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CONSERVATION OF ORANGES BY UV IRRADIATION

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ABSTRACT

In Argentina, around 900,000 tn of oranges are produced. There are commercial crops throughout the Litoral, from the north of the province of Buenos Aires to Misiones, as well as in the Northwest, from Catamarca to Jujuy. This fruit is very popular among the inhabitants and consumed in Argentina, because it is economical. On the other hand, in recent years there has been an increasing demand for fresh and healthy products, which means that the food industry seeks non-thermal conservation technologies as alternatives to thermal treatments. The application of UV light on liquid or solid products is used in different sectors of the food industry, due to the harmful effect it causes on the DNA of many microorganisms. The objective of this work is to determine the variation of the some characteristics of oranges subjected to ultraviolet radiation and to know the temporal evolution of the fruit to evaluate the conservation method. The oranges were divided into 3 batches, one Witness (without radiation), anothers was treated with the applications of pulses of UV radiation. The parameters analyzed were vitamin C, soluble solids, acidity, color and UV-V spectrum. From the results obtained it is concluded that the treatments of the fruits with application of wavelength of 254 and 365 nm, decrease the concentration of acidity, maintain the level of vitamin C for a longer time and preserve the soluble solids in the juice. For this reason it is considered that irradiation of oranges is a useful method for the conservation of fruits maintaining the nutritional characteristics over time.

KEYWORDS: Oranges - UV irradiation – conservation.

INTRODUCTION

Currently around 900,000 tn of oranges are produced in Argentina. There are commercial crops throughout the Litoral, from the north of the province of Buenos Aires to Misiones, as well as in the Northwest, from Catamarca to Jujuy.

Half of the production of oranges in Argentina is consumed as fresh fruit in the local market. Its per capita consumption is 10-12 kg / inhabitant / year. Of the remaining 50% more than half is industrialized (25-30% of total production). The country's orange juice industry competes with difficulty with Brazil, due to the immense size of its installed factories.

The remaining 20-25% is exported as fresh fruit. In recent years the export of oranges was between 140-190,000 tons. The main markets for oranges are: the European Union, Russia and Latin America. Volumes sent to other regions, such as North America, Asia or Africa, are minute. Both in Europe and in Russia, Argentina has to face strong competition from South Africa, which is the major exporter of southern oranges.

This fruit is popular and consumed in Argentina, because it is economical and healthy. On the other hand, in recent years there has been an increasing demand for fresh and healthy products, which leads the food industry to look for safe, reliable, non-polluting and economic processing technologies. A possible alternative for conservation is irradiation that is also useful to delay the ripening of tropical fruits such as bananas, doubling or tripling their useful life, as well as delaying the senescence of mushrooms and asparagus (López-Malo, A., and Palou, E., 2005). This method also allows to extend the shelf life of "fine fruits" (strawberries, cherries, blueberries, raspberries, berrys) by reducing total microbial contamination. In this way, by improving the hygienic-sanitary quality of the food without chemical additions and by prolonging the shelf life, the time of commercialization is also prolonged. Then could reach demanding markets, expanding the export capacities of the country (Lante, A. et. al., 2016). For several years, the effects of radiation on bacteria and other organisms were investigated, which started from the concept of cellular damage caused by the incidence of solar radiation on living organisms. Later, the effect produced by monochromatic radiations of the ultraviolet (UV) spectrum was studied. In the food industry, it is used to disinfect, for example, conveyor belts, sheets and closure caps, and containers. Also the surfaces of some solid foods such as fruits, vegetables, fish (its application is effective at the surface level (López-Malo, A., & Palou, E., 2005; Cote Daza S. P., 2011)) and liquids such as juices and water. In aquaculture, for example, it is used to protect the flow and recirculation in freshwater or saltwater aquariums. At present the most used irradiation system is named continuous. It consists of permanently ignited radiation emitters that apply UV light on liquid or solid products. The main use is water treatment. UV radiation is used in different sectors of the food industry, due to the noxious effect on the DNA of many microorganisms. It is also chosen because it is a process that does not alter the organoleptic properties and chemical composition of the products, reducing or eliminating the use of chemical substances in processing.

The identification and determination of the parameters of quality, that allow assuring the state of maturity of the fruit of agreement to the exigencias of the market, is fundamental to think about a successful process of commercialization. (Campero, E.V. et. al., 2016a, Campero, E.V. et. al., 2016b).

