TECHNOLOGICAL DEVELOPMENT TO ELABORATE COMMON WHITE WINE IN MISIONES, WITH ECONOMIC EVALUATION AT INDUSTRIAL SCALE

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ABSTRACT

The objective of this paper was to develop a sustainable technology on an industrial scale to produce common white wine with non viniferous grapes cultivated in Misiones. This technological project was initiated at a laboratory scale, continued in the pilot plant and industrial-scale project. It was considered as a productive unit to 12 rural families with 27 hectares of vines each. The 8 stages followed with inductive and deductive methodology were: The development of dry white wine at laboratory scale. The evaluation of process variables in the vivification. The mathematical modeling of the alcoholic fermentation in oenological conditions. The valuation of the aptitude of wines for human consumption. The establishment of a technological procedure for wine in the pilot plant. The evaluation of the pilot plant in technological procedure established. The calculation and selection of industrial equipment. The estimate of the costs and profitability of industrial technological process. It reached a technology for a production capacity of 5,834 L day^{-1}, with dynamic economic indicators whose values were: net present value of 6,602,666 U\$D, an internal rate of return of 60 % for a period of recovery of investment to net present value of 3 years.

KEY WORDS: Technology; Oenology; Economy.

INTRODUCTION

In the province of Misiones Argentina since 2004 it is developing the project Profruta to diversify production. According to Miño Valdés and Herrera (2007), the increase in grape growing was one of alternatives, using Vitis labrusca varieties that were better adapted to the soil and climate of the province as Niagara Rosada (NR) and Isabella Tinto (IT) among

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others. According to Bakos (2009) the production of table grapes in Misiones supplied market demand in 2009 with 0.61 kilograms/year habitant (hab^{-1}year^{-1}), where about 300 rural producers engaged in growing grapes. Piekun (2011a) noted that the grape harvest to Nov/2011 and Feb/2011 reached about 800 tons and of this total, 85% was sold as fresh fruit; with the remaining grapes 50 farmers produced common wine by spontaneous fermentation without control variables for family consumption. Given that the Argentine Food Code (AFC) allows regional production of table wines and not vinifera grapes and that the National Wine Institute of Argentina (NWI) authorized to market only within the country, so this activity was recorded as a diversification alternative to be evaluated. According to Piekun (2011b) prices on the farm ranged between 8 and 10 dollar/kilogram ($ kg^{-1}) at the beginning of the harvesting in Nov/2010 and then dropped to $ 6 kg^{-1} at the end of it.

The scientific problem raised was the lack of technological information obtained with scientific methodology for the development of common white wine, Vitis labrusca varieties: NR or IT cultivated in Misiones, using inocula of yeasts.

To solve this problem it was necessary to obtain and record the values of the parameters to follow the development laboratory and pilot plant scale, in three phases of technological analysis:

- Prefermentative phase included: the heavy, stemming, crushing, pressing, sulphite and clarified.

- The fermentative phase included: the addition of nutrients and yeasts at different temperatures in IT and NR musts.

- Postfermentative phase included: sulphiting, clarified, stabilized, stored, filtered and packaged.

As a hypothesis is established that it is viable from the economic and scientific point of view, to develop an appropriate technology to rural areas, to develop common white wine fit for human consumption, from mustsfrom not vinifera table grapes.

For these reasons the general goal was: to develop an appropriate and sustainable technological process for the preparation of common white wine fit for human consumption, from not viniferous grape cultivated in Misiones using indigenous yeasts or Saccharomyces cerevisiae bayanus (S. bayanus).

The specific objectives of technological development require:

- Basing from the standpoint of scientific and technological research strategy to achieve the overall objective proposed.

- Perform IT or NR grape vinification with native yeasts or S. bayanus yeast as controls with different temperatures.

- Evaluate the performance of yeasts on S. bayanus.

- Determine physicochemical suitability of common white wines produced.

- Establishing and promoting a technological process suitable for the elaboration.

- Demonstrate the economic sustainability of the developed technology and environmental impact mitigation technology for this procedure.

To achieve the specific objectives the strategy was based on a thorough analysis of the state of the art of winemaking with wine grapes, and executes actions with inductive and deductive methodology in the following scales:

At laboratory scale:

Step A. Developed common dry white wine.

Step B. Values were evaluated for tracking parameters.

Stage C. We obtained a mathematical modeling of the process.

Step D. It was verify wines fitness for human consumption.

At pilot plant scale:

Step E. A technological procedure was developed and wines were elaborated.

Step F. We evaluated the performance of each operation.

At an industrial scale:

Step G. Equipment was sized for the procedure.

Step H. We evaluated economically the established technological development.

DEVELOPMENT

Below it develops steps A, B, C and D at laboratory scale.

Stage A: developing common dry white wine with IT and NR.

Materials and Methods at laboratory scale

The grapes used were varieties of Vitis labrusca IT and NR from Cerro Azul, Misiones, 2006/2007 harvest. The native seed yeast came from the skin of grapes and S. bayanus (commercial yeast, from Spain, Anfiquímica supplier).

Native inoculum yeast: 2 kg of IT grape were pressed with skin (no stalk) and was added 1 gram/hectoliter (g hL^{-1}) ammonium phosphate (fermentation adjuvant).

Spontaneously fermented for 2 days (d), then was taken (without skin) 3% volume/volume (v/v) of Cuba foot and inoculated to 2 Liter (L) of wort prepared IT. The amount of yeast per milliliters (mL) at the beginning of wort fermentation was 12.10^3.

Inoculum of S. bayanus: yeast were added to the wort at a dose of 1 g hL^{-1} previously hydrated and reactivated with distilled water at 37 °C (Celsius) for 30 minutes (min). The initial concentration in the wort was 6 10^3 S. bayanus mL^{-1}.

Samples: 5 kg of grapes were used per sample to vinify, pressed separately without stalk to obtain 2.5 L of wort. 3 g hL^{-1} of sulfur dioxide (SQ_2) were added to the wort and 2 g hL^{-1} of pectolytic enzymes. Each container was plugged with water valve and decanted for 24 hours (h) to clarify the wort. After this time, 0.5 L of cleared were separated, obtaining samples of 2 L each. The fermentation temperatures studied were: 18 °, 22 °, 26 ° and 30 ºC with IT and 24 ° C with NR.

The added additives were prepared with solutions of potassium metabisultfite at 10% weight/weight (w/w); ammonium phosphate 5% w/w and peptolítical enzymes (Lafazym supplier, Spain origin). The inoculate, samples and additives were prepared with Pszczolkowski methodology, (2002).

