Comparative Study of Golden Berry's Nectar Preservation (*PhysalisPeruviana L*), Through Thermal Pasteurization and High Intensive Pulsed Electric Field (HIPEF)

William Fabián Teneda Llerena [1], Edwin Santamaría-Freire [2]
[1](*Faculty of Administrative Sciences, Technical University of Ambato, Ecuador-wf.teneda@uta.edu.ec)*
[2](*Faculty of Administrative Sciences, Technical University of Ambato, Ecuador)*

ABSTRACT : *The objective of this study was to produce golden berry nectar (Physalisperuviana l) by preserving its nutritional properties. A design of three factors was applied: (Factor A) 15% and 30% of pulp; (Factor B) frequencies of 50, 150 and 250 Hz; (Factor C) applied time of 15, 30 and 45 minutes. The physical-chemical properties analysis of the samples was carried out and it was compared the samples that were applied HIPEF and the ones analyzed by Tukey (p> 0,05). Then it was determined that there is no significant difference between them with a mean of 0,431 ± 0,036 for acidity (% citric acid), for ° Brix with 12,96 ± 0,066 and for viscosity with 2,774 ± 0,015 mPa * s. But the values of pH and content of Vitamin C were straight –line affected by frequencies of 50 and 150 Hz. A sensorial test was performed (incomplete block design), 5-point hedonic scale and 35 semi-trained tasters. The best treatment a1b0c2 (30% pulp-50Hz-45min) was chosen because it had a greater quantity of Vitamin C with a value of 8,297 mg Ascorbic acid / 100 ml of nectar representing 87,9% in retention index with SD ± 0,011.*

Nectar heat treated at 92 ° C for 3min had a value of 1,25 mg ascorbic acid / 100 ml representing 15,23% retention index. The lifetime based on pH and microbiological quality was: 0,49 months in the treatment a1b0c and 0,97 months for the heat treatment. For Vitamin C it was 1,73 months at 4 ° C and 1,37 months at 21 ° C with an initial value of 10,50 mg Ascorbic Acid / 100 ml, heat treated nectar was 0,47 months at 4 ° C and 0,27 months with an initial value of 2,5 mg ascorbic acid / 100 ml at 21 ° C, the organoleptic properties of the nectar treated by HIPEF remained similar to the fruit.

KEYWORDS–*golden berry, HIPEF, Nectar,pasteurization,uchuva.*

I. INTRODUCTION

The golden berry (*Physalisperuviana L*), has its origin in the low Andean valleys of Peru and Chile. It is a round-ovoid fruit like a large grape, smooth skin, yellow-gold-orange color, contains juicy pulp and small yellow seeds with cap, when ripe, is sweet with slight sour taste. [3].

Citrus juices have dominated the market, but in the last decade, new types of fruit juice have entered the market. Golden berry juice contains minerals and vitamins, essential elements for the growth, development and correct functioning of different human organs, is a source of pro vitamin A and essentially vitamin C, as well as some B vitamins (thiamine, niacin and B12 vitamin), the phosphorus content is high, but calcium levels and protein content are low. [11]. On the other hand, vitamin C is commonly recognized as the main, naturally occurring antioxidant in the diet with protective effects against various diseases related to oxidative stress [17].

The heat treatments are still one of the most used methods in the elaboration of foods, because of the preservative effect that produces due to the destruction of enzymes, microorganisms and it extends useful lifetime of the juices. However, heat also alters or destroys the nutritional quality of food and it is responsible for the change of color, flavor, degrades anthocyanins and vitamin C and antioxidant properties of juices [10][11]. The demand for fresh products has promoted the development of innovative food preservation methods, so the application of HIPEF can be a good alternative to preserve fruit juices as it allows reducing the microbiological load and the enzymes responsible for the deterioration of the fruit and minimally altering the nutritional quality. This technique is based on the property of

fluid foods, which are mainly composed of water and nutrients such as vitamins, triglycerides and minerals that have high ion concentrations and they are able to carry electrical charges. Studies have shown the validity of this technology from the point of view of preserving nutritional components, microbial destruction and reducing losses of flavor, color, taste and they have evidenced the convenience of HIPEF technology to obtain high quality fresh food [15]. Studies have been carried out on milk and fruit juices quantifying the effect of PEAIC on vitamins, carotenoids, proteins and antioxidant activity and components responsible for their aroma and flavor [1][2][6][13].

The effects that are evaluated with HIPEF pasteurization in juices have shown that the electric field strength, pulse width, pulse frequency, pulse polarity, treatment time or pulse shape are some of the most important HIPEF processing parameters in microbial inactivation and enzymatic inactivation [4][5]. In addition, most of these studies have only evaluated the influence of intensity of electric field strength and treatment time on the antioxidant potential of juices.[18]

II. Methodology

2.1. Preparation of the sample

Golden berries (*Physalisperuviana l.*), were provided by the association "Productive Land" of the district of Quero (Tungurahua - Ecuador). The caps were removed from the fruit, then the fruit was sorted per maturity index, washed (immersed in 100 ppm sodium metabisulfite solution), blanched (90°C-1 min.) to inactivate the enzymes responsible for the change of coloration [9] and drained. Then the pulp was extracted and filtered using a 50-mesh sieve and then dosed (addition of sucrose, pulp, water, Guar gum), homogenization and pasteurization (thermal/non-thermal), packaging, labeling and storage at 4°C. Thermal pasteurization was performed at 92°C for 3 minutes.

