Chemical Changes in Citron Fruit Bars Due to pH Changes During Processing[1]

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ABSTRACT

pH was a determinant factor in the resulting chemical composition of citron fruit bars as shown by a study where this preserve was prepared at pH 3.4, 3.7, 4.1, and 4.3. Vitamin C destruction increased with decreasing pH, except in the case of fruit bars at 4.1 and 4.3, where a reverse tendency seemed to appear. Total acidity in the product was directly related to the pH. Reducing and non-reducing sugars agreed with results reported in the literature related to the inversion of sucrose. In preparing citron fruit bars with sucrose, a pH of 4.1 is recommended.

INTRODUCTION

Food products, natural and processed, undergo changes due to their pH level. Chemical reactions are altered by variations in pH. These can be increased, stopped, or reversed depending on the pH adjustments made in the system. Enzyme stability and enzyme activity, which govern the quality of foods are highly dependent, among other factors, on pH and ionic strength (5). The rate of browning in mixtures of aldoses and amines increases with increasing pH, (6) thus affecting the color and flavor of food products. In poultry meat, it has been found that the muscle pH influences the rate of biochemical reactions that take place in muscle between slaughter and cooking (12); therefore, cooked muscle flavor will depend on muscle pH. High pH during cooking of poultry meat favors the production of ammonia, diacetyl, and H_2S. Judges tasting chicken broth found more intense flavor associated with broth having lower pH. Certain flavor components are released at specific pH values of their containing media (12).

In lipids, the low pH favors pro-oxidation while a high pH favors antioxidant action (13), a fact of utmost importance in the work with fat-containing products to prolong the shelf-life of the product and to improve the quality. The acid side of the isoelectric point of proteins is characterized by a set of consecutive polymerization reactions affected by temperature, time, and pH, the extent of aggregation diminishing with a decrease in pH (8, 11).

A striking change has been observed in the color of the natural pigment anthocyanin caused by variation in pH (4, 10). The stability of

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TABLE 1.—*Results of chemical analyses in citron fruit bars processed at four pH levels and dried by two different methods*

Ascorbic Acid								Total Acidity as Citric Acid							
Storage days	pH 3.4 mg/100g	Storage days	pH 3.7 mg/100g	Storage days	pH 4.1 mg/100g	Storage days	pH 4.3 mg/100g	Storage days	pH 3.4 %	Storage days	pH 3.7 %	Storage days	pH 4.1 %	Storage days	pH 4.3 %
Fruits bars dried in controlled atmosphere chamber (1st series)															
9	—	4	—	10	—	3	—	9	0.261	4	0.173	10	0.110	3	0.094
35	115.7	30	124.7	36	131.6	29	129.9	35	—	30	—	36	—	29	—
68	111.3	63	118.0	69	130.6	62	121.0	68	.256	63	.168	69	.107	62	.091
98	102.0	93	115.3	99	128.9	92	119.7	98	.243	93	.159	99	.115	92	.095
126	95.4	121	97.0	127	120.0	120	110.5	126	.247	121	.166	127	.116	120	.096
160	97.8	165	96.3	159	116.7	166	114.2	160	.243	165	.170	159	.110	166	.093
188	82.6	193	85.5	187	119.9	194	105.3	188	.250	193	.168	187	.117	194	.097
233	69.8	228	83.1	232	108.8	239	101.8	233	.245	229	.174	232	.118	239	.109
Fruit bars dried in air conditioned room (2nd series)															
6	132.5	6	135.1	6	133.0	6	137.8	6	0.344	6	0.255	6	0.143	6	0.115
37	111.3	37	115.4	37	121.6	37	128.6	37	.343	37	.255	37	.146	37	.127
67	110.0	67	109.3	67	118.5	67	116.5	67	.343	67	.257	67	.153	67	.119
105	100.5	105	93.1	105	116.4	105	111.5	105	.335	105	.240	105	.143	105	.124
148	87.1	148	89.3	148	113.6	148	103.2	148	.330	148	.244	148	.162	148	.142
193	80.7	193	73.2	193	101.0	193	93.8	193	.338	193	.247	193	.149	193	.160