They were determined: Van Rooyen-Ellis-Du Plessi and Cillis-Odifredi maturation indices, total soluble solids (TSS) measured in Brix degrees (ºBrix), hydrogen potential (pH), weight and volume of the berries, the gravity of the wort, the wort yield berries, reducing sugars, the degrees of alcohol obtained, the degree of potential alcohol, acidity (total and volatile), the temperature, the sulfur dioxide (free and total), the power fermentation (PF), the fermentation activity (AF), performance fermentative (PF), the population count and yeast generations.

The additives and determinations were performed according to the method of Chang, (2002); Pszczolkowski, (2002), INV (2005); Boulton et al. (2006) and Bordeau, (2006).

Fermentations: were inoculated in triplicate with native yeasts or S. bayanus samples of 2 L prepared at fermentation temperatures. To each wort was added 1 g hL^{-1} ammonium phosphate. The containers were filled with valve water to produce anaerobiosis. They were started simultaneously in all isothermal chamber fermentations. When the density remained constant 2 consecutive days of fermentation was terminated. To each wine obtained 6 g hL^{-1} of SO$_2$ was added. The wines were stored upright at 0 °C in refrigeration for three weeks at 0 °C.

Then, the lee formed was separated when the wine was racked into clean and sanitized bottles of 750 mL each. The free SO_2 was fixed taking it to 35 mg L^{-1} of wine for their protection. Containers were filled with cylindrical corks during 3 months and lying stored at 0 °C to stabilize them, and then they were analyzed. The methodology of alcoholic fermentation in oenological conditions was performed according to Pszczolkowski (2002).

Statistical Stat graphic Plus® package were used for Windows 1993, version 5.1 Statistical Graphics Corporation. For data analysis, the mean, standard deviation and range. The Fischer test (F) for the analysis of unknown variances and to compare the mean test with equal variances (t) of Student, both statisticians were applied with a confidence level (CL) of 95% and two tails.

Results at laboratory scale

Figs 1, 2, 3 and 4 show the values of density, TSS, pH and yeast population respectively vs. time for native yeast-fermented mash.
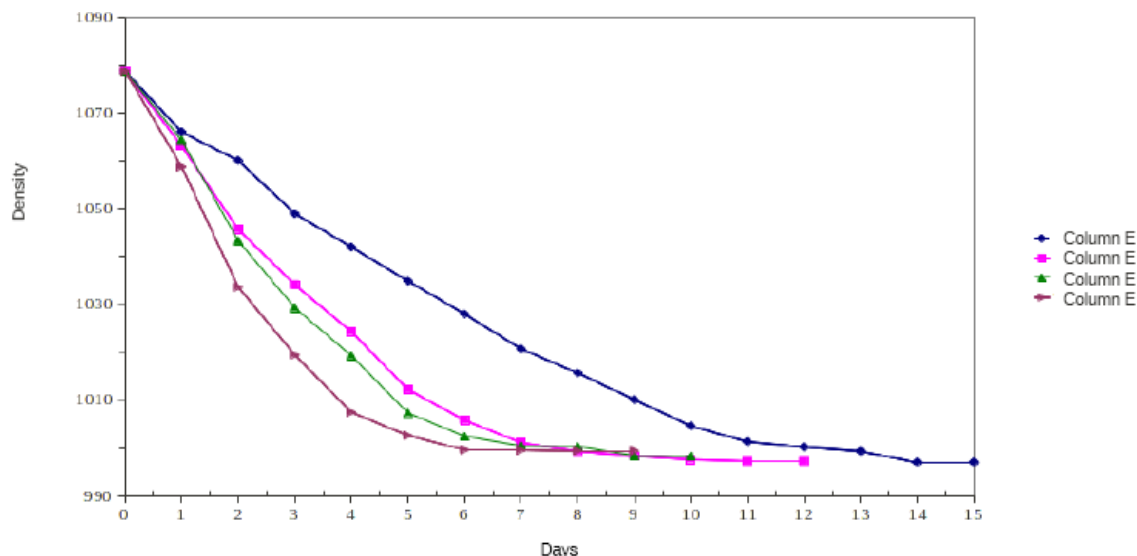

Figure 1. Density vs. Fermentation time in musts with IT yeast native
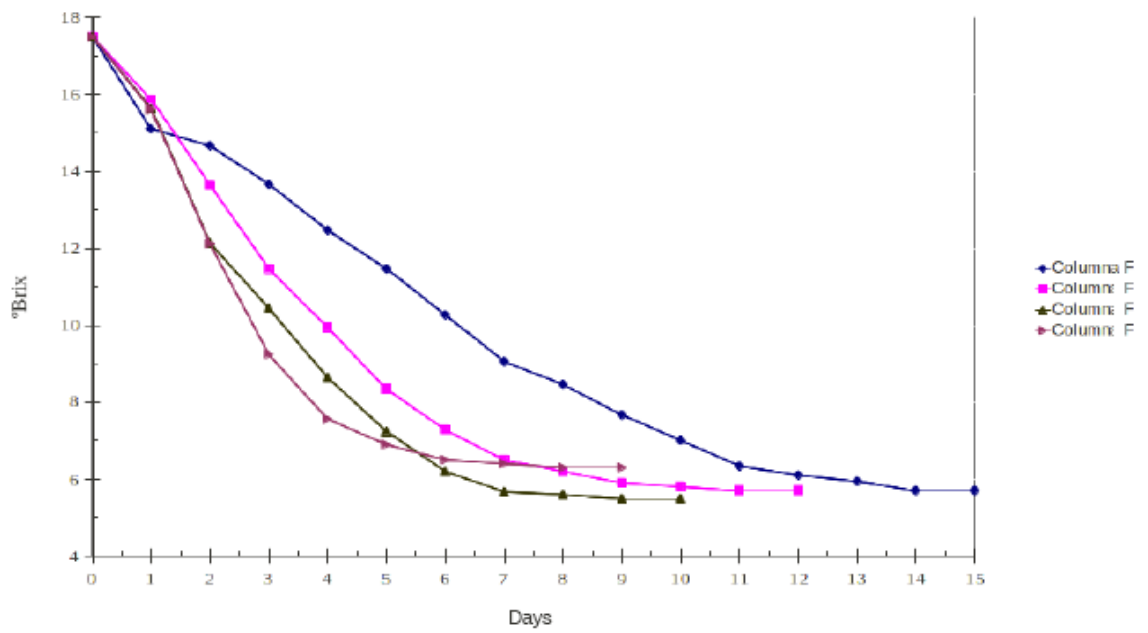**Source:** Own Elaboration