2.2. Pulsed electric field processing mechanism

HIPEF treatments were performed with a continuous flow scale system (equipment designed by the Technical University of Ambato), with a flow rate of 0,0705lt / s, bipolar mode and square wave pulse, electronic plate generating high electrical pulses voltage (400 V) that by means of electric magnetic induction amplifies to 4000 V (4 kV), frequency (50, 150 and 250 Hz) that is controlled by a pump, treatment time (15, 30 and 45 min). The treatment chamber device consisted of four stainless steel electrodes separated by a space of 0.2 cm. The equipment used generates a field strength from 1kV to 20kV / cm with treatment volume of 12 liters in empty chamber and net with product. The treatment temperature was maintained at about 21 ± 1 ° C.

2.3. Compounds related to nutrients preservation in golden berry nectar

Vitamin C

Vitamin C in golden berry nectar (*Physalisperuviana l*) was determined by using the AOAC of Analysis 1980 method (923.09). A 25 ml sample of the nectar was mixed with an equal volume of the 1.6% oxalic acid solution. It was homogenized for 2-5 minutes (to prevent enzymatic oxidation of ascorbic acid resulting from the maceration of the fruit, then the mixture was quantitatively transferred to a 100 ml volumetric flask, (if there are air bubbles in the solution, shake and add a drop of caprylic alcohol to break the foam). An aliquot was taken and titrated with the solution of (DFI) this is reduced by the ascorbic acid, which shows a pink coloration. The ending point of the titration will be when this coloration persists in the mixture that is titrated for 15 sec. or more.

The template is used to format your paper and style the text. All margins, column widths, line spaces, and text fonts are prescribed; please do not alter them. You may note peculiarities. For example, the head margin in this template measures proportionately more than is customary. This measurement and others are deliberate, using specifications that anticipate your paper as one part of the entire journals, and not as an independent document. Please do not revise any of the current designations.

Standardization of the solution (DFI)

For the standardization 50 mg of ascorbic acid was weighed and brought to 250 ml with the 1.6% oxalic acid solution. A 2 ml aliquot of this solution was diluted with 5 ml of the 1,6% oxalic acid solution and titrated with the DFI solution with a pink color, produced by unreacted (non-reduced) DFI in acid medium, Eq. 1 was used as the result of Vitamin C and expressed as mg ascorbic acid / 100 ml of juice (or 100 g of fruit).

$$\boldsymbol{Vitamin\ C} = \frac{\boldsymbol{P_b * V_2}}{\boldsymbol{V_1}} * \frac{\boldsymbol{V_3 * 100\ gr}}{\boldsymbol{V_4 * P}} \qquad \text{Ec. 1}$$

Where:

$\boldsymbol{P_b}$: White ascorbic acid weight (mg)

$\boldsymbol{P}$: Weight of sample analyzed (g)

V_1: Spent white titration volume (ml)
V_2: Spent titration volume of the sample (ml)
V_3: Volume of ascorbic acid in which the sample was prepared (ml)
V_4: Volume of the sample to be titrated (ml).

Vitamin C was quantified at 14 days of storage built with pure standards of ascorbic acid and the results were expressed as relative concentration of vitamin C compared to the untreated sample.

2.4. Experimental design

The formulations were constructed using a three-factor ABC design, varying the percentages of: pulp (15% and 30%), frequency Hz (50, 150, 250), pulse time (15, 30 and 45 minutes). A total of 18 formulations were proposed, with three replicates, with 2 heat treatment samples (92 ° C-3 minutes at 15 and 30% pulp) and two control samples, using the mathematical model presented in Ec.2

$Y_{ijkl} = \mu + A_i + B_j + C_k + (AB)_{ij} + (AC)_{ik} + (BC)_{jk} + (ABC)_{ijk} + R_l + E_{ijk}$ Ec. 2

Table 1: Experimental design of three ABC factors for vitamin C, pH, acidity, viscosity, soluble solids, golden berry nectar treated by different pulsed combinations of high electric intensity.