Reducing Sugars								Non-reducing Sugars							
	%		%		%		%		%		%		%		%
Fruit bars dried in controlled atmosphere chamber (1st series)															
9	47.6	4	30.0	10	15.3	3	12.0	9	24.3	4	44.6	10	57.5	3	62.2
35	49.6	30	31.1	36	16.9	29	14.5	35	24.1	30	43.5	36	57.4	29	59.5
68	50.3	63	32.1	69	16.7	62	15.2	68	23.3	63	43.2	69	59.9	62	61.5
98	50.8	93	34.5	99	17.6	92	14.1	98	25.7	93	44.0	99	63.1	92	63.4
126	53.5	121	35.2	127	19.9	120	15.2	126	24.5	121	43.8	127	59.6	120	62.3
160	55.1	165	34.9	159	20.3	166	16.8	160	23.1	165	44.5	159	59.2	166	63.2
188	55.0	193	36.8	187	20.5	194	17.5	188	22.1	193	42.6	187	60.6	194	61.1
233	54.0	228	36.2	232	22.6	239	18.4	233	22.4	228	41.2	232	64.2	239	61.9
Fruit bars dried in air conditioned room (2nd series)															
6	51.1	6	34.2	6	16.2	6	11.5	6	24.3	6	42.2	6	59.9	6	65.2
37	50.9	37	35.4	37	17.5	37	12.9	37	26.1	37	40.8	37	59.9	37	64.8
67	52.8	67	37.2	67	19.0	67	13.1	67	24.0	67	38.4	67	57.4	67	63.3
105	55.5	105	37.4	105	19.9	105	14.8	105	20.7	105	38.6	105	56.5	105	63.2
148	54.6	148	37.8	148	21.3	148	16.1	148	19.4	148	38.1	148	55.5	148	62.2
193	56.4	193	40.5	193	21.8	193	20.4	193	35.1	193	55.8	193	55.8	193	63.3

nutrients in foods is affected by changes in pH level. Most amino acids and vitamins are partially destroyed at certain pH values, some on the acid and others on the alkaline side (7).

Since a study was made to determine the effect of pH on the texture of citron fruit bar (3), steps were taken to determine results in chemical composition of the product. This paper reports changes in chemical composition of citron fruit bar due to variations in pH during processing.

MATERIALS AND METHODS

Citron fruit bars were prepared according to the method proposed by Cancel and Hernández (2) which was later modified by the same authors

