Technical coefficients for utilization in the preparation of investment projects in the fields of agro-industries and post-harvest

by
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Content Table

1. Introduction

In order to facilitate and simplify the use of Agriventure, - INPhO's software for the financial feasibility analysis of agro-industrial investment projects, it was considered helpful to provide its users with a database containing a number of technical coefficients of selected projects, so that they can utilize them to estimate the coefficients they have to employ in the preparation of data for their own projects.

This database includes technical coefficients for raw materials (kg of final product per kg of raw materials); other inputs, packaging, labour, energy, water and other resources necessary for the operation of a food processing factory.

The eleven standard projects selected for that purpose are listed below:-
(the Plant Capacity, expressed as raw material processed per day, is indicated in brackets):

1. Fruit and Vegetable Canning (1075 kg)
2. Cashew Nuts (500 kg)
3. Dried Banana (900 kg)
4. Cassava Flour (5000 kg)
5. Milk Cooling (1000 l)
6. Minimally Processed Vegetables (800 kg)
7. Poultry slaughtering (200 units)
8. Soy Milk (300 kg)
9. Tomato Pulp (530 kg)
10. Fish Filleting (430 kg)
11. Palm Oil (358 kg)

2 PART 1: SUMMARY INPUT-OUTPUT TABLES

2.1. Fruit and Vegetable Canning Project (Corn, Peas and Pineapple)

Table 2.1 Summary of the Technical Ratios: Fruit and Vegetable Canning Plant (1075 KG of Raw Material / Day)

Ratios associated with the products	
Raw material	
kg corn / kg of final product	3,51 kg/kg
kg peas / kg of final product	0,50 kg/kg
kg pineapple / kg of final product	2,17 kg/kg
Sanitizer	
g active chlorine / kg of final product (corn and peas)	0,27 g/kg
g active chlorine / kg of final product (pineapple)t	0,36 kg/kg
Packaging	
cans (units of 320 g) / kg of final product (corn)	5 cans/kg
cans (units of 320 g) / kg of final product (peas)	5 cans/kg

cans (units of 900 g) / kg of final product (pineapple)	2,2 cans/kg
Inputs for corn and peas	
kg sugar / kg of final product	0,012 kg/kg
kg salt / kg of final product	0,012 kg/kg
g sodium bicarbonate consumption / kg of final product	0,12 g/kg
Inputs for pineapple	
kg sugar / kg of final product	0,71 kg/ kg
Ratios associated with the products	
Raw material	
kg corn / kg of final product	3,51 kg/kg
kg peas / kg of final product	0,50 kg/kg
kg pineapple / kg of final product	2,17 kg/kg
Sanitizer	
g active chlorine / kg of final product (corn and peas)	0,27 g/kg
g active chlorine / kg of final product (pineapple)t	0,36 kg/kg
Packaging	
cans (units of 320 g) / kg of final product (corn)	5 cans/kg
cans (units of 320 g) / kg of final product (peas)	5 cans/kg
cans (units of 900 g) / kg of final product (pineapple)	2,2 cans/kg
Water	
l / kg raw material	8,24 L/kg
l / kg of corn and peas	8,12 l/kg
l / kg of pineapple	8,77 l/kg
Electricity	
kWh / kg raw material)	0,055 kWh/kg
Electricity for Corn and Peas	
kWh / kg of raw material	0,056 kWh/kg
Electricity for Pineapple	
kWh / kg of raw material	0,050 kWh/kg
Firewood	
m3 / kg raw material	0,024 m3/kg
Firewood for Corn and Peas	

m3 per kg of raw material	0,0025 m3/kg
Firewood for Pineapple	
m3 per kg of raw material	0,0020 m3/kg

2.2. Cashew Nuts

Table 2.2. Summary of the technical ratios: Cashew Nut Processing Plant (500 kg of Raw Material / day)

Ratios associated with the final product (cashew kernels)	
Raw material	
kg nuts/kg of fried kernel	4.929 kg / kg
kg nuts/kg of CNSL (cashew nut shell liquid)	10.044 kg/ kg
Inputs	
g active chlorine/kg fried kernels	0.949 g / kg
kg salt (kg) per kg of fried kernels	0.0196 kg / kg
vegetable oil (litres) per kg of fried kernels	0.0331 litres / kg
Packages	
PE bags (0.4 kg/unit) of fried kernels	2.504 units / kg
Ratios associated with the raw material (cashew nuts)	
Utilities	
water (litres)/kg cashew nuts	6,149 l/ kg
electricity (kWh)/kg cashew nuts	0.362 kWh/ kg
firewood (m3)/kg cashew nuts	0.194 m3 / kg
gas (kg)/kg of cashew nuts	0.03 kg / kg

2.3 Dried Banana

Table 2.3. Summary of the technical ratios: Dried Banana Plant (900 kg of Raw Material / Day)

Ratios associated with the products	
Raw material	
kg banana / kg of dried banana	6,67 kg / kg
kg banana / banana flour	6,944 kg / kg
Inputs	
g of active chlorine / kg of dried banana	0,2252 g / kg

g carburet / kg of dried banana	0,1281 g / kg
g sulphur dioxide / kg of dried banana	16,67 g / kg
Packaging	
Low density polyethylene (LDPE) bags (10 kg unit) / kg of dried banana	0,10 Unit / kg
Low density polyethylene (LDPE) bags (10kg unit) / kg banana flour	0,10 Unit / kg
Cellophane sheets (unit) / kg of dried banana	0,333 Unit / kg
Cardboard boxes (4kg unit) / kg of dried banana	0,25 Unit / kg
Cardboard boxes (10kg unit) / kg of dried banana	0,10 Unit / kg
Label (unit) / kg of dried banana (200g product)	5 Unit / kg
Label (unit) / kg of dried banana (10kg product)	0,1 Unit/ kg
Label (unit) / kg of banana flour (10kg product)	0,1 Unit / kg

2.4. Manioc Flour

Table 2.4. Summary of Technical Ratios: Manioc Flour Plant (5000 kg of Manioc Roots / Day)

Ratios associated with the products	
Raw material	
kg of manioc / kg of manioc flour	3,97 kg / kg
kg of manioc/ kg of starch	57,63 kg / kg
kg of manioc / kg of rasps	25,71 kg / kg
Packaging	
PP bags (1 kg unit) / kg of dried manioc flour	1 Unit / kg
PP bags (1 kg unit)/ kg of starch	1 Unit / kg de
Twisted (crisscrossed) LDPE bag (50 kg unit) / kg of rasps	0,02 Unit / kg
Label (unit) / kg of manioc flour	1 Unit/ kg
Label (unit) / kg of starch	1 Unit / kg
Label (unit) / kg of rasps	0,02 Unit / kg
Utilities	
l of water (l) / kg of manioc	1,32 l / kg
kWh Electricity / kg of manioc	0,05 kWh / kg
m3 of firewood consumption / kg of manioc	0,0004 m3 / kg
g active chlorine / kg of manioc	0,01 g / kg

2.5. Milk Cooling

Table 2.5. Summary of Technical Ratios: Milk Cooling Unit (1000 l of Raw Milk/day)

Ratios associated with the final product	
Raw material	
l raw milk / l cooled milk	1 l/ l
Detergent	
kg detergent / l cooled milk	0,00075 kg / l
Sanitizer	
g active chlorine / l cooled milk	0,000025 kg/l

Ratios associated with the raw material	
Electricity	
kWh / l milk	0,068213 kWh/l
Water	
l water / l milk	1 l/ l

2.6. Minimally Processed Vegetables (800 kg of Raw Materials / day)

Ratios associated with the products	
Raw material	
Raw material/kg of final product	2 kg/kg
Sanitizer	
Sanitizer /kg of final product	0.0015725 kg/kg
Packaging	
Package (18 cmx13 cm)/kg of whole leaves	6.667 kg/kg
Package (18 cmx13 cm)/kg of chopped leaves	5 packages/kg
Package (30 cmx46 cm)/kg of chopped leaves	1 package/kg
Package (18 cmx22 cm)/kg of roots	3.333 packages/kg
Package (31 cmx51 cm)/kg of roots	1 package/kg
Package (18 cmx22 cm)/ kg of cauliflower and broccoli	3.333 packages/kg
Package (30 cmx50 cm)/kg of cauliflower and broccoli	1 package/kg
Package (18 cmx22 cm)/kg of fruits	3.333 packages/kg
Package (18 cmx22 cm)/kg of salad	4 packages/kg
Package (30 cmx50 cm)/ kg of salad	1 package/kg

Bags (50 kg)/kg of organic compound	0.02 bags/kg
Labels	
Label (18 cmx13 cm) / kg of whole leaves	6.667 labels/kg
Label (18 cmx13 cm) / kg of chopped leaves	5 labels /kg
Label (30 cmx46 cm) / kg of chopped leaves	1 label /kg
Label (18 cmx22 cm) / kg of roots	3.333 labels /kg
Label (31 cmx51 cm) / kg of roots	1 labels /kg s
Label (18 cmx22 cm) / kg of cauliflower and broccoli	3.333 labels /kg
Label (30 cmx50 cm) / kg of cauliflower and broccoli	1 label/kg
Label (18 cmx22 cm) / kg of fruits	3.333 labels /kg
Label (18 cmx22 cm) / kg of salad	4 labels /kg
Label (30 cmx50 cm) / kg of salad	1 labels /kg
Label (50 kg) / kg of organic compound	0.02 labels /kg

Utilities	
Water (litres)/kg of raw material	8.0875 l/kg
Electricity (kWh)/kg of raw material	0.24945 kWh/kg

2.7. Poultry Slaughtering Plant (200 Units / day)

Ratios associated with the products (Frozen poultry and edible viscera)	
Raw material	
kg live poultry/ kg of product (frozen poultry)	1.478 kg / kg
kg live poultry)/ kg of VC (edible viscera)	26.32 kg/ kg
Inputs	
g active chlorine/kg of frozen poultry	0.196 g / kg
Packaging	
1.64 kg bags/kg frozen poultry	0.61 Unit. / kg
Raw material	
kg live poultry/ kg of product (frozen poultry)	1.478 kg / kg
kg live poultry)/ kg of VC (edible viscera)	26.32 kg/ kg
Inputs	
g active chlorine/kg of frozen poultry	0.196 g / kg
Ratios associated with the raw material	

Utilities	
water (litres) / kg	8.29 l/ kg
electricity (kWh) / kg	0.1481 kWh / kg
liquefied petroleum gas (kg) / kg	0.00209 kg / kg

2.8 Soy Milk Plant (300 kg/day)

Ratios associated with the products	
Raw material	
kg of soy / litres of soluble soy extract “Soymilk”	0.13kg / l
kg of soy / kg of whole soy flour “Kinako”	1.06 kg / kg
Inputs	
Compressed air (m3) / litres of “Soymilk”	0.06 m3 / l
Packages	
Low density polyethylene (LDPE) bags (unit of 1kg) / litres of “Soymilk”	1.0 Unit / l
Low density polyethylene (LDPE) bags (unit of 1kg) / kg of “Kinako”	1.0 Unit / kg
Cardboard boxes (unit of 10 kg) / litre or kg of the product	0.10 Unit / l or kg
Labels (unit) / l of “Soymilk”	1 Unit / l
Labels (unit) / kg of “Kinako”	1 Unit / kg
Utilities	
water (litres) / kg	5.94 l / kg
electricity (kWh) / kg	0.13 kWh / kg
g active chlorine / kg	0.03g / kg

2.9 Tomato Pulp Plant (530 kg of Raw Material / day)

Ratios associated with the products	
Raw material	
kg tomatoes/ kg of pulp	3.93 kg /kg
Inputs	
g active chlorine/ kg of pulp	0.000786 kg /kg p
kg salt/ kg of pulp	0.089kg /kg
kg sugar/ kg of pulp	0.0179 kg/kg
Packages	

tinplate cans/ kg of pulp	2.94 unit/kg
cardboard boxes / kg of pulp	0.126 unit/kg
labels / kg of pulp	2.94 unit/kg
Ratios associated with the raw material	
water (litres) / kg of raw material	14.49 l / kg
electricity (kWh) / kg of raw material	0.1055 kWh / kg
firewood (m3) / kg of raw material	0.0033 m3/kg

2.10. Fish Filleting Plant (430kg of fresh fish/day)

Ratios associated with the products	
Raw material	
kg of fish) / kg of fish steak	2.593 kg/kg
kg of fish / kg of fish parings	18.18 kg/kg
kg of fish) / kg of fish flour	8.654 kg/kg
Inputs	
g tripolyphosphate/ kg of product	1.372 g/kg
g active chlorine) / kg of product	0.388 g/kg
Packages	
low density polyethylene (LDPE) bags (capacity of 0.8 kg) / kg of product	1.206 units/kg
cardboard boxes (capacity of 8.80 kg) / kg of product	0.115 units/kg
Ratios associated with the raw material	
Utilities	
water (litres) / kg of fish	8.366 l/kg
electricity (KW.h) / kg of fish	0.058 kWh/kg
ice / kg of fish	0.333 kg/kg

2.11. Palm Oil Processing Plant (358 kg of Raw Material / day)

Ratios associated with the products	
Raw material	
kg fruit bunches/ kg of palm oil	4.69 kg / kg
Packages	
Plastic gallon (unit of 50 litres) /kg of palm oil	0.0217 units/ kg

Labels (unit) /kg of palm oil	0.0217 units / kg
Utilities	
water (litres)/kg of raw material	8.1 l / kg
electricity (kWh)/ kg of raw material	0.1756 kWh / kg
firewood consumption (m3)/ kg of raw material	0.0251 kg / kg

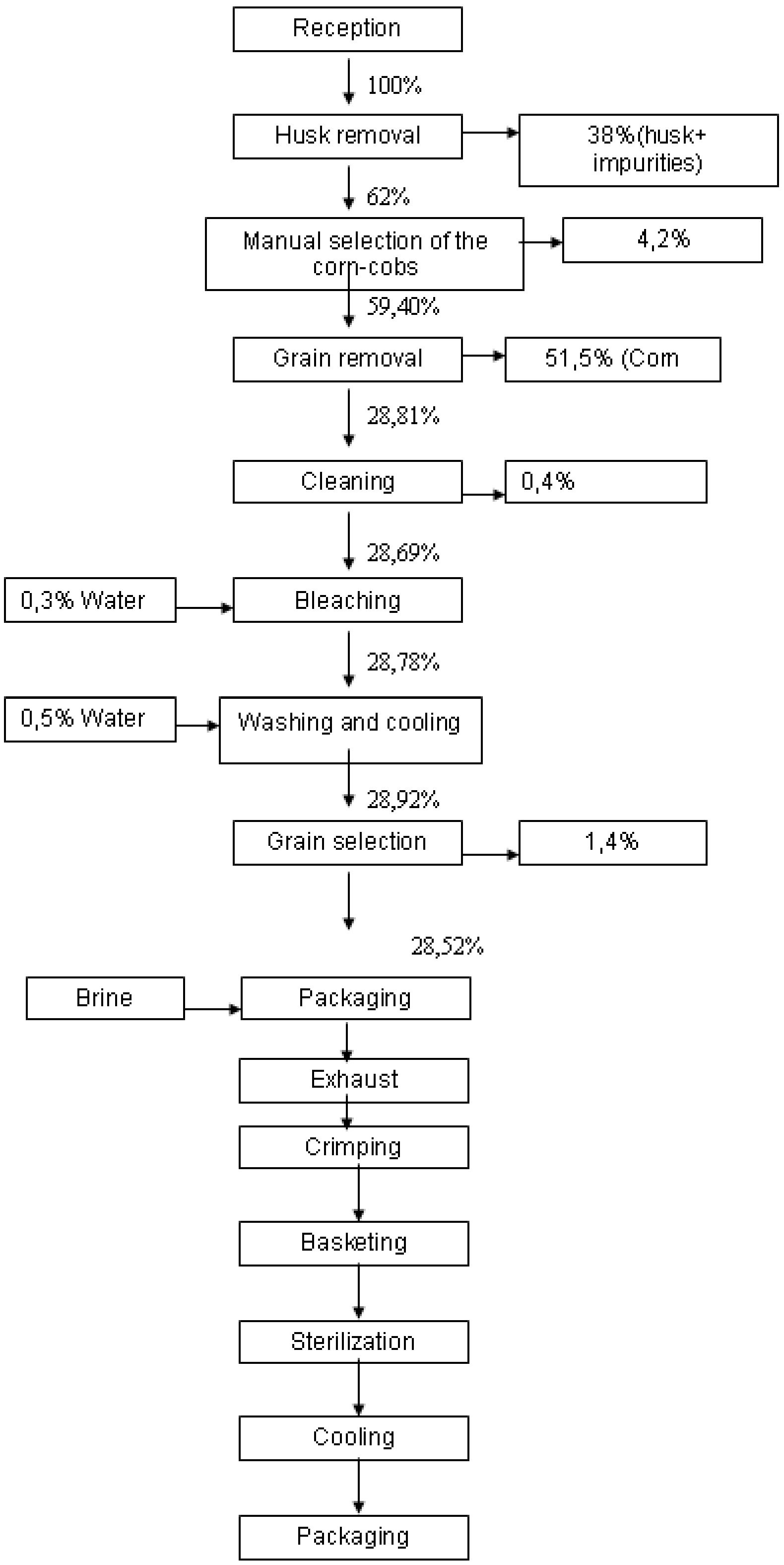
3. PART 2: TECHNICAL DESCRIPTION

3.1 Vegetable Canning

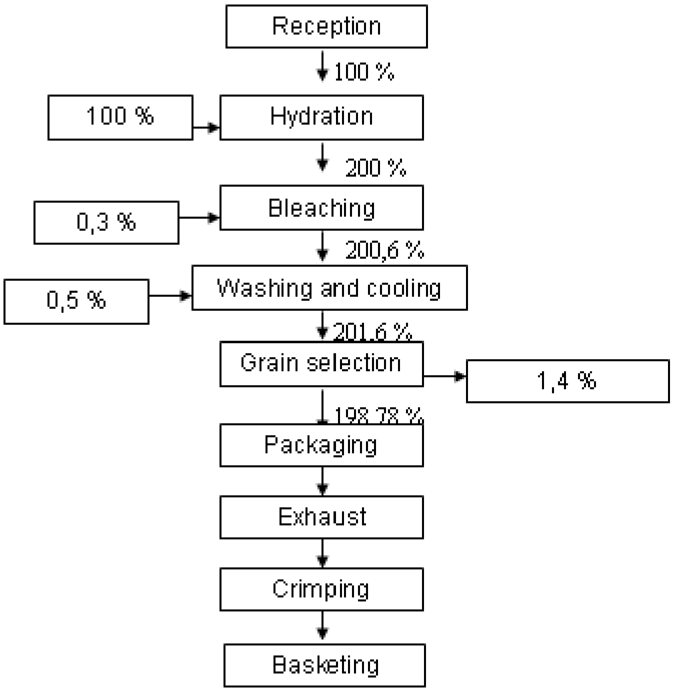
Overall Assumptions:

Working days per year: 260 (210 days/year '→ corn/peas and 50 days/year →pineapple)
Daily operational capacity: (600 kg of corn) + (100 kg of peas) + (250 pineapple units) = approximately 1075 kg of raw material.
Number of workers needed: 6 workers

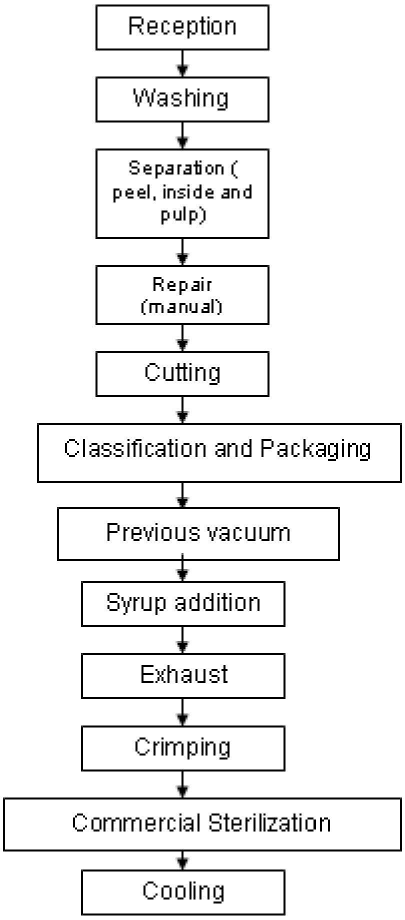
3.1.1. Flow chart for the corn canning process



3.1.2. Flow Chart for the pea canning process



3.1.3. Process Flow Chart for pineapple embedded in syrup



3.1.4. Processing ratios calculations

3.1.4.1. Corn

Corn (C) (100%) arrives in the processing line and undergoes a husk removal process, where there are approximately 38% of losses.
Corn without the husk = 100 - 38 = 62 %(C)
Corn without husk is then selected (4,2% of losses).
Selected corn = (100 - 4,2) x 62 = 59,40 %(C)
The selected corn undergoes a grain (kern) removal process (51,5% of losses).
Shelled Corn = (100 - 51,5) x 59,40 = 28,81%(C)
The shelled corn undergoes a cleaning process (0,4% of losses).
Cleaned corn = (100 - 0,4) x 28,81 = 28,69%(C)
The cleaned corn goes through a thermal treatment process, in which it incorporates a percentage of water (0,3%).
Treated corn = (100 + 0,3) x 28,69 = 28,78%
This product undergoes a cooling/washing process, during which it incorporates some percentage of water (0,5%).
Cooled corn = (100 + 0,5) x 28,78 = 28,92%
The cooled kerns go through a selection process (1,4% of losses).
Final product = (100 - 1,40) x 28,92 = 28,52%
The final product is ready for the packaging process, from which there are no more losses.
Hence, the processing ratio is:
Ratio = (Corn)/(Final product) = 3,5069 kg / kg of final product.
These calculations are summarized below.

Variable	**Name**	**Value**
Mv	Green Corn	100% = 600 kg
Mp = Mv -38	Corn without husk	62% = 372 kg
(100 – 4,2) x Mp = Ms	Selected corn	59,40% = 356,4 kg
(100 – 51,5) x Ms = Md	Shelled Corn	28,81% = 172,9 kg
(100 – 0,4) x Md = Ml	Cleaned corn	28,69% = 172,1 kg
(100 + 0,3) x Ml = Mb	Treated corn	28,78% = 172,7 kg
(100 + 0,5) x Mb = Mr	Cooled corn	28,92% = 173,5 kg
(100 – 1,40) x Mr = P1	Final corn	28,52% = 171,11 kg
Mv/P1	Ratio	3,51 kg/kg of final product

3.1.4.2. Peas

Peas (E) (100%) arrive at the processing line and undergo a hydration process (100% of gain).
Hydrated peas = 100 + 100 = 200 %(E)
The hydrated peas go through a thermal treatment (bleaching) in which they incorporate a percentage of water (0,3%).
Peas treated = (100 + 0,3) x 200 =200,6 %(E)
These peas undergo a cooling/washing process, and during this they incorporate a percentage of water (0,5%)
Cooled peas = (100 + 0,5) X 200,6 = 201,6%(E)
The cooled grains undergo a selection

Final product = (100 - 1,40) x 201,6 = 198,78%
The final product is ready for packaging. There are no more losses and the final processing ratio is:
Ratio = (Peas)/(Final product) = 0,50 kg / kg of final product.
The calculations are summarized below.

Variable	**Name**	**Value**
E	Peas	100% = 100 kg
Eh = 100 + 100	Hydrated peas	200% = 200 kg
Eb = (100 + 0,3) x Eh	Treated peas	200,6% = 200,6 kg
Er = (100 + 0,5) x Eb	Cooled peas	201,6% = 201,6 kg
P2 = (100 – 1,40) x Er	Final product	198,78% = 198,78 kg
E/P2	Ratio	0,50kg/kg of final product

3.1.4.3. Pineapple

The pineapple to be processed arrives at the processing plant without the crown (in order to demand less space during transportation). The approximate fruit yield, in solid particles, is 46%.
For the processing of pineapple embedded in syrup, the variety considered was Smooth Cayenne.
The daily amount of processed pineapple is 250 fruits. Taking into account that each fruit has about 2,5 kg, we have 625 kg of raw material per day
Pineapple (without the crown) = Raw material = Mi = 100% = 625 kg
Solid parts = Final product = P3 = 46% = 287,5 kg
Ratio = Mi/P3 = 2,17 kg of raw material / kg of final product
These calculations are summarized below.

Variable	**Name**	**Value**
Mi	Pineapple (raw material)	625 kg/day
P3	Final product	287,5 kg/day
Mi/P3	Ratio	2,17 kg/kg of final product

3.1.5. Water consumption ratios

It has been considered for this item that water is consumed in the hygiene process of the raw material, the hygiene of the processing plant, the workers use and an amount of 10% of the sum of the other items, as a security estimate.
a) raw material hygiene, hydration of peas and cooling.
- Corn:
For the corn hygiene process, the estimated consumption is 250 l of water.
A1 = 250 l/day
- Pineapple: for the hygiene of each kg of raw material, one uses 2,5 l of water. As such, it is possible to determine the water demand (A2).
A2 = 2,5 (l/kg) x 625 (kg) = 1562,5 l/ day
- Peas: The peas arrive dehydrated at the processing plant. So, it is necessary to hydrate them (this hydration process lasts approximately 10 hours) for the next processes. Each kg of peas incorporates 1 l of water during the hydration. Therefore one may determine the

water consumption (A3).
A3 = 100 (kg of peas) x 1(l/kg) = 100 l/ day
- Cooling: after the treatment of the corn and the peas, they undergo a washing/cooling process, in which the water amount required is 250 l (A4).
A4 = 250l/ day
b) Water consumption for equipment use
- Boiler
The boiler should work during 7 hours when the processing plant processes corn/peas, and 5 hours when processing pineapple. Each working hour the boiler consumes 500 l of water. Therefore, one can calculate the water volume (A5 and A6) utilized by the boiler:
A5 =7(l) x 0,5 (m3 water/h) = 3,5 m3 = 3500 l/ day
A6 = 5(l) x 0,5 (m3 water/h) = 2,5 m3 = 2500 l/ day
- Lung Vessel:
This vessel is used to elaborate the brine solution. The tank capacity is 150 l. For each 200g of canned vegetables, there are 120 g of brine (which is made of water, salt, sugar and sodium). Considering that the brine density equals to 1g/cm3, one may determine the water consumption for the brine (A7):
0,200 kg of canned vegetables --- 0,120 l of water
369,88 kg of canned vegetables --- A7
A7 = 221,93 l/ day
- Kettle
In order to prepare the pineapple syrup, it is necessary 287,55 kg of syrup.
112 kg of syrup - 100 l of water
287,55 kg of syrup - A8
A8 = 256,74 l/day
- Still Retort:
For the utilization of this equipment, 100 l of water/hour are necessary. When the plant processes pineapple, 3 working hours are required. Therefore, it is possible to determine de water consumption (A8).
A9 = 100 (l/h) x 3 (h) = 300 l/day
When the plant produces corn and peas, 5 working hours are required. Then, one may determine the water consumption (A9).
A10 = 100 (l/h) x 5(h) = 500 l/day
c) Hygiene in the Processing plant:
Water consumption was computed according to high-pressure washer equipment data, model HD585, 500 l / hour capacity, from the company KARCHER. As in the previous item, this water volume is needed for washing and sanitizing the plant.
Considering 1 hour as an average time for the hygiene process, then:
A11 = (500x1) = 500 l/day
d) Workers hygiene:
According to the Brazilian Labour Ministry's regulation: NR 24 - Sanitary and Comfort Conditions within the working sites (124.000-5), it is established a minimal daily water volume of 60 l for each worker, then
60 l water -------------------------- 1 worker/day
A3 -------------------------- 6 workers/day
A12 = 360 l/day
Total water consumption (Pineapple) = At1 = A2 + A6 + A8 + A9 + A11+ A12 = 5479,24 l/day
Ratio = At/(Mi) = 8,77 l/ kg of raw material
Total water consumption (Corn/Peas) = At2 = A1 + A3 + A4 + A5 + A7 + A10 + A11+ A12 = 5681,93 l/day
Ratio= At/(Mv + E) = 8,12 l/ kg of raw material
Average Ratio = 8,24 l/ kg of raw material
The calculations are summarized below.