trial number[a]	Treatment	Vitamin C[b]	Retention of Vitamin C[b] (%)	pH[b]	Acidity[b] (mg of citric acid / 100 ml of nectar)	Viscosity[b] *mPa*s*	Soluble solids °Brix
1	$a_0b_0c_0$	7,33	91,7 ± 0,036	4,11 ± 0,19	0,38 ± 0,04	2,63 ± 0,02	12,79 ± 0,08
2	$a_0b_0c_1$	7,25	90,7 ± 0,044	4,09 ± 0,18	0,43 ± 0,03	2,62 ± 0,02	12,64 ± 0,08
3	$a_0b_0c_2$	7,08	88,6 ± 0,033	4,09 ± 0,18	0,36 ± 0,03	2,63 ± 0,03	12,66 ± 0,03
4	$a_0b_1c_0$	6,92	86,5 ± 0,014	4,07 ± 0,16	0,40 ± 0,05	2,64 ± 0,02	12,84 ± 0,04
5	$a_0b_1c_1$	6,79	84,9 ± 0,013	4,07 ± 0,13	0,37 ± 0,05	2,65 ± 0,02	12,91 ± 0,04
6	$a_0b_1c_2$	6,63	82,8 ± 0,026	4,04 ± 0,14	0,38 ± 0,02	2,66 ± 0,02	12,75 ± 0,11
7	$a_0b_2c_0$	6,50	81,3 ± 0,021	4,09 ± 0,14	0,39 ± 0,03	2,67 ± 0,01	12,85 ± 0,04
8	$a_0b_2c_1$	6,42	80,2 ± 0,020	4,08 ± 0,14	0,41 ± 0,03	2,69 ± 0,02	12,85 ± 0,03
9	$a_0b_2c_2$	6,29	78,7 ± 0,011	4,09 ± 0,15	0,39 ± 0,03	2,70 ± 0,02	12,83 ± 0,03
10	$a_1b_0c_0$	8,29	89,2 ± 0,002	4,02 ± 0,15	0,42 ± 0,04	2,88 ± 0,01	12,86 ± 0,05
11	$a_1b_0c_1$	7,96	85,7 ± 0,049	4,02 ± 0,13	0,39 ± 0,04	2,88 ± 0,01	12,88 ± 0,05
12	$a_1b_0c_2$	8,17	87,9 ± 0,011	4,01 ± 0,13	0,42 ± 0,05	2,88 ± 0,01	12,94 ± 0,02
13	$a_1b_1c_0$	7,79	83,8 ± 0,012	4,04 ± 0,14	0,39 ± 0,05	2,89 ± 0,01	13,06 ± 0,03
14	$a_1b_1c_1$	7,67	82,5 ± 0,025	4,01 ± 0,14	0,46 ± 0,04	2,90 ± 0,01	13,14 ± 0,03
15	$a_1b_1c_2$	7,54	81,1 ± 0,011	4,02 ± 0,13	0,50 ± 0,02	2,90 ± 0,01	13,17 ± 0,02
16	$a_1b_2c_0$	7,38	79,4 ± 0,012	4,06 ± 0,15	0,50 ± 0,03	2,90 ± 0,00	13,29 ± 0,03
17	$a_1b_2c_1$	7,38	79,4 ± 0,012	4,07 ± 0,13	0,51 ± 0,04	2,91 ± 0,00	13,25 ± 0,04
18	$a_1b_2c_2$	7,33	78,9 ± 0,018	4,07 ± 0,13	0,49 ± 0,03	2,91 ± 0,00	13,30 ± 0,05

a Order of trials was random, and the HIPEF treatment was set at 20 kV / cm for 45 minutes.
b The data shown are the mean ± SD of two replicates of treatment, each trial was performed in triplicate.
Established levels: a0 = 15% pulp; A1 = 30% pulp; B0 = 50Hz; B1 = 150Hz; B2 = 250Hz; C0 = 15min.; C1 = 30min; C2 = 45min.

Where: μ = global effect Ai = factor A level effect; I = l, ..., a Bj = effect of factor B level; J = 1, ..., b Ck = effect of the factor C level; K = 1, ..., c (AB) ij = effect of interaction between factors A, B (AC) ik = effect of interaction between factors A, C (BC) jk = effect of interaction between factors B , C (ABC) ijk = effect of interaction between factors A, B, C Rl = effect of experiment replication; L = 1, ..., r Eijkl = residual or experimental error.

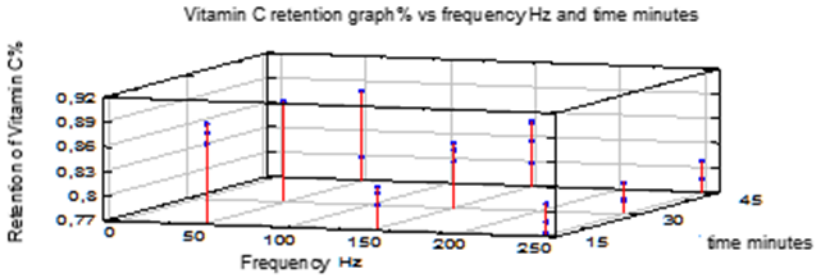

Figure 1 - Retention rate of Vitamin C with 30% of golden berry pulp

In Fig. 1 we have the average values of Vitamin C the control samples had an average value of: 8,23 mg in 15% of pulp and 9,29 mg in 30% of pulp and in heat treatment was 1,25 mg in 15% pulp and 1,46 mg in 30% pulp

2.5 Physical and chemical properties

The requirements for the preparation of the nectar were based on the INEN Standard 2 337: 2008-12: and CODEX STAN 247-2005: General Codex Standard for Fruit juices and nectars.

Soluble solids (° Brix) were determined by method 932.12 AOAC Official Method Solids (Soluble) in Fruits and Fruit Products, Refractometer Method. The acidity (% citric acid) was determined by the Norm NTE INEN 398. The pH of the product was determined by a pH meter according to the Norm NTE INEN 398, the viscosity values were obtained by a microprocessor equipment QUIMIS.

2.6 Microbiological quality

The best treatments were submitted to analysis of Total bacterial count, National Institute of Standardization INEN 0411: 1979. Ecuadorian Technical Standard (INEN 1 529-11: 98) Microbiological Control of Foods. Determination of Viable Molds and Yeasts INEN 1093-1984-04.Determination of total coliforms INEN 529-7-1990-02.