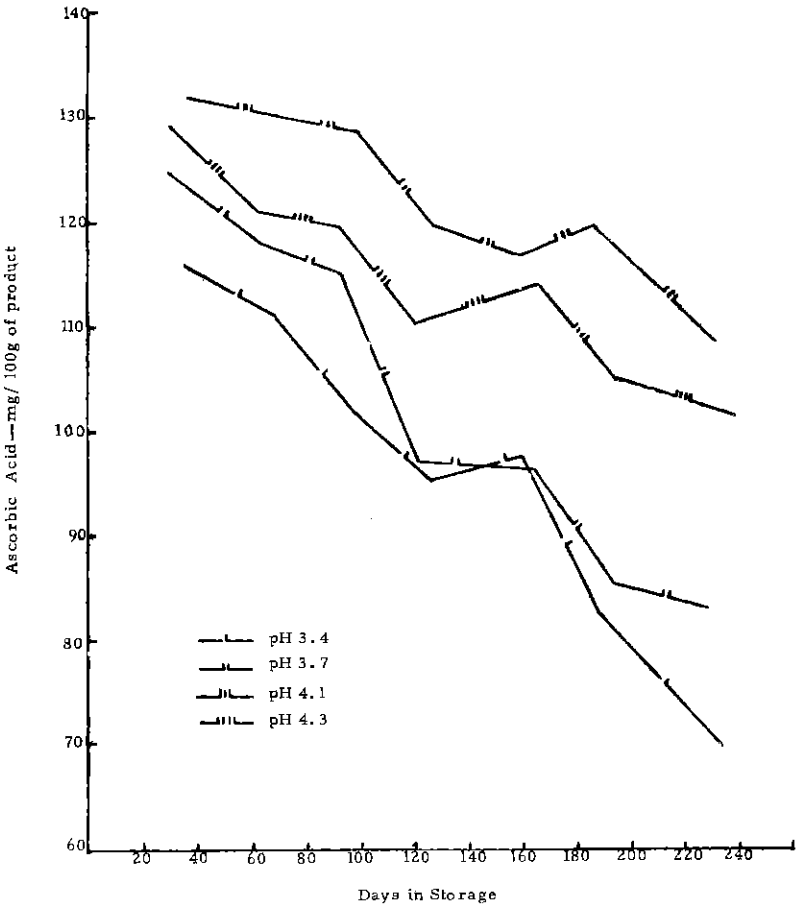

FIG. 1.—Ascorbic acid in citron fruit bars processed at different pH levels and dried in a controlled atmosphere chamber (1st series).

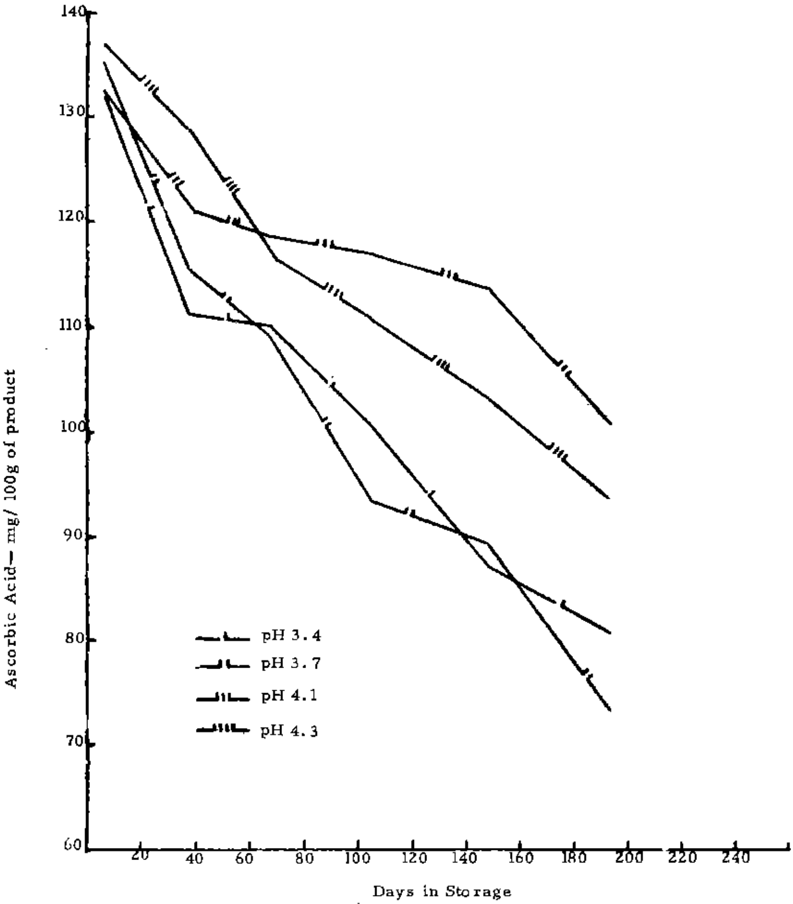

FIG. 2. —Ascorbic acid in citron fruit bars processed at different pH levels and dried in an air conditioned room (2nd series).

(3) to provide for a study on the effect of pH on the texture of citron fruit bars.

Chemical analyses of vitamin C were made by the iodate method as modified by Ballantine (1). All analyses were made in triplicate and the results averaged.

