

**INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH  
TECHNOLOGY****EFFECT OF THERMAL PASTEURIZATION ON THE PHYSICOCHEMICAL  
STABILITY AND NUTRITIONAL QUALITY OF MOROCCAN VALENCIA LATE  
ORANGE JUICE****H. Azzouzi<sup>1</sup>, K. Elfazazi<sup>2\*</sup>, M. Achchoub<sup>1</sup>, L. Chafki<sup>3</sup>, M. Jbilou<sup>2</sup>, S. Salmaoui<sup>1\*</sup>**1: Laboratory of environment and valorization of agro resources, Faculty of Sciences and Techniques,  
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**ABSTRACT**

A better knowledge of the effect of pasteurization on the physicochemical stability and the nutritional quality of foods processed by emerging technologies with regard to thermal traditional technology is necessary. Thus, freshly squeezed orange juice of Moroccan Valencia Late orange variety was processed by four thermal scales 65°C/30min, 77°C/1min, 88°C/15s, 92°C/30s. The pH, soluble dry matter, total acidity, Vitamin C, total polyphenols, condensed tannins and flavonoids of fresh and treated juices were evaluated. The thermal effect on total acidity and soluble dry matter, or Brix analysis showed insignificant modifications due to all pasteurization treatments. However, the pH values increased considerably for all pasteurization treatments. Furthermore, the contents of total polyphenols revealed significant increase with 88°C/15s treatment. Also, a considerable decrease of the rate of the flavonoids was observed especially with 77°C/1min and 65°C/30min treatments. Moreover, an increase in condensed tannins compared to fresh orange juice was remarkably noted, especially for the thermal scale of 88°C/15s and 65°C/30 min. During treatments, orange juice maintained the same concentration of vitamin C.

**KEYWORDS:** Valencia Orange juice; physicochemical analysis; nutritional quality; pasteurization; thermal scales.**I. INTRODUCTION**

The citrus sector in Morocco plays a socio-economic role of first choice, which makes it one of the most important branches of the national economy. Citrus exports, which average around 500,000 tons per year, represent a major source of foreign exchange with the equivalent of nearly 3 billion dirhams per year [1]. The citrus industry has experienced significant development over the last two decades thanks to the efforts made under the Green Morocco Plan [2].

Valencia orange is one of the principal sweet orange varieties for processing. The variety of Valencia late oranges is late maturing; maturing is between spring and summer. Valencia oranges is the most important global range, puts in evidence its large amount of slightly acidic flavour juice comparing with other varieties of orange. It can be used for both feeding and for extracting refreshing orange juice [3].

Orange juice is widely consumed in many countries because of its high nutritional value and health-related properties. Traditionally, it has been pasteurized by heat treatment to prolong its shelf life. However, this process may cause irreversible losses of nutritional quality and in consequence may affect the health-related properties.

In order to produce a good quality orange juice, the processor must take into account both nutritional and hygienic qualities. Orange juice, as with many other food products, can be subjected to degradation of nutritional quality

due processing conditions. Many studies have been carried out on the quality and stability of pasteurized orange juices [4], [5], [6]. But in some cases the juices are obtained from concentrates [7], in other cases [5] and [6] the pasteurization conditions applied are fairly intense (from 90°C/15 s to 110°C/15 s), anticipating storage at ambient temperature or a very long shelf life in refrigeration.

In these latter cases the impact of pasteurization on quality is clearly appreciable. In other cases, there are studies on the effect of certain processes, the conditions of processing, canning or storage, on one or more specific quality parameters [8]; [9]; [10]; [11]; [12]; [13]; [14]; [15]; [16].

In view of the absence of data for the stability of Moroccan orange juices under different pasteurization conditions, the aim of the present work is to investigate the effect of pasteurization under different thermal scales on the physicochemical stability and nutritional quality of the orange juices obtained from Moroccan Valencia late orange variety.

## II. MATERIALS AND METHODS

### II.1. Orange Juice processing

Orange fruits (*Citrus sinensis* L. variety Valencia late, Morocco) were purchased from the citrus collection of INRA (National Institute of Agronomic Research, Morocco). Orange juice was obtained using a domestic squeezer. All treatments were carried out with this juice.