Variable	Name	Value

A1	Corn Hygiene	250 l/day
A2	Pineapple Hygiene	1562,5 l/day
A3	Peas Hydration	100 l/day
A4	Cooling (Corn/ Peas)	250 l/day
A5	Boiler (Corn/ Peas)	3500 l/day
A6	Boiler (Pineapple)	2500 l/day
A7	Lung vessel	221,93 l/day
A8	Water for syrup	256,74 l/day
A9	Retort (Pineapple)	300 l/day
A10	Retort (Corn/ Peas)	500 l/day
A11	Plant Hygiene	500 l/day
A12	Workers	360 l/day
At/(Mv + E)	Ratio (Corn/Peas)	8,12 l/ kg of raw material
At/(Mi)	Ratio (Pineapple)	8,77 l/ kg of raw material
Average Ratio		8,24 l/ kg of raw material

3.1.6. Electricity Ratios

a) Electricity required for the equipments:
- Double Corn Husk Remover MOD JC 36 A

The capacity is 1000 cobs/hour and the equipment potency is 1 HP. Admitting a 2 hours and 30 minutes operation time, the energy consumption of this equipment will be:
E1 = 0,7457 (KW) x 2,5 (h) = 1,86 Kw.h/day
- Vapour kettle with reversible mixer MOD JC 02

The kettle is used to prepare the product covering syrup (or solution of sugar) called "fruit in syrup". The estimated preparing time is 2 hours. The motor potency utilized is 2 HP. So, one can determine the energy outlay (E2).
E2 = 2 (HP) x 0,7457 (KW/HP) x 2 (h) = 2,983 KW.h/day.
- Exhaust Tunnel MOD JC 31

This equipment is used for producing vacuum within the cans. Its potency is 1 HP and the operation time is approximately 2 hours long, so that the energy consumption is:
E3 = 1 (HP) x 0,7457 (KW/HP) x 2(h) = 1,49 kWh/day.
-Horizontal Firewood boiler MOD JC 100

The boiler operates during 7 hours when the plant processes corn and peas (E4), and it operates for 5 hours when processing pineapple (E5). The motor potency of this equipment is 2 HP. The energy spent is:
E4 = 2 (HP) x 0,7457 (KW/HP) x 7(h) =10,44 KW.h/day.
E5 = 2 (HP) x 0,7457 (KW/HP) x 5(h) =7,46 KW.h/day.
- Corn/ Pea Washer MOD JC 22 E

The washer has a processing capacity up to 500 kg/h. Therefore, one hour of working time supplies the amount of corn/pea produced per day. The motor potency used is 0,5 HP. This way, we may determine the energy consumption (E6)
E6 = 0,5 (HP) x 0,7457 (KW/HP) x 1(h) = 0,37 KW.h/day.

- Pre-cooker for corn MOD JC 24 E
The pre-cooker has a processing capacity up to 500 kg/h. Therefore, one hour working period supplies the amount of corn/peas produced per day. The potency of the motor utilized is 3 HP. This way, one can determine the energy outlay (E7)
E7 = 3 (HP) x 0,7457 (KW/HP) x 1(h) =2,24 KW.h/day.
- Manual Crimper MOD JC 28
This equipment has a capacity of 20 cans per minute. The plant estimate is for an approximate production of 1850 cans/day for corn/peas and 640 for pineapple. The estimated operation time is 2 hours for the corn/pea (E8) and 1 hour for the pineapple (E9). Knowing that the motor potency is 1 HP, and then the energy consumption can be calculated as followed:
E8 = 1 (HP) x 0,7457 (KW/HP) x 2 (h) = 1,49 KW.h/day
E9 = 1 (HP) x 0,7457 (KW/HP) x 1 (h) = 0,75 KW.h/day
- High pressure washer, model HD585 KARCHER, 2,2 KW potency, considering 1 hour working time
E10 = 2,2(Kw-h) x 1 (h) = 2,2 KW.h/day.
b) Energy consumed due to illumination:
The energy consumption calculations due to illuminating the agro industrial plant were based on the Lumens Method in accordance with FILHO, (2002).
Considerations:
Light coloured walls and ceiling, dark coloured pavement.
Necessary illumination
Reception and washing, as well as processing and packaging area
Stocking and Storage area: 500 lux
Offices: 250 lux
Utilization of wide lamps in a continuous line
By means of the calculations indicated by FILHO (2002), it was established the light/ m2 ratio as 0,8 KW/m2
For this canned fruits and vegetables processing plant, it was assumed an area of 100 m2.
Consequently, the energy spent with illumination is:
E11 = 0,18 (KW.h/m2) x 100 (m2) = 18 KW.h/day.

c) Energy consumed by the administrative area
The energy consumption within the administrative area (including one restaurant, two toilets and one office with a total area of 40 m2) is as follows:
Office: 0,390 KW.h
Restaurant: 0,130 KW.h
Toilets: 0,260 KW.h
Total administrative area (E12): 0,78 KW.h/day.
Total electricity consumption (Pineapple) = Et1 = E2 + E3 + E5 + E9 + E10 + E11 + E12 = 31,46 kWh/day.
Ratio = Et/(Mi) = 0,050 kWh/ kg of raw material
Total electricity consumption (Corn/Peas) = Et2 = E1 + E3 + E4 + E6 + E7 + E8 E10 + E11+ E12 = 38,88 kWh/day
Ratio = Et2/(Mv + E) = 0,056 kWh/kg of raw material
Average ratio = 0,055 kWh/kg of raw material
The calculations are summarized below

Variable	Name	Value
E1	Corn Husk Remover	1,86 kWh/day
E2	Bowl 250 l	2,98 kWh/day
E3	Exhaust Tunnel	1,49 kWh/ day

E4	Boiler (corn/peas)	10,44 kWh/ day
E5	Boiler (pineapple)	7,46 kWh/ day
E6	Corn washer	0,37 kWh/ day
E7	Pre-cooker	2,24 Kw-h/ day
E8	Crimper (corn/peas)	1,49 kWh/ day
E9	Crimper (pineapple)	0,75 Kw-h/ day
E10	High Pressure Washer	2,2 KW.h/ day
E11	Light	18 kWh/ day
E12	Management area	0,78 kWh/ day
Et1/(Mi)	ratio(pineapple)	0,050 kWh/kg of raw material
Et2/(Mv + E)	ratio(corn/peas)	0,056 kWh/kg of raw material
Average Ratio		0,055 kWh/kg of raw material

3.1.7. Firewood consumption ratio

The firewood consumption of the boiler is 0,25 m3/h. It will work 7 hours per day when the processing corn and peas (L1) and 5 hours when processing pineapple (L2). Therefore, one can determine the daily firewood consumption:

L1 = 0,25 m3/h x 7 h = 1,75 m3/day

Ratio = L1/(Mv + E) = 0,0025 m3/kg of raw material

L2 = 0,25 m3/h x 5 h = 1,25 m3/day

Ratio = L2/(Mi) = 0,0020 m3/kg of raw material

Average Ratio = 0,0024 m3/kg of raw material

The calculations are summarized below

Variable	**Name**	**Value**
L1	Firewood (Corn/Peas)	1,75 m3/day
L2	Firewood (Pineapple)	1,25 m3/day
L1/(Mv + E)	Ratio (Corn/peas)	0,0025 m3/kg of raw material
L2/(Mi)	Ratio (Pineapple)	0,0020 m3/kg of raw material
Average Ratio		0,0024 m3/kg of raw material

3.1.8. Sanitizing material consumption ratio

a) Sanitizer required for the pineapple

For the sanitization of the pineapple, 50 % of the water for hygiene is required. The recommended chlorine concentration is 5 ppm (MEDINA 1987). Therefore, one can determine the sanitizer consumption (S1) as:

S1 = 0,5 x 1562,5 (l) x 5/1000000(kg/l) = 0,003 kg/day

b) Sanitizer required for the plant hygiene process

For the plant sanitization 500 l of water will be needed. The recommended chlorine concentration is 200 ppm (ANDRADE, 1996). Therefore, we may determine the sanitizer consumption (S2).

S2 = 500 (l) x 200/1000000(kg/l) = 0,10 kg/day

Ratio = (S1 + S2)/P3 = 0,00036 kg/kg of final product

Ratio = (S2)/(P1 + P2) = 0,00027 kg/kg of final product

These calculations are summarized below.

Variable	Name	Value
S1	sanitizer (pineapple)	0,003 kg/day
S2	sanitizer (room)	0,10 kg/day
(S1 + S2)/P3	Ratio (pineapple)	0,00036 kg/day
S2/(P1 + P2)	ratio (corn/peas)	0,00027 kg/day

3.1.9. Packaging ratios

The can utilized has a capacity of storing 320 g. 200g of this capacity corresponds to the preserved vegetables and 120 g correspond to the brine added. The can for the pineapple embedded in syrup has a storing capacity of 900 g, and 450g of this capacity corresponds to the pineapple slices, while 450 g corresponds to the syrup to be added. Hence, if we know the final product quantity produced per day, it is possible to determine the daily amount of cans necessary.

1 can - 0,200 kg

Lt1 - 369,88 kg

Lt1 = 1850 cans/day (Corn and peas)

Ratio (corn and peas) = Lt1/(P1 + P2) = 5 cans/kg of final product

1 can - 0,45 kg

Lt2 - 287,5 kg

Lt2 = 639 cans/day (pineapple)

Ratio (pineapple) = Lt2/P3 = 2,22 cans/kg of final product

These calculations are summarized below.

Variable	Name	Value
Lt1	Cans (Corn/peas)	1850 cans/day
Lt2	Cans (pineapple)	639 cans/day
Lt1/(P1 + P2)	Ratio (corn/peas)	5 cans/kg of final product
Lt2/P3	Ratio (pineapple)	2,22 cans/kg of final product

3.1.10. Ratios for other inputs

a) Inputs for corn and peas

In the manufacture of brine, for each 100 l of water, it is necessary kg of sugar, 2 kg of salt and 20 g of sodium bicarbonate. For each 200 g of the final product, 120 g of brine is required (if assumed that 120 g = 120 ml). If we know the final product quantity produced per day, we can obtain the consumption of these inputs for the brine solution.

Amount of brine necessary = 221,93 l of brine/day

Amount of salt necessary (I1) = 2/100 (kg/l) x 221,93 (l) = 4,44 kg/day

Ratio = I1/(P1 + P2) = 0,012 kg/kg of final product

Amount of sugar necessary (I2) = 2/100 (kg/l) x 221,93 (l) = 4,44 kg/day
Ratio = I2/(P1 + P2) = 0,012 kg/kg of final product
Amount of bicarbonate necessary (I3) = 0,020/100 (kg/l) x 221,93 (l) = 0,044 kg/day
Ratio = I3/(P1 + P2) = 0,00012 kg/kg of final product
These calculations are summarized below

Variable	Name	Value
I1	Salt	4,44 kg/day
I2	Sugar	4,44 kg/day
I3	Bicarbonate	0,044 kg/day
I1/(P1 + P2)	Ratio (salt)	0,012 kg/ kg of final product
I2/(P1 + P2)	Ratio (sugar)	0,012 kg/ kg of final product
I3/(P1 + P2)	Ratio (bicarbonate)	0,00012 kg/ kg of final product

b) Inputs for pineapple
For preparing the pineapple syrup, 79 kg of sugar are needed for each 100 l of water, having a yield of 112 kg of syrup. For each 450 g of final product, 450 g of syrup are used (if assumed that 450 g = 450 ml. If we know the final product quantity produced per day, we can obtain the daily consumption of inputs.
Amount of syrup necessary = 287,55 kg/day.
Amount of sugar necessary (I4) = 287,5 (kg) x 79/112 (kg/kg) = 202,83 kg/day
Ratio = I4/P3 = 0,71 kg/kg of final product
These calculations are summarized below.

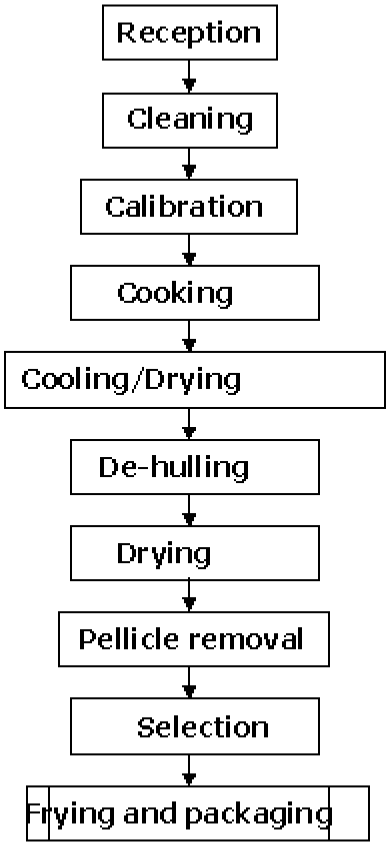
Variable	Name	Value
I4	Sugar	202,83 kg/day
I4/P3	Ratio	0,71 kg/kg of final product

3.2. Cashew Nuts

Overall Assumptions:
- Plant processing per day: 500 of raw cashew
- Fried nuts production (Packages of 400 g)
- Number of workers: 17 workers (1 manager, 1 secretary, 15 workman)
- Number of working days in a year: 260 (Saturdays and Sundays not accounted)
- Plant working period: 8 hours per day

Observation: all the final ratios will be presented associated with the final product and raw material quantity.

3.2.1. Processing Flow Chart:



3.2.2. Processing Ratios

According to the technicians from CNPAT/EMBRAPA (2003), one may consider the following data:
Raw material: cashew nut (Initial moisture content: Ui =20%)
Residue: peel
Residue uptake: LCC (Nut peel liquid)
For the calculations of the yields and losses over the various processing stages, we will assume 500 kg of raw cashew nut (M1), the equivalent to 1 production day
a) Initial drying (pre-storage):
Data: initial moisture content of 20% and final of 8% (CNPAT/EMBRAPA, 2003).
Process: 500 kg (raw nut) 434,8 kg (dry nut)
Losses (P1): 500 - 434,8 = 65,2 kg (evaporated water)
b) Initial cleaning:
Data: 5% of dirt and impurities (average) (CNPAT/EMBRAPA, 2003).
Process: 434,8 kg (dried nut) 413,05 kg (cleaned nut)
Losses (P2): 434,8 - 413,05 = 21,75 kg (dirt and impurities)
c) Cooling and Drying:
Data: average weight gain of 3% (CNPAT/EMBRAPA, 2003).
Process: 413,05 kg (cleaned nut) 425,45 kg (cooled nut)
Gains (G1): 425,45 - 413,05 = 12,4 kg (water absorption)
d) De-hulling
Data: average of 55,31% (initial weight) of peel (FERRÃO, 1995)
Process: 425,45 kg (cooled nut) 148,9 kg (nut without peel)
Losses (P3): 425,45 - 148,9 = 276,55 kg (peel - residue)
e) Drying
Data: initial moisture content of 10% and final of 5% (CNPAT/EMBRAPA, 2003).

Process: 148,9 kg (nut without peel) 141,05 kg (dried and naked nut)
Losses (P4): 148,9 - 141,05 = 7,85 kg (evaporated water)
f) Pellicle removal:
Data: average of 2,04% (initial weight) of pellicles (FERRÃO, 1995)
Process: 141,05 kg (dried and naked nut) 130,85 kg (raw almond)
Losses (P5): 141,05 - 130,85 = 10,20 kg (pellicles)
g) Selection:
Data: average of 20% of pieces, bungs (CNPAT/EMBRAPA, 2003).
Process: 130,85 kg (raw almond) 104,7 kg (selected raw almond)
Losses (P6): 130,85 - 104,70 = 26,15 kg (pieces, bungs, etc.)
h) Frying:
Data: average of 5% of water loss (CNPAT/EMBRAPA, 2003).
Process: 104,7 kg (selected raw almond) 99,45 kg (fried almond)
Losses (P7): 104,7 - 99,45 = 5,25 kg (water)
i) Salting:
Data: average weight gain of 2% (SILVA et.al, 2003)
Process: 99,45 kg (fried almond) 101,45 kg (A1- salty fried almond)
Gains (G2): 101,45 - 99,45 = 2,0 kg (salt)
j) Residues utilization (peels):
Data: average of 18% nut peel liquid (SILVA et.al, 2003)
Process: 276,55 kg (peels) 49,78 kg (LCC)
Losses: 276,55 - 49,78 = 226,72 kg (waste cake)
These calculations are summarized below.

Variable	Name	Value
M1	Initial raw material	500 kg/day
P1	Water loss (Initial drying)	65,2 kg/ day
P2	Dirt loss (Initial cleaning)	21,75 kg/ day
G1	Absorption gain (Cooling)	12,40 kg/ day
P3	Peels loss (De-hulling)	276,55 kg/ day
P4	Water loss (Drying)	7,85 kg/ day
P5	Pellicle loss (Pellicle removal)	10,20 kg/ day
P6	Pieces loss (Selection)	26,15 kg/ day
P7	Weight loss (Frying)	5,25 kg/ day
G2	Salt gain (Salting)	2,00 kg/ day
A1	Salty fried almond	101,45 kg/ day
LCC	Nut peel liquid (residue)	49,78 kg/ day
M1/A1	Ratio 1	4,9285 kg nut/kg almond
M1/LCC	Ratio 2	10,0442 kg nut/kg LCC

Ratio 1 = (500/101,45) = 4,93 kg of nut/kg of almond.
Ratio 2 = (500/49,78) = 10,04 kg of nut/kg of LCC

3.2.3. Water Consumption Ratios:

The computation considered the water required for plant and equipment hygiene, boiler usage (vapour generation), workers use and also a figure of 10% of all the other items, as a safety estimate.

a) Equipment and Processing Plant Hygiene:

Water consumption was computed according to the high-pressure washer model HD585, capacity of 500 l/hour. Considering an average time for hygiene of 90 minutes for the plant and 75 minutes for the equipments, and also taking into account that the plant is cleaned every 5 days, then:

A1 = (500x2,75)/5 = 275 l of water per day

b) Boiler:

Water consumption was estimated as 150 l/h. If we consider 10 hours as a daily operational period, then:

A2 = (150x10) = 1500 l of water per day

c) Workers hygiene:

According to the Brazilian Labour Ministry: NR 24 - Sanitary and Comfort Conditions in the work site (124.000-5), which establishes a minimal water volume of 60 l for each worker, we have:

60 l water --------------------------- 1 worker / day

A3 --------------------------- 17 workers / day

A3 = 1020 l of water per day

These calculations are summarized below

Variable	**Name**	**Value**
A1	Plant and Equipments Hygiene	275 l/day
A2	Boiler use	1500 l/day
A3	Workers hygiene	1020 l/day
A4 = (A1+A2+A3) x 0,10	Safety mark (10%)	279,5 l/day
At/Mi	Ratio	8,57 l/kg initial raw material

Total water consumption per day = 275 + 1500 + 1020 + 279,5 = 3074,5 l

Water Ratio: 3074,5 / 500 = 6,149 l de water/ kg initial raw material

3.2.4. Electricity Ratios:

a) Plant Operations

Here, we took into account the daily individual consumptions of each piece of equipment of the processing line suggested by (SILVA et.al., 2003). The electrical potency values and estimated usage time of these equipments were supplied by the suppliers RICAJU, BENETRON and KARCHER, from Brazil.

- Rotational Calibrator, potency of 2 HP, or 1,4914 KW, which works 1,5 hours per day. Therefore,

E1 = 1,4914 x 1,5 = 2,24 KW.h

- Vertical boiler, potency of 3 HP, or 2,237 KW. Considering 10 hours of work, then:

E2 = 2,237 x 10 = 22,37 KW.h

- Metallic stove run by vapour, potency of 5 HP, or 3,7285 KW. Considering 6 hours of work, then:

E3 = 3,73 x 6 = 22,37 KW.h

- Rotational pellicle remover, potency of 1 HP, or 0,7457 KW. Considering 1 hour of work, we have

E4 = 0,7457 x 1 = 0,75 KW.h

- Stamping machine, potency of 0,20 HP, or 0,15 KW. Considering 1 hour of work,

E5 = 0,15 x 1 = 0,15 KW.h

- Vacuum Crimper, potency of ½ HP, or 0,37285 KW. Considering 2 hours of work, then
E6 = 0,37285 x 2 = 0,75 KW.h
- Centrifuge with ½ HP, or 0,37285 KW. Considering ½ hour of work, then,
E7 = 0,37285 x 0,5 = 0,19 KW.h
- High-pressure washer, potency of 2,2 KW, considering 2,75 hours of work every 5 days,
E8 = (2,2 x 2,75)/5 = 1,21 KW.h
Subtotal of consumed energy per day
Energy 01 = 2,24 + 22,37 + 22,37 + 0,75 + 0,15 + 0,75 + 0,19 + 1,21 = 50,03 KW.h
b) Energy required for illumination of the processing room:
The calculation of the electricity required for the agro industrial plant illumination was based on the Lumens approach (FILHO, 2002). For this plant, we considered 0,2 KW.h/m2 as the ratio. This has originally been calculated for the dried banana project, but was used here given the similarity between both production processes (see item 3.3.). The interested reader can see more details concerning the kind of calculations in the study mentioned above.
Because the total production area was intended to be 86,5 m2 (SILVA et al., 2003), the electricity consumption due to illumination is the following:
The daily electricity consumption due to illumination (E9): 0,2 x 86,5 = 17,30 KW.h
c) Electricity needed for the office (administration):
For this plant, the office's electricity consumption was considered to be 0,78 KW.h/day (E10), which had been calculated for the dried banana project (see item 3.3). The interested reader can see more details concerning the kind of calculations in the study mentioned above.
These calculations are summarized below.

Variable	**Name**	**Value**
E1	Rotational calibrator	2,24 kWh/day
E2	Vertical boiler	22,37 kWh/day
E3	Metallic stove	22,37 kWh/day
E4	Rotational pellicle remover	0,75 kWh/day
E5	Stamping machine	0,15 kWh/day
E6	Vacuum crimper	0,75 kWh/day
E7	Centrifuge	0,19 kWh/day
E8	High pressure washer	1,21 kWh/day
E9	Room Illumination	17,30 kWh/day
E10	Office consumption	0,78 kWh/day
Et/Mi	Ratio	0,1362 kWh/kg of initial raw material

Total electricity (Et) = E1 + E2 + E3 + E4 + E5 + E6 + E7 + E8 + E9 + E10 = 68,11 KW.h
Electricity Ratio: (68,11)/(500) = 0,1362 KW.h / kg of initial raw material

3.2.5. Firewood Consumption

The firewood need was computed based in the boiler's daily consumption. The boiler supplier consulted (RICAJU) estimated a usage of 1 m3 of firewood per working hour. The total operation time (9,7 hours) was calculated based in the individual use estimate for each equipment that needs water vapour (1,5 h for the retort, 6 h for the stove, 0,2 h for the humidification room and 2 h for upkeep).
V1 = 1 x 9,7 = 9,7 m3/day
These calculations are summarized below

Variable	Name	Value
V1	Firewood boiler	9,7 kg de m3/ day
Vt/Mi	Ratio	0,0194 kg/kg of initial raw material

Ratio: (9,7)/(500) = 0,0194 m3 of firewood / kg of initial raw material

3.2.6. Gas Consumption:

According to RICAJU's (equipment supplier) indications, the gas fryer, with the capacity of 10 kg of vegetable oil and 6 kg of nuts per operation, presents the following gas consumption relationship:
1 kg of gas ----------------------------- 1 working hour
G1 ---------------------------------1,5 working hour
G1 = 1,5 kg de GLP per production day
These calculations are summarized below

Variable	Name	Value
G1	Fryer	1,5 kg de GLP/ day
GLPt/Mi	Ratio	0,003 kg/kg of initial raw material

Ratio: (1,5)/(500) = 0,003 kg of gas / kg of raw material

3.2.7. Sanitizer Consumption (Active Chlorine):

The total sanitizer (active chlorine) consumption, considers the need for processing plant and equipment sanitization. If we assume that 35% of the water used for hygiene (S1) is supposed to be utilized in the sanitization process, then we have a total of 481,25 l. For such process, it was also considered that the water spent has a concentration of 200 ppm or 200 mg of active chlorine per litre of solution (ANDRADE & MACEDO, 1996).
Total consumption: (481,5 x 200)/1000 = 96,3 g of active chlorine / day
These calculations are summarized below

Variable	Name	Value
S1	Sanitizer for the plant and equipments	96,3 g/day
S1/A1	Ratio	0,94924 g/kg of fried nuts

Total consumption of active chlorine per day (S1) = 96,3 g.
Sanitizer ratio: 96,3/(101,45) = 0,95 g of active chlorine/ kg of fried nuts

3.2.8. Salt Consumption:

According to SILVA et al. (2003), during the salting stage, one is allowed to add 2% of salt proportionally to the fried nuts weight. For the capacity being considered in this work (500 kg of nut/day), we have 99,45 kg of fried nuts without salt per day. Therefore, it is possible to obtain the required daily salt quantity:
S1 = 99,45 x 0,02 = 1,989 kg/day

The ratio can be then calculated:
Salt consumption ratio: 1,989/(101,45) = 0,0196 kg salt / kg of fried nuts

3.2.9. Vegetable Oil Consumption:

According to SILVA et al. (2003), in a small-scaled factory that produces 24,47 tons of fried nuts per year, the vegetable oil consumption is 810 L. Consequently, this project's consumption (26,38 tons per year) can be estimated through the approach below:

24472,8 kg of nuts ------------------- 810 L of vegetable oil
26377 kg of nuts ------------------- X
X = 873,03 l of oil / year
Ratio (O1) = (873,03)/(26377) = 0,0331 l of vegetable oil / kg of fried almond

3.2.10. Consumption of Packaging Materials:

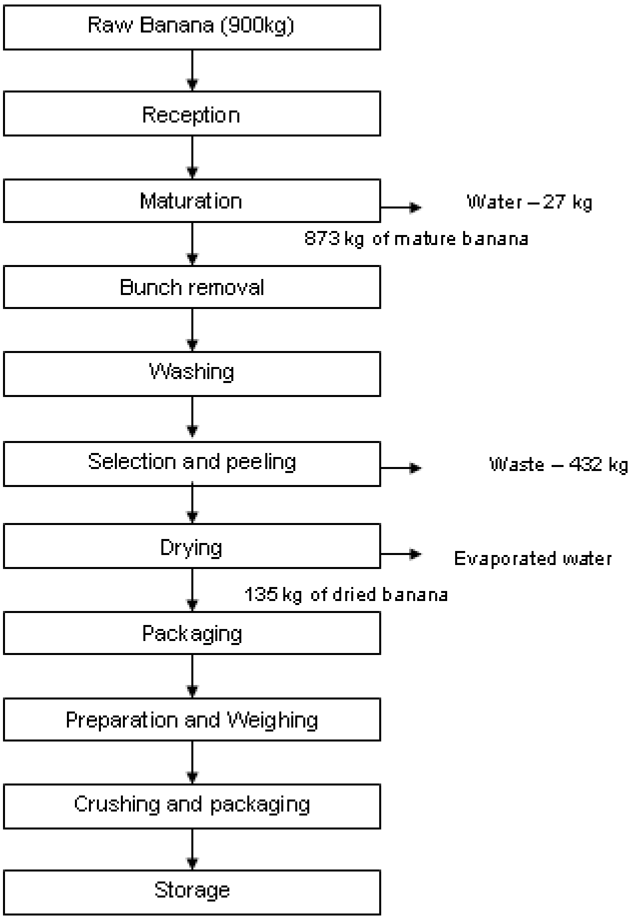
The package consumption estimation was made by taking into account that all the production will be packed within low-density polyethylene bags with the capacity of 400 g. As the daily production is 101,45 kg of fried nuts, the number of bags required per day will be:
Package consumption: (101,45 / 400) x 1000 254 bags/day
This calculation is summarized below.