III. Results and discussion

3.1. Effect of pulse rate and time of application on vitamin C

The vitamin C content of golden berry fruit was 36,25 mg ascorbic acid / 100 ml. Table 1 shows the results for the retention of vitamin C obtained under each experimental condition. The results are in the range reported by [18] for carrot orange juice treated at different HIPEF electric field intensities (25, 30, 35 and 40 kV / cm) for different treatment times (30-340 Ms) using 2,5-ms bipolar pulses. But [16] obtained the retention of vitamin C of tomato juice between 58,2% and 99,0% after application of the same HIPEF conditions. These differences in vitamin C retention between HIPEF -treated juices may be due to the low pH of strawberry juice compared to tomato's juice, it is known that at higher acidic conditions vitamin C stabilizes (Young, 1985).

Thus, [4][5] and Martín-Belloso (2007) reported that retention of vitamin C depended largely on pulse rate and pulse width, during HIPEF -processing of orange juice and gazpacho, which is a cold vegetable soup, in different combinations of time applied in minutes can lead to the same levels of vitamin C. In this way it was observed that golden berry nectar (30% pulp) treated at 50 Hz had a Vitamin C retention index of 87,9% to 89,2%, but at 150 Hz the retention index was 81,1% to 83,8% when the HIPEF treatments with 20 kV / cm were carried out. Vitamin C is a health-related compound sensitive to heat in the presence of oxygen (Davey, 2000). Therefore, the Joule effect produced by heat during processing with HIPEF by increasing the frequency parameter from 50 to 150Hz, the vitamin C content in the nectar of the vines can greatly affect the rates of nutrient content degradation; the temperature Reached during the HIPEF treatment was 21°C. The high temperature results in a considerable loss of vitamin C accelerating the oxidation process of ascorbic acid (Gahler, 2003)

Statistical analysis (Table 2) indicates that the proposed model for vitamin C, physicochemical properties, sensory evaluation was adequate(P> 0,05) and there was only a significant difference between values of pH and

vitamin C content.

Table 2- Table of Analysis of variance for pH, Vitamin C and Acidity in golden berry nectar.

Sources:	pH			Vitamin C (mg Aci. asc/100 ml)			Acidity (mg Aci. cit/100 ml)		
Main effects	SC	*Reason-F*	*Value-P*	SC	*Reason-F*	*Value-P*	SC	*Reason-F*	*Value-P*
A:% Pulp	0,118	0,29	0,7509	11,490	595,03	0,0001*	0,110	74,64	0,0001*
B:Frecuency Hz	0,033	499,8	0,0001*	5,787	149,96	0,0001*	0,097	2,60	0,0884
C:Minutes time	0,009	68,00	0,0001*	0,349	9,08	0,0008*	0,003	1,10	0,3428
INTERACTIONS									
AB	0,028	13,99	0,0001*	0,0127	0,32	0,7292	0,004	1,58	0,2207
AC	0,000	59,28	0,0001*	0,0644	1,63	0,2111	0,001	0,40	0,6745
BC	0,004	0,94	0,3881	0,0778	1,01	0,4296	0,009	1,51	0,2187
ABC	0,000	0,94	0,3881	0,0685	0,89	0,4948	0,001	0,15	0,9623
WASTE	0,009			0,6933			0,051		
TOTAL	0,199			18,552			0,188		

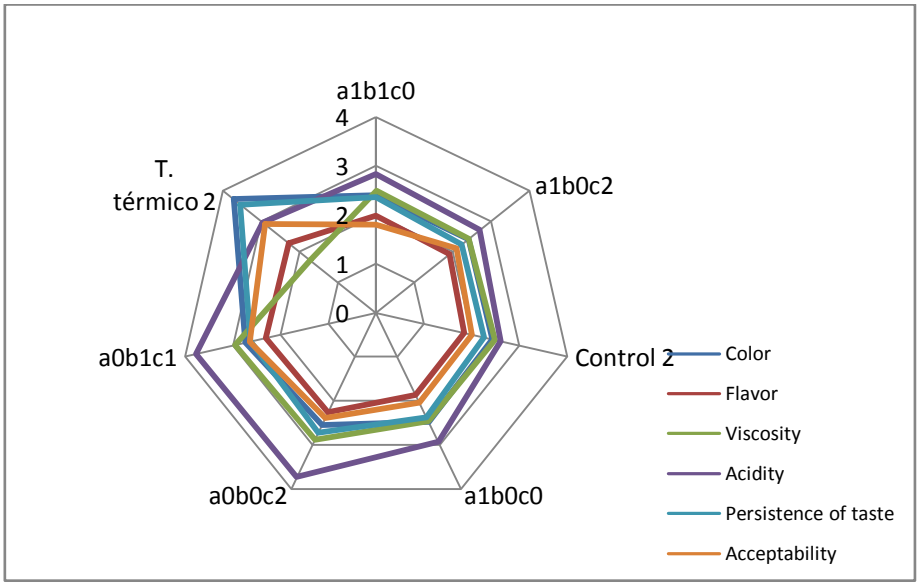

Illustration A: Radar chart of treatments undergoing sensory evaluation

3.2. Sensory evaluation

For the sensorial evaluation 7 treatments were

chosen and the parameters analyzed were: color, flavor, viscosity, acidity, persistence of taste, acceptability. Based on the ANOVA tables and Color: there is significant difference between treatments. The heat treatment obtained a score of 3,718 which is equivalent to "opaque", whereas the treatment a1b1c0 obtained 2,4029 which is equivalent to "intense", as for flavor did not have difference between treatments, for Viscosity was: 1,72178 which equals "viscose" was the best in viscosity followed by the treatment a1b0c2 with a value of 2.41411 which equates to "neither viscose nor fluid". For acidity was: a0b1c1 with a value of 3,676795 which is equivalent to "Smooth", for persistence of flavor there was significant difference between blocks and treatments and was chosen the treatment a1b0c2 with a value of 2,23362 which is equivalent to "Normal" And in Tukey comparison test p> 0,05, the results can be seen in Figure A.