Figure 2. SST vs. Time musts fermented with native yeasts IT
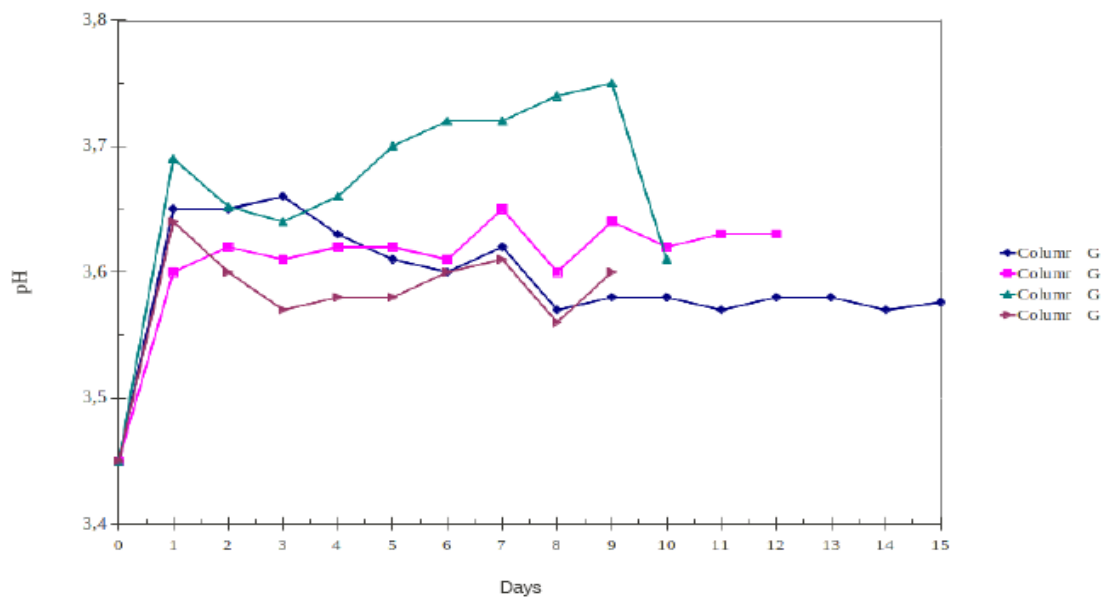**Source:** Own Elaboration

Figure 3. vs. pH. Time musts fermented with native yeasts IT
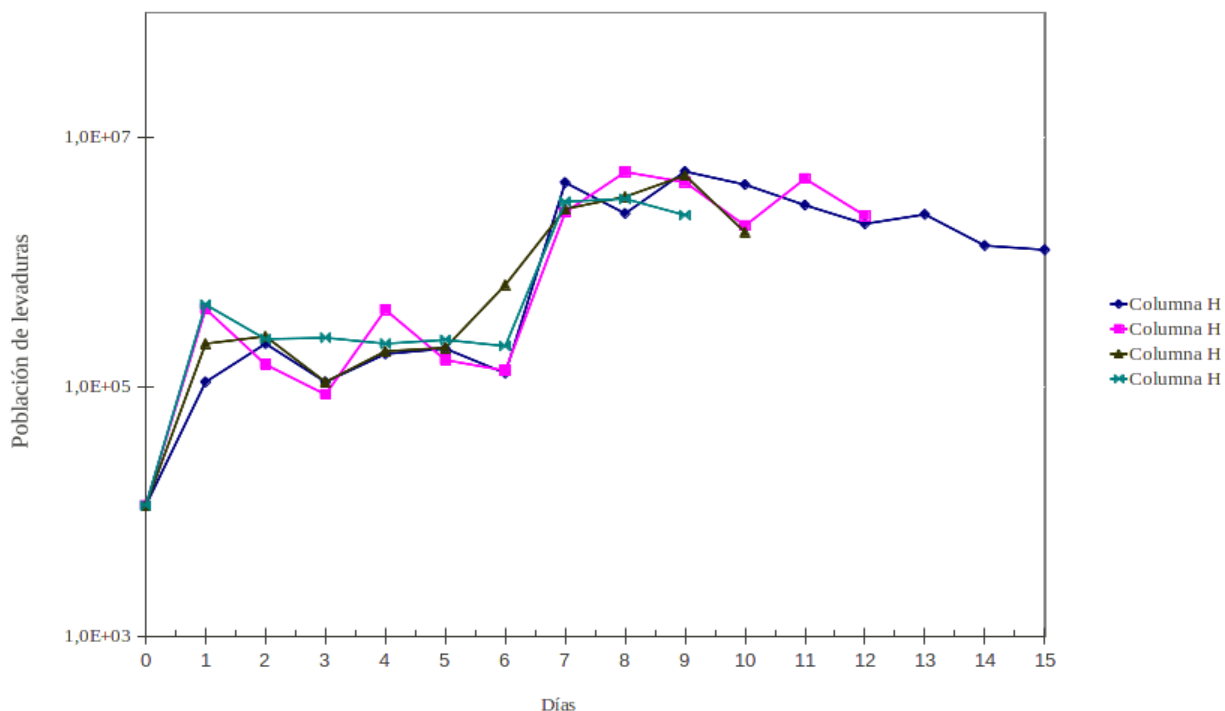**Source:** Own Elaboration

Figure 4. ML -1 vs native yeasts. Fermentation time in IT musts
Source: Own Elaboration

IT and S. bayanus are shown in Fig 5, 6, 7 and 8 with the values of density, TSS, pH and yeast population respectively in function of the fermentation time.
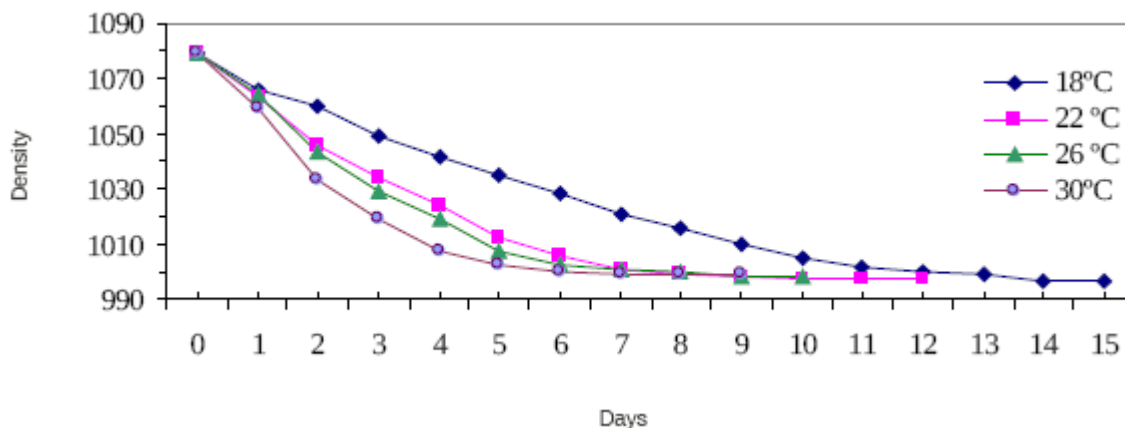