Variable	Name	Value	Ratio
Package1	PE bags / 400 g	day	2,5037 bags/ kg of fried nuts

3.3. Dried Banana

Overall Assumptions
- Plant daily processing capacity: 900 kg of raw banana.
- Number of workers: 6 (1 manger+ 1 secretary + 4 workmen)
- Number of working days per year: 260 (Saturdays and Sundays not accounted).
- Plant working period: 8 hours.
- Working period within the banana drying area: 24 hours
Observation: all the final ratios will be presented associated with the final product quantity

3.3.1.Flow Chart of the Dried Banana Process



3.3.2. Processing Ratios

According to TRAVAGLINI, NETO, BLEINROTH and LEITÃO, (1993):
Raw material: raw banana (Initial moisture content: Ui=75%)
Final product: dehydrated banana (Final moisture content: Uf = up to 23%)
Waste: banana peel
Waste uptake: Dried banana peel flour.
Observation: The banana peel flour will be used as an animal feed.
The percentages below are associated with the raw material (raw banana).
Initial raw material (Mi) = 900 kg of green banana per day
Maturation (PAM): water loss (3%): 900 x 0,03 = 27,0 kg
Mature banana: 900 - 27,0 = 873,0 kg
Residues (R) = peel (48% of the green banana): 900 x 0,48 = 432,0 kg
Banana without peel: (mature banana) - (peel) = 873 - 432,0 = 441,0 kg
Drying (PAS): water loss (34%): 900 x 0,34 = 306,0 kg
Product 1: (BANPAS) Dried banana (15%): 900 x 0,15 = 135 kg
Product 2: (FCB) banana peel flour (14,4%): 900 x 0,144 = 129,6 kg
These calculations are summarized below:

Variable	Name	Value
Mi	Initial raw material	900 kg/day
PAM	Maturation water loss	27 kg/day

R	Residues	432 kg/day
PAS	Drying water loss	306 kg/day
BANPAS = Mi - PAM – R - PAS	Dried Banana	135 kg/day
FCB	Banana peel flour	129,6 kg/day
Mi/BANPAS	Ratio 1	6,67 kg of banana/kg of dried banana
Mi/FCB	Ratio 2	6,944 kg of banana/kg of banana peel flour

Ratio 1 = (900/135) = 6,67 kg of banana/kg of dried banana.
Ratio 2 = (900/129,6) = 6,944 kg of banana/kg of banana peel flour

3.3.3 Water Consumption Ratios:

This item takes into account the water required for the hygiene processes of both raw materials and plant equipment, as well as workers' usage. An additional 10% of the total usage was also considered, as a safety measure.
a) Raw material hygiene process:
According to TRAVAGLINI, NETO, BLEINROTH, LEITÃO, (1993), it is necessary 2 L of water for each raw material kg. Then:
2 L water ---------------------------- 1 kg of green banana
A1 --------------------------- 900 kg of green banana
A1 = 1800 L of water per day
In this item, the calculated water volume is used for the washing, sanitization and raw material rinsing processes.
c) Processing plant hygiene:
Water consumption was estimated according to the specifications of the high-pressure washer model HD585, capacity of 500 L/ hour, from the supplier KARCHER. As in the previous item, this water volume is designated for the processing plant washing and sanitization.
Considering 1 hour as an average time for hygiene, then:
A2 = (500x1) = 500 L of water per day
d) Workers hygiene:
According to the Brazilian Labour Ministry regulation NR 24 - Sanitary and Comfort Conditions in the Work Site (124.000-5), 60 L is established as a minimal water volume per day for each worker. Therefore:
60 L water --------------------------- 1 worker / day
A3 --------------------------- 6 worker / day
A3 = 360 L of water per day
These calculations are summarized below

Variable	**Name**	**Value**
A1 A2 A3 A4 = (A1+A2+A3) x 0,10	Raw material washing Plant Hygiene Workers hygiene Guarantee (10%)	1800 L/day 500 L/day 360 L/day 316 L/day
At/Mi	Ratio	3,251 L/kg

		initial raw material

Total water consumption per day = 2660 + 266 = 2926 L
Water ratio: 2926 / 900 = 3,251 L of water/ kg initial raw material

3.3.4. Electricity Ratios

a) Electricity required for plant equipment
The computed data are in accordance with the equipment suggested by STRINGHETA et al. (2003). They are:
- Fencer, a part of the drying system (dehydrator MELONI, model PD 250H, potency of 1 HP or 0,7457 KW, which works 24 hours).
E1 = 0,7457 x 24 = 17,90 KW.h
- Grinder, 3 HP, or 2,237 KW. If we consider 1 working hour, then,
E2 = 2,237 x 1 = 2,237 KW.h
- High pressure washer, model HD585 KARCHER, 2,2 KW potency, considering 1 working hour,
E3 = 2,2 x 1 = 2,2 KW.h
b) Electricity needed for illumination:
The calculation for the energy consumed with the agro industrial plant illumination was based upon the Lumens method according to FILHO, (2002).
The following considerations and computations were made:
Ceiling and wall painted with light colours, floor with dark colour.
Necessary illumination:
Reception, washing, processing and packaging areas: 500 lux;
Storage/ stocking and other areas: 100 lux
Offices: 250 lux
Use of wide lamps in a continuous line
Reception, washing, preparation and packaging areas; it was considered a need for 9 lamps with 2 fluorescents light bulbs of 65 W each (3 lamps for each room).
For the dehydration area, it was considered a need for 2 lamps with 2 fluorescents light bulbs of 40W each.
For the storage/stocking area and office, it was taken into account the need for 1 lamp with 1 light bulb of 65 W

The daily electricity consumption due to illumination is: E4 = 10,71 KW.h
c) Electricity consumption within the managing area:
The managing area includes 1 restaurant, two toilets and an office. The total area is 40 m2. As such, we have the following needs:
Office: 0,390 KW.h
Restaurant: 0,130 KW.h
Toilets: 0,260 KW.h
Total administrative area (E5): 0,78 KW.h
These calculations are summarized below

Variable	**Name**	**Value**
E1	Dryer fencer	17,90 kWh/day
E2	Grinder	2,237 kWh/day
E3	High pressure washer	2,20 kWh/day
E4	Illumination	10,71 kWh/day

E5	Office equipment	0,78 kWh/day
Et/Mi	Ratio	0,03759 kWh/kg of initial raw material

3.3.5. Gas Required For The Dryer:

In accordance with the supplier's indications (MELONI Consulting), the dryer PD 250H suggested for the banana drying process, with a capacity of 450 kg of banana without peel, presents the following gas consumption relationship:
1,62 kg de GLP ---------------------------- 1 operational hour
m --------------------------------24 operational hours
m = 38,8 kg of gas per production day
These calculations are summarized below.

Variable	Name	Value
gas	Liquefied Petroleum Gas	38,8 kg/day
GLPt/Mi	Ratio	0,04311 kg/kg of initial raw material

Ratio: (38,8)/(900) 0,04311 kg of gas / kg of initial raw material

3.3.6. Sanitizer Ratio

The total sanitizer consumption is estimated for usage in the processing plant cleaning and in two raw material washing processes.
a) Raw material hygiene:
Of all the water used for the raw material hygiene process, we considered 50 % for washing, 40 % for sanitization and 10% for rinsing, then:
a.1) Washing (50% of the total water):
The first hygiene stage is simple water washing, in which the dirt is removed only through the physical contact between the water and the fruits.
a.2) Sanitization (40% of the total water) (S1):
In accordance with TRAVAGLINI et al. (1993), for the raw material washing, it is necessary the immersion of the fruits inside vessels, containing a prepared solution of 50 ppm of active chlorine = 50 mg of chlorine / litre of solution.
Active chlorine quantity = 50 mg (1800 L of water) x (0,40 sanitization) / 1 L = 36000 mg = 36 g.
a.3) Raw material rinsing (10% of total water) (S2):
According to TRAVAGLINI et al., (1993) this process is performed with a chlorine solution (20 ppm), then:
Active chlorine quantity = 20 mg (1800 L of water) x (0,10 rinsing) / 1 L = 3600mg = 3,6 g.
b) Processing plant hygiene (S3):
According to ANDRADE & MACEDO, (1996) this process is fulfilled with a chlorine solution of 200 ppm. Of the total water used for the plant cleaning, half (50%) is needed for washing, 20% for sanitization and 30% for rinsing (without the use of chlorine), therefore:
Active chlorine quantity = (200 mg) x (500 L of water) x (0,2 washing)/ 1 L = 20000 mg = 20 g.
These calculations are summarized as follows:

Variable	Name	Value
S1 S2 S3	Sanitizer for raw material washing Sanitizer for raw material	36 g/day 3,6 g/day 20 g/day

	rinsing Plant hygiene	
St/BANPAS	Ratio	0,2252 g/kg of dried banana

The total active chlorine consumption per day (St) = 36 + 3,6 + 20 = 59,6 g.
Sanitizer ratio: 59,6/(135) =0,4415 g of active chlorine/ kg of dried banana

3.3.7.Calcium Carburet Ratio

The calcium carburet is widely used in the maturation rooms, where the bananas are placed in order to achieve the ideal maturation point for processing. According to TRAVAGLINI et al., (1993) the relationship between the compound and the room's volume is:
2,66 g of calcium carburet ----------------------------- 1 m3 of room
m ---------------------------- 6,5 m3 of room
m = 17,29 g of Carburet of Calcium (CC)
These calculations are summarized below.

Variable	Name	Value
CC	Calcium carburet	17,29 g/day
CCt/BANBAS	Ratio	0,1281 g/kg of dried banana

Ratio: 17,29/(135) = 0,13 g calcium carburet / kg of dried banana

3.3.8. Sulphur Dioxide Ratio

The sulphur dioxide (SO2) is used in order to avoid banana darkening due to enzymatic reactions which occur in the fruits. The residual sulphur concentration mustn't exceed 100 ppm. According to TRAVAGLINI et alii (1993), the relationship compound per kg of banana is:
250 g de SO2 ---------------------------- 100 kg of banana
m ---------------------------- 900 kg of banana
m = 2,25 kg of SO2 per day
These calculations are summarized below.

Variable	Name	Value
DE	Sulphur dioxide	2,25 g/day
DEt/BANPAS	Ratio	16,67 g/kg of dried banana

Ratio: 16,67 g de SO2 / kg of dried banana

3.3.9. Packaging Calculations

Packages utilized:
a) Polyethylene bags
a1) Low density Polyethylene sacs (LDPE) for 10kg (pac.1) = 37 sacs/day
Capacity of 10 kg for packaging the dried banana and for the final product: 10 kg dried banana.
During one operation day, 135 kg of dried banana are produced. Consequently, 14 sacs are necessary to pack this amount. In addition, 70% of the production is packed in quantities of 10 kg. Then we have: 135 x 0,7 = 94,5 kg of dried banana inside these packages. Therefore, 10 more sacs will be needed.
In order to pack the peel flour, 10 kg bags will be utilized, so the amount of bags, 129,6/10 = 12,96 = 13 LDPE bags of 10 kg for flour.

- LDPE sacs (10kg) ratio / kg of dried banana: 0,10 Unit/kg of dried banana
- LDPE sacs (10kg ratio / kg of banana peel flour: 0,10 Unit/ kg of peel flour

b) Cellophane sheets for 200g (Pac.2) = 14 sheets/day

The cellophane sheets are indicated for the 200g dried banana packages. Each sheet packs 15 portions of 200 g.
The cellophane sheet dimensions are: 1,00m x 1,00m
Of the entire dried banana production, 30% is packed in these packages; therefore we have: 135 x 0,30 = 40,50 kg of dried banana. In order to know the amount of sheets needed, we have: (40,50/0,200)/15 = 13,50, i.e., 14 sheets are required.
- Ratio: Cellophane sheet/kg of dried banana = 0,333 Unit. / kg of dried banana
c) Cardboard boxes

c1) Wavy cardboard boxes with capacity of 4 kg (Pac.3) = 10 boxes/day
These boxes will be used as secondary packages for dried banana (200g). The amount of boxes needed may be calculated as follows:
Dried banana: (135 x 0,30)/4 = 10,13 = 10 boxes
- Wavy cardboard boxes ratio (4kg)/kg of dried banana: 1/4 = 0,25 Unit/kg of dried banana
c2) Wavy cardboard box with capacity of 10 kg (Pac.4) = 10 boxes/day
These boxes will be used as secondary packages for dried banana (10 kg). The amount of boxes needed is: (135 x 0,7)/10 = 9,45 = 10 boxes
- Wavy cardboard boxes ratio (10 kg)/ kg of dried banana = 1/10 = 0,10 Unit/ kg of dried banana.
d) Labels (Pac.5) = 228 labels/day

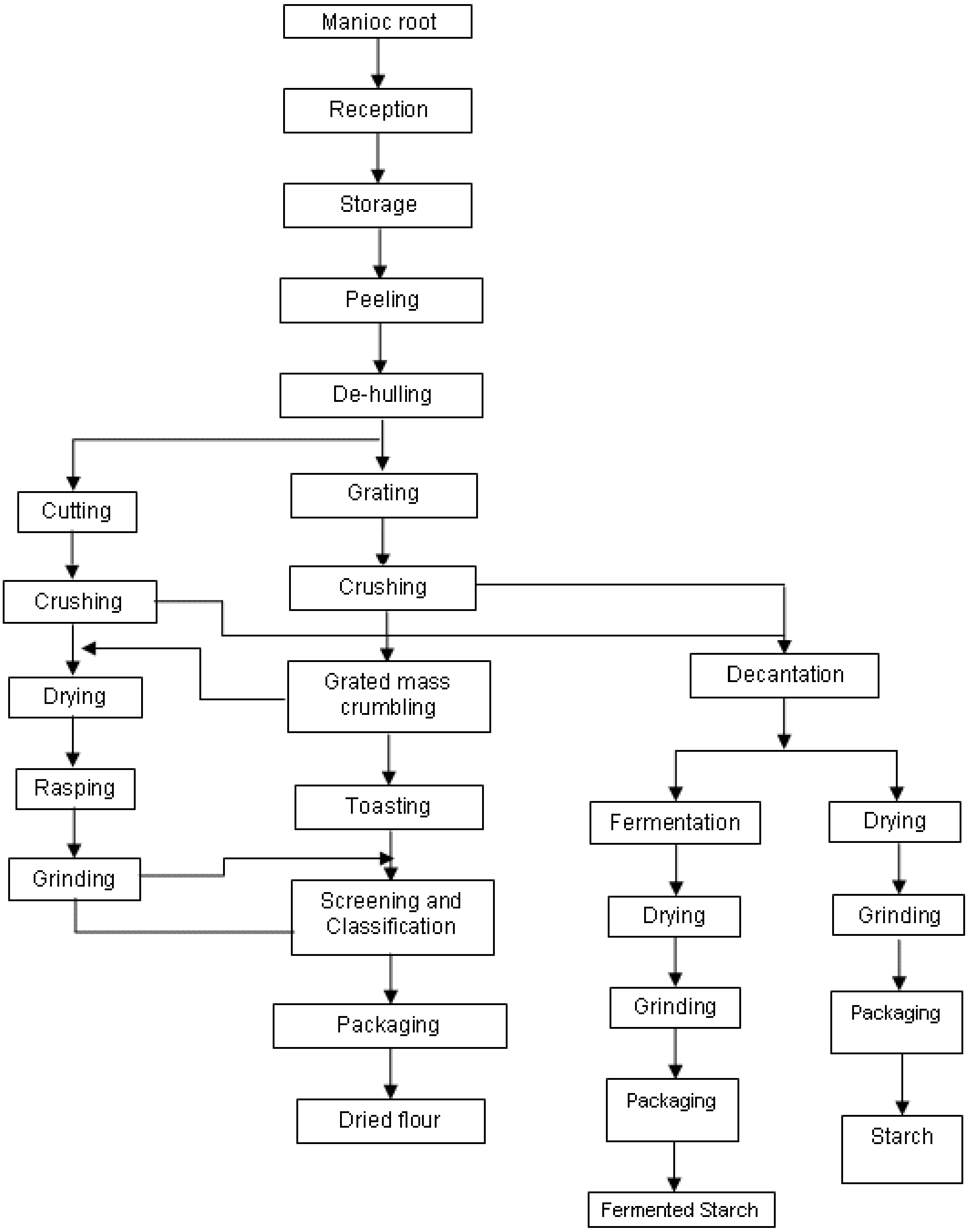
The amount of labels is computed in accordance with the amount of packages produced, which includes the 10 kg sacs and the 200g packages. Therefore:
205 units for the de 200g packages of dried banana, ratio: 5 labels/ kg of dried banana (200g).
10 units for the 10 kg sacs of dried banana, ratio: 0,1 label/kg of dried banana.
13 units for the 10 kg sacs of flour, ratio: 0,1 label/ kg of dried banana.
These calculations are summarized below.

Variable	**Name**	**Value**	**Ratio**
Pac.1	LDPE sacs for 10kg	37 sacs/day	0,10 Unit/ kg of dried banana 0,10 Unit/ kg of peel flour
Pac. 2	Cellophane sheets	14 sheets/day	0,333 Unit/ kg of dried banana
Pac. 3	Cardboard boxes for 4kg	10 boxes/day	0,25 Unit/ kg of dried banana
Pac.b4	Cardboard boxes for 10kg	10 boxes/day	0,10 Unit/ kg of dried banana
Pac. 5	Labels	228 labels/day	5 Unit/ kg of dried banana (200g) 0,1 Unit/ kg of dried banana (10kg) 0,1 Unit/ kg of peel flour (10kg)

3.4. Manioc Flour

Overall Assumptions
- Plant processing capacity per day: 5000 kg of manioc root.
- Labour amount: 8 (1 manager + 1 secretary + 6 operational workers)
- Amount of working days in a year: 260 (Saturdays and Sundays not accounted)
- Plant working period: 10 hours

3.4.1. Flow Chart of Manioc Processing, Including Waste Utilization



3.4.2. Processing Ratios

According to CRUZ et al. (2003), we have the following data:
Raw material: manioc root
Final product: manioc flour (final moisture content: Uf = 10-12%)
Wastes: peels, "crueira" (waste fibre material), starch
Waste uptake: rasps and starch
Observation: The rasps will be used as fertilizer and/or for cattle feeding. From the starch, one can produce sour and sweet fine manioc powder, which can be used as an ingredient for bakery products.
The percentages displayed are associated with the raw material need (manioc root)

Initial raw material (Mi) (100%): 5000 kg of manioc root per day
Evaporated water over the process (AEP) (13,37%): 5000 x 0,1337 = 668,50 kg
Peels (C) (19,62%): 5000 x 0,1962 = 981,00 kg
"Crueira" (Cru) (3,89%): 5000 x 0,0389 = 194,50 kg
Disposal (D) (9,02%): 5000 x 0,0902 kg = 451,00 kg
Waste water + Starch (AA) (28,92%): 5000 x 0,2892 = 1446,00 kg
Product 1: (FMS) Dried manioc Flour (25,18%): 5000 x 0,2518 = 1259 kg
Product 2: (Ami) Starch (1,735%): 5000 x 0,01735 = 86,76 kg
Product 3: (Rp) Rasps (3,89%): 5000 x 0,0389 = 194,50 kg
These calculations are summarized below.

Variable	Name	Value
Mi	Initial raw material	5000,00 kg/day
AEP	Evaporated water over the process	668,50 kg/ day
C	Peels	981,00 kg/ day
CRU	“Crueira”	194,50 kg/ day
D	Disposal	451,00 kg/ day
AA	Waste water + Starch	1446,00 kg/ day
FMS	Dried Manioc Flour	1259,00 kg day
Ami	Starch	86,76 kg/ day
Rp	Rasps	194,50 kg/ day
Mi/FMS	Ratio 1	3,97 kg of manioc root/kg of manioc flour
Mi/FCB	Ratio 2	57,63 kg of manioc root /kg of starch
Mi/Rp	Ratio 3	25,71 kg of manioc root//kg of rasps

Ratio 1 = (5000/1259) = 3,97 kg of manioc root//kg of manioc flour
Ratio 2 = (5000/86,76) = 57,63 kg of manioc root/kg of starch
Ratio 3 = (5000/194,50) = 25,71 kg of manioc root/kg of rasps

3.4.3. Water Consumption Ratio:

This item considers water consumption over the starch and manioc flour processing, as well as for the processing plant hygiene and the use by workers. In addition, an additional estimate of 10% of the total consumption was considered, as a safety precaution.
a) Water consumed by the equipments:
Calculations followed the equipment specifications that form the Manioc Flour Kit from the Machines Industry D'ANDRÉA S.A. In order to have a daily processing capacity of 5000 kg of manioc, 5000 L are required
A1 = 5000 L of water per day
Here, the water volume supplies the capacity of all equipments used, stage by stage.
b) Processing plant hygiene:
Water consumption was estimated in accordance with the technical specifications of the high-pressure washer, model HD585, with capacity of 500 L/ hour, from the company KARCHER. As with the previous item, this water volume is to be utilized for washing and sanitizing the plant. Considering 1 hour as an average time for the hygiene process, we have:
A2 = (500x1) = 500 L of water per day

c) Workers hygiene:
According to the Brazilian Labour Ministry regulation NR 24 - Sanitary and Comfort Conditions in the Work Site (124.000-5), a minimal water volume of 60 L per day for each worker it is established. Therefore, we have:
60 L water -------------------------- 1 worker/ day
A3 -------------------------- 8 workers / day
A3 = 480 L of water per day
These calculations are summarized below

Variable	Name	Value
A1	Water used by the equipments	5000 L/day
A2	Plant Hygiene	500 L/day
A3	Workers hygiene	480 L/day
A4 = (A1+A2+A3) x 0,10	Guarantee (10%)	598 L/day
At/Mi	Ratio	1,32 L/kg initial raw material

Total water consumption per day = 5980 + 598 = 6578 L
Water ratio: 6578 / 5000 = 1,32 L of water/ kg of initial raw material

3.4.4. Electrical Energy Ratios

a) Electricity required by the equipment
According to the supplier Machines Industry D'Andrea, which provides the equipments for the manioc flour production, the following equipment is required:
- Transporting conveyor belt;
- Washer/ peeler;
- Grater;
- Mass bomb;
- Hydraulic crusher;
- Left right screw thread
- Crumbler (Bran reducer);
- Transporting screw thread;
- Classification set;
- Transporting screw thread;
- Transferring bomb;
- Drying, pelage kit.

The potency of these equipments, for processing 5000 kg of manioc, according to the provider, is approximately 26 CV. We considered 10 hours as the plant working period. If we transform this quantity into electricity consumption, we have the following:
E1 = 0,7457 (KW /CV) x 26 (CV) x 10h = 193,9 KW.h per day
- High pressure washer, model HD585 KARCHER, 2,2 KW potency, considering 1 working hour,
E2 = 2,2 x 1 = 2,2 KW.h
b) Electricity consumption due to illumination
The calculation of the electricity due to the agro industrial plant illumination was based upon the Lumens method, in accordance with FILHO, (2002).
Considerations:
Ceiling and wall painted with light colours, floor painted with a dark colour.
Necessary illumination
Reception and washing, processing and packaging areas: 500 lux;
Storage/stocking and other areas: 100 lux
Offices: 250 lux
Utilization of wide lamps in a continuous line

For the reception, washing, preparation and packaging areas, a need for 9 lamps with 2 fluorescents light bulbs of 65 W each was considered, being 3 lamps for each room.
For the dehydration area, 2 lamps with 2 fluorescents light bulbs of 40W each were considered.
For the storage/stocking area and the office, 1 lamp with 1 light bulb of 65 W is needed
Therefore it was possible to establish an electricity ratio due to illumination per industrial area, which is equal to 0,18.
Electricity daily consumption due to illumination is: E3 = 329 x 0,18 = 59,22 KW.h
c) Administrative area electricity consumption
The administrative area electricity consumption takes into account a restaurant, two toilets and an office. The total area is 40 m2.
The calculations were made based on the reference mentioned above.
Office: 0,390 KW.h
Restaurant: 0,130 KW.h
Toilets: 0,260 KW.h
Total administrative area (E4): 0,78 KW.h
These calculations are summarized below

Variable	**Name**	**Value**
E1	Manioc flour set	193,9 kWh/day
E2	High pressure washer	2,20 kWh/day
E3	Illumination	59,22 kWh/day
E4	Office equipment	0,78 kWh/day
Et/Mi	Ratio	256,1 kWh/kg of initial raw material

Total energy (Et) = E1 + E2 + E3 + E4 = 256,1 KW.h
Electricity ratio: (256,1)/(5000) = 0,05122 KW.h / kg of initial raw material

3.4.5. Firewood Required for the Manioc Flour Toasting Equipment

According the indications of the supplying company Machines Industry D'ANDREA S.A, the kit for manioc flour toasting for a daily processing capacity of 5000 kg of manioc, consumes 2,0 m3 of firewood (L), as summarized below.

Variable	**Name**	**Value**
L	Firewood	2,0 m3/day
L/Mi	Ratio	0,0004 m3/kg of initial raw material

Ratio: (2,0)/(5000) 0,0004 m3 of firewood / kg of initial raw material

3.4.6. Sanitizer Ratio

The total sanitizer consumption is computed in relation to the cleaning needs of the processing plant. Accordingly, we have:
a) Processing plant hygiene process (S1):
According to ANDRADE & MACEDO, (1996), this process is carried out using a chlorine solution with a concentration of 200 ppm. Half of the total water is utilized for cleaning. From these, 30% is for washing, 20% for sanitization and 30% for rinsing (without using chlorine).
Hence
Active chlorine quantity = (200 mg) x (500 L of water) x (0,2 washing)/ 1 L = 20000 mg = 20 g.
These calculations are summarized as follows:

Variable	**Name**	**Value**

S1	Plant hygiene	20 g/day
St/FMS	Ratio	0,016 g/kg of initial raw material

The total active chlorine consumption per day (St) = 20g.
Sanitizer ratio: 20/(5000) =0,004 g of active chlorine/ kg of initial raw material

3.4.7. Packaging Ratios

Packages employed:
a) Polyethylene bags
a1) Polypropylene bags (PP) p/ 1kg (Emb1) = 1346 bags/day.
1259 kg of toasted manioc flour are produced per day. Therefore, 1259 LDPE bags (1 kg) is needed to pack this quantity.
In addition, approximately 87 kg of starch are produced per day, which represents the result of the residues utilization. Consequently, 87 additional 1 kg bags are required for packaging this product.
The total PP packages quantity used per day is equal to 1346 bags.
- PP bags (1kg) ratio/ kg of manioc flour: 1 Unit./kg of manioc flour.
- PP bags ratio (1kg) / kg of sour or sweet fine powder: 1 Unit./ kg of powder.

a2) Twisted Low density Polyethylene (LDPE) for 50 kg (Pac2) = 4 bags/day.

These packages are supposed to pack the manioc rasps. 194,5 kg of rasps are produced per day. Therefore, 194,5/50 = 4 packages per day are needed for this product.
b) Labels (Pac3) = 1350 labels/day

The amount of labels was computed in accordance with the amount of packages produced in one day:
1259 units the packages of 1 kg of toasted manioc flour, ratio: 1 label/ kg of manioc flour.
87 units for the packages of 1 kg of fermented starch, ratio: 1 label/kg of starch.
4 units for the packages of 50 kg of manioc filings (rasps), ratio: 0,02 labels/kg of rasps.
These calculations are summarized below.