acceptability treatments were accepted and a1b1c0 and a1b0c2 with similar values of 2,03 that is equivalent to "Agrada"

3.3. Microbiological analysis before processing the fruit (without scalding, nor pasteurized)

It was possible to determine that the useful life time of fresh nectar without any heat treatment was maximum two days. In Table 3, we have the results and comparing with the parameters established by NORMA INEN 2337; 2008, the nectar is in the B classification

Table 3 - Microbiological analysis of golden berry nectar without any treatment, nor scalded

Parameter	Test result	REFERENCE VALUES
Total count of mesophilic aerobes UFC/ml	$28*10^1$	<10
Total Coliforms NMP/cm^3	<3	<3
Fungus UFC/ml	$17*10^1$	10 ---- <10
Yeasts UFC/ml	$15*10^1$	10 ---- <10

The treatments a1b1c0 (30% pul-150Hz-15min) and a1b0c2 (30% pul-50Hz-15min) were subjected to microbiological analysis and the results are reported in Table 4. This test was performed once production, physical-chemical analysis and sensorial evaluation of the golden berry nectar was done, which was stored at 4 ° C.

Table 4 - Microbiological analysis of the 3 treatments selected from the golden berry nectar after being processed and pasteurized based on the growth of molds and yeasts.

	T4: T. Thermal 2		T17:$a_1b_1c_0$		T16:$a_1b_0c_2$		
Time(h)	Total Count of Mesophilic Bacteria (UFC/ml) × 10^{-1}	Molds and yeasts (UPC/ml) × 10^{-1}	Total Count of Mesophilic Bacteria (UFC/ml) × 10^{-1}	Molds and yeasts (UPC/ml) × 10^{-1}	Total Count of Mesophilic Bacteria (UFC/ml) × 10^{-1}	Molds and yeasts (UPC/ml) × 10^{-1}	Total Coliform (NMP/cm^3) × 10^{-1}
72	<10	1	<10	2	<10	2	<3
144	<10	2	<10	4	<10	4	<3
240	<10	3	20	5	<10	6	<3
336	<10	3	20	7	20	8	<3

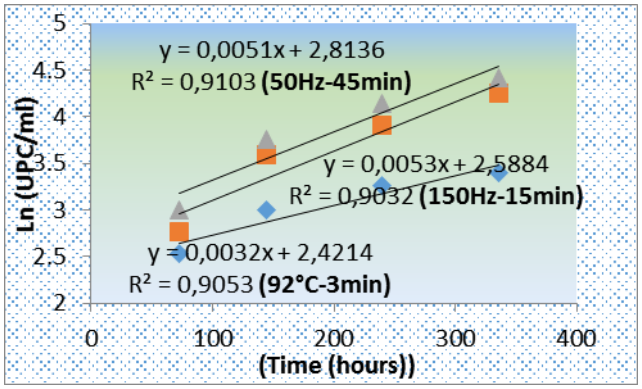

Figure 2 - Ln of the concentration of microorganisms UPC / ml vs. Growing time on golden berry nectar

The colony propagating units quantified in golden berry nectar by counting method were: Total counts of mesophilic bacteria (cfu / ml) × 10-1 (> 10 CFU / ml), total coliforms (<3 NMP / ml) , Fungi and Yeast (<10 UPC / ml). These values were within the permissible ranges required by the NTE Norm ENEN 2 337: 2008 for pasteurized fruit nectars with a maximum duration of 30 days of storage.

The heat-treated golden berry nectar (pasteurization) has the appropriate conditions to obtain a commercial product, useful lifetime was 28,43 days analyzed with logarithmic linearization ln C = kt + Ln Co (Fig2).

3.4. Determination of real-time useful life time of golden berry nectar (Physalisperuviana l) at two storage temperatures (4 ° C and 21 ° C)

The values of Acidity, ° Brix, Viscosity of the golden berry nectar determine that there is no difference between them and the values of the mean were 0,431 ± 0,036 for acidity (% citric acid), for °Brix with 12,96 ± 0,066 and for viscosity with 2,774 ± 0,015 mPa * s. Therefore, they are not quality parameters for the determination of the useful lifetime of the elaborated product, whereas the pH and content of Vitamin C do not oscillate around of an average value and its diverse value defining by this way the quality and lifetime of the elaborated product. The analysis and modeling of the kinetics of degradation of Vitamin C in the product stored as a function of the order of reaction of the 3 samples, a1b1c0; a1b0c2 and heat treatment 2 (92 ° C, 3 min) can be shown in Table 6 and 7.