Figure 5. Density vs Time IT musts fermented with S. bayanus
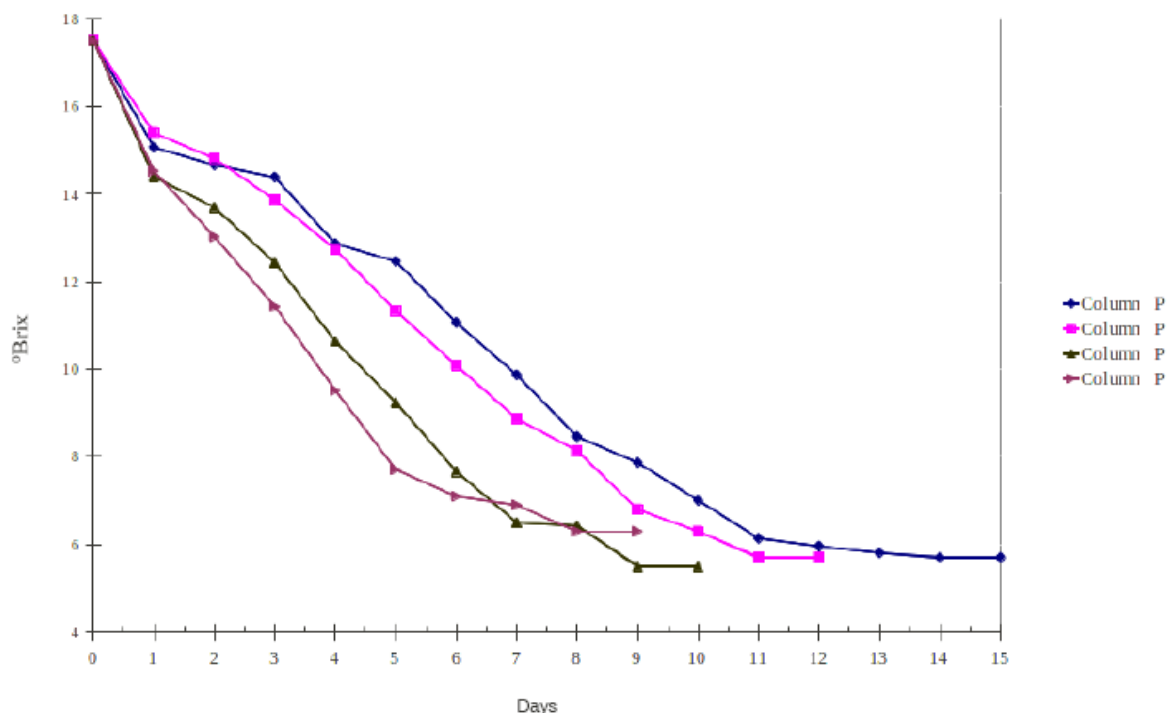**Source:** Own Elaboration

Figure 6. SST (º Brix) vs Time IT musts fermented with S. bayanus
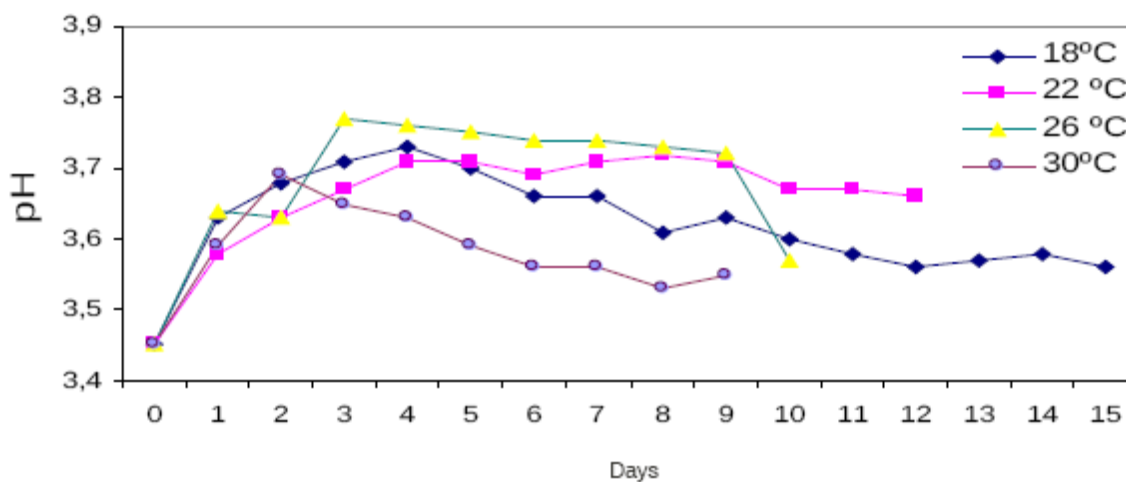**Source:** Own Elaboration

Figure 7. pH vs Time IT musts fermentation with S. bayanus
Source: Own Elaboration
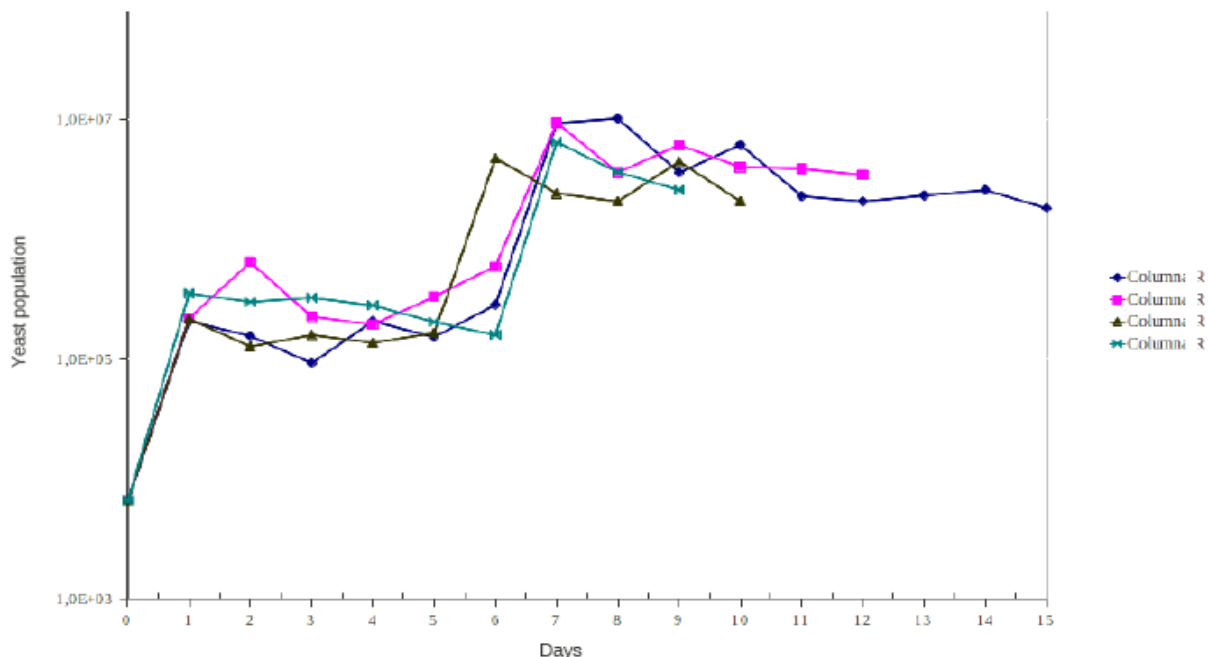
Figure 8. S. bayanus vs fermentation time IT musts
Source: Own Elaboration