Variable	Name	Value	Ratio
Pac1	PP bag 1kg	1346 bags/day	1 Unit/ kg of manioc flour 1 Unit/ kg of starch
Pac2	Crisscrossed LDPE bag 50 kg	4 bags/day	0,02 Unit/ kg of rasps
Pac3	Labels	1350 labels/day	1 Unit/ kg of manioc flour 1 Unit/ kg of starch 0,02 Unit/ kg of rasps

3.5. Milk Cooling

Overall Assumptions
Working days per year: 365
Operational capacity: 1000L/day
Raw material quantity processed in a year: 365000 L
Observation: The plant cleaning occurs every other day, i.e., the water, sanitizer, detergent and washer electricity consumption should be divided by two in order to obtain the daily consumption.

3.5.1. Processing ratio

Raw milk suffers only a cooling process. Therefore, there are no losses.

Raw material (MP) = produced milk = 1000 L/day
Final product (P) = cooled milk = 1000 L./day
Ratio = MP/P = 1L/ L of final product
These computations are summarized below

Variable	Name	Value
MP	Produced milk	1000 L
P	Final product	1000 L
MP/P	Ratio	1L/ L of final product

3.5.2. Electrical Energy Ratios

The cooling tank remains turned on approximately 18 hours per day. As the motor reducer has a 3,7285 KW potency, one can calculate the energy consumption (E1) as follows:
E1 = 3,7285 (KW) x 18 h = 67,113 kWh
For washing the plant, one uses a high-pressure washer with a potency of 2,20 KW. Then, we may calculate the electricity consumption (E2).
E2 = 2,20 (KW) x 1 (h) /2 = 1,10 kWh
The total electricity consumption is:
Et = E1 + E2 = 68,213 kWh.
Ratio = Et/MP = 0,068213 kWh/L of raw material
These calculations are summarized below

Variable	Name	Value
E1	Tank	67,113 kWh
E2	Washer	1,10 kWh
Et/MP	Ratio	0,068213 kWh/L of raw material

3.5.3. Water usage ratio

We estimated that for each litre of cooled water, 2 L of water are necessary for the following operations: cleaning the plant, washing the tank and washing the utensils used in the process, such as milk cans. Therefore, one is able to determine the water expenditure (A).
2 L of water - 1 L of cooled milk
2A -- 1000 L of cooled milk
2A = 2000 L
A = 1000 L
Ratio = A/MP = 1L/L of raw material
These calculations are summarized as follows

Variable	Name	Value
A	Water	1000 L
A/MP	Ratio	1L/L of raw material

3.5.4. Detergent usage ratio

The alkaline detergent is a formulation used to remove milk fat that remains inside the cooling tank and the cans. The detergent added to the water (0,5 kg per 100L) is then

applied to this solution. 1500 L of water are designated for washing the tank and utensils (30 % initial washing, 20/% detergent mixture, 50% rinsing) 20 % of this is for the mixture with the detergent. Hence, it is possible to determine the detergent consumption (D).
Water for mixture = 0,2 x 1500 L = 300 L
0,5 kg - 100 L
2D -- 300L
D = 0,75 kg
Ratio = D/P = 0,00075 kg/ L of final product.
These calculations are summarized below.

Variable	Name	Value
D	Detergent	0,75 kg
D/P	Ratio	0,00075 kg/ L of final product

3.5.5. Sanitizer ratio

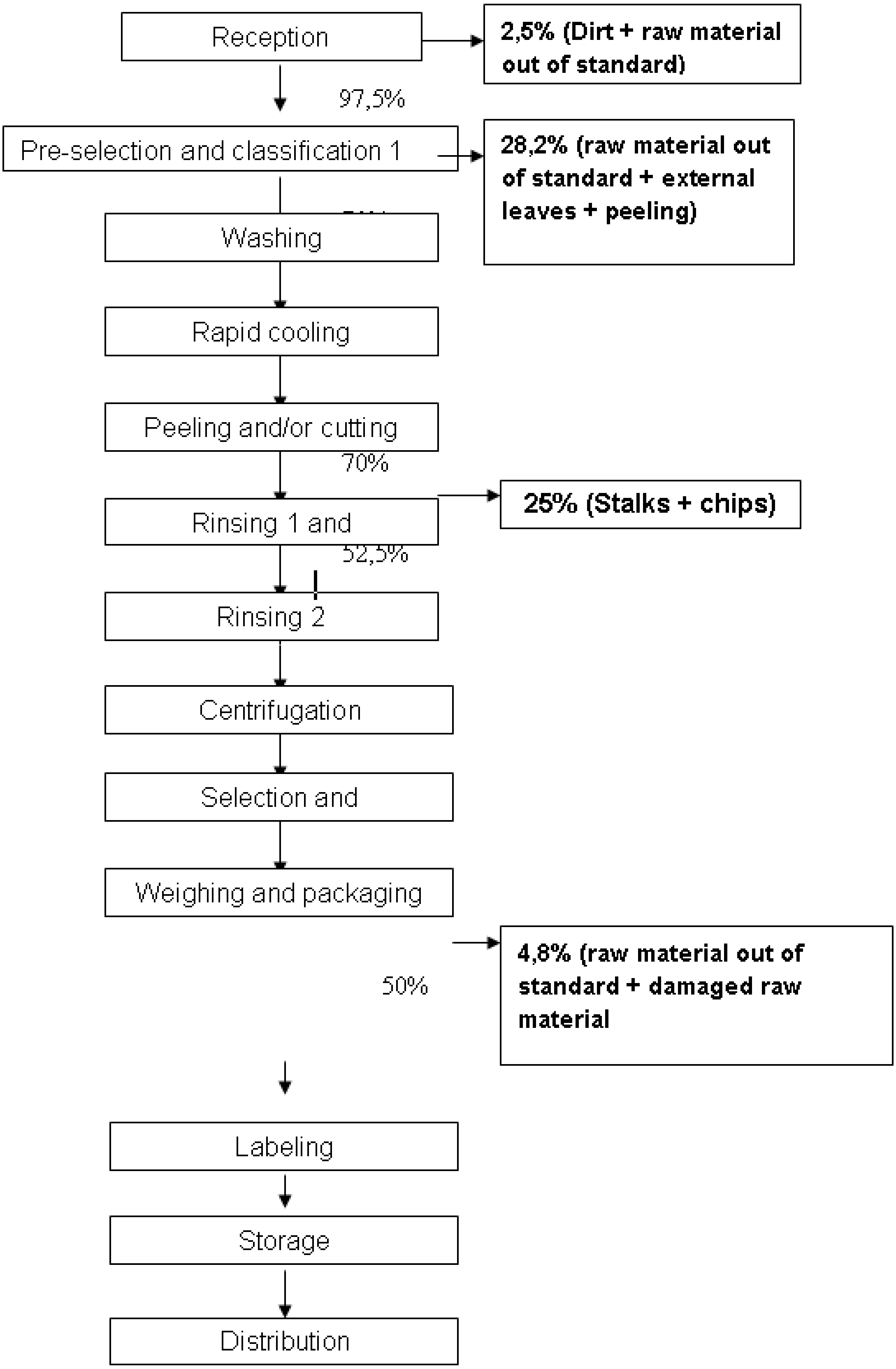
Water consumption due to the room's hygiene: 500 L
Chlorine quantity in the sanitization: 200 ppm, according to ANDRADE, 1996.
The sanitizer daily consumption (S) is:
0,2 g of active chlorine - 1 L of water
2S - 500 L of water
S = 0,050kg.
ratio = S/P = 0,00005 kg/ L of final product
These calculations are summarized below.

Variable	**Name**	**Value**
S	sanitizer	0,050 kg
S/P	Ratio	0,00005 kg/ L of final product

3.6. Minimally Processed Vegetables

Overall Assumptions
Working days per year: 260
Operational capacity: 800 kg/day
Raw material processed in a year: 208000 kg
Number of working hours per day: 8
Number of workers: 12 (1 manager, 1 secretary and 10 workmen)

3.6.1. Processing flow chart



3.6.2. Processing ratios

The vegetables arrive at the processing site and during the reception, they undergo a selection process. Losses (Dirt + raw material out of standard) correspond to 2,5% (PUSCHMANN 2004).
Selected vegetables1 (Vs1) = 100 - 2,5 = 97,5%(V)
The selected vegetables are washed and the damaged parts are discarded (ex.: external leaves). In this procedure, losses correspond to 28,2% (PUSCHMANN, 2004).
Washed vegetables (Vl) = (100 - 28,2) x 97,5 = 70,0%(V)
The washed vegetables undergo a rapid cooling, and after this procedure, they are cut and or discarded. The losses (stalks + chips) over the peeling stage correspond to 25% (PUSCHMANN 2004).
Cut vegetables (Vc) = (100 - 25) x 70 = 52,5%
The cut vegetables are sanitized, rinsed and then centrifuged (during this process, one is encouraged to regulate the centrifuging time in order to remove the water that had been incorporated to the vegetable and to avoid loss of constitution water). After these procedures, the vegetables are selected again (now they are ready to be weighed and packed). Losses (product out of standard and damaged raw material) during this process correspond to 4,8% (PUSCHMANN 2004).
Selected vegetables 2 = Final product (P) = (100 - 4,8) x 52,5 = 50,0%
V/P= (800 kg/day)/(400 kg/day) = 2 kg/kg of final product.
These calculations are summarized below.

Variable	Name	Value
V	Vegetables	100%
Vs1 = V-2,5	Selected vegetables 1	97,5%
Vl = Vs1 x (100 – 28,2)	Washed vegetables	70,0%
Vc = Vl x (100 – 25)	Cut vegetables	52,5%
Vs2 = P = Vc x (100 – 4,8)	Selected vegetables 2	50,0%
V/P	Ratio	2 kg/kg of final product

3.6.3. Electrical Energy Ratio

The electricity consumption presentation is divided into the needs for illumination and equipment usage.
a) .Food processor
The food processor used has a processing capacity of 250 kg/h.
To determine how long the processor is utilized in a day, all we need to do is a simple proportional rule:
250 kg - 1 hour
400 kg - X hours
X = 1,6 hour
To improve accuracy in the calculation, one considers the food processor working period as 2 hours. As the processor potency is 1000 W, the electricity consumption (E1) per day is:
E1 = 1000 W x 2,0 h = 2,0 kWh
b) .Industrial centrifuge
The centrifuge used has a processing capacity of 10 kg of food per cycle. If we consider that each cycle lasts an average time of 5 minutes, then we have the following result:
10 kg - 5 min.
400kg - X min.
X = 200 min. = 3,33 hours

We consider the centrifuge working period as 3,5 hours. As its potency is 1300 W, the electricity consumption (E2) per day is:
E2 = 1300 W X 3,5 h = 4,55 kW-h
c) Hygiene system
The washer used operates for 3,5 hours (since 1730L of water are necessary for the hygiene procedure) per day. As the washer potency is 2200 W, the electricity consumption (E3) per day is:
E3 = 2200 W x 3,46 h = 7,61 kWh
d) Residue collector
The residue collector operates for 2 hours per day, and since it has 1119 W power, the electricity required (E4) per day is:
E4 = 1119 W x 2,0 h = 2,238 kWh.
e) Cold water generation system
The cold water generation system working period equals to 8 hours per day. This equipment potency is 7457 W, so that the electricity consumption (E5) per day is:
E5 = 7457 W x 8,0 h = 59,656 kWh.
e) Cold chamber
The cold chamber used has an average working time of 18 hours per day. The compressor potency is 1000 W, so that the electricity consumption (E6) per day is:
E6 = 1000 W x 18 h = 18,0 kWh
f) Air conditioner
4 air conditioning devices are necessary in the processing room. Each one has a potency of 18000 BTU/h. These will be turned on during the processing period (8 hours), (2 in full swing and 6 hours with 25% of the refrigeration capacity). Therefore, one can determine the electricity required (E7) for these devices.
Total potency = 4 x 18000 BTU/h = 72000 btu/h
1 BTU/h - 0,29307 W
72000 BTU/h - Potency (W)
Potency (W) = 21101,04 W
E7 = 21101,4 W x 2 h + 21101,4 W x 6h x 0,25 = 42,202 kWh + 31,65 kWh = 73,85 kWh
g) Electricity consumption due to the plant illumination
The electricity calculation due to the agro industrial plant's illumination was based on the Lumens approach, according to FILHO, 2002.
Considerations: Ceiling and walls light-coloured, floor dark-coloured.
Necessary illumination:

Reception and washing, processing and packaging area: 500 lux;
Storage/stocking and other areas: 100 lux
Offices: 250 lux
Use of wide lamps in a continuous line
The electricity consumption ratio due to the agro-industrial plant's illumination was determined. This ratio is 0,1785 kWh/m2. Therefore, one can determine the daily consumption required for illumination (E8).
Agro-industrial plant area = 173 m2
0,1785 kWh - 1 m2
E8 - 173 m2
E8 = 30,8805 kWh.
h) Electricity consumption of the administrative area
The energy consumption of the administrative area includes the needs of one restaurant, two toilets and one office, with a total area of 40 m2.
The calculations were made based on FILHO (2002). Accordingly, we found the daily consumption (E9) below:
Offices: 0,390 KW.h
Restaurant: 0,130 KW.h
Toilets: 0,260 KW.h

E9 = 0,390 kWh + 0,130 kWh + 0,260 kWh = 0,78 kWh.
i) Overall Electricity Consumption Ratio Determination
To determine the final ratio, one should obtain the total electricity consumption per day (Et) and divide this figure by the final product daily quantity (P).
Total consumption (Et) = E1 + E2 + E3 + E4 + E5 + E6 + E7 + E8 + E9 =199,56 kWh/day
Ratio = (Et)/(V) = 0,3682 kWh / kg of raw material
These calculations are summarized below.

Variable	Name	Value
E1	Food processor	2,0 kWh/day
E2	Centrifuge	4,55 kWh/day
E3	Hygiene system	7,70 kWh/day
E4	Residue collector	2,238 kWh/day
E5	Cold water generation system	59,656 kWh/day
E6	Cold chamber	18,0 kWh/day
E7	Air conditioner	73,85 kWh/day
E8	Room illumination	30,8805 kWh/day
E9	Managing area	0,78 kWh/day
Et/P	Ratio	0,24945 kWh / kg of raw material

3.6.4. Water ratio

a).Water consumption during washing
In accordance with PUSCHMANN (2004) for each kg of processed raw material, 10 L of water are required during processing. Over the washing procedure, 40% of water is needed (PUSCHMANN, 2004). In this way, we can determine the water consumption during the washing (A1).
10 L - 1 kg of processed raw material
At L - 400kg of processed raw material
At = Total water consumption during the processing = 4000 L
A1 = 0,40 x At = 1600 L
b) Water consumption with sanitization
In the sanitization process, 35% of the water used within the processing is needed (PUSCHMANN, 2004). Then, the water usage for sanitization is calculated (A2).
A2 = 0,35 x At = 1400 L
c) Water consumption during rinsing
In the rinsing procedure, 25% of the water utilized for processing is required (PUSCHMANN, 2004). Then, the water consumption due to rinsing is calculated (A3) as:
A3 = 0,25 x At = 1000 L
d) Water consumption due to the plant hygiene
For the hygiene process, the expected water consumption corresponds to 10 L of water/m2 (PUSCHMANN 2004). Therefore, one may determine the water consumption (A4) as:
Useful area = 173 m2
10 L - 1 m2
A4 - 173 m2
A4 = 1730 L
e) Water available for worker usage

The NR 14 norm of the Brazilian Labour Ministry requires that, for each worker, there should be 60 L of water. Since this project's labour demand corresponds to 12 workers, the water consumption (A5) is:
60 L of water - 1 worker
A5 - 12 workers
A5 = 720 L
f) Final Water Ratio determination
To determine the ratio, we need to obtain the total water consumption per day (At) and divide the result by the final product daily quantity (P)
Total consumption (At) = A1 + A2 + A3 + A4 + A5 = 6450 L
Ratio = (At)/(V) = 8,0625 L/kg of raw material.
These calculations are summarized below

Variable	**Name**	**Value**
A1	Water consumption during washing	1600 L/day
A2	Water consumption during sanitization	1400 L/day
A3	Water consumption during rinsing	1000 L/day
A4	Water consumption during cleaning	1730L/day
A5	Water for labour	720 L/day
At/V	Ratio	8,0625 L/kg of raw material

3.6.5. Sanitizer ratio

a).Sanitizer required for the sanitization process
Water consumption due to sanitization: 1400 L
Chlorine amount in the sanitization: 200 ppm (SILVA, 2003)
Therefore, the sanitization daily consumption (S1) is:
0,2 g of active chlorine - 1 L of water
S1 - 1400 L of water
S1 = 0,280 kg.
b) Sanitizer required for the rinsing process
Water consumption due to rinsing: 1000 L
Chlorine amount in the sanitization: 3 ppm(SILVA, 2003)
Therefore, the sanitization daily consumption (S2) is:
0,0030 g of active chlorine - 1 L of water
S1 - 1000 L of water
S2 = 0,0030 kg.
c) Sanitizer required for the plant hygiene process
Water consumption due to rinsing: 1730 L
Chlorine amount in the sanitization: 200 ppm (ANDRADE 1996)
Therefore, the sanitization daily consumption (S3) is:
0,2 g of active chlorine - 1 L of water
S1 - 1730 L of water
S3 = 0,346 kg.
d) Final Ratio determination
In order to determine the final ratio, we need to obtain the total sanitizer consumption per day (St) and divide the result by the final product daily quantity (P).
Total consumption (St) = S1 + S2 + S3 = 0,629 kg
Ratio = (St)/(P) = 0,0015725 kg / kg of final product.
These calculations are summarized below.

Variable	Name	Value
S1	Sanitizer consumption during sanitation	0,280 kg/day
S2	Sanitizer consumption during rinsing	0,003 kg/day
S3	Sanitizer consumption during hygiene	0,346 kg/day
St/P	Ratio	0,0015725 kg/kg of final product

3.6.6. Packaging Ratios

Taking into account the operational capacity of 800 kg/day and a yield of 400kg/day of final product (and 400 kg/day of waste), we have the table below:

Products	Mass (kg)	Final product
Whole leaves	12	80 packs. of 150g.
Chopped leaves	88	40 pack. of 1 kg.
		240 pack. of 200 g.
Fruits in pieces	24	80 pack. of 300g.
Roots in pieces	160	100 pack. of 1 kg.
		200 pack. of 300g.
Cauliflower and broccoli	40	70 pack. of 300 g.
		19 pack. of 1 kg.
Mixed salads	76	40 pack. of 1 kg.
		144 pack. of 250g.
Organic compound	400	8 pack. of 50 kg

There is a label for each package, so if we determine the number of packages to be used per day, then we are capable of calculating the number of labels per day.
Packages (daily consumption) = Tags = 80 + 40 + 240 + 80 + 100 + 200 + 70 + 19 + 40 + 144 + 8 = 1021
There is a specific package for each product. The description of each package for the final products is presented below.
a) Whole leaves
The whole leaves (separated into groups of 150 g.) will be packed in closed trays with 18 cm x 13 cm each (Pac.1 => 80 packages). We recommend a specific gas composition injection in this case.
Ratio = 1 package/0,150 kg of whole leave = 6,667 package /kg of whole leave
b) Chopped leaves
The shopped leaves will be packed in closed trays of two sizes: 18 cm x 13 cm Pac.2 => 240 packages) for a mass of 200 g and 30 cm x 46 cm (Pac.3 => 40 packages) for 1 kg.
Ratio (pack. of 18 x 13) = 1 package/0,200 kg of snipped
= 5 packages/kg of snipped leaves.
Ratio (Pac. 30 x 46) = 1 package/kg of snipped leaves.
c) Mixed salad
The mixed salad will be packed in closed trays of two sizes: 18 cm x 22 cm (Pac.4 => 144packages) for a mass o f250 g and 30 cm x 50 cm (Pac.5 => 40 packages) for 1 kg.

Ratio (pack. of 18 x 22) = 1 package/0,250 kg of mixed salad= 4 packages /kg of mixed salad.
Ratio (pack. of 30 x 50) = 1 package/kg of mixed salad.
d) Fruits
The fruits (separated into groups of 300 g) will be packed in closed trays with the following dimensions: 18 cm x 22 cm (Pac. 6 => 80 packages).
Ratio (pack. of 18 x 22) = 1 package/0,300 kg of fruits = 3,333 packages /kg of fruits.
e) Cauliflower and broccoli
These materials will be packed in closed trays of two sizes: 18 cm x 22 cm (Pac.7 => 70 packages) for a mass of 300 g and 30 cm x 50 cm (Pac.8 => 19 packages) for 1 kg.
Ratio (pack. of 18 x 22) = 1 package/0,300 kg of raw materials
= 3,333 packages/kg of raw materials

f) Roots
The roots will be packed in closed trays of two sizes: 18 cm x 22 cm (Pac.9 => 200 packages) for a mass of 300 g and 31 cm x 51 cm (Pac.10 => 100 packages) for a mass of 1 kg.
Ratio (pack. of 18 x 22) = 1 package/0,300 kg of roots = 3,333 packages/kg of roots.
Ratio (pack. de 31 x 51) = 1 package/kg of roots.
g) Organic compound
The organic compounds (separated into groups of 50 kg) will be packed into large sacks (Pac.11 => 8 sacs) with the capacity of 50 kg.
Ratio = 1 large sack/50 kg of organic compound = 0,0020 sack/kg of organic compound
These calculations are summarized below.

Variable	**Name**	**Value**	**Ratio**
Pac.1	Closed trays for whole leaves (18 cm x 13 cm)	80	6,667 packages/kg of whole leaves
Pac.2	Closed trays for snipped leaves (18 cm x 13 cm)	240	5 packages /kg of snipped leaves
pac.3	Closed trays for snipped leaves (30 cm x 46cm)	40	1 package /kg of snipped leaves
Pac. 4	Closed trays for mixed salad (18 cm x 22 cm)	144	4 packages /kg of mixed salad
Pac. 5	Closed trays for chopped leaves (30 cm x 50 cm)	40	1 package/kg of mixed salad
Pac b. 6	Closed trays for fruits (18 cm x 22 cm)	80	3,333 packages/kg of fruits
Pac. 7	Closed trays for broccoli and cauliflower (18 cm x 22 cm)	70	3,333 packages /kg of broccoli and cauliflower
Pac. 8	Closed trays for broccoli and cauliflower (30 cm x 50 cm)	19	1 package/kg of broccoli and cauliflower
Pac. 9	Closed trays for roots (18 cm x 22 cm)	200	3,333 packages /kg of roots
Pac. 10	Closed trays for roots (31 cm x 51 cm)	100	1 package /kg of roots
Pac. 11	Large sacks with capacity of 50 kg for organic compound	8	0,002 large sack/kg of organic compound

3.6.7. Labels

a) Whole leaves
The whole leaves (separated into groups of 150 g.) will be packed in closed trays of the following dimensions: 18 cm x 13 cm (rol.1 => 80 labels).
Raw = 1 label/0,150 kg of whole leave = 6,667 labels/kg of whole leaves
b) Chopped leaves
The chopped leaves will be packed in closed trays of two sizes: 18 cm x 13 cm for a mass of 200 g (label.2 => 240 labels) and 30 cm x 46 cm for 1 kg (label 3 => 40 labels).
Ratio (pack. of 18 x 13) = 1 label/0,200 kg of chopped leaves = 5 labels/kg of chopped leaves.
Ratio (pack. of 30 x 46) = 1 label/kg of chopped leaves.
c) Mixed salad
The mixed salad will be packed in closed trays of two sizes: 18 cm x 22 cm for a mass of 250 g (label.4 => 144 labels) and 30 cm x 50 cm for 1 kg (label.5 => 40 labels).
Ratio (pack. of 18 x 22) = 1 label/0,250 kg of mixed salad = 4 labels/kg of mixed salads.
Ratio (pack. of 30 x 50) = 1 label/kg of mixed salad.
d) Fruits
The fruits (separated into groups of 300 g.) will be packed in closed trays of the following dimensions: 18 cm x 22 cm (label 6 => 80 labels).
Ratio = 1 label/0,300 kg of fruits = 3,333 labels/kg of fruits.
e) Broccoli and cauliflower
These materials will be packed in closed trays of two sizes: 18 cm x 22 cm for a mass of 300 g (label 7 => 70 labels) and 30 cm x 50 cm for 1 kg (label 8 => 19 labels).
Ratio (pack. of 18 x 22) = 1 label/0,300 kg of cauliflower and broccolis = 3,333 labels/kg of cauliflower and broccoli.
Ratio (pack. of 30 x 50) = 1 label/kg of cauliflower and broccoli.
f) .Roots
The roots will be packed in closed trays of two sizes: 18 cm x 22 cm for a mass of 300 g (label 9 => 200 labels) and 31 cm x 51 cm for 1 kg (label 10 => 100 labels).
Ratio (pack. of 18 x 22) = 1 label/0,300 kg of roots = 3,333 labels /kg of roots.
Ratio (pack. of 31 x 51) = 1 label/kg of roots.
g) .Organic compounds
The organic compounds (separated into groups of 50 kg) will be packed in large sacks (label 11 => 8 labels) with a capacity of 50 kg.
Ratio = 1 label/50 kg of organic compound = 0,0020 labels /kg of organic compound

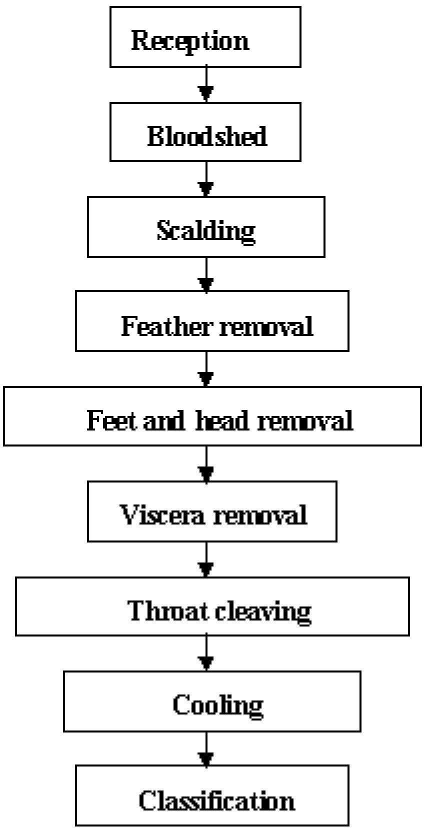
Variable	Name	Value	Ratio
Label 1	Label for whole leaves packages (18 cm x 13 cm)	80	6,667 Labels/kg of whole leaves
Label.2	Label for chopped leaves packages (18 cm x 13 cm)	240	5 labels /kg of chopped leaves
Label 3	Label for chopped leaves packages (30 cm x 46cm)	40	1 label/kg of chopped leaves
Label 4	Label for mixed salad packages (18 cm x 22 cm)	144	4 labels/kg of mixed salad
Label 5	Label for chopped leaves packages (30 cm x 50 cm)	40	1 label/kg of mixed salad
Label 6	Label for fruits packages (18 cm x 22 cm)	80	3,333 labels/kg of fruits
Label 7	Label for cauliflower and broccoli packages (18 cm x 22 cm)	70	3,333 labels /kg of cauliflower and broccoli

Label 8	Label for cauliflower and broccoli packages (30 cm x 50 cm)	19	1 label/kg of cauliflower and broccoli
Label 9	Label for roots packages (18 cm x 22 cm)	200	3,333 labels/kg of roots
Label 10	Label for roots packages (31 cm x 51 cm)	100	1 label/kg of roots
Label 11	Label for sacs of 50 kg of organic compounds	8	0,002 labels/kg of organic compounds

3.7. Poultry Slaughtering

OVERALL ASSUMPTIONS
" Plant Processing capacity per day: 200 chickens/day (478 kg/day)
" Living chicken weight: 2,39 kg
" Labour: 9 workers (1 manager, 1 secretary, 7 workman)
" Number of working days in a year: 260 (Saturdays and Sundays not accounted)
" Plant working period: 8 hours per day

3.7.1. Processing Flow Chart



3.7.2. Processing Ratios

According to SILVA et al. (2003), the following data can be considered:
Living poultry weight (raw material) = 2,39 kg/chicken
Residues to be treated: edible viscera (heart, liver and gizzards)
For the calculation of yields and losses of many processing stages, we will consider the slaughter of 200 chickens (2,39 each) or 478 kg of raw material (M1), per production day. It is important to emphasize that the percentages below are associated with the live chicken weight.

a) Bloodshed / Feather removal / Removal (blood, feathers, feet, paws and neck):
Data: 11,35% of blood and feather, 2.67% of paws (PIF PAF, 2003), 2,43% of neck and 3,65% of feet (ROÇA, 2000)
losses (P1): 20,10% = 96,08 kg
b) Viscera removal (edible and inedible viscera):
Data: 23,09% of feathers, blood and inedible viscera, 1,86% of liver, 1,36% of gizzard, 0,58% of heart (ROÇA, 2000) e 11, 35% of blood and feather (PIF PAF, 2003).
If we subtract the total percentage of feathers, blood and inedible viscera from the total percentage of blood and feathers (PIF PAF 2003), we will have 11, 74% inedible viscera. The total amount of edible ones (3,80%) is referred to the sum of the liver, gizzard and heart (ROÇA, 2000).
Losses (P2): 15,54% = 74,28 kg
c) Cooling (moisture absorption):
Data: maximum allowed weight gain of 8% (SAAFI, 2003)
Gains (G1): 8% = 24,55 kg
d) Classification:
Data: 1,20% of retails/fat and 0,49% of waste (ROÇA, 2000)
Losses (P3): 1,69% = 8,08 kg
These calculations are summarized below.