Total acidity was measured by potentiometric titration with 0.1 *N* NaOH solution to pH 8.1 using glass calomel electrodes. The acidity was calculated as percent citric acid.

Total and reducing sugars were determined by the Lane and Eynon method (9).

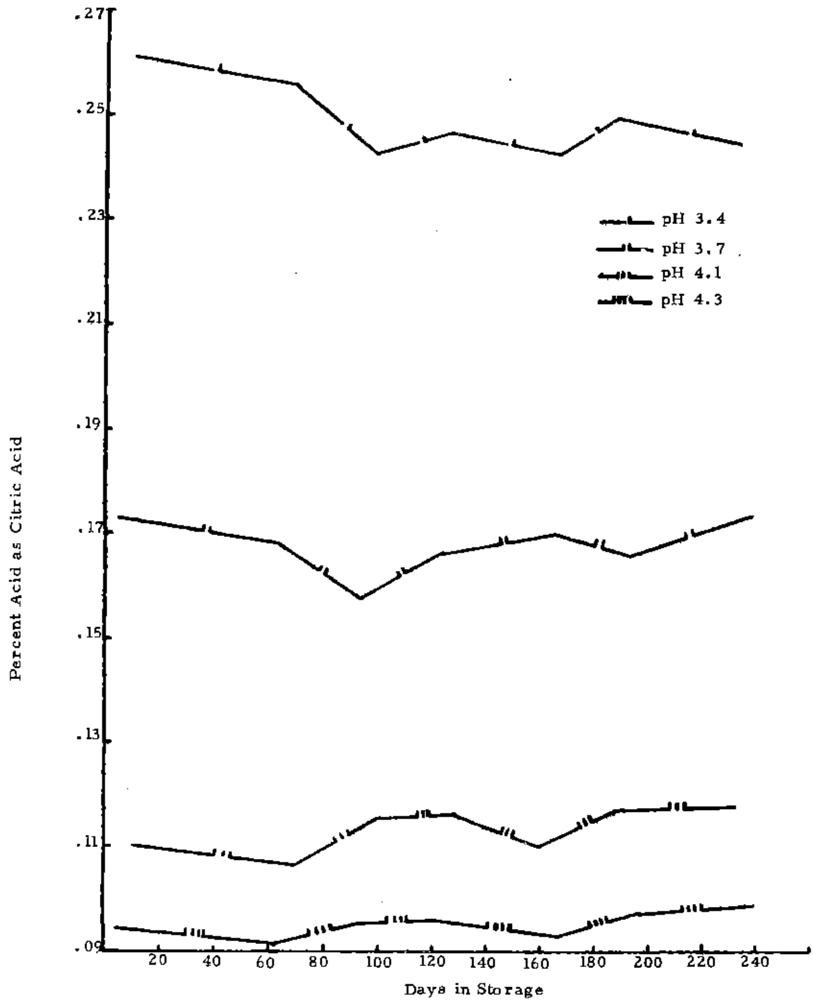

FIG. 3.—Total acidity (as citric acid) in citron fruit bars processed at different pH levels and dried in a controlled atmosphere chamber (1st series).

RESULTS AND DISCUSSION

The results of the chemical analyses of the citron fruit bars under study are presented in table 1. The data on vitamin C stability in the product dried in a controlled atmosphere chamber at 44–48% relative humidity and 75° F, and dried in an air conditioned room at 50% relative humidity and 72° F, is shown in figures 1 and 2, respectively. The effect of pH on the stability of vitamin C is clearly defined, especially for the products at pH 3.4 and 3.7, as compared to those at 4.1 and 4.3.

Figures 3 and 4 show the behavior of the total acid composition during storage of the products prepared in the two series of experiments.