The results with NR grapes inoculated with native yeasts and S. bayanus at 24 °C are shown in Tab.1

Table 1. Density, pH and TSS vs. Time NR musts fermentation at 24 ° C

Time	Density (g L^{-1})		pH		SST (ºBrix)	
Days	*S.bayanus*	Native	*S.bayanus*	Native	*S.bayanus*	Native
0	1080,3	1080,3	3,20	3,20	19,0	19,0
1	1058,6	1058,8	3,29	3,32	15,5	15,89
2	1045,8	1046,7	3,28	3,26	13,4	13,85
3	1035,8	1035,8	3,26	3,26	11,6	12,09
4	1021,9	1023,7	3,25	3,19	10,3	10,75
5	1013,7	1015,7	3,23	3,18	8,75	8,25
6	1005,6	1006,7	3,21	3,20	7,21	7,75
7	1001,7	1001,4	3,24	3,21	6,84	6,60
8	997,7	997,7	3,23	3,25	6,24	6,24
9	995,7	995,6	3,24	3,23	5,74	5,71
10	993,7	993,6	3,25	3,23	5,74	5,71
11	993,6	993,6	3,27	3,24	5,71	5,61

Source: Own Elaboration

Stage B:

Evaluation of the results of the process of winemaking grape IT at different temperatures with the t test for a confidence level (CL) of 95% were:

The average pH did not differ significantly: at 18, 22 and 26 ºC with inocula native yeast; at 18, 22 and 26 ºC with inocula of S. bayanus; at 18, 22, 26 and 30 ºC with native inocula respect to S.bayanus at each temperature.

The average pH showed significant differences: at 30 °C compared to 18, 22 and 26 ºC with native yeast inocula; at 30 °C compared to 18, 22 and 26 ºC with inocula of S. bayanus.

The average SST values were not significantly different: at 18, 22, 26 and 30 ºC with native yeast inocula; at 18, 22, 26 and 30 ºC with inocula of S. bayanus; at 18, 22, 26 and 30 ºC with respect to native S.bayanus at each temperature.

The PF in [(ºAlcohol obtained) 10^2 (ºAlcohol expected)$^{-1}$]: by comparing the PF at each temperature; yeast of S. bayanus were higher than the native at 18 °C by 9.1% (98.9 to 89.8); at 22 °C by 4.1% (93.9 to 89.8); at 26 °C 5% (95.9 to 90.9), respectively, but at 30 ºC natives were better with a difference in favor of 8% (90.8 to 82.8).

The AF in (g day^{-1} sugar): IT musts of S. bayanus and native was similar at the same temperature with the following values: 11.2 at 18 °C, 14 at 22 °C, 16.8 at 26 °C, 18.6 at 30 °C, and 14.6 at 24 °C in NR musts.

The PF in (g sugar / º Alcohol)

From this point of view the PF of S.bayanus had more performance than natives: (17.14 and 18.87) at 18 °C, (18.06 and 18.87) at 22 °C, (17.68 and 18.66) at 26 °C, respectively, but at 30 °C the best PF obtained the native with 20.48 respect to S.bayanus with 18.66).

The yeast population: Generation 1 was 12 10^3 mL^{-1} native and bayanus 6 10^3 mL^{-1} respectively. The maximum regarding the initial generation 1 in IT musts were:

At 18 °C: for native 8-9 generations and S.bayanus 10-11 generations

At 22 °C: for native 8-9 generations and S.bayanus 10-11 generations

At 26 °C: for native 8-9 generations and S.bayanus 9- 10 generations

At 30 °C: for native 8-9 generations and S.bayanus 9- 10 generations

The final populations regarding the initial IT musts were:

At 18 °C: for native 6-7 generations and S.bayanus 8-9 generations.

At 22 °C: for native 7-8 generations and S.bayanus 9- 10 generations

At 26 °C and 30 °C: for native 7-8 generations and S.bayanus 8- 9 generations

The final population of 18-30 °C with native IT S.bayanus were (1.25 to 2.37) 10 [6] cells mL [-1] and 6-8 generations (1.82 to 3.47) 0.10 [6-1] cells mL of 8-10 generations.

Stage C:

The model of alcoholic fermentation in oenological conditions is presented in Fig. 9. The contribution to the formation of ethanol, the population of S.bayanus and decreased substrate were for IT must fermentation at 18 °C.
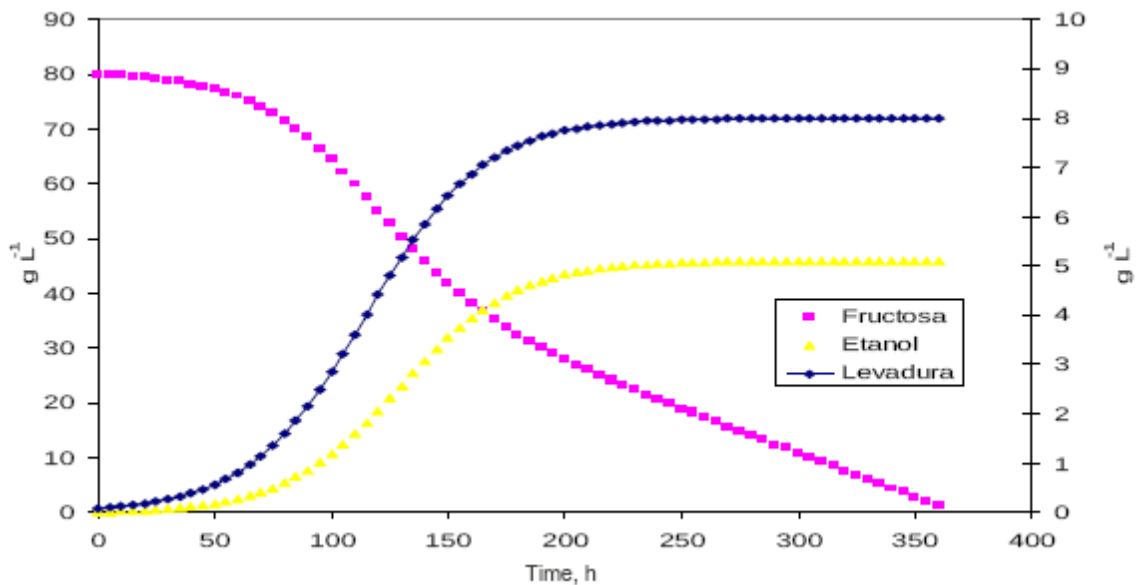
Figure 9. Simulated curves of fructose consumption by S. bayanus in the logistic model
Source: Own Elaboration