Variable	**Name**	**Value**
M1	Initial raw material	478 kg/day
P1	Blood, feathers, feet, paws and neck losses (Bleeding/feather removal)	96,78 kg/day
P2	Edible and inedible viscera (viscera removal)	74,28 kg/day
G1	Moisture Absorption (Cooling)	24,55 kg/day
P3	Retails and residues (classification)	8,08 kg/day
V1	Edible viscera (VC)	18,16 kg/day
M1/R1	Ratio 1	1,478 kg living poultry / kg frozen poultry
M1/V1	Ratio 2	26,32 kg living poultry / kg VC

Yield 1 (R1) = (M1) / (M1 - P1 - P2 + G1 - P3) = (478) / (323,41) = 1,4780 kg of live poultry /kg of frozen poultry.
Yield 2 (R2) = (M1)/(V1) = (478/18,16) = 26,3216 kg of live poultry/kg of VC

3.7.3. Water Consumption Ratios

In this item we considered the water consumption for plant and equipment usage as well as for hygiene processes, usage within the processing stages, workers' use, plus an additional 10% of the total as a safety measure.
a) Processing plant and equipments hygiene process:
Water consumption was estimated according the specification data for the high-pressure washer, model HD585, capacity of 500 L/ hour, from the company KARCHER (www.karcher.com.br). If we consider an average time for hygiene as 30 minutes for the plant and 80 minutes for the equipment (including 20 minutes for crates and 60 minutes for others), then we have:
V1 = (500x1,83) = 917 L of water per day
b) Viscera removal and washing the carcass (post-inspection):

For these stages, the use of a common faucet, with an outflow of 0,08 L/s or 288 L/h, was considered. The usage time in the manual viscera removal of 200 chickens was estimated as 150 minutes and for the carcass washing as 30 minutes.
Therefore, within a total of 3 hours, the water consumption is:
V2 = (288x3) = 864 L of water per day
b) Scalding Vessel:
The scalding vessel capacity is 80 L, for the processing of 200 chickens per day. Considering that the tank has a scalding capacity of 6 animals at each batch, that each carcass occupies an approximate volume of 2 litres (20x10x10 cm), and that there is a necessity of periodical water changes during this stage (10 batches), the total water consumption (V3) will be:
V3 = 10 x (80 - 6x2) = 10 x 68 = 680 L
c) Rehydration Vessel:
The rehydration vessel capacity is 300 L for processing 200 chickens per day, as suggested by SILVA et alii. (2003). In each batch, 25 carcasses will be cooled. Considering that 1/3 of the volume (100 L) is occupied by ice (or water originated from the ice fusion), 1/6 is occupied by the in-process chickens (50 L), and the water needs to be changed from time to time during this stage (4 times), the total water consumption will be:
V4 = 5x(300 - (1/3)x300 - (1/6)x300) = 4 x 150 = 600 L
d) Workers hygiene:
According to the Brazilian Labour Ministry's regulation: NR 24 - Sanitary and Comfort Conditions in the Work Location (124.000-5), which establishes a minimum water volume of 60 L per day for each worker, we have:
60 L water -------------------------- 1 worker / day
V5 -------------------------- 9 workers / day
V5 = 540 L of water per day
These calculations are summarized below.

Variable	**Name**	**Value**
V1	Plant and Equipments Hygiene	917 L/day
V2	Viscera removal and washing the carcass	864 L/day
V3	Scalding vessel	680 L/day
V4	Rehydration vessel	600 L/day
V5	Workers hygiene	540 L/day
V6 = (V1+V2+...+V5) x 0,10	Guarantee (10%)	360 L/day
Vt/Mi	Ratio	8,29 L/kg of initial raw material

Total water consumption per day = 3601+ 360,1 = 3961,1 L
Water Ratio: 3961,1 / 478 = 8,2868 L of water/ kg of raw material

3.7.4. Electrical Energy Ratio

a) Operational usage
In this item, the individual daily consumption of each equipment from the line suggested by SILVA et alii (2003), was considered.
- Feather remover with potency of 2 HP, or 1,4914 KW, operating 1,5 hours per day. Then, E1 = 1,4914 x 1,5 = 2,24 KW.h
- Air conditioner, 7 HP potency, or 5,2199 KW. 6 hours of work were considered. Therefore, E2 = 5,2199 x 6 = 31,32 KW.h

- Horizontal freezer, from the maker Cônsul model 530L, 0,16 HP potency, or 0,1193 KW. Considering 2 freezers, with 16 daily working hours each, we have
E3 = 0,1193 x 2 x 16 = 3,82 KW.h
- Ice cube maker (100 kg/day), from the maker Taylor, model Q-Series 210, which consumes 16,3 KW.h for each 100 kg of produced ice. Therefore,
E4 = 16,3 KW.h
- High-pressure washer, 2,2 KW potency, considering 1,83 working hour (plant and equipment hygiene). So, we have
E5 = 2,2 x 1,83 = 4,03 KW.h
Subtotal of the electricity required by the plant equipment
E6 = 2,24 + 31,32 + 3,82 + 16,30 + 4,03 = 57,71 KW.h
b) Electricity needed for the illumination of the processing plant:
The calculation for the electricity required for the agro industrial plant illumination was based upon the Lumens method (FILHO, 2002). For this processing plant, we considered the ratio of 0,2 KW.h/m2, which has been computes for the dried-banana project previously presented.
Because the total industrial area was planned to be 61,5 m2 (SILVA et al., 2003), the electricity required for illumination is as follows:
The daily electricity consumption due to illumination (E6) is: 0,2 x 61,5 = 12,30 KW.h
b) Electricity required for the office (administration):
To estimate the electricity required for the management office, we considered the consumption of 0,78 KW.h KW.h/day (E7), which has been computed for the dried-banana project (Item 3.3).
These calculations are summarized below.

Variable	Name	Value
E1	Feather remover machine	2,24 KW.h/day
E2	Air conditioner	31,32 KW.h/day
E3	Horizontal freezer	3,82 KW.h/day
E4	Ice machine	16,3KW.h/day
E5	High pressure washer	4,03 KW.h/day
E6	Illumination	12,30 KW.h/day
E7	Office consumption	0,78 KW.h/day
Et/Mi	Ratio	0,1481 KW.h/kg of initial raw material

Total electricity (Et) = E1 + E2 + E3 + E4 + E5 + E6 + E7 = 70,79 KW.h
Electricity ratio: (70,79)/(478) = 0,1481 KW.h / kg of initial raw material

3.7.5. Gas Consumption

According to a supplier consulted, a gas operated warming tank, with a capacity of 80 L (6 chickens), consumes 0,4 kg / hour. Considering 2,5 minutes / 52ºC as the thermal treatment (SILVA et alii., 2003), the total daily work time for processing 200 chickens will be approximately 2,5 hours (1,5 hours of processing and 1 hour of maintenance)
0,4 kg of gas ---------------------------- 1 working hour
G1 --------------------------------2,5 working hours
G1 = 1 kg of gas per production day
This calculation is summarized below.

Variable	Name	Value
G1	Warming tank	1 kg of gas / day

GLPt/Mi	Ratio	0,00209 kg/kg of initial raw material

3.7.6. Sanitizer Consumption (Active Chlorine):

The total sanitizer consumption, expressed in active chlorine, was computed with basis on the processing plant and equipment sanitization needs. If we assume that 35% of the water spent with hygiene (S1) is used for the sanitization process, we have a total of 321 L. For such process, it was still considered that the water spent has an active chlorine concentration of 200 ppm or 200 mg per litre of solution (ANDRADE & MACEDO, 1996).
Total consumption: (321 x 200)/1000 = 64,2 g of active chlorine/day
These calculations are summarized below.

Variable	Name	Value
S1	Sanitizer for the plant and equipments	64,2 g/day
S1/A1	Ratio	0,1960 g/kg of frozen poultry

The total daily chlorine (S1) = 64,2 g.
Sanitizer ratio: 64,2/(327,54) = 0,1960 g of active chlorine/ kg of frozen chicken

3.7.7. Packaging Ratios

In the package consumption estimation, it was considered that all the production will be packaged in individual low density polyethylene bags. Therefore, 1 bag will be required to pack each chicken individually (slaughtered poultry of 1,64 kg each). The ratio for plastic bags consumption per kg of frozen chicken ratio is presented below:

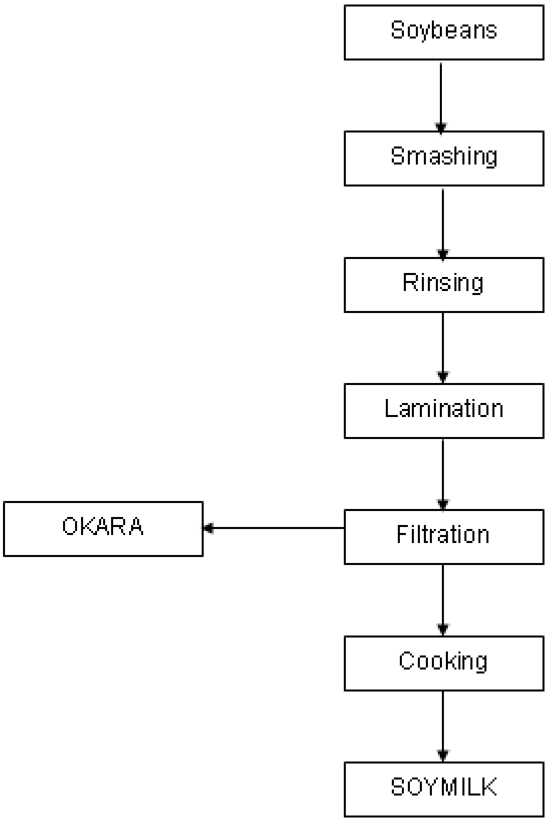
Variable	Name	Value	Ratio
Package 1	whole chicken bags	200 bags/day	0,61 bags/ kg of frozen chicken

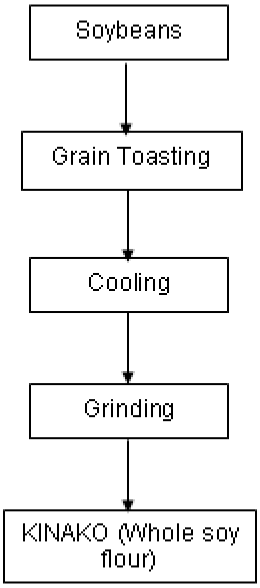
Plastic bags ratio = 0,60975 sacs/ kg of frozen chicken

3.8. Soy Milk

Overall Assumptions
- Plant processing capacity per day: 300 kg of soy (grains).
- Number of workers: 4 (1 manager + 1 secretary + 2 workmen)
- Number of working days in a year: 260 (Saturdays and Sundays not counted).
- Plant working period: 8 hours.

3.8.1. Flow chart for the production of "Soymilk" and "Kinako" (whole soy flour)





3.8.2. Processing Ratios

The data below are in accordance with LIU (1997) and the company EMBRASOY.
Initial raw material (MI): 400kg soybeans (Initial moisture content: Ui=13%)
Residue (OKARA): 172 kg (moisture content: U = 75,5%)
Final products (PF): 1600L of "Soymilk" (Final moisture content: Uf1 = 92%)
189,1 kg of Kinako (Final moisture content: Uf2 = 8%)
Some applications of "OKARA" in human and animal feed:

In terms of food applications, there are various ways of using "okara". In some parts of China, okara is salted and spiced and served as a pickle, or simply made into a dish meat or vegetables. It may be pressed into cakes and allowed to ferment for 10-15 days until each is covered with a white mycelium of Rhizopus mold. The cakes are dried in the sun and then deep-fried or cooked with vegetables. Also, okara may be mixed with soybeans before fermentation. Okara may also be used to produce Tempeh, a fermented soyfood originated in Indonesia centuries ago.
50% of the initial mass of soybeans will be used for producing "Soymilk" and 50% for producing "Kinako" (whole soy flour).
The soybeans/water proportion is 1:8,1. The calculations were made based upon the table below:
Variable Name Value
Mi Initial raw material 200 kg ("Soymilk")
200 kg (Kinako)
A Water 1620 L
R Waste 172 kg
Pf1 Final product 1 1648 kg = 1600 L
Pf2 Final product 2 189,1 kg
Mi/Pf1 Ratio 1 0,125 kg of soybeans/L of "Soymilk"
Mi/Pf2 Ratio 2 1,058 kg of soybeans / kg of Kinako

Variable	Name	Value
Mi	Initial raw material	200 kg (“Soymilk”)
		200 kg (Kinako)
A	Water	1620 L
R	Waste	172 kg
Pf1	Final product 1	1648 kg = 1600 L
Pf2	Final product 2	189,1 kg
Mi/Pf1	Ratio 1	0,125 kg of soybeans/L of “Soymilk”
Mi/Pf2	Ratio 2	1,058 kg of soybeans / kg of Kinako

Mi (for "Soymilk") = 200 kg
A = 1620 L = 1620 kg (the water density is 1,0 kg/L)
"Soymilk" (Pf1): soybeans quantity x 8 = 200 x 8 = 1600 L
"Soymilk" density: 1,03 kg/L, then 1600 x 1,03 = 1648 kg
R = Mi + A - Pf1 = 200 + 1620 - 1648 = 172 kg
Mi (for Kinako) = 150 kg,
Ui = 13%, solids content: 100-13 = 87%
Uf (Kinako) = 8%, solids content: 100 - 8 = 92%
Pf2 = [(200x0,87)x100]/92 = 189,1 kg
For the ratio, we have:
"Soymilk" processing ratio = (200/1600) = 0,1252 kg of soybean/ L of "Soymilk".
Kinako processing ratio = (200/189,1) = 1,058 kg of soybean /kg of Kinako.

3.8.3. Water consumption ratio

For this item we considered the water needed for the soy extract "Soymilk" formulation, for raw material and plant hygiene process, for the workers' usage and an additional amount of 10%, as a safety precaution. This data follows the specifications of an equipment provider consulted, namely the company EMBRASOY (model ULSH 600).

The water consumption suggested by this industry is 1920 litres for one day of production (8 working hours). This quantity only includes the formulation usage and the processing plant and raw material hygiene needs.
a) Water as raw material:
The soybeans/water proportion for producing "Soymilk" is 8 litres of water for each kg of soybeans. Thus:
8,1 L water ---------------------------- 1 kg of soybeans
A1 --------------------------- 200 kg of soybeans
A1 = 1620 L of water per day
b) Plant processing hygiene:
The water consumption will be equal to the total consumption, 1920 L, discounting the volume utilized for processing (1620). Therefore,
A2 = (1920-1620) = 300 L of water per day
c) Workers' hygiene:
According to the Brazilian Labour Ministry norm NR 24 - Sanitary and Comfort Conditions in the work sites (124.000-5), 60 L of water is established as a minimal daily volume for each worker. Hence,
60 L water--------------------------- 1 worker / day
A3 --------------------------- 4 workers / day
A3 = 240 L of water per day
The subtotal, V1 + V2 + V3 = 1620 + 300 + 240 = 2160 L
Safety estimate: 10% (A4) = 2160 x 0,10 = 216,0 L
Total water consumption per day (At) = 2160 + 216 = 2376 L
These calculations are summarized below.

Variable	Name	Value
A1	Water as raw material	1620 L/day
A2	Water for hygiene	300 L/day
A3	Water for workers hygiene	240 L/day
A4 = (A1+A2+A3) x 0,10	Safety mark (10%)	216,0 L/day
At/Mi	Ratio	5,94 L/kg of initial raw material

Water ratio: 2376 / 400 = 5,94 L of water/ kg of product

3.8.4. Electrical Energy Ratios

a) Electricity required for the equipment
According to the equipment supplier, the daily electricity consumption at the soy processing line for both "Soymilk" and whole soy flour processing, is equal to 38 KWh per day. This estimation takes into account that the equipment units are independent and do not work simultaneously. The line is formed by:
a. ""Soymilk"" production module
b. Temperature lowering module
c. Pre-heating module
d. Automatic packer
e. Cold unit module
f. Processing module
E1 = 38KW.h
High pressure washer, model HD585 KARCHER, with 2,2 KW potency, considering 40 minutes of operation, which, according to the manufacturer, is sufficient for the equipment hygiene process.
E2 = 2,2 x (2/3) = 1,467 KW.h
b) Electricity required for illumination:
The calculation of the energy required for the plant's illumination was based on the Lumens approach, according to FILHO (2002).
Considerations:

Ceiling and walls light-colored, floor dark-coloured.
Illumination necessary:
Reception and washing area, processing and packaging: 500 lux;
Storage/stocking and other areas: 100 lux
Offices: 250 lux
Utilization of wide lamps in a continuous line
For the reception, washing, preparation and packaging areas, we considered a need for 9 lamps with 2 fluorescent light bulbs of 65 W each, being 3 lamps for each room.
For the dehydration area, we considered 2 lamps with 2 fluorescent light bulbs of 40W each.
For the storage/stocking area and office, we need 1 lamp with 1 light bulb of 65 W
The electricity consumption due to illumination is equal to: E3 = 10,71 KW.h
c) Administrative area electricity consumption:
The administrative area includes one restaurant, two toilets and one office, with total area of 40 m2.
The calculations were made based upon the reference mentioned above:
Office: 0,390 KW.h
Restaurant: 0,130 KW.h
Toilets: 0,260 KW.h
Total administrative area (E5): 0,78 KW.h
These calculations are summarized below

Variable	Name	Value
E1	Production line	38 kWh/day
E2	Hygiene system	1,467 kWh/day
E3	Illumination	10,71 kWh/day
E4	Office	0,78kWh/day
Et/Mi	Ratio	0,1274 kWh/kg of raw material

Total electricity consumption per working day:
Electricity consumption: (38 + 1,467 +10,71 +0,78)/400 = 0,1274 KW.h / kg of raw material

3.8.5. Compressed Air Required For The Packaging System:

The compressed air consumption is equal to 0,06 m3 per package, then:
0,06 m3 of air ---------------------------- 1 package
96 m3 --------------------------------1600 packages
These calculations are summarized below

Variable	Name	Value
AC	Air compressed for packages	72 m3/day
ACt/"Soymilk"	Ratio	0,06 m3/L of "Soymilk"

Ratio: 0,06 m3 of compressed air per litre of "Soymilk"
Obs: This ratio is only a function of the soy extract, since the flour does not required compressed air for its processing.

3.8.6. Hygienization Ratios

The total sanitizer consumption is related to the water volume used for the processing plant hygiene. According to ANDRADE & MACEDO, (1996) this process is performed using a chlorine solution of 200 ppm, and of all the water required for the plant's, 50% is designated for washing, 20% for sanitization and 30% for rinsing. Therefore:
Active chlorine quantity (S) = (200 mg) x (300 L of water) x (0,20 sanitization)/ 1 L = 12000 mg = 12 g.
Total active chlorine consumption per day = 12 g.

These calculations are summarized below

Variable	Name	Value
S1	Sanitizer consumption due to hygiene	12 g/day
St/ Mi	Ratio	0,03 g/kg of raw material

Sanitizer consumption: 12/(400) =0,03 g of active chlorine / kg of raw material

3.8.7 Packaging Ratios

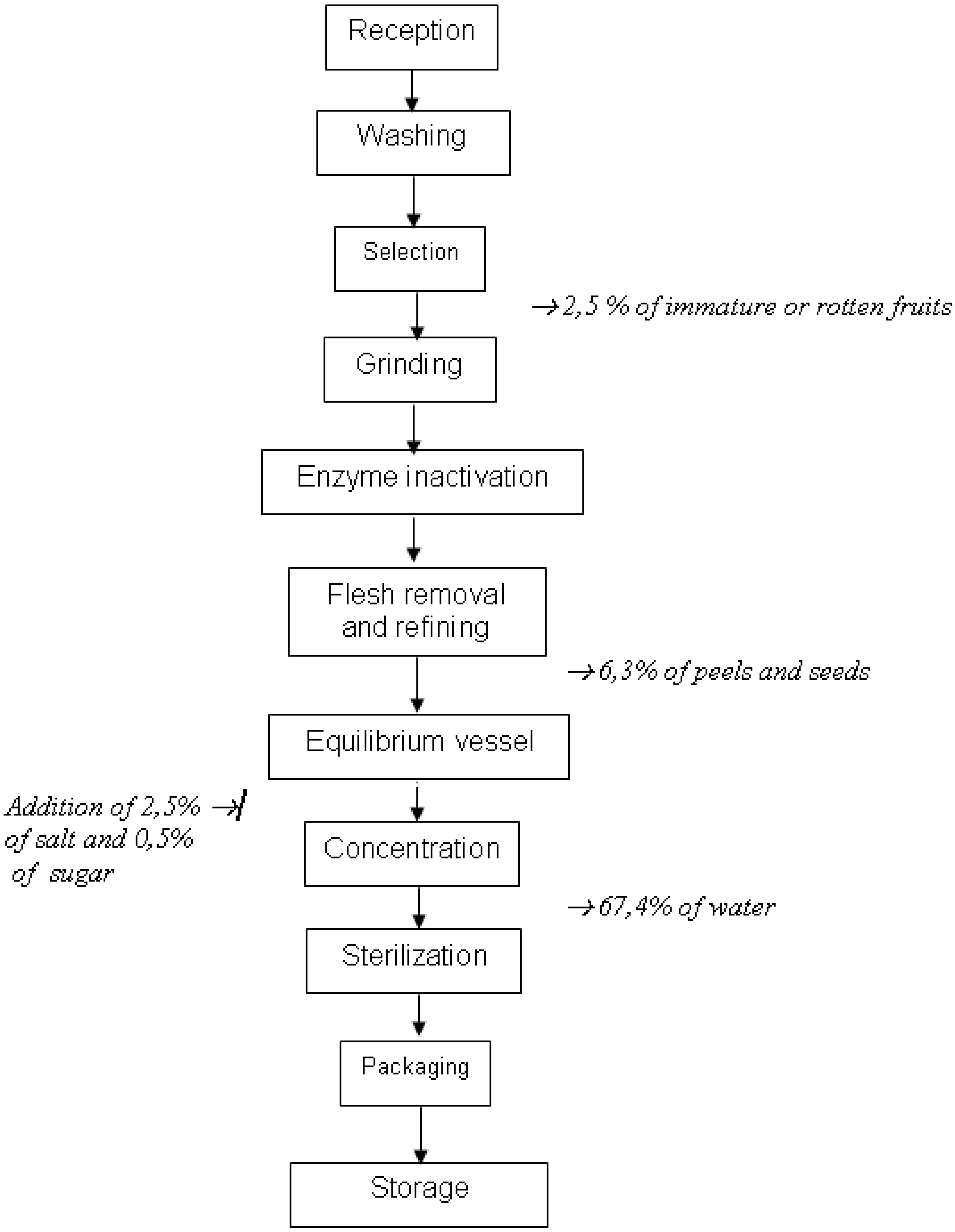
In order to pack the two products, namely soy extract ("Soymilk") and whole soy flour (Kinako), small, low density polyethylene (LDPE) bags will be utilized. The capacity is 1 litre, or 1 kg. Then the amount of LDPE packages is equal to 1789, as summarized below.

Variable	Name	Value	Ratios
Emb1	Packages for "Soymilk"	1600 unit/day	1 unit/kg of "Soymilk"
Emb2	Packages for Kinako	189,1 unit/day	1 unit/kg of Kinako
Emb3	Labels	1789 unit/day	1 unit/kg of product
Emb4	Wavy cardboard boxes (10 kg)		0,1 unit/ kg of product

3.9. Tomato Pulp

OVERALL ASSUMPTIONS
- Plant's processing capacity per day: 530 kg of tomato
- Number of workers: 5 (1 manager + 4 workmen)
- Number of working days in a year: 260 (Saturdays and Sundays not computed).
- Daily working period: 8 hours.

3.9.1 Processing flowchart



3.9.2.Processing Ratios

Initial raw material (Mi) =530 kg of tomato
According to MINAMI & FONSECA (1984), 2,5% of immature spoiled fruits are discarded within the selection process. Also, approximately 6,3% of the initial raw material is held back inside the flesh remover machine. Moreover,) 67,4% of water evaporates during the concentration stage.
Hence:
Selection (Se): loss of 2,5% of green rotten fruits: 530 x 0,025 = 13,25 kg
Flesh remover (D): 6,3 % of peels and seeds: 530 x 0,063 = 33,39 kg

Concentrator (C): 67,4% of water loss due to the concentration process: 530 x 0,674 = 357,22 kg
We considered an addition of 2,5% of salt, which represents half of the amount that is allowed by the Brazilian legislation.
Salt (Sa): Addition of 2,5% of salt: (530 - 13,25 - 33,39) x 0,025 = 12,08 kg of salt
We also considered the addition of 0,5% of sugar , which represents half of the amount that is allowed by the Brazilian legislation.
Sugar (A): addition of 0,5% of sugar : (530 –13,25 – 33,39) x 0,005 = 2,42 kg of sugar
Still according to MINAMI & FONSECA (1984), there is a loss of 4,08% of the final product over the processing operations.
Processing losses (PP): 4,08% of final product: 5,74 kg
The calculations are summarized below.

