainly manual.

3.2.4. Sizing of the press

In the unit planned, the pressing will be done with a mechanical press suitable for small capacity, but its power, its loading and unloading will be carried out manually by the operators. The choice of a press that is simple and robust, is preferred in order to facilitate its use, its maintenance and maintenance in the local conditions.

The production capacity is retained for the unit is:

$$M_{RFF} = 2\,000\ kg/j$$

For an operating time of 8 hours per day, the average flow rate is:

$$Q = \frac{2\,000}{8}$$

$$Q = 250\ kg/h$$

Taking into account the margin of capacity of 20% deduction for principal facilities:

$$Q_c = 250 \times 1{,}20$$

$$Q_c = 300\ kg/h$$

The press must therefore be able to handle at least 250 kg/h of dough, with a design capacity of the order of 300 kg/h This value is used to treat the nominal flow rate of 250 kg/h with an operating margin of 20 % (Table 3.4).

Table 3.4: design of the press

Recap	Parameter	Value chosen
1	Generation of RFF	2 000 kg/j
2	operating Time	8 h/d
3	average Throughput	250 kg/h
4	Margin of capacity	20 %
5	Ability of the press	**to 300 kg/h**
6	Power supply	**Manual**
7	Loading	Manual
8	Unloading	Manual
9	Output liquid	To clarification
10	Output solid	Fibers + nuts

Thus, the media retainer is designed for a capacity of about 300 kg/h, while maintaining a conduct manual adapted to the size of the unit.

3.2.5. Sizing of the clarifier

The method chosen is based on a clarification by gravity settling, conducted in a tank equipped with devices allowing you to recover gradually clarified oil.

The daily production of oil retained in the study is:

$$M_{HPB} = 260\ kg/d$$

The duration of operation 8 h/d, the production zone average of oil is:

$$Q_{HPB} = \frac{260}{8}$$

$$Q_{HPB} = 32{,}5\ kg/h$$

The results are given in table 3.5.

Table 3.5: design of the clarifier

Recap	Parameter	Value retainer
1	oil Production	260 kg/d
2	Production schedule	32.5 kg/h
3	Volume of oil	≈ 36,1 L/h
4	Water clarification	780 L/j
5	Blend oil + water	≈ 1 040 L/j
6	Mode of clarification	**gravity Settling**
7	Operating	**batch, manual**
8	Capacity retention	**1 200 L**
9	Diameter proposed	≈ 1.10 m
10	proposed Height	≈ 1.30 m
11	Power supply	**is Not needed for the clarification**

Thus, the choice of a clarifier gravity of about 1 200 L is consistent with the ability of the unit and with the principle of manual operation selected. This solution has also the advantage of being simple to operate, inexpensive, and easy to maintain.

3.2.6. Dimensioning of the dryer and storage tanks

In the framework of this study, the drying will be performed with a system simple and adapted to the operation manual of the unit. The operator ensures the loading of clarified oil, the monitoring of the drying process and the transfer of the oil dried to the storage tanks.

Table 3.6: Sizing the storage capacity

Parameter	Value selected
oil Production	260 kg/day
initial Water	5,20 kg/d
Water final	0.52 kg/d of
Water to eliminate	≈ 4,68 kg/d
Energy theoretical evaporation	≈ 10,58 MJ/day
Energy corrected to 60 %	≈ 17,63 MJ/j
thermal Power theoretical	≈ 0,61 kW
Power practice restraint	**1.5 kW**
storage Capacity	≈ 867 The
Capacity retention	**1 000 L**
Configuration	**2 × 500 L**
Power storage	**Manual**

Thus, the drying and storage remain consistent with the level of mechanization used for the unit. The storage does not require any engine, and the transfer of oil between the clarifier, the dryer and the tanks can be carried out manually with the help of containers adapted.

4. CONCLUSION

The sizing done shows that a unit semi-industrial processing 0.26 per tonne of fresh fruit bunches per day may be designed around a nominal capacity of 32kg/h. The proposed process mainly includes sterilization by steam, a stalking mechanical, digestion, extraction by screw press, a clarification and a storage of the oil.

On the basis of an extraction of 20 %, the production potential is approximately 289 litres of palm oil per day. The daily requirements are estimated to be approximately 780 liters of water and 5 kWh of electricity, whilea boiler of about30-40 kgsteam/h is a basis for pre-sizing.

The energy recovery of the fibers, and nuts could contribute to reduce the dependence of the unit vis-à-vis fuel external. However, the final confirmation of the sizing requires experimental tests on the plans that are available locally, particularly to determine the extraction rate real, physico-chemical characteristics of the fruits, energy needs and the composition of by-products.

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