Table 6- Vitamin C content and Vitamin C retention index in golden berry nectar with 30% pulp golden berry in storage

Time (days)	Vitamin C (mg Ac.as/100ml	150 Hz-15 min	Vitamina C (mg Ac.as/100ml)	50 Hz-45 min	Vitamin C (mg Ac.as/100ml	150 Hz-15 min	Vitamin C (mg Ac.as/100ml	50 Hz-45 min	Vitamin C (mg Ac.as/100ml)	Heat treatment	Vitamin C (mg Ac.as/100ml)	Heat treatment
	4°C		4°C		21°C		21°C		4°C			21°C
0	10,50	1	10,50	1	10,50	1	10,50	1	2,25	1	2,25	1
1	10,27	0,9781	10,43	0,9933	10,03	0,9552	10,00	0,9524	1,97	0,8756	1,90	0,8444
7	9,65	0,9190	9,95	0,9476	9,41	0,8962	9,47	0,9019	1,68	0,7467	1,56	0,6933
14	8,97	0,8543	9,18	0,8743	8,73	0,8314	8,95	0,8524	1,38	0,6133	1,13	0,5022
21	8,50	0,8095	8,94	0,8514	8,04	0,7657	8,13	0,7743	1,10	0,4889	1,00	0,4444
28	8,20	0,7810	8,61	0,8200	8,00	0,7619	8,04	0,7657	1,00	0,4444	0,50	0,2222

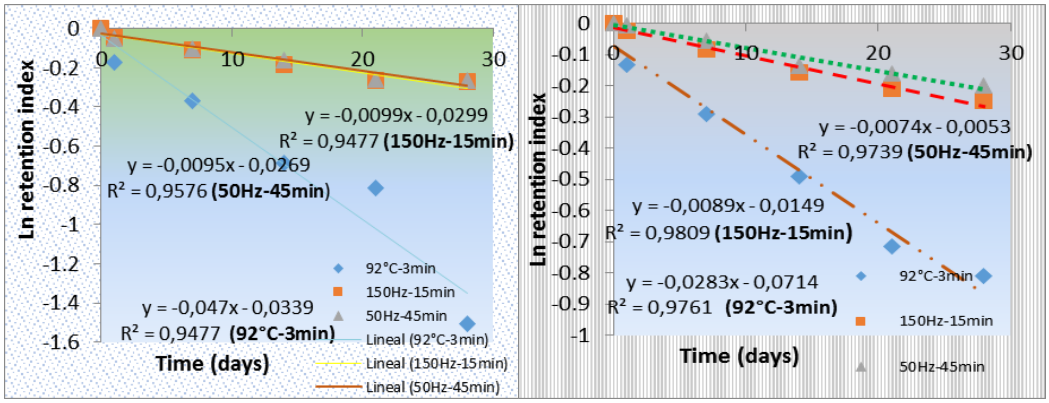

Figure 3a and 3b- Vitamin C Degradation Chart at 4 ° C (left) and 21 ° C (right): First Order Kinetics

The data were transformed to fraction of the initial value, the value of the natural logarithm was calculated and the value of the apparent constant (kinetic degradation) was calculated. Regression analysis showed that the data were adjusted by the model of a first-order reaction kinetics (Fig. 3) with a R2 = 97.39. The negative sign indicates that vitamin C is degrading.

Equation obtained y = -0,0283*tiempo-0,0714 (T: 92°C - 3min) storaged at 4°C. According to the equation ln⁡〖{C}/{C_o }〗 =-kt we have:
Where y = ln C/Co then C = 7,5 y
Co = 11, 02, así C/Co =0, 68058076 y
Ln C/Co = -0,38480878
t = -0,38480878 / -0,0283
t = 13,59748 means14 days (0,47 months)

Table 7 - Reaction patterns and orders and Life Summary of golden berry nectar (4- 21 ° C)

Treatment	Storage temperature (°C)	Reaction order	Linearization Line Equation	Kinetic speed constant (k)	Calculated Life	
					Days	Months
92°C-3 min	4	One	$\ln\frac{C}{Co} = -0,0283 * time - 0,0714$	0,0283	14	0,47
	21	One	$\ln\frac{C}{Co} = -0,047 * time - 0,0339$	0,047	8	0,27
150 Hz-15min	4	One	$\ln\frac{c}{co} = -0,0089 * time - 0,0149$	0,0089	43	1,43
	21	One	$\ln\frac{C}{Co} = -0,0099 * time - 0,0299$	0,0099	39	1,30
50 Hz-45min	4	One	$\ln\frac{C}{Co} = -0,0074 * time - 0,0053$	0,0074	52	1,73
	21	One	$\ln\frac{C}{Co} = -0,0095 * time - 0,0269$	0,0095	41	1,37

In the nectar it is stated that the vitamin C content corresponds to 25% of the DRA (200 ml). (FNIC) indicates a value of 60 mg based on a 2000 kcal (48) diet. Therefore this product should provide 15 mg per serving (200 ml) or 17,775 mg per 237 ml bottle. Using the regression equations shown and substituting for the final vitamin C concentration value to be reduced to half the initial value (7,5 mg / 100 ml), the initial concentration of the nectar was 11,02 (mg A. Ascorbic / 100ml nectar) before being pasteurized with HIPEF with 30% of pulp.