Variable	Name	Value
Mi	Initial raw material	530 kg / day
Se	Loss of green rotten fruits	13,25 kg / day
D	Peels and seeds	33,39 kg / day
C	Water loss Concentration	357,22 kg / day
Sa	Addition of salt	12,08 kg / day
A	Addition of sugar	2,42 kg / day
PP	Losses over the processing	5,74 kg / day
Po=(Mi-Se-D-C+Sa+A) x 0.9592	Pulp	134,9 kg / day
Mi /Po	Ratio	3,93 kg of tomato / kg of tomato pulp

3.9.3.Water Consumption Ratios

a) Raw material hygiene process
According to Minami e Fonseca (1984), 4,5 L of water per kg of processed raw material are required for the industrial hygiene process.
1 kg ------------------- 4,5 litres of water
530 kg --------------- x
A1= 2385 litres of water per day
b) Processing plant hygiene process
For the plant's hygiene process, the use of a high-pressure washer from the company KARCHER, model HD585, with a capacity of 500 litres/hour, operating during 1 hour (average), was taken into account. Therefore, the water consumption due to this operation is:
A2 = 500 litres of water per day
c) Workers hygiene:
The Brazilian Labour Ministry norm NR 24 – Sanitary and Comfort Conditions in the Work (124.000-5), establishes 60 L as a minimal water volume per day for each worker. Based in this coefficient, we have:
60 L water -------------------------- 1 worker / day
A3 -------------------------- 5 workers / day
A3 = 300 L of water per day
d) Boiler
The boiler is supposed to work 7 hours during the tomato processing operations. It requires 500 L of water for each working hour:
A4 = 7 hours/day x 500 L/hour = 3500 L/day
A4 = 3500 L of water per day
e) Still retort
In order to utilize this equipment, 100 L of water/hour are needed.
A5 = 5 hours/day x 100 L/hour = 500 L/day

A5 = 500 L of water per day
These calculations are summarized below.

Variable	Name	Value
A1	Raw material washing	2385 L/day
A2	Plant hygiene	500 L/day
A3	Workers hygiene	300 L/day
A4	Boiler	3500 L/day
A5	Still retort	500 L/day
A6 = (A1+A2+A3+A4+A5) x 0,10	Guarantee (10%)	718,5 L/day
At/ Mi	Ratio	14,91 L/kg of initial raw material

We considered an additional 10% of the total water quantity as a safety measure.
Total daily water consumption = 7185 + 718,5 = 7903.5 L
Water ratio: 7903,5 / 530 = 14,91 L of water / kg of initial raw material

3.9.4. Sanitizer Consumption Ratio

a) Sanitizer required for the tomato plant hygiene process:
For the tomato plant sanitization, 50 % of the water used for the raw material hygiene is needed. The recommended chlorine concentration is 5 ppm, according to ANDRADE & MACEDO, (1996). As such, we can determine the sanitizer consumption (S1) as follows:
S1 = 0,5 x 2385 (L) x 5/1000000(kg/L) = 0,006 kg/day
b) Sanitizer required for the plant's hygiene process:
For the sanitization of the plant, 500 L of water will be required. The recommended chlorine concentration is 200 ppm (ANDRADE & MACEDO, 1996). The sanitizer consumption (S2) is:
S2 = 500 (L) x 200/1000000(kg/L) = 0,10 kg/day
Ratio = (S1 + S2)/ Po = 0,000786 kg/kg of final product
These calculations are summarized below

Variable	Name	Value
S1	Sanitizer (tomato)	0,006 kg/day
S2	Sanitizer (plant)	0,10 kg/day
(S1 + S2)/ Po	Ratio (tomato)	0,000786 kg/kg of pulp

3.9.5. Electrical Energy Ratios

a) Electricity required by plant equipment:
- Flesh remover with an average capacity of 200 kg of raw material per hour, operating 2.65 hours per day. (flesh remover /double stage refiner set , electrical potency of 10 HP or 7.457 KW)

E1=2,65 hours x 7,457 KW.h = 19,7kW.h
- Crimper ("Can turning type"), semi-automatic (Electrical potency of 1,5 HP or 1,1185KW) with the capacity of 30 cans per minute

1 minute------------30 cans
x ---------------------397 cans
x= 13,23 minutes = 0,22 hour
E2=0,22 hour x 1,1185 KW.h = 2,4460 kW.h
Vapour bowl with reversible mixer MOD JC 02
The bowl is used to concentrate the pulp. The estimated preparation time is 2 hours. The motor potency is 2 HP. Then it is possible to calculate the energy spent (E2).
E3 = 2 (HP) x 0,7457 (KW/HP) x 2 (h) = 2,983 KW.h/day.
- Exhaust tunnel MOD JC 31

This equipment is utilized for making vacuum within the cans. Its potency is 1HP and the operational time is approximately 2 hours, so that the energy consumption will be:
E4 = 1 (HP) x 0,7457 (KW/HP) x 2(h) = 1,49 kWh/day.
- Firewood boiler MOD JC 100 (horizontal type)
The boiler operates during 7 hours. The potency of this equipment's motor is 2 HP. The energy consumption is:
E5 = 2 (HP) x 0,7457 (KW/HP) x 7(h) =10,44 KW.h/day.
- High pressure washer, model HD585 KARCHER, 2,2 KW potency, considering 1 hour of work,
E6 = 2,2 x 1 = 2,2 KW.h
b) Electricity consumption due to illumination:
The calculation concerning the electricity consumption due to illumination of the agro industrial plant was based upon the lumens approach , following FILHO , (2002).
Considerations:
Walls and ceiling light-coloured, floor dark-coloured.
Necessary illumination
Reception and washing, processing and packaging area: 500 lux;
Storage/stocking and other areas: 100 lux
Offices: 250 lux
Use of wide lamps in a continuous line
Through the calculations suggested by FILHO (2002), it was established the light ratio/ m2, which is 0,18 KW.h/m2.
For this specific plant, it was assumed that the total area equals to 60 m2. Consequently, the electricity required for illumination is:
E7 = 0,18 (KW.h/m2) x 60 (m2) = 10,8 KW.h/day.
c) Electricity required for the managing area
The administrative area includes one restaurant, two toilets and one office, with a total area of 40 m2.
The calculations were performed based on the reference mentioned above.
Office: 0,390 KW.h
Restaurant: 0,130 KW.h
Toilets: 0,260 KW.h
Total administrative area (E8): 0,78 KW.h/day.
It was considered 10% of the total estimated quantity as a safety precaution.
E9 = (E1 + E2 + E3 + E4 + E5 + E6 + E7 + E8) x 0,1 = 5,084
Total electricity (Et) = E1 + E2 + E3 + E4 + E5 + E6 + E7 + E8 + E9 = 50,84+5,084 = 55,924KW.h
Electricity ratio: (55,924)/(530) = 0,1055 KW.h / kg of initial raw material
These calculations are summarized below

Variable	**Name**	**Value**
E1	Pulp (flesh) remover	19,7 KW.h
E2	Crimper	2,4460 KW.h
E3	Bowl	2,983 KW.h
E4	Exhaust tunnel	1,49 KW.h
E5	Boiler	10,44 KW.h
E6	High pressure washer	2,2 KW.h
E7	Processing plant	10,8 KW.h
E8	Administrative area	0,78 KW.h
E9 = (E1+E2+...+E8) x 0,10	Guarantee (10%)	5,084 KW.h
Et/ Mi	Ratio	0,1055 KW.h/kg initial raw material

3.9.6. Firewood Consumption Ratio

The firewood amount required by the boiler is 0,25 m 3/h. This boiler will work 7 hours per day. Therefore, one may calculate the daily firewood consumption as follows:
L = 0,25 m 3/h x 7 h = 1,75 m 3/day
L/ Mi = 1,75 /530 = 0,0033 m 3/ kg of raw material
The estimated calculations are presented below.

Variable	Name	Value
L	Firewood	1,75 m 3/day
L/ Mi	Ratio	0,0033 m 3/kg of raw material

3.9.7. Salt Consumption Ratio

We considered the addition of 2,5% of salt inside the concentrator, which represents half of the quantity permitted by the Brazilian legislation.
Total salt consumption per day = (530 - 13,25 - 33,39) x 0,025 = 12,08 kg of salt
Salt ratio: 12,08/134,9 = 0.089 kg of salt/ kg of pulp
The calculations are summarized below.

Variable	Name	Value
CS	Salt	12,08 kg /day
CS/Po	Ratio	0,089 kg /kg of pulp

3.9.8. Sugar Consumption Ratio

We considered the addition of 0,5% of sugar inside the concentrator, which represents half of the quantity permitted by the Brazilian legislation.
Total sugar consumption per day = (530 – 13,25 – 33,3) x 0,005 = 2,42 kg of salt
Sugar ratio: 2,42/134,9= 0,0179 kg of sugar / kg of pulp
The calculations are summarized below.

Variable	Name	Value
CA	Sugar	2,42 kg /day
CA/Po	Ratio	0,0179 kg /kg of pulp

3.9.9. Packaging ratios

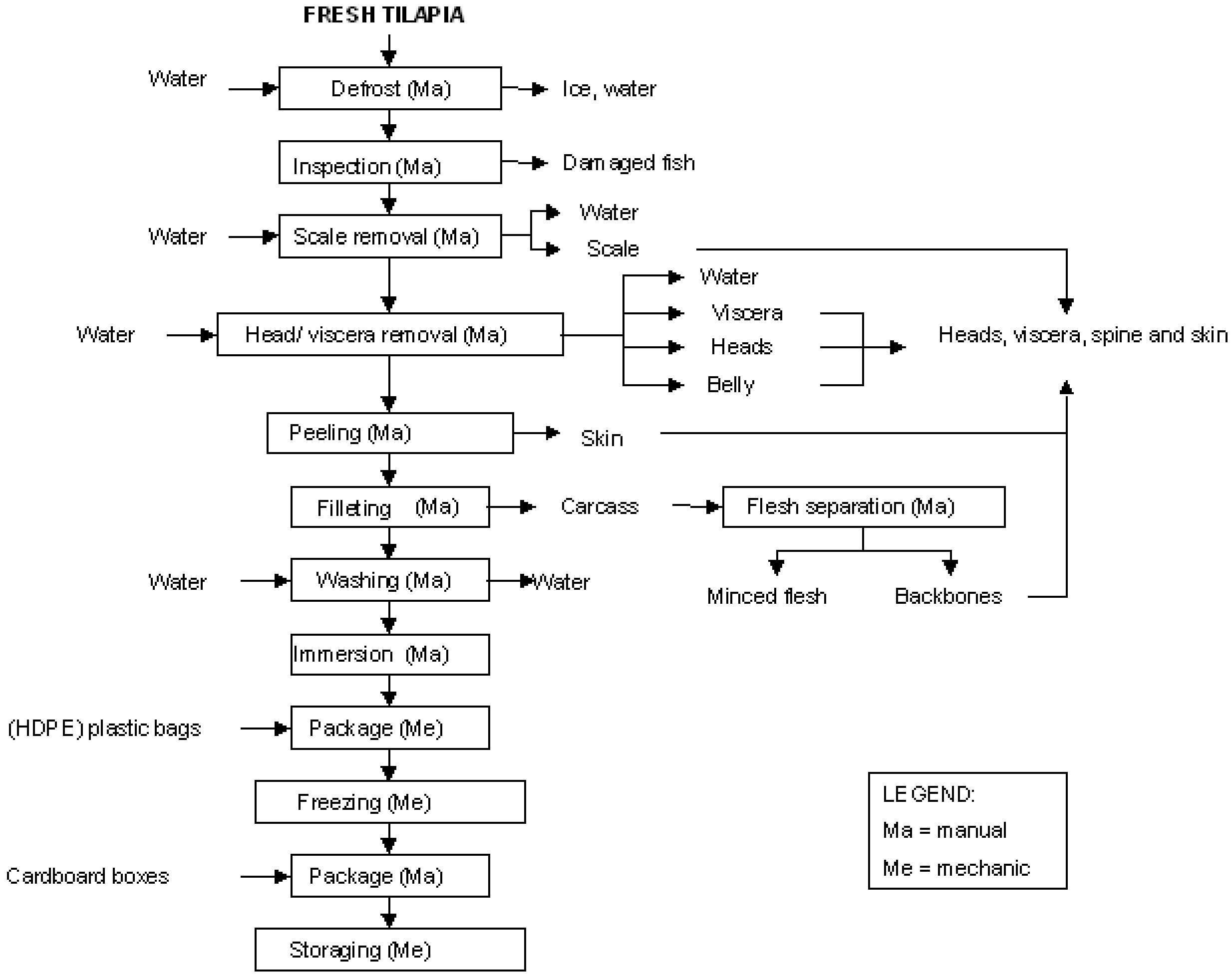
a) Cans
The final product is packed into cans that are capable of containing 340g each.
Everyday 134,9 kg of tomato pulp is produced. Then, 397 cans are required.
Total cans needed per day: 134,9 kg /0,340 kg = 496,76 = 397 cans
Cans ratio: 397/134,9 = 2,94 cans/ kg of pulp
b) Cardboard boxes
The product takes up one secondary cardboard package with the capacity of containing 24 cans.
Then, we need 17 cardboard boxes per day.
Total cardboard boxes amount: 397 cans/ 24 cans = 16,54 =17 boxes
Cardboard boxes ratio: 17/134,9 = 0,126 boxes / kg of pulp
c) Labels
Each can is supposed to take up one label; therefore 400 labels are needed per day.
Total labels: 397
Labels ratio: 397/134.9 = 2,94 labels/ kg of pulp
The calculations are summarized below.

Variable	Name	Value
LF	Cans	397 cans/day
CP	Cardboard boxes	17 boxes /day
Ro	Labels	397 labels/day
LF/Po	Ratio	2,94 cans/ kg of pulp
CP/Po	Ratio	0,126 boxes / kg of pulp
Ro/Po	Ratio	2,94 labels/ kg of pulp

3.10 Fish Filleting (Nile Tilapia - Oreochromis Niloticus)

OVERALL ASSUMPTIONS
Plant processing capacity per day: 430 kg of fresh fish
Average weight of fresh fish: 0,650 kg
Average number of fresh fish units per day: 660 units
Tilapia fillets daily production: 165,80 kg
Average weight of tilapia fillet: 0,200 kg
Approximate tilapia production per day: 830 units
Fish fillet dimensions: 0,2 x 0,01 x 0,1 m
Number of workers: 8 (1 supervisor , 1 secretary, 6 workmen), according to Bykowski & Dutkiewicz (1996), for small-scaled plants.
Number of working days in a year: 250 (Saturdays and Sundays not computed), based on Shirota et al (2002).

3.10.1 Processing Flow Chart



3.10.2. Processing Ratios

Raw material : fresh tilapia
Residues : heads, viscera, skin, scales, carcass, bellyful
Residue utilization : A) Fish flour (heads, viscera, skin, scales, belly and spine); B) Fish parings (chippings) (carcass removal)
For the calculation of the various processing stages yields and losses, we will consider 430 kg of fresh tilapia (M1), equivalent to one production day.
a) Scales removal
Data : average of 2,97% of scales (SOUZA, 2002).
Process: 430 kg (fresh tilapia) ® 417,23 kg (fish without scales)
Losses: 430 – 417,23 = 12,77 kg (scales [P1])
b) Heads and viscera removal
Data : averages of 13% of heads, 16% of viscera and 3% of belly related to the entire fresh fish (Pereira & Campos , 2000).
Process: 417,23 kg (fish without scales) ® 279,63 kg (fish without heads and viscera)
Losses: 417,23 – 279,63 = 137,60 kg (55,90 kg of heads[P2], 68,80 kg of viscera [P3] and 12,9 kg of belly [P4])
c) Skin removal
Data : average of 6,31% of skin (Souza, 2002)
Process: 279,63 kg (fish without head and viscera) ® 252,50 kg (muscle)
Losses: 279,63 – 252,50 = 27,13 (skin [P5])
d) Filleting
Data : average of 22% of carcass (Pereira & Campos , 2000).
Process: 252,50 kg (muscle) ® 157,90 kg (fish fillets [FF1])
Losses: 252,50 – 157,90 = 94,60 kg (carcass [P6])
e) Polyphosphate immersion
Data : gain of 5% in weight (ANDRADE et al, 2003)
Process: 157,90 ® 165,80 kg (fish fillets [FF2])
Gains: 165,80 - 157,90 ® 7,9 kg (water [W1])
f) Residues uptake (carcass)
Data : average of 25% of flesh within the carcass (Pereira & Campos , 2000).
Process: 94,60 kg (carcass) ® 23,65 kg (fish parings [FL])
Losses: 94,60 – 23,65 ® 70,95 kg (spine [P7])
g) Residues uptake (scales, heads, viscera, belly, skin and spine)
Data : average of 20% of flour obtained from waste (STORI, 2000)
Process: 248,45 kg (residues [P8]) ® 49,69 kg (fish flour 1 [F1])
Losses: 248,45 – 49,69 = 198,76 kg (final waste [P9])
These calculations are summarized below.

Variable	Item	Value
M1	Raw material	430 kg/day
P1	Scales (scales removal)	12,77 kg/day
P2	Heads (heads removal)	55,90 kg/day
P3	Víscera (víscera removal)	68,80 kg/day
P4	Belly (víscera removal)	12,90 kg/day
P5	Skin (skin removal)	27,13 kg/day
FF1	Fish fillets (filleting)	157,90 kg/day
FF2	Fish fillets (polyphosphate immersion)	165,80 kg/day
W	Water absorbed (polyphosphate immersion)	7,90 kg/day
P6	Carcass (filleting)	94,60 kg/day
FL	Fish parings (flesh separation)	23,65 kg/day
P7	Spine (flesh separation)	70,95 kg/day

P8	Residues (P1 + P2 + P3 + P4 + P5 + P7)	248,45 kg/day
F	Fish flour (flour elaboration)	49,69 kg/day
P9	Final residue (flour elaboration)	198,76 kg/day

Ratio 1	M1/FF2 = 430/165,8	2,593 kg fresh fish/kg fish fillet
Ratio 2	M1/FL = 430/23,65	18,18 kg fresh fish /kg fish parings
Ratio 3	M1/F = 430/49,69	8,654 kg fresh fish /kg fish flour

1 The residue composition for the flour elaboration depends upon the fish production process (fish steaks, fish chips , fish without viscera etc). In the filleting case, all the residues (scales, heads, viscera, belly, skin and backbone) can be taken up and utilized.

3.10.3 Water Consumption Ratios

For this item , we took into account the water required for the hygiene process of the processing plant and equipment, for product washing over certain processing stages, as well as the water needed for the polyphosphate immersion and the workers' usage; we also considered 10% of the sum of all other items as a safety margin.

a) Hygiene process of the plant and the equipments

Water consumption was estimated according to data provided by the specifications of the high-pressure washer, model HD585, capacity of 500 L/hour, manufactured by the company KARCHER (www.karcher.com.br). If one considers an average time for the hygiene process is 45 minutes (necessary for the industrial plant), and 60 minutes (required for the equipment), then:

A1 = (500 x 1,75) = 875 of water per day

b) Washing the product over the processing operations

Considerations:

300 L/h flow for the sink showers (measured value)

Two workers working together in each stage

430 kg of fresh fish correspond to an average figure of 660 raw material units

Time spent for each processed fish unit: defrost, scales removal and washing (5-10s) = 7,5s; heads/viscera removal (40-50s) = 45s

Total time spent due to water consumption:

67,5s x (660 units / 2 workmen) = 22275s or 6,1875h

Total water volume required for washing the product:

300 L 1h

A2 L .... 6,1875 h

A2 = 22275 x (300/3600) = 1856,25 L

c) Polyphosphate immersion

The plastic boxes for the immersion have the following dimensions: 0,25 x 0,66 x 0,45 m. If we consider their approximate useful volume (0,15 x 0,66 x 0,45m) as 45L, then:

Data :

- Volume occupied by 830 produced fish units = 166L
- Number of boxes necessary = 5 units
- Volume occupied by the fish in each box à 166 ¸ 5 = 33,2L
- Water volume absorbed by the fish fillets [W] = 7,9L
- Additional water volume (needed to fulfil the useful volume) à 45 – 33,2 – 7,9 = 3,9L

Water volume required for the immersion [A3] = (7,9 + 3,9) x 5 = 59L

d) Workers hygiene

According to the Brazilian Ministry of Labour norm NR 24 – Sanitary and Comfort Conditions in the Work Sites (124.000-5), a minimal water volume of 60 L per day for each worker is established. Hence:

60 L water .... worker / day

A4 .... 8 workers / day

A4 = 480 L of water per day

These calculations are summarized below.

Variable	Item	Value
A1	Plant and equipments hygiene process	875 L/day
A2	Waste displacement over the processing	1856,25 L/day
A3	Immersion water	59 L/day
A4	Workers hygiene	480 L/day
As	As = A1 + A2 + A3 + A4	3270,25 L/day
A5	Guarantee (10% of As)	327,03 L/day
At	Total water consumption (As + A5)	3597,33 L/day

Ratio At/M1 = 3597,33/430 8,366 L water/kg raw material

3.10.4 Electricity Consumption Ratios

a) Operational needs
In this item , the individual daily consumptions of the equipments were taken into account. The equipment supplier companies BENETRON and KLIMAQUIP provided the electrical potency and the estimated usage time of these equipment units.
- Sealing machine (produced by BENETRON), potency of 0,20 HP or 0,149 KW. Considering 1 working hour:
[E1] = 0,149 x 1 = 0,149 KW.h
- Fast freezer KLIMAQUIP, model UK12/3.0, potency of 3 HP or 2,237 KW, internal capacity of 272 L.
If we consider 2 hours as the average time for rapidly freezing fish (Agroindustry, Food and Nutrition Department, Luiz de Queiroz Agriculture Superior School), coming down to a 4-hour working period:
[E2] = 2,237 x 4 = 8,948 KW.h
- Mini cold storage manufactured by KLIMAQUIP, model MCK 30R 1P, and potency of 0,5 HP or 0,373 KW. Considering 16 hours of work:
[E3] = 0,373 x 16 = 5,968 KW.h
Subtotal electricity consumption due to the equipments
Electricity Eq = 0,149 + 8,948 + 5,968 = 15,065 KW.h
b) Electricity required for the processing room illumination
The calculation of the electricity needed for the agro industrial plant illumination was based on the Lumens approach (FILHO , 2002). As a reference, we will use the electricity consumption ratio of the dried banana project, which is 0,2 KW.h/m 2, given the similarity between this latter project and the tilapia filleting one. More details concerning the calculation procedures may be seen in the dried banana project (Item 3.3). Because the total plant area is supposed to be 45 m 2, the electricity required for illumination is as follows:
Electricity daily consumption due to illumination [E4]: 0,2 x 45 = 9 KW.h
c) Electricity consumed by the office (administration):
Still having in mind the calculations performed for the dried banana project as a reference, for this one, we considered the electricity consumption of 0,78 KW.h/day [E5] due to the management office with a total area of 40 m 2. More details concerning the calculation procedures may be seen in the project mentioned above.
These calculations are summarized below.

Variable	Item	Value
E1	Sealing machine	0,149 KW.h/day
E2	Fast freezer	8,948 KW.h/day
E3	Mini cold storage	5,968 KW.h/day
E4	Room illumination	9,000 KW.h/day
E5	Office consumption	0,780 KW.h/day

Et	Total electricity consumption	24,845 KW.h/day

Ratio Et/M1 = 24,845/430 0,058 KW.h/kg of raw material

3.10.5 Ice Consumption Ratio

According to the note n o50 off FAO's document "Some Notes on Fish Handling and Processing" elaborated in 2001, one part of ice for three parts of fish is sufficient for its preservation during 5 days. Therefore:
1 kg ice .... 3 kg fish
G 430kg
G = 143,33 kg of ice per day
This calculation is summarized below.

Variable	Item	Value
G	Ice needed for the raw material preservation	143,33 kg ice/day

Ratio G/M1 = 143,33/430 0,333 kg ice/kg of raw material

3.10.6 Tripolyphosphate Consumption

The tripolyphosphate is added to the immersion water with a 1% concentration. Consequently, for a total immersion water volume of 59L [A3], one has:
1g 100mL
[TP] 59000mL
[TP] = 590g
This calculation is summarized below.

Variable	Item	Value
TP	Tripolyphosphate	590 g tripolyphosphate/day

Ratio TP/M1 = 590/430 1,372 g tripolyphosphate /kg of raw material

3.10.7. Sanitizer Consumption (Active Chlorine)

The total sanitizer consumption, expressed in active chlorine, corresponds to the needs of sanitization processes for the processing plant and equipment. Assuming that 35% of the water required for the hygiene process [A1] is designated to sanitization [S1], then the total volume is 306,25L. For the latter process, it was also taken into account that the water concentration is 200 ppm or 200 mg of active chlorine per litre of solution (ANDRADE & MACEDO, 1996).
Total consumption [S1]: (306,25 x 200)/1000 = 61,25 g of active chlorine/day
These calculations are summarized below.

Variable	Item	Value
S1	Sanitizer for the plant and equipments	0,06125 kg active chlorine/day

Ratio S1/FP = 0,06125/157,90 0,388 g active chlorine/kg of fish fillets

3.10.8. Packaging Ratios

a) Primary packages
The estimated primary package consumption assumes that all products would be packed in high density polyethylene bags (HDPE) with a capacity of 0,800 kg with the dimensions 0,20

x 0,25m (Selovac). Since the daily production is 157,90 kg of tilapia fish, the amount of bags necessary per day is:
Primary package consumption [emb1]: 165,80/0,8 » 207 bags/day
b) Secondary package
The estimated secondary package consumption assumes that all the products would be placed inside cardboard boxes with the dimensions 0,454 x 0,271 x 0,137 m (Flumipast Ind. and Com . Ltd.), taking up 60% of their volume . It was further assumed that the volume occupied by each primary package, containing 4 fish fillets, is equal to [V1] = 0,001m 3 (0,25 x 0,20 x 0,02 m).
Data :
- Secondary package useful volume [V2] = (0,454 x 0,271 x 0,137) x 0,60 = 0,01011m 3
- Secondary package capacity: [V1] ¸ [V2] = 0,01011 ¸ 0,001 » 11 bags
- Secondary package capacity: 11 x 0,8 = 8,80 kg
Secondary package consumption [PAC 2] = 165,80/8,80 » 19 units
These calculations are summarized below.

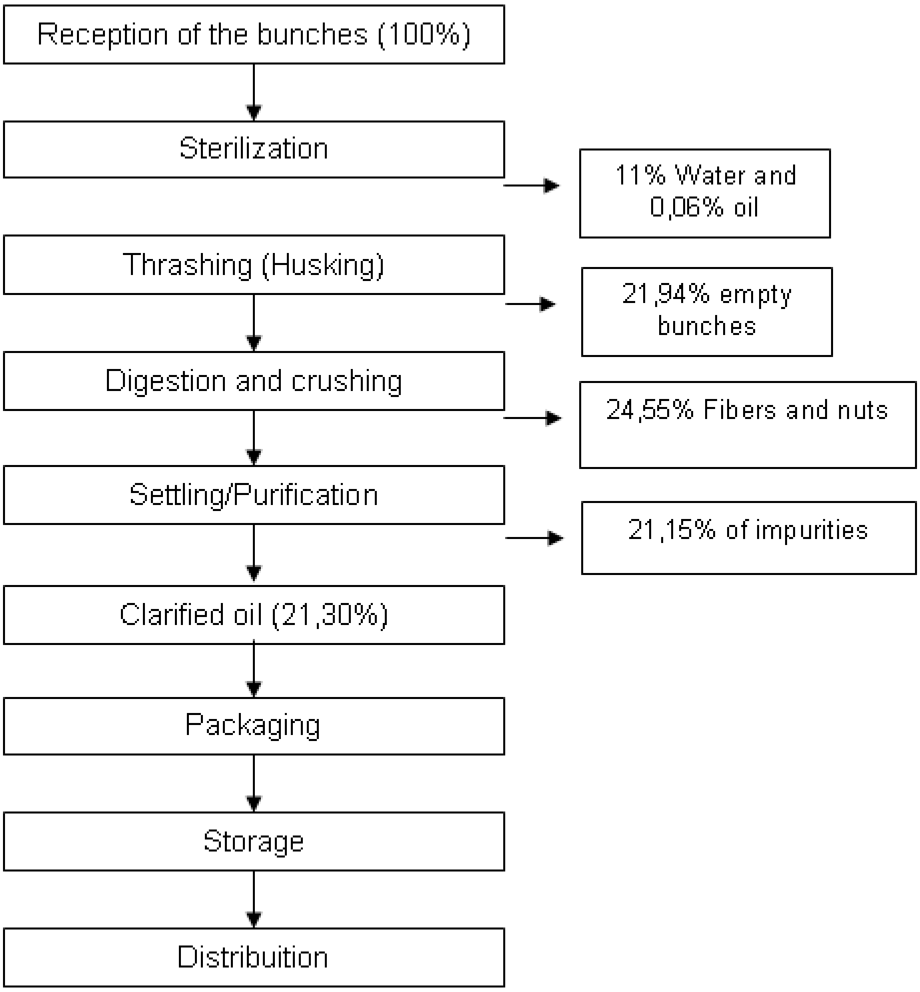
Variable	Item	Value
PAC1	HDPE bags of 0,800 kg	207 bags/day
PAC2	Cardboard boxes of 8,80 kg	19 boxes /day

Ratio 1	PAC1 /FP = 207/165,80	1,25 bags/kg of fish fillets
Ratio 2	PAC 2/fp = 19/165,80	0,115 bags/kg of fish fillets

3.11. Palm Oil Processing

OVERALL ASSUMPTIONS
- Plant processing capacity per day: 358 kg of fruit bunches.
- Number of workers: 4 workmen.
- Number of working days in a year: 260 (Saturdays and Sundays not computed).
- Plant working period: 8 hours per day.