In this work, it is proposed to study the temporal evolution of the physicochemical, nutritional and organoleptic properties of the orange fruit to evaluate the effect of ultraviolet radiation as a conservation method.

MATERIALS AND METHODS

Identical representative samples of Oranges (Harris, from farms in the province of Tucumán) were used, according to the following scheme

1 - Witness (without irradiation).

2 - Sample subjected irradiation UV of 254 nm

3 - Sample subjected irradiation UV of 365 nm.

In each sample acidity, total soluble solids (brix), vitamin C, % weight loss, UV-V spectra and degree of maturity by color were determined. All of these measuremente were realiced at the time of the irradiation and 21 days later.

The determination and simultaneous quantification of sugars by high performance liquid chromatography was also performed, but only for the initial time (t0). All samples after irradiation were stored at room temperature (average temperature 14 ° C), 70% humidity and atmospheric pressure (978 hPa). In all cases the pressure and temperature conditions of the samples were kept identical. In the radiation applications the sample quantity and the geometry of the application cell were preserved. For the evaluation of all the parameters of maturity, the fruits were cut and the juice extracted by squeezing the oranges. The juice was centrifuged and the whole was filtered and then divided into equal portions for each measurements

Parameters

Titrated Acidity: Potentiometric titration, expressing the results as percentage of citric acid (AOAC, 1984).

Total soluble solids: With portable refractometer Atago 0-32º brix and the results were expressed in ° Brix.

Weight loss percentage: It was determined through weighing differences in the OHAUS digital scale Traveler model TA302, 300g e = 0.01g.

Vitamin C: (AOAC 43.064) (1984)) The results were expressed as vitamin C in mg ascorbic acid / 100 mL of juice.

UV-Visible Spectra: A HITACHI U-1900 spectrophotometer was used.

HPLC: Walters, model Alliance e2695.

Chromatograms

Column: Sugar Pack C18, Detector: Refraction Index, Mobile Phase: Water + 0.05g Calcium EDTA, T (column) 85 ºC, T (detector) 45 ºC, Flow rate: 0.5 ml / min, System: Isocratic, Sample temperature: 15 °C, Injection volume: 20 ul.

Color: A spectrophotometer (Photoresearch PR715 SpectraScan) was used to obtain the reflectance profile of the three batches of orange in the range 380 to 10685 nm. The measurements were made by placing each of the oranges in the center of a uniform lighting cabinet inside which there are D65 illuminators. Three oranges were measured from each of the batches of oranges (control, irradiated with UV 254 nm and irradiated with UV 365 nm), and the representative representative values for each batch were calculated.

RESULTS AND DISCUSSION

The experimental values of the measured quantities at the initial time and at 21 days are shown in table1.

It is observed that

A - Ascorbic acid

1. The amount of ascorbic acid decreases with time in the control sample as already observed by Marsanasco, M. et. al., (2011), which proposes the addition of liposomes to prevent the decrease of vitamin C.
2. The amount of ascorbic acid grows over time in the irradiated samples.
3. Batches treated with 365 nm radiation have markedly higher values after 21 days, which agrees with the determinations of Mditshwa A. et. al., (2017).

Table 1: Brix, Vitamin C, acidity and weight loss in the treated oranges.

Treatment	Days	Brix (% soluble solids)	Acidity (g citric acid/ 100 mL of juice)	Vitamin C (mg of ascorbic acid/ 100 mL of juice)	Weight loss %
Without treating	0	11,2	1,3±0,4	85±3	
	21	12,2	1,25±0,03	76±2	24±9
254	0	12	1,2±0,1	76,1±0,7	
	21	11	1,12±0,03	81,3±0,7	18±5
365	0	10,8	1,40±0,06	88±7	
	21	11,8	1,21±0,06	91±3	22±9

B- Soluble solids

1. The amount of soluble solids increases with time in the control sample, which indicates greater maturation
2. The amount of soluble solids increases with time in the sample irradiated with 365 nm UV radiation, but with smaller values than in the witness sample.
3. The amount of soluble solids decreases with time in the sample irradiated with UV radiation of 265 nm.

Regarding the acidity, all the samples exhibited a reduction of the acid content in the juice, which means that they have matured; although the one that reaches a lower value at 21 days, is the batch irradiated 254 nm.

In Fig. 1 you can see the UV-V spectrum of the oranges juice, observing that all treatments with radiation and the control do not differ significantly.