It seemed appropriate to bring oenological science, numerical equations to predict the change of scale, explain technological behavior and predict the performance of yeast in pilot plant or at industrial level. Solving the equations by the Newton method nonlinear regression simulation has led to the fermentation process of fructose from known biomass concentration and evolution of consumption of fructose, present in amounts equivalent to glucose must.

It was designed with the following set of variables where their units define the meaning of each: $\mu_{M=}$ 0.04 h $^{-1,}$ m = 0.02 g fructose (g biomass h) $^{-1}$

$Y_{X/S}$= 0.2 g biomass (G fructose)$^{-1;}$ □ t = 14.56 h$^{-1,}$ $Y_{P/X}$ = 5.78 g ethanol (g biomass)$^{-1}$

The mathematical model obtained adequately represented the results observed by Minho Valdés (2010).

Step D:

Regarding the lab wines fitness for consumption, the Tab.2 presents the physical and chemical parameters measured by Minho Valdés and Herrera (2007).

Table 2. Physical-chemical parameters of white wine

WINE	Yeast	pH	SO_2 free $mg\ L^{-1}$	SO_2 total $mg\ L^{-1}$	[1]Acidity total $g\ L^{-1}$	[2]Acidity Volatile $g\ L^{-1}$
Grape						
Temperatura						
IT	S. bayanus	3,56	14	107,52	6,97	0,98
18ºC	Native	3,57	16,6	96	6,52	0,98
IT	S. bayanus	3,66	7,60	108,8	7,42	1,05
22ºC	Native	3,63	12,8	119	6,07	0,78
NR	S. bayanus	3,27	34,5	81,92	5,92	0,36
24ºC	Native	3,24	19,2	81,92	5,85	0,27
IT	S. bayanus	3,57	14	96	5,92	1,06
26ºC	Native	3,61	14	102,4	6,07	1,04
IT	S. bayanus	3,55	25,6	98,56	6,75	0,86
30ºC	Native	3,6	8,9	115	7,05	0,84
Limits of dry with INV		4		180±35		1± 0,2
Adjusting for conservation			25-30		4 a 8	

The free SO_2 was 35 mg L^{-1} before storing wine.

[1]as tartaric acid; [2] such as acetic acid.

Source: Own Elaboration

From the point of view of the measured variables wines were suitable for consumption.

Partial conclusions at laboratory scale: stages A, B, C and D

1. In isothermal fermentations at 18, 22, 26 and 30 ºC with IT and 24 ºC with NR using native yeasts from the same berries or pure bayanus strains it was feasible to develop common dry white wine.

2. Density, TSS, pH and the yeast population: with IT musts densities with native at 18, 22, 26 and 30 °C showed no significant difference. The same is for the densities of musts with bayanus. The same for the densities of native musts and bayanus musts at the same temperature. Idem for °Brix and yeast population of musts with both strains. The pH of the musts at 18, 22 and 26 °C showed no significant difference with native, either pH in musts with S. bayanus, nor the pH in musts with native and S. bayanus at the same temperature.

3. The PF (in % v/v): Isabella in red musts with native yeasts was better at 30 °C and 26 °C (90.8 and 90.9) than at 22 and 18 °C (with 89.8 and 89, 8). With S. bayanus were better at 18 °C (98.9) than at 22 °C (93.9) at 26 °C (95.9) and 30 ºC (82.8). In NR musts at 24 °C with S. bayanus (99.1) were better than with native yeasts (96.3).

4. AF (In g day^{-1} sugar): Isabella in red musts with native yeasts and S. bayanus values

were the same: at 18.6 at 30 °C, 16.8 at 26 °C, 14-22 °C, and 11.2 at 18 °C. In NR musts with native yeasts and S. bayanus values were from 16.6 at 24 ºC.

5. The PF (in g initial sugar °Alcohol^{-1}): IT musts with native yeasts was best at 26-30 °C to 18-22 °C (18.66 and 18.87) respectively. With S.bayanus was better at 18 °C (17.14) than at 22 °C (18.06), 26 °C (16.8) and 30 °C (20.48). The PF means (18, 22, 26 and 30) ºC was better for S.bayanus (18.34) than for native (18.76) respectively. Musts NR were better with the S. bayanus (17.26) than with native yeasts (17.76) at 24 °C.

6. Duration of isothermal fermentation IT musts (at 18, 22, 24, 26 and 30) °C with inocula of 12 10^3 mL^{-1} native, delayed 15, 12, 11, 10 and 9 days, respectively; with inocula bayanus 6 10^3 mL^{-1}, delayed 15, 12, 11, 10 and 9 days respectively.

7. Generations of native yeasts and S. bayanus in IT grape must were 6-8 and 8-9 with maximum of 8-9 and 9-11 respectively.

8. Mathematical modeling obtained properly accounted to the observed pattern of evolution of fructose according to the logistic model solved, the contribution justified 50% of the total ethanol obtained, whereas glucose and fructose were in equivalent amounts in the fermentation of musts IT at 18 °C with S. bayanus.

Based on the previous partial conclusions, to advance to the E and F stage pilot plant, were selected temperatures of 20, 22 and 24 °C for producing wines in pilot plant with IT and NR grapes and S. bayanus yeasts.

Following is a description of pilot plant scale technology for steps E, F and stages for industrial scale G and H.

Step E:

To establish a pilot plant technological process we used the criteria of similarities. According to Ibarz and Barboza (2005), for the design and construction of equipment on a larger scale, there are two models the mathematical and empirical. The mathematical similarity criterion is m` equal to k by m; where m and m' are measures of the same magnitude in the model and in the industrial prototype respectively, where k is the scaling factor. Similarities were applied: mechanical, geometrical, thermal and concentration for all tests wine made.