The curves plotted using the results of the reducing sugars determination on the fruit bars prepared at four levels of pH are presented in

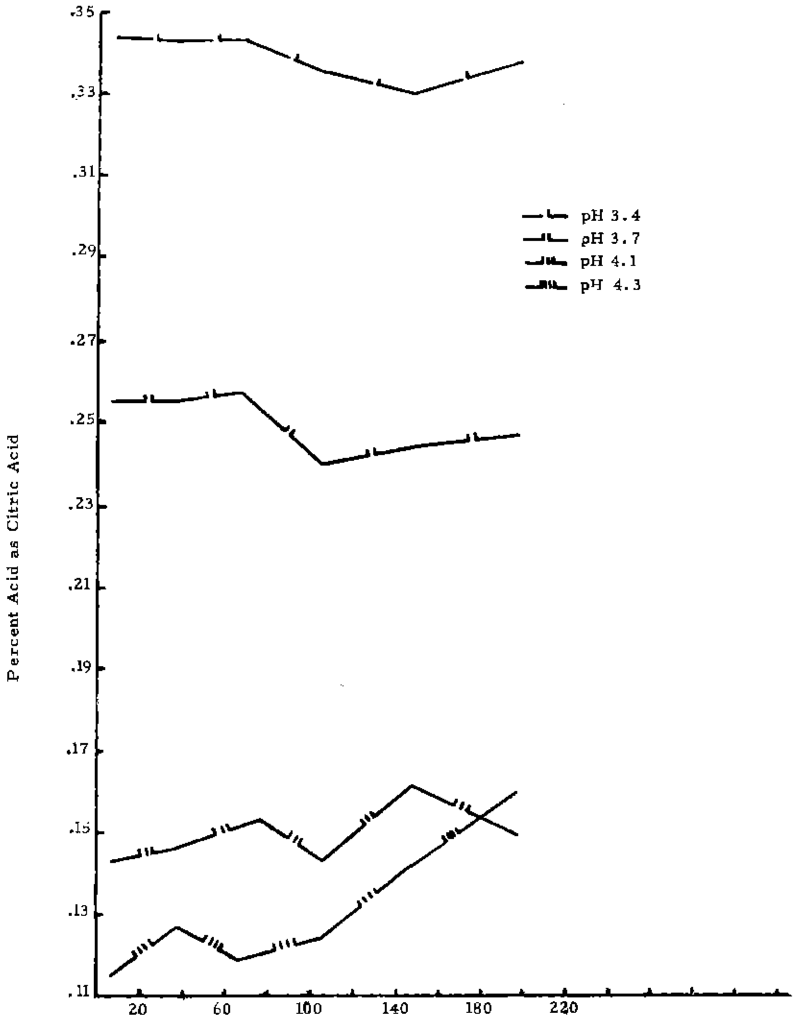

FIG. 4.—Total acidity (as citric acid) in citron fruit bars processed at different pH levels and dried in an air conditioned room (2nd series).

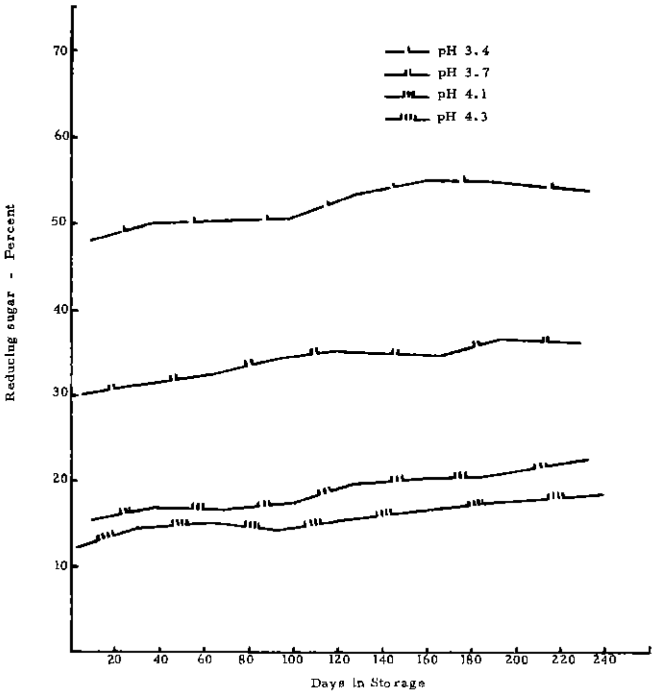

FIG. 5.—Reducing sugars in citron fruit bars processed at different pH levels and dried in a controlled atmosphere chamber (1st series).