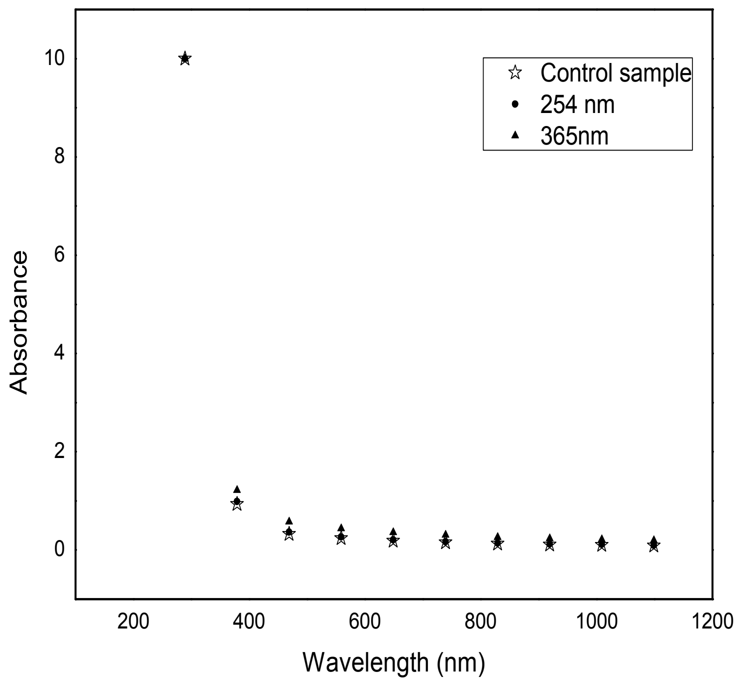

Figure 1: UV-Visible spectra of juice of treated oranges.

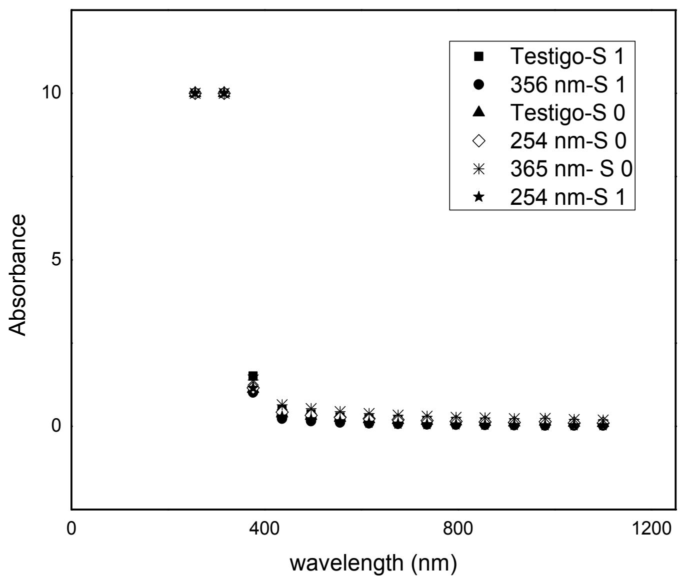

Figure 2: UV-Visible spectra of orange juice.

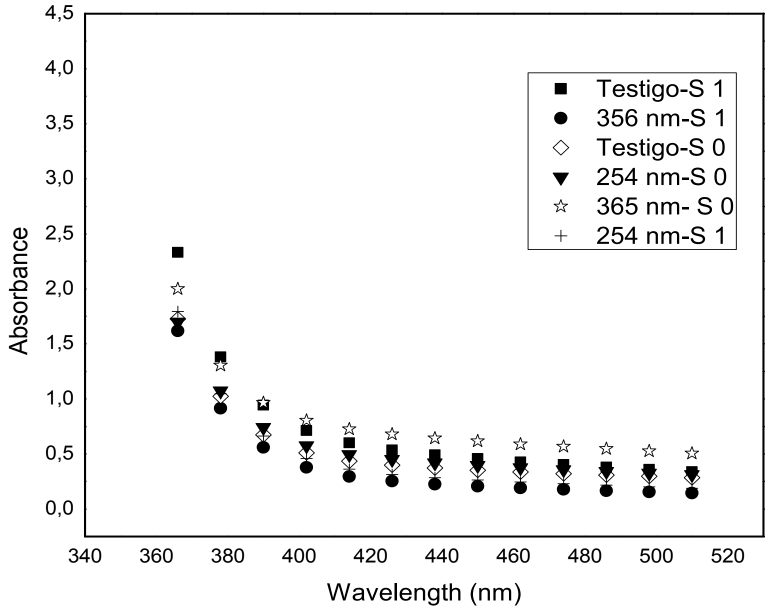

Figure 3: UV-Visible spectra of orange juice in (350 – 500) nm region.