The Tab. 3 shows the transactions provided for making white wine from no viniferous colored grapes with inoculum of S. bayanus.

Table 3. Operations to develop pilot plant white wine with color grapes

Operations	Vineyard	Additives
1	RECEPTION	
2	WEIGH	
3	STEMMING	
4	CRUSHING	
5	PRESSING	
6	CLARIFIED	$(3\ g\ SO_2 + 2\ g\ peptolíticas\ enzymes)\ hL^{-1}$
7	FERMENTED	$(1g\ fosfato\ amonio + 1\ g\ bayanus\ )\ hL^{-1}$
8	CLARIFIED	$6\ g\ SO_2\ hL^{-1}$
9	STORED	
10	FILTERING	
11	BOTTLING	Take to $35\ mg\ SO_{2\ free}\ hL^{-1}$

Source: Flanzy 2003

The similar criteria applied between the model and the prototype were four: a) the geometric (proportionality between the size of equipment); b) mechanics (reception, weigh, stemming, crushing, pressing, clarified, stored, filtering, bottling and fluid motion); c) the thermal (fermented and cooled); d) concentration (yeasts and additives in operations). In this step there was applied a scaling factor k of 40, resulting in the sample of pilot plant 200 kg.

Step F:

To assess the technological process in the pilot plant set in Tab. 3, vinifications were developed using materials and laboratory methods, for a sample size of 200 kg vineyard. Yields were obtained for each operation and with these values the total income of each wine.

Partial Conclusions steps E and F

1. Pilot plant yields were: 52.3% (L white wine kg^{-1} vineyard NR) at 20 °C, from 56.4% (L white wine kg^{-1} vineyard IT) at 20 °C, from 53.5% (L white wine kg^{-1} vineyard NR) at 22 °C and 54.7% (L white wine kg^{-1} vineyard NR) at 24 °C.

2. The fermentation times in a pilot plant on the laboratory were a) with k = 40 to 14 days at 20 °C and seeding of 1 g levadura hL^{-1}, b) with k> 40 (yeast and additives) for 10 days at 22 °C and 8 days at 24 °C, c) with k> 40 (with 20 glevadura hL^{-1}) were 10 days at 22 °C and for 8 days at 24 °C.

3. All wines produced were fit for human consumption according to the protocol analysis INV National Wine Institute (2007).

Step G:

The procedure evaluated in pilot plant was testing at industrial size; it was necessary to establish a production unit, calculate the production of the vineyard and estimate a plant size to calculate and select industrial equipment.

The production unit was established at 12 families, with an average of 27 hectare each vneyard.

From the 3rd year of seed it could be harvested between 10 and 18 tons per hectare[-1] by INTA, (2008). In 27 hectares families[-1] planted with 9 hec. of *Venus* to harvest in November, 9 hec of NR to harvest in December and 9 hec of IT to harvest in January by MAyP, (2007).

Production of 12 families, three months per year was calculated at: 4,212 tons vineyard per year[-1].

The plant size required to satisfy the production unit for a working day of 8 h/day at 30 days/month requires 46.8 tn vineyard per day[1].

To operate 6 h/day with 2 hours of cleaning requires a size 8 tons vineyard per h[-1.]

We applied a scaling factor of k=40, from 200 kg per sample vineyard pilot plant to industrial scale was obtained 8.000 kg h^{-1} vineyard.

Projected industrial yields with k 40 for 8.000 kg h^{-1} vineyard wine expressed in L and in bottles of 750 mL each were:

For 20 °C with NR could get 4,184 L of white wine (5,578 bottles).

For 20 °C with IT could get 4,512 L of white wine (6,016 bottles).

For 22 ºC with NR could get 4,280 L of white wine (5,706 bottles).

For 24 °C with NR could get 4,376 L of white wine (5,834 bottles).

Below are presented in Tab. 4 the results of the calculations and equipment selection for the prototype considering industrial yields expected.

Table 4. Equipment and devices to calculated the process of 8 tons per vineyard h[-1]

Equipment	Variables	Calculated Results
Hopper per boxs	Screw Diameter	0,32 m
Pneumatic Press	Capacity and power	32 hL; 6,6 kW
Fermentator - clarifier	Volume Hight Diámeter Fang Speed Clarifying Time Clarification Barrel	31,9 m³ 6,5 m 2,5 m 0,15 m h⁻¹ 2 días 8
Wine Tank	Volume Length width hight Stabiliztion Time Floor Inclineve Number of tanks	270 m³ 30 m, 3 m, 3 m 3 meses 2º 9
Fermenor	molec. Weight $C_6H_{12}O_6$ Heat generated by mol Heat generated by L	180 g mol⁻¹ 24,5 kcal molglucosa⁻¹ 24,9 kcal L⁻¹

	Fermentation time	8 days
	Heat generated in 8 days	.735 kcal h$^{-1barrel1}$
Lining Water	Cpwater	1,002 kcal kg^{-1} ºC^{-1}
	Cooling water	219,3 kg h^{-1} cuba^{-1}
	Simultaneity factor	1,4
	Performance	85%
	Heat to disipate total process	49.214 kcal h^{-1}

Source: Own Elaboration

The equipment selected regarding their size were:

1 Central refrigeration of 24 Hp; 54.000 frig h^{-1}; wáter entrance and exit 12 y 7ºC.

1 Mobile pump (2 Hp, 2 veloc. 470 rpm, flow of 12 m^3 h^{-1} at 16 m hight.

1 Screw Pump for watering mills of 4 kW, (10 m^3 h^{-1}, 1,8 bar y 200 rpm).

1Elevating conveyor for vineyard in stainless steelAISI 304 (380 V, 50 Hz, y 1,5 kW h).

1 Steel Manual Master AISI 304, (7 - 9). 10^3 Kgviñedo h^{-1} y 1,87 kW h.

1 Scales for 250 kg to weigh to weigh different plastic boxes with 10-13 kgvines each one.

1 diatomeas filter para 4 m^3 h^{-1}; capacity 85 L, preassure 6 bar, power 1,75 KWh.

1 Frame Filter and y 40 plaques of 50, 80 y 100 L plaques $^{-1}$h^{-1} for smothing the wine.

1 Piston steel pump AISI-304, (with 2 speeds from 4300 to 8500 L h^{-1} and1,5 hp).

1 Wine cooler 6 m. with 4 concentric tubes of 80 mm and 114 mm.

1 Steel catwalk, with leg protector with railing,, grile floor and ladder.

13 sets of internal plumbing for internal cold water for refrigerarator fermentors (going and coming)

2 Lung tanks for cold water and return with a capacity of 1,500 L each one.

3 Circulation pumps: one primary and two 2 hp secondary ones.

13 Steel tanks for fermentation and clarification calculated at 31.9 m^3 ^{each}

1 manual packing for bottles of 750 cm^3.