The useful lifetime is within the storage temperature and is not within the period specified in the labeling of the product to be marketed (6

months) as Sunny

Nectar, as the golden berry nectar is not added with ascorbic acid or Preservative, the actual container (glass bottle) is not equal to commercial nectar (Sunny-Tetrapack). To commercialize at 26 ° C with Q10: 1.27 shows that the nectar has a minimum durability of 30,629 days.

$$\left(Q_{10}\right)^{\frac{\Delta T}{10}} = \frac{\Theta_T}{\Theta_{T+\Delta T}}$$

Where: Θ is the useful life at the indicated temperature

$$\left(Q_{10}\right)^{1,7} = \frac{52}{41} = 1,27$$

Fig. 4 and 5 indicates the pH variation during the storage time (days) of the treatment ***a1b0c2***, it has a R2 = 0,9659 (21°C) and 0,9571 (4°C) the slope value is 0,0165 and 0,0154 corresponding to the velocity constant (k). As we know the activation energy follows the mathematical model proposed by [14], and a zero order reaction kinetics was obtained. The linear regression curves were calculated for the stored nectar samples (Fig. 6), in order to establish the value of k. The linearization of the Arrhenius equation is plotted and the velocity constant is calculated at 20 ° C, which allows knowing the useful life for each of the treatments.

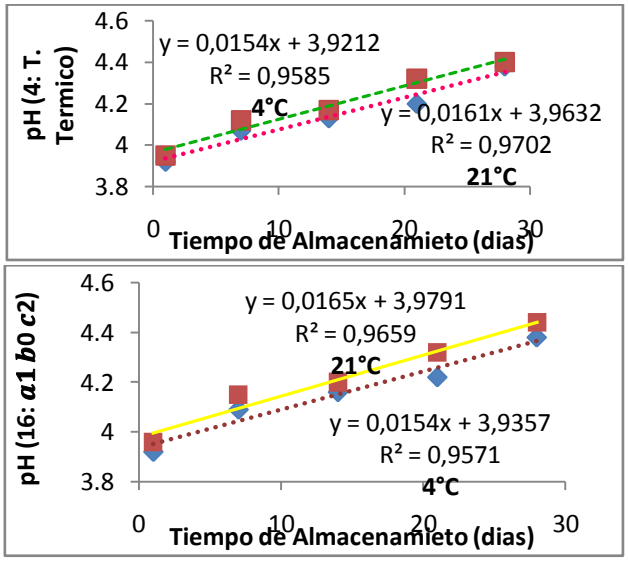

Figure 4 - Variation of pH vs. Storage time (days) thermal treatment, at two temperatures (4 ° C and 21 ° C)

Table C-4 1 - Linearization using the Arrhenius equation for pH.

Storage temperature (° K)	1/T	ln k $a_1b_1c_0$	ln k $a_1b_0c_2$	ln k ***T.Thermal***
277,15	0,00360815	-4,17338777	-4,17338777	-4,17338777
294,15	0,00339963	-4,11047394	-4,1043949	-4,12893601

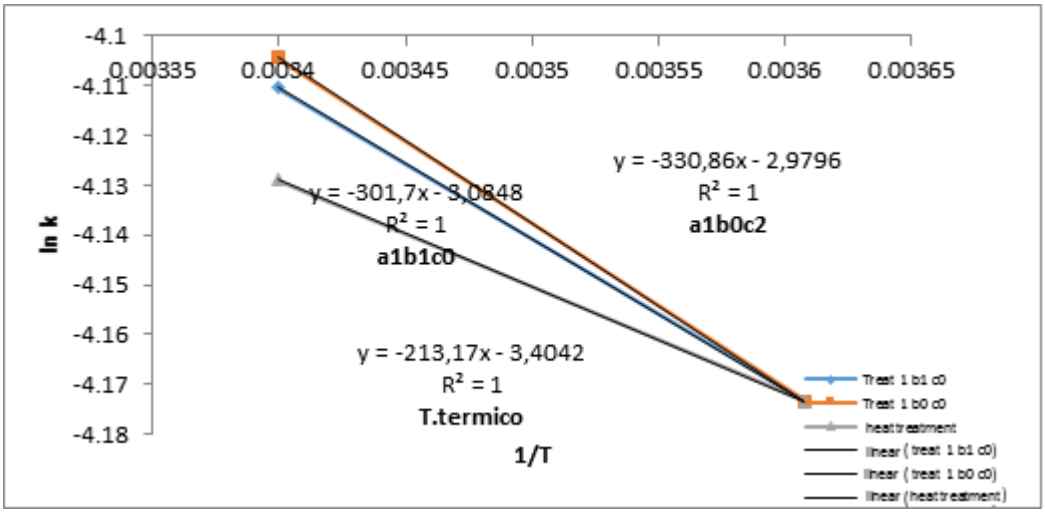

Figure 6 - Determination of the k value for the shelf life of golden berry nectar

Table C-5. 2 Summary of useful lifetime in physico-chemical parameter pH

Treatment	*Equation*	*Ea (cal/mol)*	*Value k*	*Useful life$_{20}$ (days)*
$\mathbf{a_1b_1c_0}$	y = -301,70* time - 3,0848	599,18	**0,1280**	17,85
$\mathbf{a_1b_0c_2}$	y = -330,86* time - 2,9796	657,09	**0,1571**	14,01
H. thermal 2	y = -213,17* time - 3,4042	423,36	**0,0688**	31,99

IV. Conclusions

From the 15% and 30% pulp formulations, vary the pulse rate (50, 150, 250 Hz) and application time (15, 30, 45, minutes). It was established that the best treatment was a1b0c2 (30% pulp-50Hz-45min) with values of 0,431 ± 0,036 for acidity (% citric acid), for Brix with 12,96 ± 0,066 and for viscosity with 2,774 ± 0,015mPa * s , With a pH value of 4,12 ± 0,015. After 14 days of storage, independent of physical-chemical properties values was the best treatment in vitamin C content with a value of 8,17 mg ascorbic acid / 100ml with a retention index of 87.9% with a SD ± 0.011 represented in 30% of the golden berry pulp, the heat-treated nectar had a much lower RI of 15,23% compared to the HIPEF in addition the nectar had only 1,25 mg in Vitamin. With these values, it is concluded that the Joule effect produced by heat during processing with HIPEF by increasing the frequency parameter from 50 to 150 Hz, the vitamin C content in the golden berry nectar can greatly affect the degradation rates of nutritional content. The loss of vitamin C in the heat treatment at 92 ° C was considerable in comparison with HIPEF.