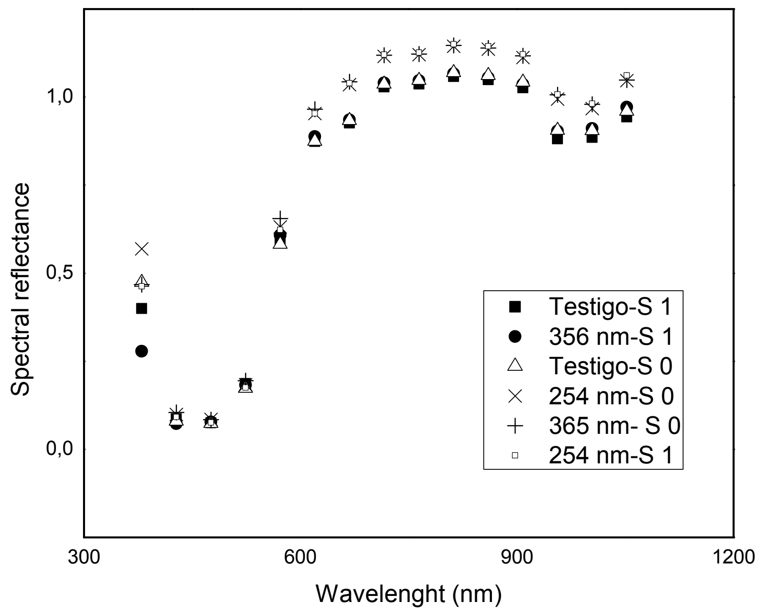

Figure 4: Average spectral reflectance of orange juice.

Figure 4 shows that the spectral reflectance of oranges does not vary significantly when they are subjected to radiation treatments of 254 and 365 nm, but that does vary with time. There is a total agreement between the behavior of the reflectance and the data of soluble solids and acidity since they all show that a greater state of fruit ripening.

The average chromatic coordinates (u', v') of the oranges juices in each lot are:

Table 2: Average chromatic coordinates of the oranges in each batch and the variation in these coordinates due to the ripening of the fruit.

	Time 0 days	*Time 7 days*	**Standard variation**
Witness	(0,363; 0,5423)	(0,368; 0,5416)	(0,003; 0,0005)
254 nm	(0,362; 0,5426)	(0,365; 0,5421)	(0,003; 0,0003)
365 nm	(0,366; 0,5420)	(0,369; 0,5417)	(0,003; 0,0002)

From Table 2 it can be seen that the perceived color of the oranges does not vary significantly when they are subjected to radiation treatments of 254 and 365 nm, and also after 7 days of fruit ripening.

HPLC

Today, high-performance liquid chromatography (HPLC) has become one of the most important laboratory techniques as an analytical tool to separate and detect chemical compounds. This technique allows the separation, identification and quantification of the sugars present in organic samples. The retention times of the chromatographic peaks of the sugars (fructose, glucose and sucrose) were obtained, being able to define and validate the method to quantify these carbohydrates. The concentration of these analytes in the studied samples was determined.

A slight increase of sugars with irradiation is observed, being higher for the 365 nm as can be seen in table 3, this is in agreement with the results obtained for soluble solids, acidity and color

Table 3: Amount of sucrose, glucose and fructose from untreated orange juice samples and treated after 21 days.

	Witness	**Sample treated at 254 nm**	**Sample treated at 365 nm**
Sucrose	3,702	3,602	3,857
Glucose	1,722	1,899	2,022
Fructose	1,922	2,103	2,127

CONCLUSIONS

The treatment of the fruits by application of UV radiation of wavelength of 254 and 365 nm, produces the decrease in the concentration of acidity as well as maintains the level of vitamin C for a longer time, preserves the soluble solids in the juice and the loss of weight is less.

It is also observed that there is a slight increase in maturation.

Therefore, it is considered that irradiation of oranges is a useful method to preserve fruits maintaining the nutritional characteristics for more than 20 days without any additional treatment, which is economically profitable and environmentally recommendable.

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