Step H:

Estimation of capital investment and production costs as from Peters and Timmerhaus point of view, (1981).

You can use various methods to analyze capital investment. The choice of method depends on the amount of detail available and the accuracy that is desired. In this time, the method C of percentage of equipment delivered was used. Then, the remaining items of direct cost of the plant are estimated as a percentage of the cost of equipment delivered. Additional components of capital investment are based on a % average of total direct cost of

the plant, in total direct and indirect costs or in the total capital investment. The Tab. 5 presents the fixed capital invested for the alternatives studied in pilot plant and industrial scale projected with a proportionality factor of k=40.

Tabla 5. Fixed Capital Invested updated based on fermentation temperatures

CONCEPTS	Cost U$D 2005 (441)	Cost U$D 2012 (620) 1	Cost U$D 2012 (620) 2	Cost U$D 2012 (620) 3
Production of white wine	at 20ºC	at 24ºC	a 22ºC	a 20ºC
Alternative No.		20g lev.hL^{-1}	20g lev.hL^{-1}	1 g lev. hL^{-1}
I. Direct Costs	533 341.0	702 000.1	747 619.1	900 363.0
1.1. Equipment *				
A. Equipment acquired	360 633.0	507 013.9	535 646.25	645 083.40
☐ Instruments and controls	2 200.0	3 092.98	3 267.64	3 935.25
☐ Pipes and tubes	3 200.0	4 498.88	4 752.94	5 724.01
☐ Electrical	2 800.0	3 936.52	4 158.82	5 008.50
B. Civil works (including services)	141 115.0	198 393.6	209 597.3	252 419.9
C. Utilities (mounted)	1 100.0	1 546.49	1 633.82	1 967.62
D. Ground	500.0	702.95	742.64	894.37
II. Indirect Costs		100 332	101 764	107 236
A. Engineering and supervision	7 330.0	37 491.25	37 491.21	37 491.26
B. Construct expenses and fees	20 000.0	37 491.25	37 491.21	37 491.26
C. Possible	18 031.6	25 350.6	26 782.30	32 254.1
III. Fixed capital invested = I + II		802 332.1	849 383.1	1 007 599

Source: Own Elaboration

Tab. 6 shows the production costs for options 1, 2 and 3 tested in pilot plant and industrial scale applied.

Table 6. Production costs depending on fermentation temperatures

CONCEPTS and estimation ways	Cost U$D 2012 1	Cost U$D 2012 2	Cost U$D 2012 3
Winemaking	at 24ºC	at 22ºC	at 20ºC
I. Manufacturing costs			
A. Direct production costs			
1. Quote commodity deals	2 800 899	2 799 032	2 792 173.50
2. Labor costs 10% of total product cost	361 029,6	360 799.27	360 746.48
3. Direct supervision. 1% of total product cost	36 102,9	36 079.93	36 074.65
4. Utilities calculation data	3 960	3 960	3 960
5. Maintenance and repair 2% of fixed capital invested	16 594.6	16 594.6	17 487.9
6. Operational supplies	4 148.6	4 148.6	4 371.9
0.5 % del Capital Fijo Invertido			
7. Lab expenses 1 % of total costs of product	36 102,9	36 079.9	36 074.6
8. Patents y royalties 1 % of total product costs	36 102,9	36 079.9	36 074.6
B. Fixed expenses			
1. Depreciation 10 % of Fixed Invested. Capital	82 973.4	82 973.4	87 439.9
2. Local taxes1 % of Fixed Invested. Capital	8 297.3	8 297.3	8 743.9
3. Insurance 0.4 % of Fixed Invested. Capital	3 318.94	3 318.94	3 497.59
4. Rent (own property)	0	0	0
II. General Expenses			
a. Administrative costs: 2 % of total product cost	72 205.8	72 159.8	72 149.3
b. Distribution and sales costs : 2% of total product costs	72 205.8	72 159.8	72 149.3

c. Research and Development : 2% of total product costs	72 205.8	72 159.8	72 149.3
d. Financial Interest : 0.5 of Fixed Capital fijo Invested	4 148.6	4 148.6	4 371.9
III. Total Product Costs = I + II	3 610 296.7	3 607 992.7	3 607 464.8

Source: Own Elaboration

Regarding the capacity of the plant to produce Tnviñedo h^{-1}; it was established that the 1st year the work would be at 70%, 2nd at 85 %, 3th at 90% and from the 4th at 95%. The sell price for the wine in bottle ready the go was fixed at 1.5 U$D during the economic analysis and the 6 hours labor day

To choose the best production alternative Tab. 7 shows the analysis with the productions alternatives.

Table 7. Dinamic analysis depending the fermentation temperatures

Elaborations	1	2	3
	24ºC	22ºC	20ºC
Winemaking	5 834	5 706	5 578
	bottles.day^{-1}	bottles.day^{-1}	bottles.day^{-1}
[1]VAN (2012)	6.602.660	5.403.308	5.647.471
[2]Tir %	60	56	53
[3]PRD years	3	3,4	3,6

[1] Net updated Value

[2] Internal Tax returns

[3] Investment recuperation Pedriod at up dated value

Source: Own Elaboration

This type of estimation is commonly used for preliminary results and study. However in the case of comparable plants of different capacities, this method allows very accurate time estimations according to Peters and Timmerhaus (1981).

According to the Tab. 7 the three alternatives are viable for investment but the best is number one, because it is recovered in the shortest period (three years) the present value of the investment.

CONCLUSION

From the economic and technical point of view it is feasible to establish a production unit consisting of 12 families with 27 hec for each vineyard

With the developed technology it is feasible to obtain common white wines fit for human consumption from Vitis labrusca varieties: Niagara Rosada and Isabella Tinto.

The native yeasts are suitable and additives added presented continuous fermentation, non-stop, for endogenous or exogenous reasons to yeast.

Musts color grapes are suitable to develop common white wine and do not need to correct the initial acidity and sugar, to have normal fermentations.

It is profitable from the economic point of view, the projected industrial size with established technology, to develop common white wine at 1.5 U$D per 750 mL, with Isabella grape grown Red or Pink in Misiones.

The best investment was projected at 24 °C for Niagara Rosada grapes presented at NPV of 6,602,666 U$D, and IRR of 60% and a 3-year PRD.

BIBLIOGRAPHY

Please refer to articles Spanish Bibliography.