The life time of the final product and the result was 1,73 months at 4 ° C and 1,37 months at 21 ° C for vitamin C. For pH and microbiological quality, the estimated lifetime was: 0,49 Months and 0,97 months for the heat treatment. The HIPEF s preserved the organoleptic properties of golden berry nectar, thus maintaining a similar product to fresh, values of ° Brix, Acidity, Electrical conductivity there was no significant difference between the values but if in pH, vitamin C content.

References

[1] Barsotti, L. D. (2002). Efectos de los pulsos eléctricos de alto voltaje en constituyentes de los alimentos a base de proteínas y estructuras. Tendencias en Ciencia de los Alimentos y Tecnología, 12: 136-144.

[2] Bendicho, S. B.-C. (2002). Procesamiento de leche por la alta intensidad Pulsos Eléctricos. Tendencias en Ciencia de los Alimentos y Tecnología, 13(6/7):195-204.

[3] Brito, D. (2002). Productores de uvilla para exportación. Agro exportación de productos no tradicionales "Fundación Aliñambi ", 11.

[4] Elez- Martínez, P. M.-B. (2007). Effects of

high intensity pulsed electric field processing conditions on vitamin C and antioxidant capacity of orange juice and gazpacho, a cold vegetable soup. Food Chemistry, 102, 201–209.

[5] Elez, M. P.-F. (2006). Comparative study on shelf-life of orange juice processed by high intensity pulsed electric fields or heat treatments. EuropeanFoodResearchTechnology, 222, 321 329.

[6] Evrendilek, G. J. (2000). Seguridad microbiana y la vida útil de jugo de manzana y sidra procesada por los sistemas de PEF banco y escala piloto. Ciencia Innovadora de Alimentos y Tecnologías Emergentes, 1(1), 77-86.

[7] FNIC. (13 de septiembre de 2011). Food and NutritionInformation Center. Recuperado el 25 de agosto de 2014, de NationalAgricultural Library, USDA: http://fnic.nal.usda.gov/nal_display/index.php?info_center=4&tax_level=3&tax_subject=256&topic_id=1342&level3_id=5140

[8] Gahler, S. O. (2003). Alterations of vitamin C, total phenolics, and antioxidant capacity as affected by processing tomatoes to different products. Journal of Agricultural and Food Chemistry, 51, 7962–7968.

[9] Gimferrer, N. M. (1 de junio de 2012). Escaldado de alimentos para mayor inocuidad. Recuperado el 2 de mayo de 2015, de http://www.consumer.es/seguridad-alimentaria/ciencia-y-tecnologia/2009/05/25/185488.php

[10] ITDG, S. (1998). Procesamieto de Alimento. En S. ITDG, Nectares de Fruta (pág. 14). Perú: ISBN 9972 47 011 3.

[11] Juntamay, T. E. (2010). Evaluación nutricional de la uvilla (Physalis peruviana L.) deshidratada a tres temperaturas mediante un deshidratador de bandejas. Evaluación nutricional de la uvilla (Physalis peruviana L.) deshidratada a tres temperaturas mediante un deshidratador de bandejas. Riobamba, Ecuador: Tesis de GradoPg: 29.

[12] Klopotek, Y. O. (2005). Processing strawberries to different products alters contents of vitamin C, total phenolics, total anthocyanins, and antioxidant capacity. Journal of Agricultural and Food Chemistry, 53, 5640–5646.

[13] Knorr D., F. A. (2011). Las nuevas tecnologías en la elaboración de alimentos. Revisión Anual de Ciencia de los Alimentos y Tecnología, 2: 203-235.

[14] Labuza, T., &Riboh, D. (1982). La teoría y la aplicación de la cinética de Arrhenius para la predicción de la pérdida de nutrientes en los alimentos. Tecnologia de Alimentos., v. 36, n.10, p. 66-74.

[15] Mertens, B. K. (1992). Developments of nonthermal processes for food preservation. Food Technology, 46, 124–133.

[16] Odriozola-Serrano, I. A.-A.-F.-A.-B.(2007). Lycopene, vitamin C, and antioxidant capacity of tomato juice as affected by high-intensity pulsed electric fields critical parameters. Journal of Agricultural and Food Chemistry, 55, 9036–9042.

[17] Omaye, S. T. (1998). En S. T. W. R. Bidlack, Phytochemical interactions: b-carotene, tocopherol and ascorbic acid. (págs. 53–75). Lancaster: Technomic.: Phytochemicals, a new paradigm.

[18] Torregrosa, F. E. (2006). Ascorbic acid stability during refrigerated storage of orange-carrot juice treated by high pulsed electric field and comparison with pasteurized juice.Journal of Food Engineering, 73, 339–3.