3.11.1. Processing Flow Chart



3.11.2. Processing Ratios

According to the information provided by the equipment supplier company named Ecirtec Equipamentos e Acessórios Industriais Ltda, we have the following specifications:

Raw material : fruit bunches
Final product: palm oil
Residue: fibers and nuts
Initial raw material (Mi) = 358 kg of fruit bunches per day
Water loss within the sterilization (PAE) (11%): 358 x 0,11 = 39,38 kg
Oil loss within the sterilization (Op) (0,06%): 358 x 0,0006 = 0,215 kg
Empty bunches in the thrashing process (CVD) (21,94%): 358 x 0,2194 = 78,55 kg
Fibers and nuts (FN) (24,55): 358 x 0,2455 = 87,89 kg
Impurities from the clarification (IC) (21,15%): 358 x 0,2115 = 75,72 kg
Product 1: (OPa) palm oil (21,3%): 358 x 0,213 = 76,25 kg
These calculations are summarized below.

Variable	Name	Value
Mi	Initial raw material	358,0 kg/day
PAE	Water loss due to sterilization	39,38 kg/day
Op	Oil loss due to sterilization	0,215 kg/day
CVD	Empty bunches (trashing)	78,55 kg/day

FN	Fibers and nuts	87,89 kg/day
IC	Impurities from the clarification	75,72 kg/day
OPa	Palm oil	76,25 kg/day
Mi / OPa	Ratio 1	4,69 kg de bunches/kg of oil palm

Ratio 1 = (358/76,25) = 4,69 kg of bunches/kg of oil palm.

3.11.3 Water Consumption Ratio:

a) Equipment
a.1) Boiler
According to the information provided by the supplier, the fruits are subject to a direct steam treatment in order to inactivate the enzymes and facilitate the thrashing process. AS such, a boiler is required for producing steam. This equipment has a maximum capacity of 150 kg vapour/hour. For each working hour of the boiler 280 L are needed. Therefore,
280 L of water ---------------------------- 1 h
A1 --------------------------- 6 h
A1 = 1680 L of water per day
a.2) Cooker
One of the various processing stages is cooking, or digestion, which is performed in a cooker with the following approximate internal dimensions: 1,20 m diameter, 0,65 m high. This cooker capacity is 130 kg/h of raw material and the water volume required is 400 L to begin the digestion process. After the first cooking batch, 20% of the water volume utilized is renewed. Once the raw material quantity that is taken up by this equipment is equal to 240 kg, then we have the calculations below:
Number of batches: 240 /130 = 1,85, i.e., 2 batches of 120 kg.
The water volume utilized is 400 L (1 st batch) + 80 L (2 nd batch) = 480 L/day.
A2 = 480 L/day
b) Processing plant hygiene process:
Water consumption was estimated in accordance with specification data from the high-pressure washer; model HD585, capacity of 500 L/ hour, manufactured by the company KARCHER. As in the previous item , this water volume is designated for washing and sanitizing the processing plant.
If we consider 1 hour as an average time for the hygiene process, then:
A3 = (500x1) = 500 L of water per day
c) Workers hygiene:
According to the Brazilian Labour Ministry Norm NR 24 – Sanitary and Comfort Conditions in the Work Site (124.000-5), 60 L of water is established as a minimal daily volume for each worker:
60 L water--------------------------- 1 worker / day
A4 -------------------------- 4 workers / day
A4 = 240 L of water per day
These calculations are summarized below.

Variable	Name	Value
A1	Feed of the boiler	1680 L/day
A2	Feed of the cooker	480 L/day
A3	Plant hygiene	500 L/day
A4	Workers hygiene	240 L/day
At	Total water amount	2900 L/day
At/ Mi	Ratio	8,1 L/kg initial raw material

Total water consumption per day =A1 + A2 + A3 + A4 = 2900 L
Water ratio: 2900/ 358 = 8,1 of water/ kg of initial raw material

3.11.4. Electrical Energy Ratios

a) Equipment electricity requirements:
The data is in accordance with the equipment suggested by the supplying firm ECIRTEC:
- Mini-Crusher MPE-40, potency of 3 CV and pressing capacity of 40 kg / hour; considering 6 hours of work in order to reach the desired capacity, then
E1 = 0,7457 x 3 x 6 = 13,42 KW.h
- Grinding mill MTE-30, potency of 3 CV, or 2,237 KW. Considering 4 hours of work, then,
E2 = 2,237 x 4 = 8,95 KW.h
- Vertical cooker TCE-100, potency of 3 CV, or 2,237 KW. Considering 6 hours of work, then
E3 = 2,237 x 6 = 13,42 KW.h
- Press-filter FPE 25/10, potency of 0,5 CV, or 0,3728 KW. Considering 2 hours of work, then
E4 = 0,3728 x 2 = 0,7456 KW.h
- Boiler , potency of 2,0 CV, or 1,49 KW. Considering 6 hours of work, then
E5 = 1,49 x 6 = 8,95 KW.h
- High pressure washer, model HD585 KARCHER, 2,2 KW potency. Considering 1 hour of work, then
E6 = 2,2 x 1 = 2,2 KW.h
b) Electricity consumption due to illumination:
The calculation of the electricity needed for the agro industrial plant illumination was based on the Lumens Method according to FILHO , (2002).
Considerations:
Walls and ceiling light-coloured, floor dark-coloured.
Necessary illumination
Reception and washing, processing and packaging area: 500 lux;
Storage/stocking and other area: 100 lux
Offices: 250 lux
Use of wide lamps in a continuous line
Reception and washing, preparation and packaging areas: we considered 9 lamps with 2 fluorescent light bulbs of 65 W each, being 3 lamps for each room.
Dehydration area: we considered 2 lamps with 2 fluorescent light bulbs of 40W each.
Storage/stocking area and office: only 1 lamp with 1 65 W bulb is needed.
Thus, an electricity ratio due to the illumination, per industrial area was determined and is equal to 0,18.
The electricity consumption ratio is: E7= 80 x 0,18 = 14,40 KW.h
c) Electricity consumption of the administrative area:
The administrative area includes one restaurant, two toilets and one office, with a total area of 40 m2.
The calculations were performed based on the reference quoted above:
Office: 0,390 KW.h
Restaurant: 0,130 KW.h
Toilets: 0,260 KW.h
Total administrative area (E8): 0,78 KW.h
Et = total electricity = E1 + E2 + E3 + E4 + E5 + E6 + E7 + E8 = 62,86 kWh/day
Ratio = Et/ Mi = 0,1756 kWh/kg of initial raw material
These calculations are summarized below.

Variable	Name	Value
E1	Mini-crusher	13,42 kWh/day
E2	Grinding mill	8,95 kWh/day
E3	Cooker	13,42 kWh/day
E4	Press-filter	0,7456 kWh/day
E5	Boiler	8,95 kWh/day
E5	High pressure washer	2,2 kWh/day
E6	Illumination	14,40 kWh/day

E7	Administrative area	0,78 kWh/day
Et	Total electricity	62,86 kWh/day
Et/ Mi	Ratio	0,1756 kWh/kg of initial raw material

3.11.5. Firewood Consumption Ratio

The boiler consumes 0,15 m3 of firewood per working hour.
Firewood quantity = L = 0,15 m3/h x 6 h = 0,90 m3 of firewood/day.
Ratio = L/ Mi =0,00251m3/kg of raw material
We can summarize these results as follows:

Variable	Name	Value
L	Firewood	0,90 m3
L/ Mi	Ratio	0,0251 m3/kg of initial raw material

3.11.6. Packaging Ratio:

Packages utilized:
a) Plastic gallons containing 50 litres (Pac1)
The daily production is 76.25 KG of palm oil, with an average density of 0.92/kg.L. The plastic gallon capacity is 50 litres. Hence, each gallon can hold a 46 kg mass , as shown below.
(Gallon capacity 50 l x oil density 0.92/l)= 46 KG
Technical coefficient – plastic gallons / kg of palm oil:
(1 plastic gallon)/ 46 kg oil = 0,0217 Units / kg of palm oil
b) Labels (Emb2)
The amount of labels is proportional to the amount of plastic gallons used.
Coefficient:
1 label / 46 kg of palm oil: 0,0217 Units / kg of palm oil
These calculations are summarized as follows
These calculations are summarized as follows

Variable	Name	Coefficient
Emb1	50 litres plastic gallon	0,0217 Units / kg of palm oil
Emb2	Label	0,0217 Units / kg of palm oil

4. Bibliographical References

ANDRADE, A. M. V.; CAMPOS , F.; RODRIGUES, C. F. G.; CONDE , C. B. C. N. Agroindústria de processamento de truta arco-íris (Oncorhynchus mykiss): Análise de viabilidade técnica e econômica . Departamento de Tecnologia de Alimentos . Universidade Federal de Viçosa . Viçosa . 2003. p.56.
ANDRADE, N. J.; MACEDO, J. A. B. Higienização na Indústria de Alimentos . Departamento de Tecnologia de Alimentos . Universidade Federal de Viçosa . Viçosa , MG. 1996.
BANLIEU, J. Elaboracion de conservas vegetales (frutas e legumbres) editorial Sintes, S.A.; Lês Fonts de Terrasa, Barcelona, 1977
BRASIL - Ministério do Trabalho e Emprego
BRASIL. Norma Regulamentar n o 24 - Condições Sanitárias e de Conforto nos Locais de Trabalho (124.000-5). Ministério do Trabalho e Emprego . Disponível em : < www.mte.gov.br >. Acesso em : 15/02/2004 .
Bykowski , P.; Dutkiewicz, D. Freshwater fish processing and equipment in small plants. Sea Fisheries Institute. Roma: FAO, 1996. Disponível em : < www.fao.org>. Acesso em : 16/02/2004.
CNPAT/EMBRAPA – Embrapa Agroindústria Tropical

CRUZ , R. RIBEIRA , H.H.P, FERNANDES, A.R, SILVA, C.A.B. Processamento de Mandioca : Produção de farinha seca , raspas e amido em dois tamanhos de empreendimentos 5 e 20 t/ dia . In: SILVA, C.A.B e FERNANES, A.R. Projetos de Empreendimentos Agroindustriais : Produtos de Origem Vegetal . Universidade Federal de Viçosa-MG. Editora UFV. 2003. Cap.6.

FAO. Small-Scale Palm Oil Processing in África . FAO AGRICULTURAL SERVICES BULLETIN , n. 148, Rome, 2002.

FERRÃO , J. E. M. O Cajueiro : Instituto de Investigação Científica Tropical . Portugal : Lisboa, 1995 298p.

FILHO , J. M. Instalações Elétricas Industriais : Iluminação Industrial , Cálculo de Iluminação . 6 ed. Rio de Janeiro : LTC, 2002. p 58-63.

HORNE, J. Some Notes on Fish Handling and Processing. Department of trade and industry. Torry Research Station. Torry Advisory Note n o 50. Rome : FAO in partnership with Support unit for International Fisheries and Aquatic Research - SIFAR, 2001. Disponível em : < www.fao.org>. Acesso em : 15/02/2004.

LIU, K. Soybeans: Chemistry, Technology and Utilization. ITP, Chapman & Hall : New York , USA . 1997.

MEDINA, J.C. et al Abacaxi : cultura , matéria-prima , processamento e aspectos econômicos 2. Ed. rev. e ampl. Campinas , ITAL, 1987

MELONI, P.L.S. Como Montar uma Pequena Fábrica de Frutas Desidratas. Viçosa-MG, CPT, 1998. 42 pgs.

MINAMI, K.; FONSECA, H. Tomate : produção pré-processamento e transformação agroindustrial . Piracicaba: FEALQ, [1984]. 92p. (Série Extensão agroindustrial , 8).

Pereira , K. C.; Campos , A F. Estudo do rendimento de carcaça de tilápia (Oreochromis niloticus), após a obtenção do filé e estudo do aproveitamento do espinhaço para produção de surimi. In: International Symposium on tilapia in aquaculture, 5., 2000, Rio de Janeiro . Disponível em :< http://ag.arizona.edu/azaqua/ista/ista5work/ista5papers/BrazilPapers&Abstracts.doc >. Acesso em: 15/02/2004.

PUSCHMANN, R. e BENÍCIO, R.T. Avaliações técnicas realizadas in loco Departamento de Biologia Vegetal . UFV. 2003.

QUIJANO, J.A.T. Óleo de Palma . Revista Óleos & Grãos . 30ª Edição : Julho-Agosto de 1999.

SEBRAE/AM. Beneficiamento de Óleo de Dendê comestível . Manaus: Programa Estudos e Pesquisas , 1ª ed. 2002. 69p. (Série Perfis Empresariais).

Shirota , R., Oba , L.C. e Sonoda, D.Y. Estudos dos aspectos econômicos das processadoras de peixe provenientes da piscicultura . 2002. Disponível em : < www.cpap.embrapa.br/agencia/congresso/ Bioticos/SHIROTA-021A.pdf > Acesso em: 15/02/2004.

SILVA, C. A. B. ; FERNADES, A. R. Projetos de Empreendimentos Agroindustriais : Produtos de Origem Vegetal : Editora UFV : Volume 2 : Viçosa-MG, 2003 459p.

SOUZA, M.L. R. Comparison of six filleting methods and their relation with fillet yield and by-products of Nile Tilapia (Oreochromis niloticus) processing. Revista Brasileira de Zootecnia , v.31, n.3, p.1076-1084, 2002.

STORI, F. T. Proposta de reaproveitamento de resíduos das indústrias de beneficiamento de pescado em SC, a partir de um sistema gerencial de bolsa de resíduos . 2000. Disponível em : </www.valoronline.com.br/parceiros/ethos/trabalho_2_06.html >. Acesso em: 15/02/2004.

STRINGHETA, P.C., MELLONI,P., FERNANDES, A.R., SILVA, C.A.B. Produção de Banana-Passa. In: SILVA, C.A.B e FERNANES, A.R. Projetos de Empreendimentos Agroindustriais : Produtos de Origem Vegetal . Universidade Federal de Viçosa-MG. Editora UFV. 2003. Cap.2. p24-57.

TRAVAGLINI, D.A, NETO , M.P, BLEINROTH, E.W., LEITÃO , M.F.F. Banana-passa: princípios de secagem , conservação e produção industrial . Manual técnico n12. ITAL: Campinas , 1993.

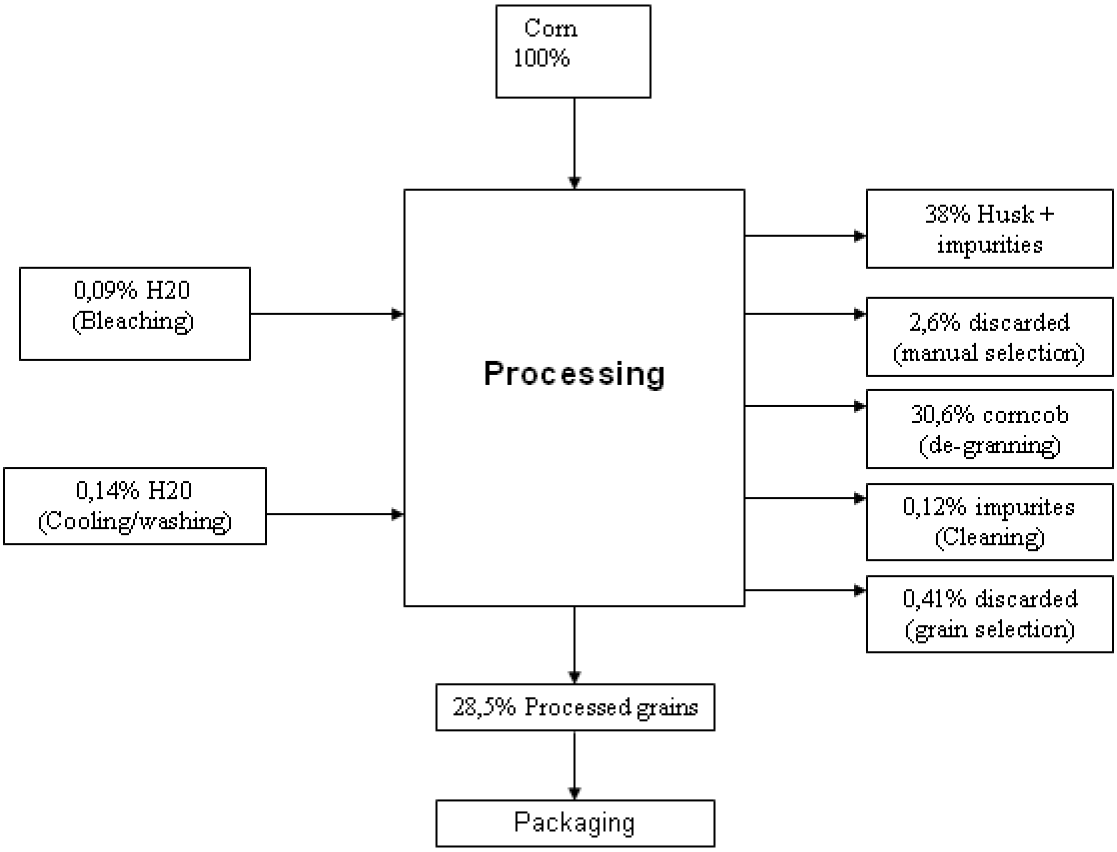
Universidade de São Paulo . Escola Superior de Agricultura Luiz de Queiroz. Departamento de Agroindústria , Alimentos e Nutrição . Aula : Tecnologia do pescado . Marília Oetterer.

Disponível em : < www.esalq.usp.br/departamentos/lan/pdf/Tecnologia%20do%20Pescado.pdf >. Acesso em: 17/02/2004 .

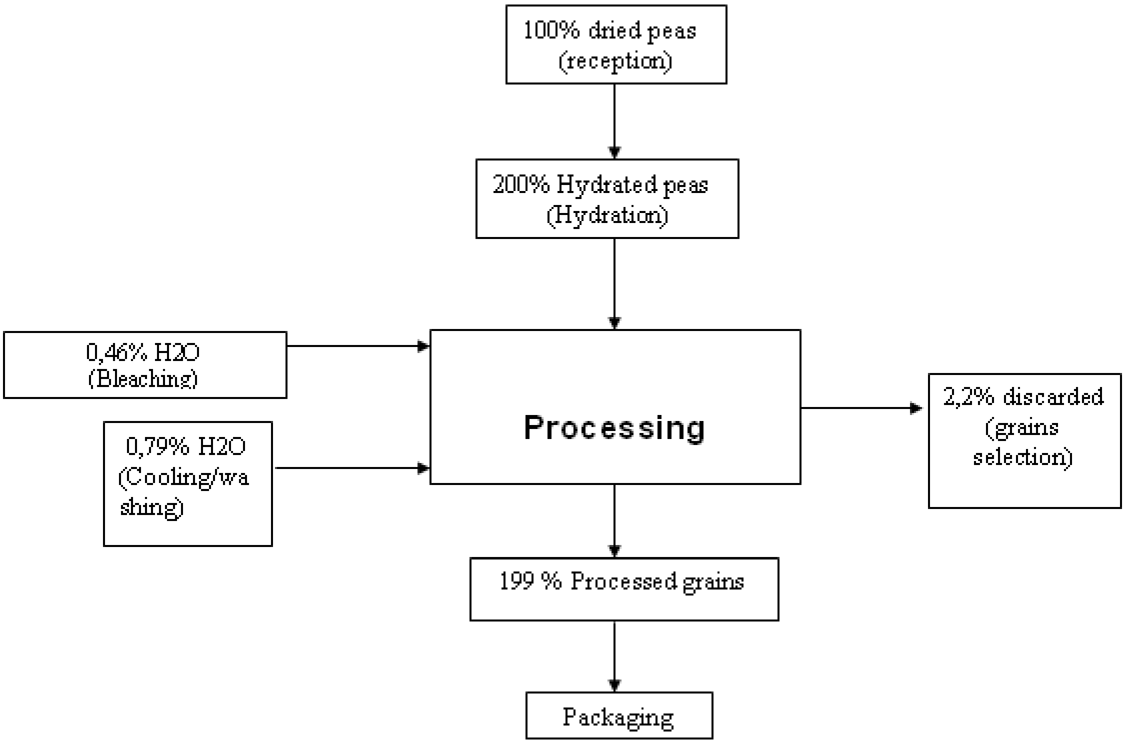
Annex

A) VEGETABLE CANNING

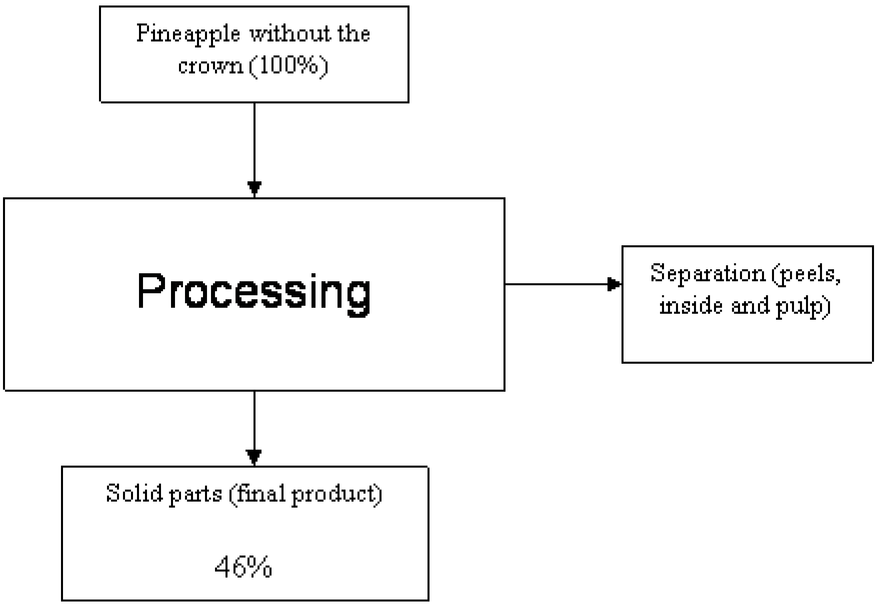
1. Mass balance (corn)



2. Mass balance (peas)

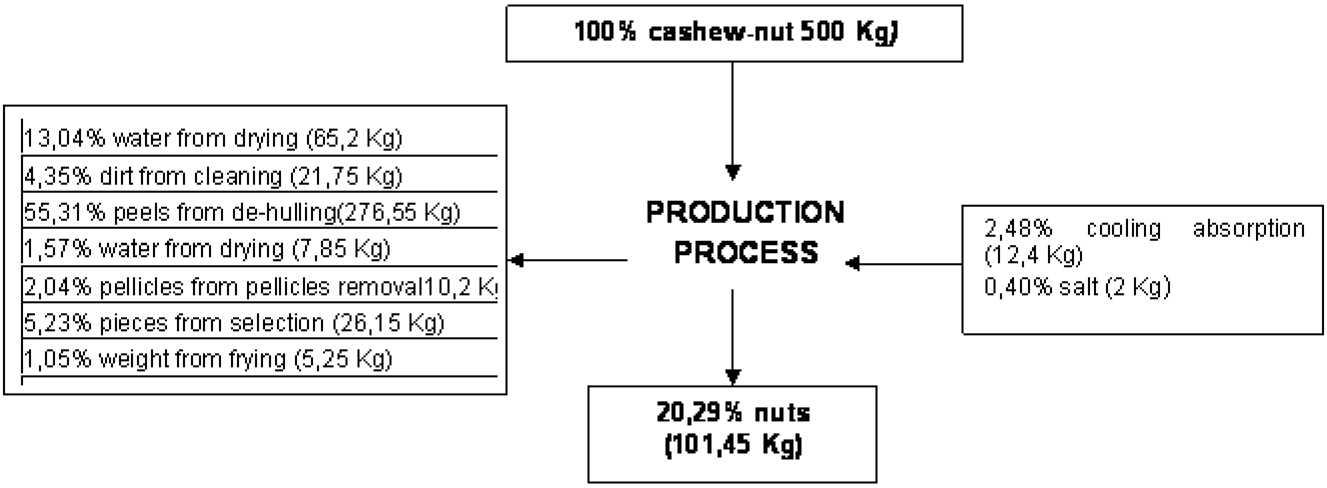


3. Mass balance ("pineapple in syrup")

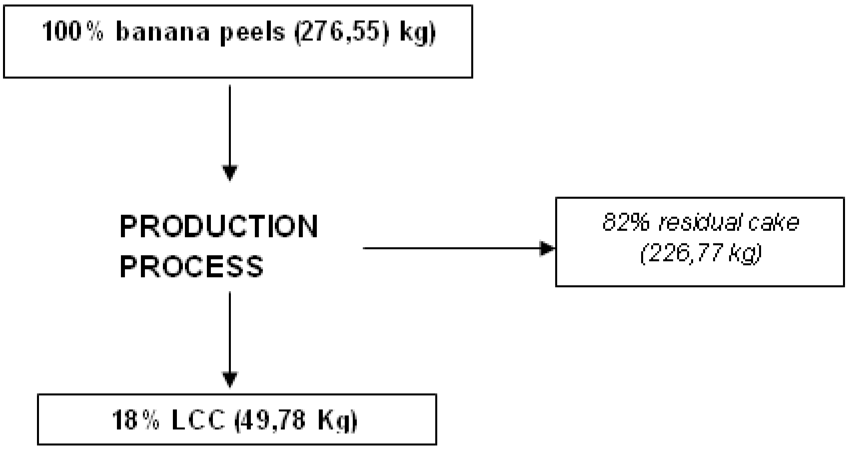


B) CASHEW-NUT AGROINDUSTRIAL PROCESSING PLANT

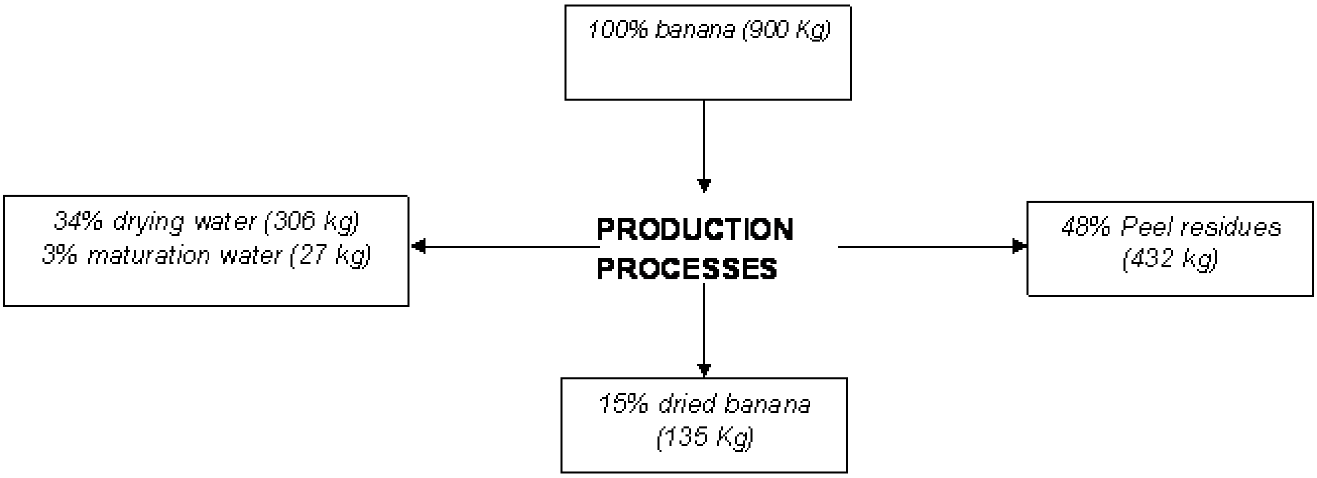
1. Fried nuts production mass balance:



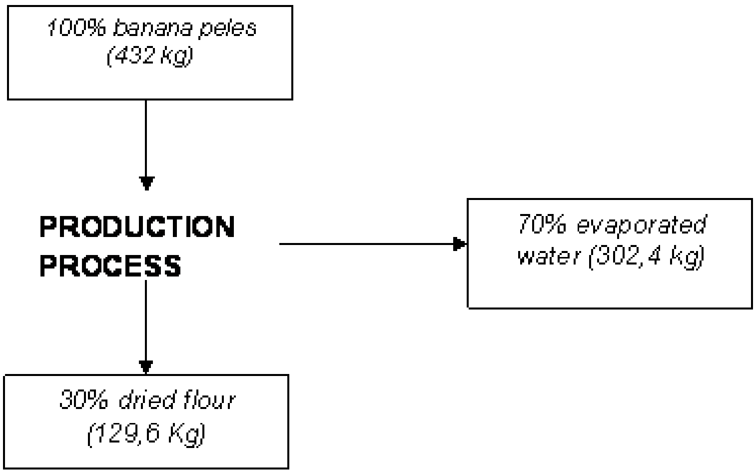
2. Mass balance of the residues uptake as nut peel liquid (LCC):



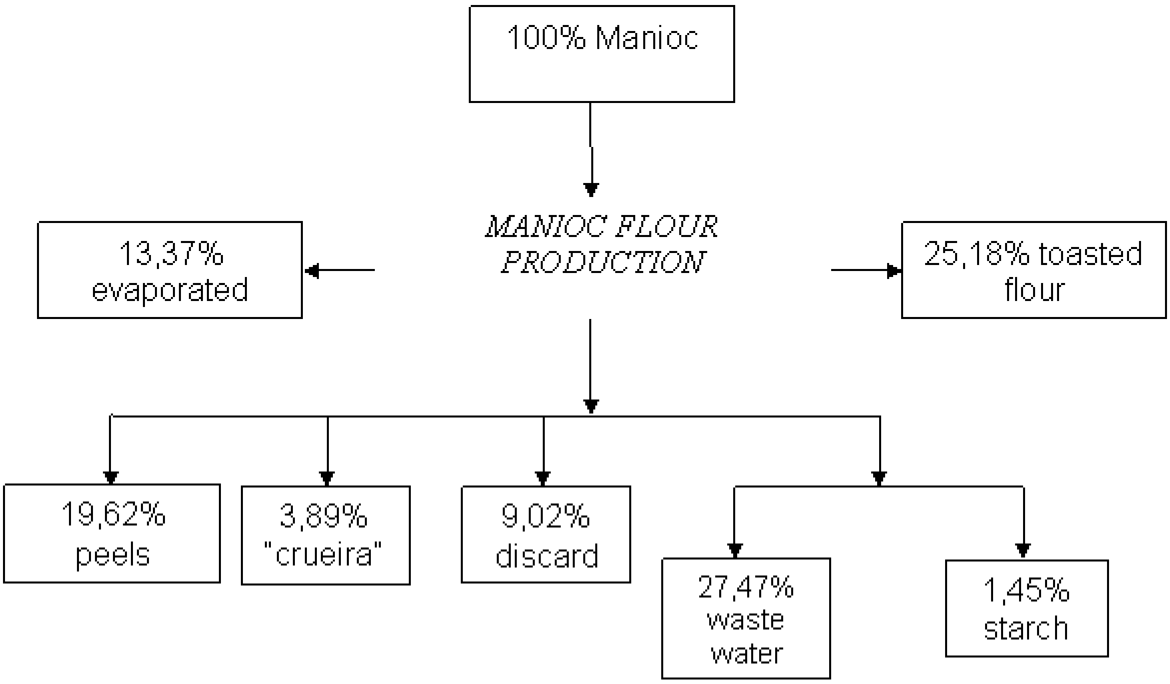
C) DRIED BANANA AND BANANA PEEL FLOUR AGROINDUSTRIAL PLANT
1. Mass balance of the dried banana process:



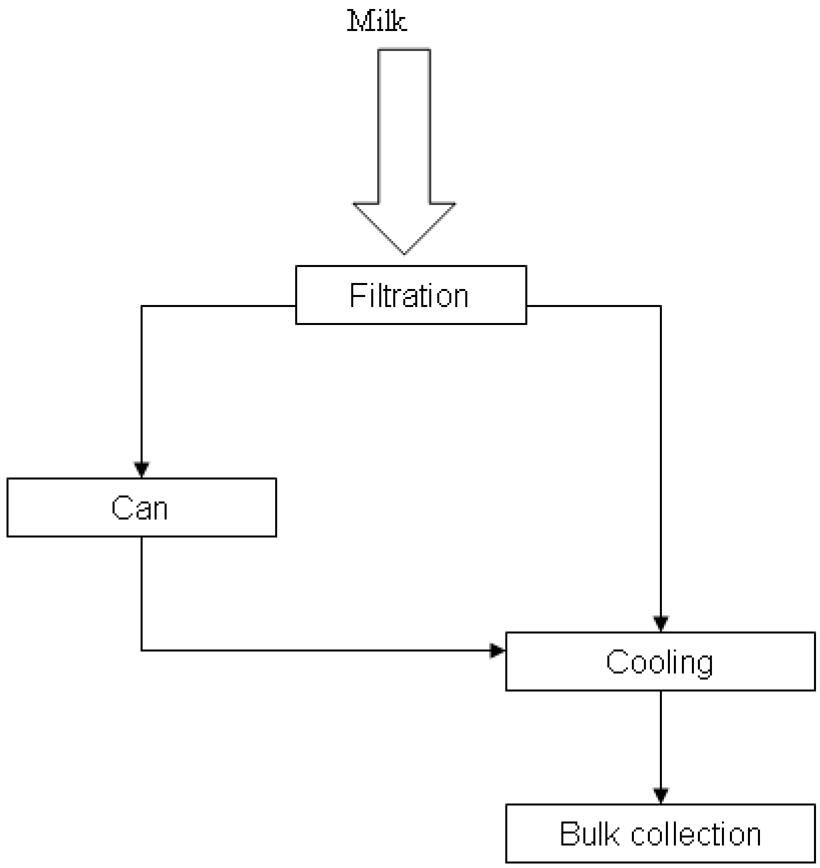
2. Mass balance of the waste utilization as banana peel dried flour:



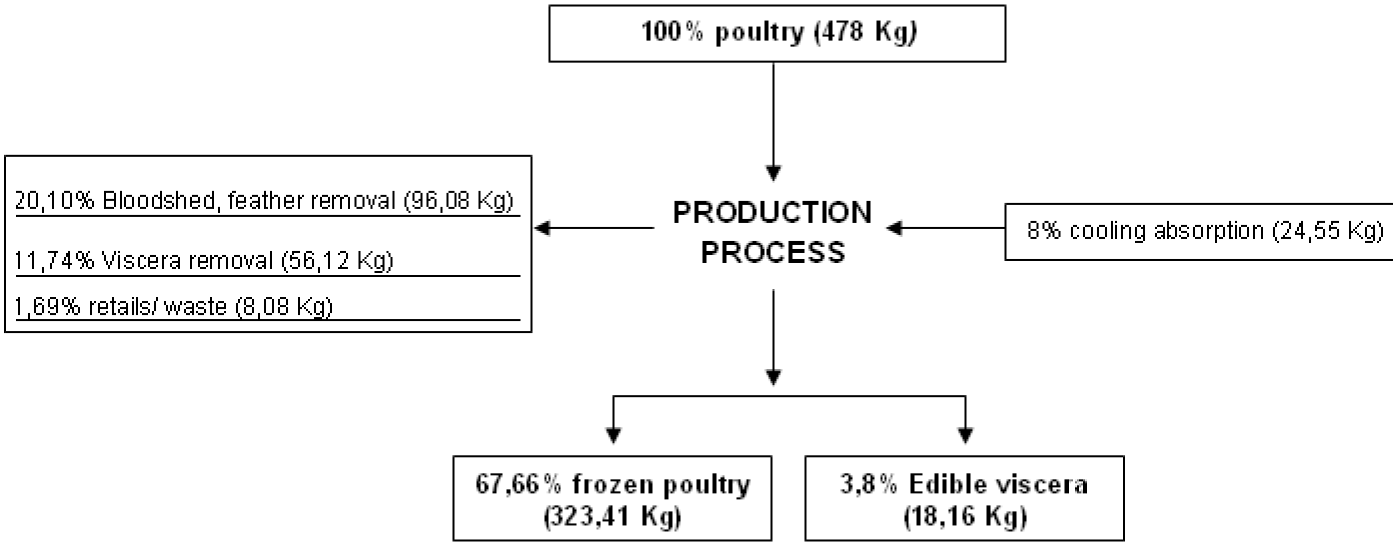
D) MANIOC FLOUR PROCESSING
1. Mass balance for manioc flour processing



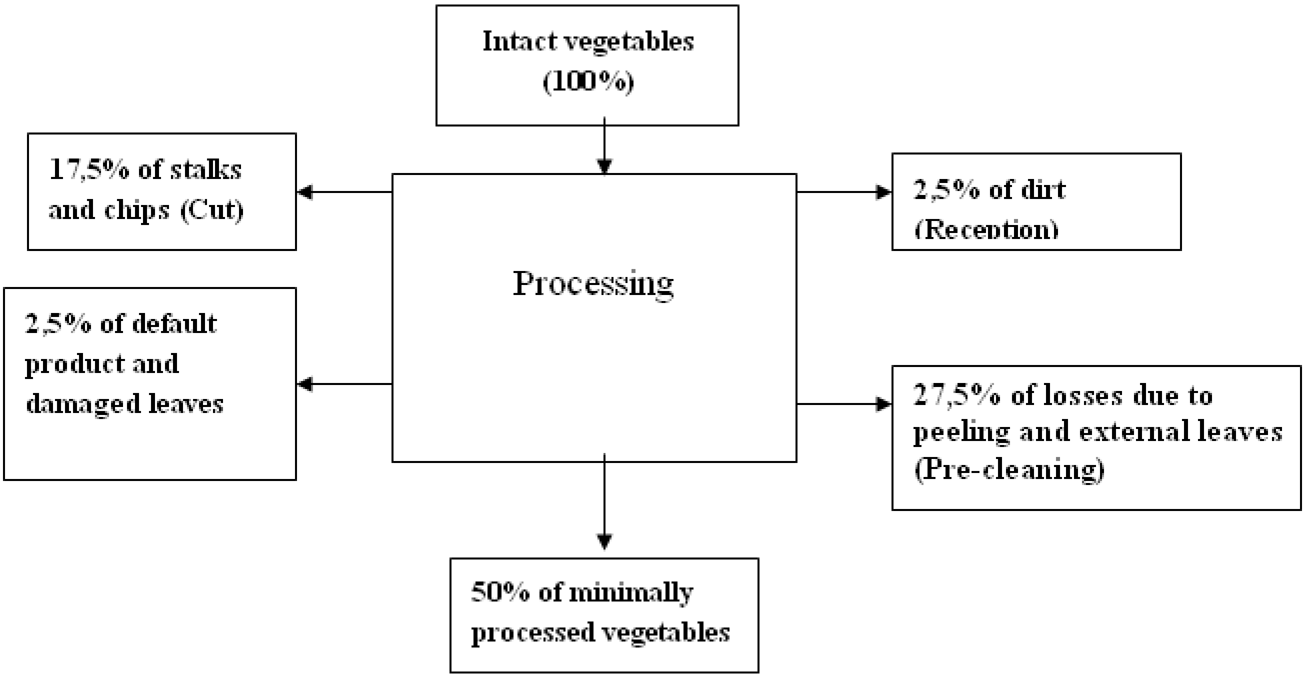
E) MILK COOLING



F) POULTRY SLAUGHTERING AGROINDUSTRIAL PROCESSING PLANT
1. Frozen Poultry production mass balance:

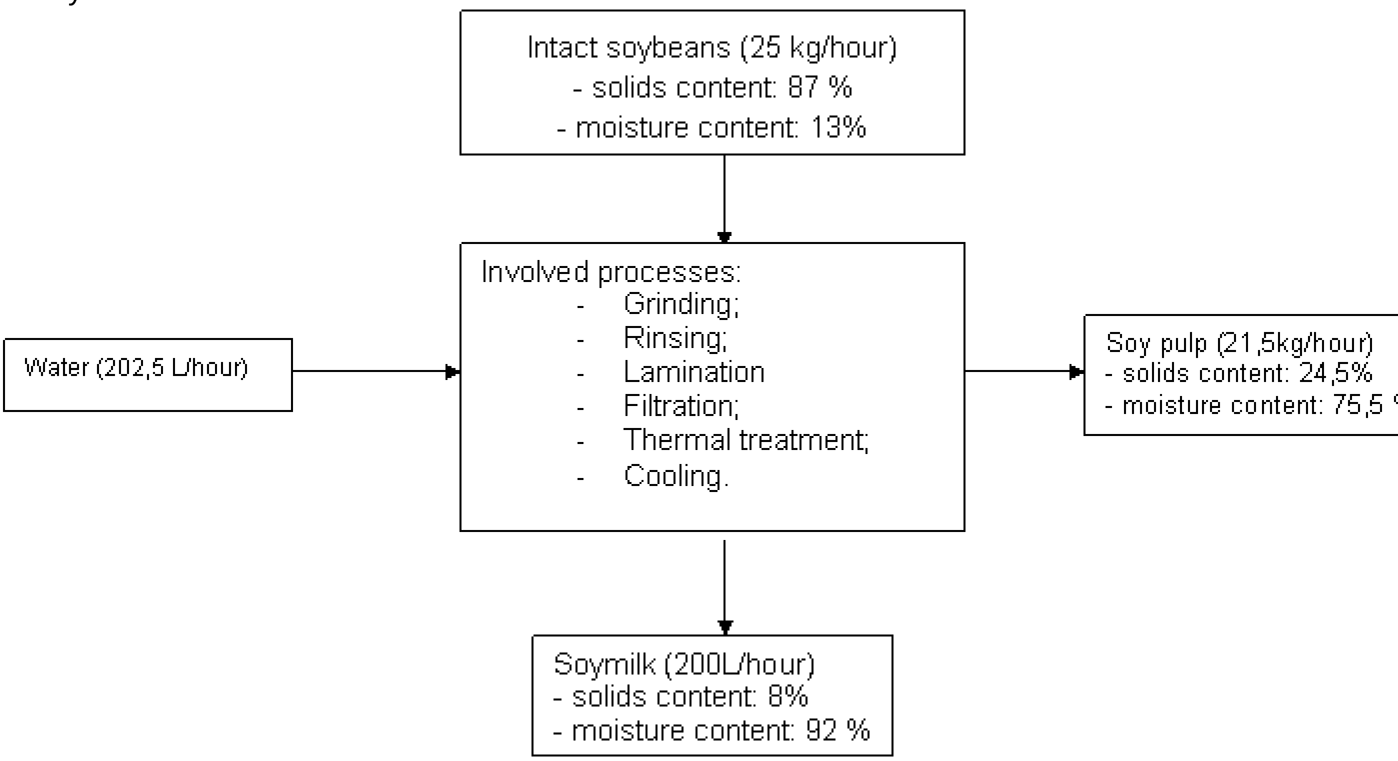


G) MINIMALLY PROCESSED VEGETABLES
1. Mass balance



H) SOYBEAN MILK

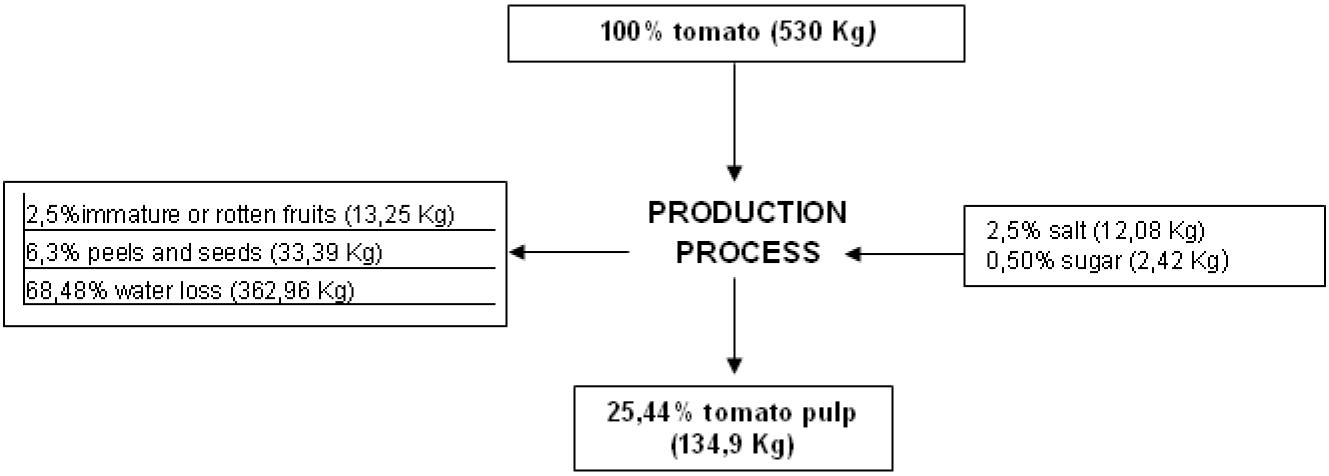
1. Soy Milk

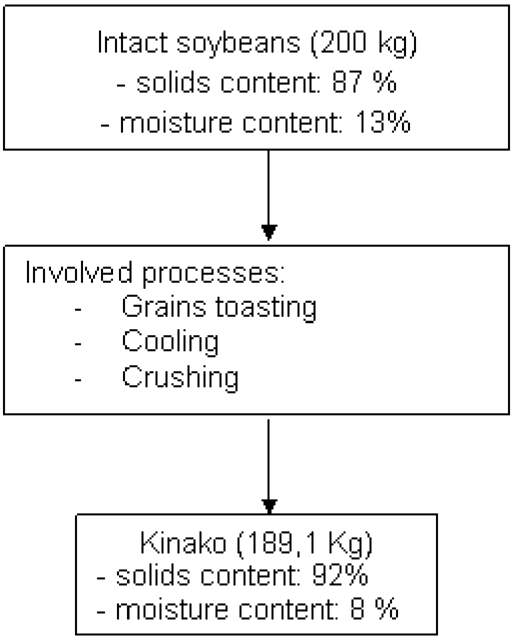


1. Kinako

I) TOMATO PULP - AGROINDUSTRIAL PROCESSING PLANT

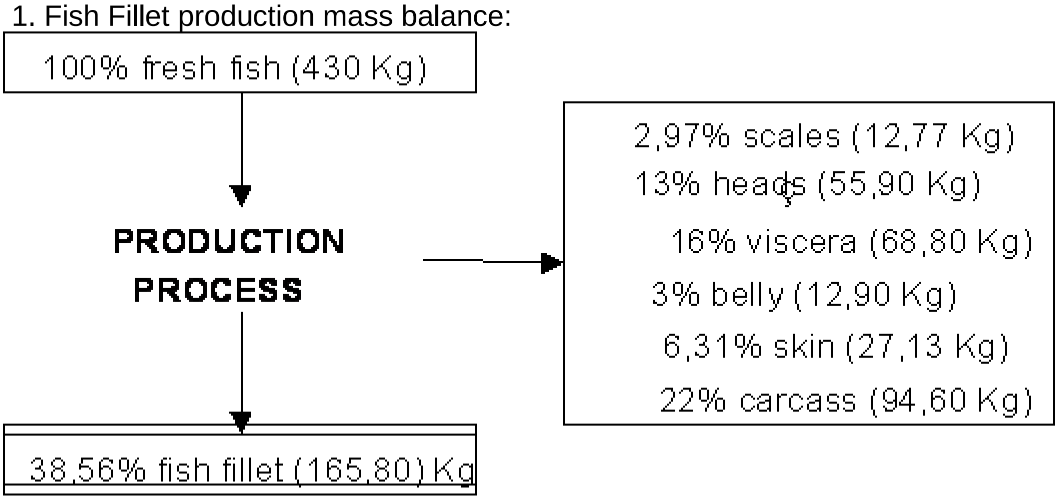
1. Tomato pulp production mass balance:



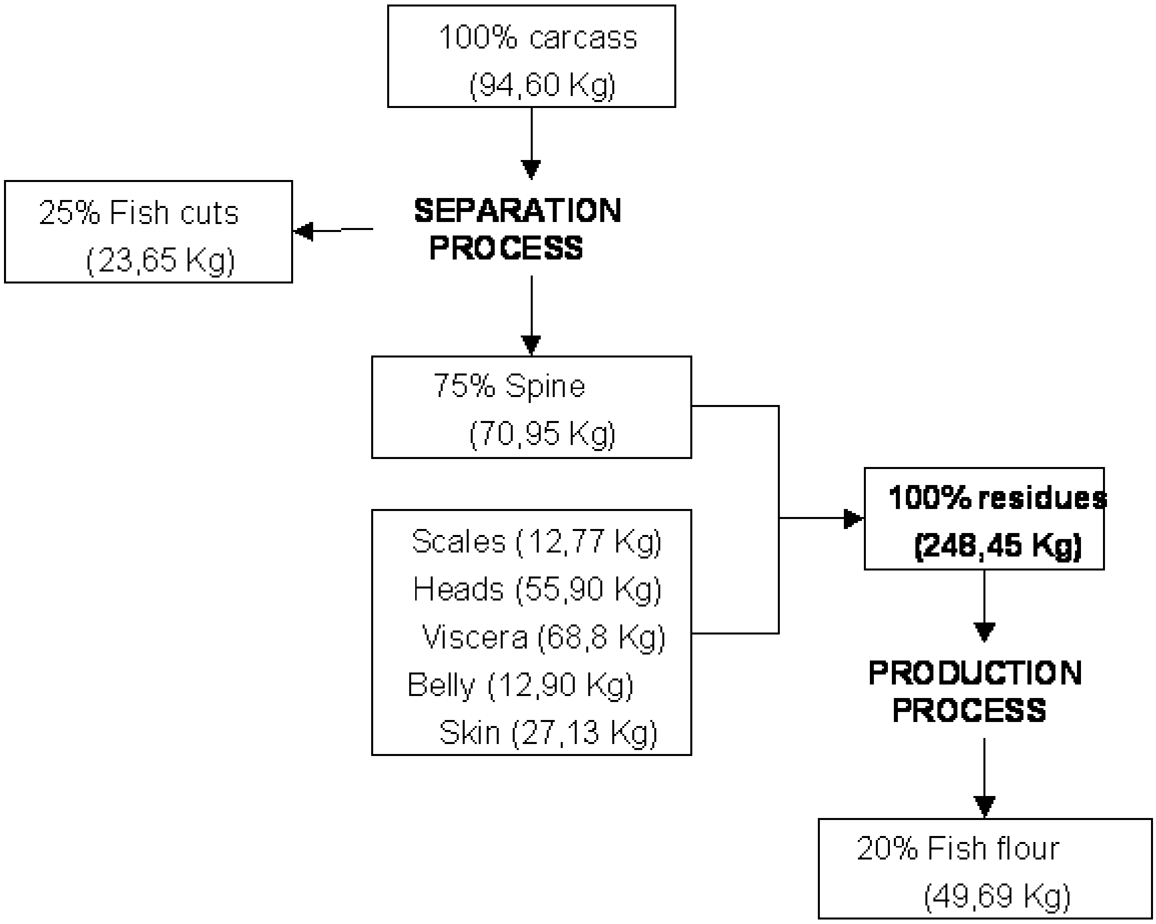


J) AGROINDUSTRIAL TILAPIA FILLETING PROCESSING PLANT

1. Fish Fillet production mass balance:

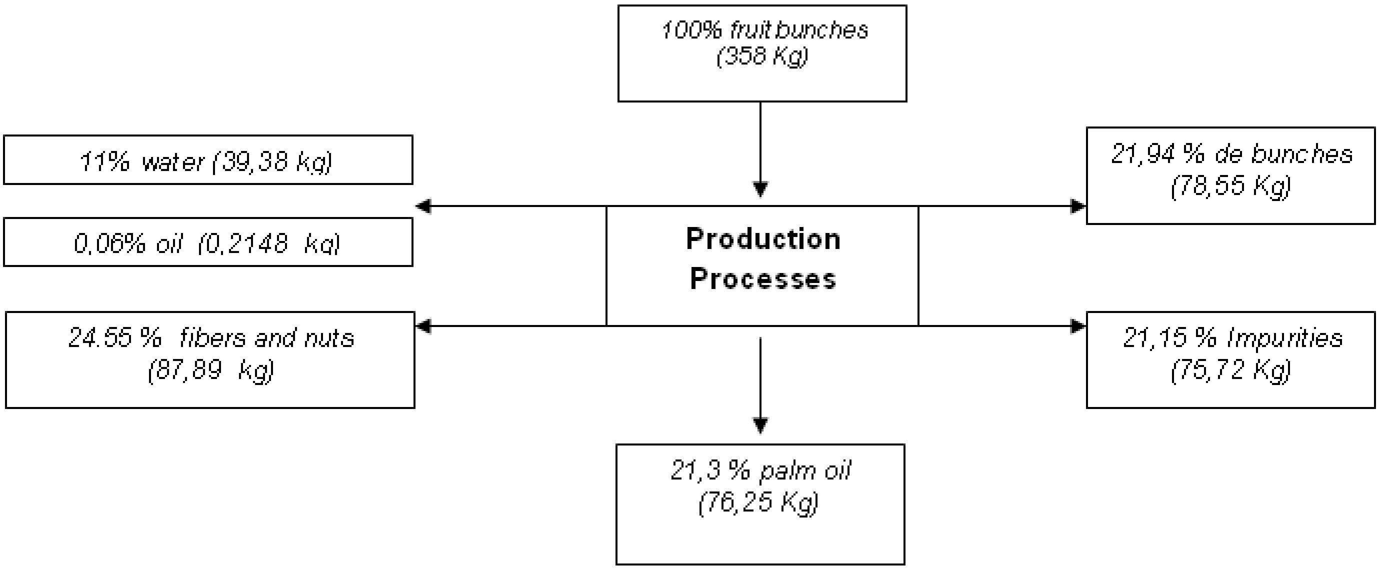


2. Residues utilization mass balance:



K) PALM OIL PROCESSING PLANT

1. Mass balance



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