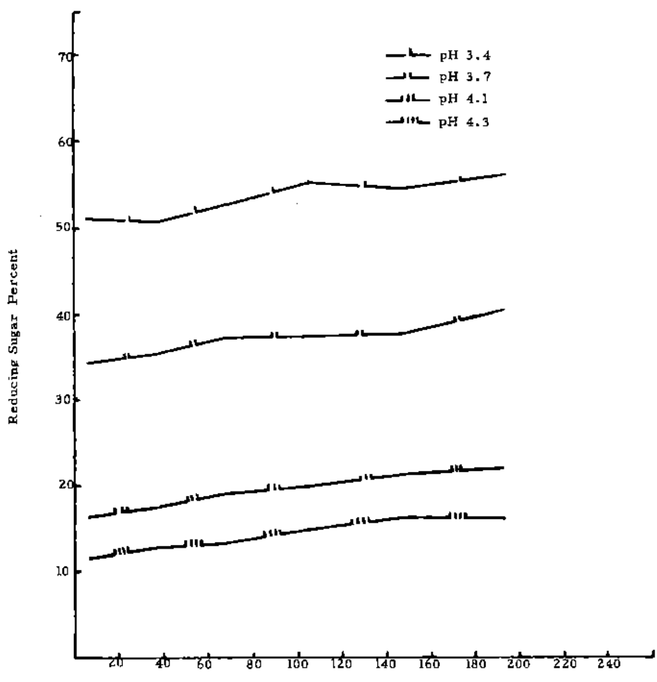

FIG. 6.—Reducing sugars in citron fruit bars processed at different pH levels and dried in an air conditioned room (2nd series).

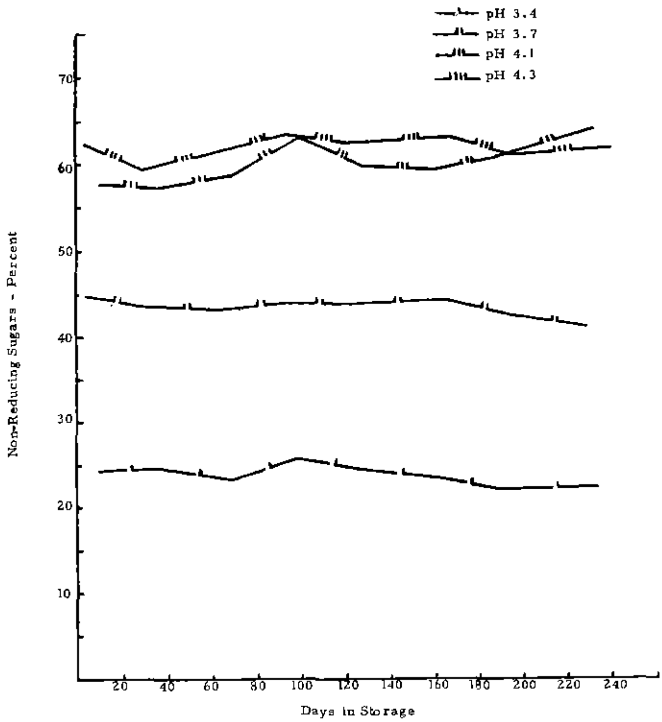

FIG. 7.—Non-reducing sugars in citron fruit bars processed at different pH levels and dried in a controlled atmosphere chamber (1st series).

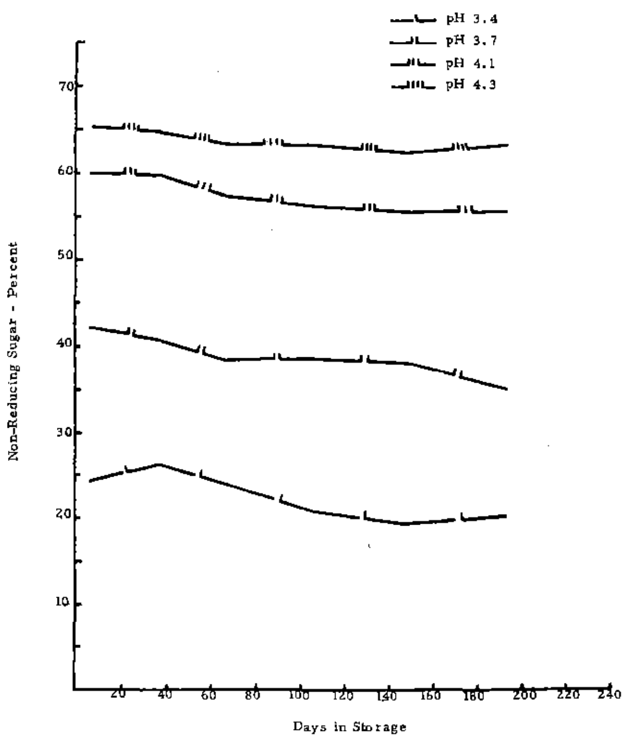

FIG. 8.—Non-reducing sugars in citron fruit bars processed at different pH levels and dried in an air conditioned room (2nd series).

figures 5 and 6. These show the sucrose inversion corresponding to each pH level and the associated changes in these during the shelf-life of the product. The degree of sucrose inversion is the factor responsible for the level of sucrose crystallization in citron bars (3).

The resulting amount of non-reducing sugars in the products under study are presented in figures 7 and 8.

Bars with pH 4.1 were the second lowest in reducing sugars and the lowest in vitamin C destruction.

RESUMEN

El nivel de pH fue determinante en la composición química de pastas de cidra elaboradas a pH 3.4, 3.7, 4.1, y 4.3.

El contenido en vitamina C fue afectado por el nivel de pH, por lo cual la destrucción de esta vitamina fue mayor en las pastas con pH más bajo (pH 3.4 y 3.7). Al terminar el estudio, o sea al cabo de aproximadamente 200 días de almacenamiento las pastas con pH 3.4 y 3.7 contenían menos vitamina C que las elaboradas a pH 4.1 y 4.3. En las dos series de experimentos la destrucción a pH 4.3 fue mayor que a 4.1, algo que los autores no pueden explicar.

El contenido total en ácido (como ácido cítrico) correspondió al pH usado al elaborarlas pero se observó una leve tendencia a bajar el nivel de acidez en las pastas elaboradas a pH 3.4 y otra leve a subir en las elaboradas a pH 4.1 y 4.3.

El nivel de azúcares reductores correspondió a lo esperado: las pastas con pH más bajo contenían mayor cantidad de azúcares reductores, hecho que está de acuerdo con la literatura en lo relacionado con la inversión de la sacarosa a diferentes niveles de pH. Los datos obtenidos durante el almacenamiento demuestran una leve tendencia a subir en los niveles de azúcares reductores.

Los azúcares no reductores variaron de acuerdo al nivel de pH, con menos inversión en las pastas a pH 4.1 y 4.3. La pasta a pH 3.4 arrojó el contenido más bajo en azúcares no reductores.

En los cuatro análisis para vitamina C, acidez total, azúcares reductores y no reductores, las diferencias entre las pastas a 4.1 y 4.3 fueron menores que entre las pastas a pH 3.4 y 3.7.

Del estudio se concluye que la pasta de cidra debe elaborarse a un pH de 4.1 cuando se usa sacarosa como dulcificante.

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