At the laboratory, we proceed as follows:

- Washing: Passage of oranges under water for cleaning.
- Bleaching: The oranges were put at a temperature of 77°C for 5 min.
- Pressing: Extraction of juice using the "Citrus juicer" (juice extractor intended to squeeze citrus juice)
- Centrifugation: Centrifugation of juice in a 2000rp/5min.
- Pasteurization: Pasteurization made in a water bath at atmospheric pressure. Thermal scales were (65°C/30min; 77°C/1min; 88°C/15s and 92°C/30s).

### II.2. Physicochemical and biochemical analysis

Parameters of samples were analyzed as described below.

- **Determination of pH, Soluble dry matter and titratable acidity**

The pH was measured using a pH meter for food (ThermoOrion 3 Star). The pH was determined using a moving pH meter. Soluble dry matter, or Brix (expressed in ° Bx), was determined by refractometry using a digital refractometer (Mettler-Toledo GmbH). The Titrable acidity was determined by means of a potentiometric titration of the acidity of the juice, with a solution of NaOH (0,1N). The results were expressed as g/l with reference to citric acid [17].

- **Determination of Vitamin C**

The dosage of vitamin C made by direct iodometric method and indirectly. First, the solution of the diode is calibrated using a solution of sodium thiosulphate of known concentration. In this assay the diode (I<sub>2</sub>) is reduced by thiosulfate (S<sub>2</sub>O<sub>3</sub><sup>2-</sup>). In a second step, the vitamin C contained in the orange will be measured by iodometry by the direct method. Vitamin C of fruit juice is oxidized by diode.

- **Quantification of Total polyphenols**

The determination of total polyphenols by the method using the Folin-Ciocalteu reagent is described by [18]. Since then, it has been widely used to characterize plant extracts of various origins. 0, 2 mL of extract juice is mixed with 1.5 mL of the Folin Ciocalteu reagent diluted 1/10 and 1.2 mL of 7.5% of the sodium carbonate. The mixture is incubated for 90 min in the dark and at room temperature after the absorbance is measured at 725 nm using a UV-visible spectrophotometer. The results are expressed in mg EAG (Equivalent Gallic Acid) / mL.

- **Quantification of the condensed tannins**

The condensed tannins are assayed according to the colorimetric method of Folin Denis, described by [19]. We introduce: 0.5 mL of juice diluted 1/10 with a water-methanol mixture (2:3), 2.5 mL of the Folin Denis reagent and 5 ml of the saturated CO<sub>3</sub>Na solution. After mechanical stirring, the preparation rests for 30 minutes, the measurement of the optical density is made at 760 nm. A standard range of tannic acid is prepared under the same conditions, whose concentrations range from 0 to 0.1 g / L, while the control is carried out under the same conditions. The results are expressed in mg EAT (Tannic Acid Equivalent) / mL.

- **Quantification of The total content of flavonoids**

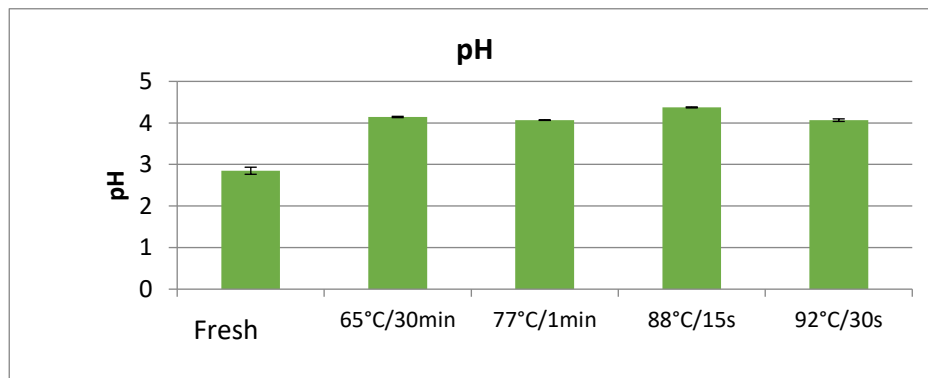
The total content of flavonoids is determined according to the method of [20]. This method is based on the formation of an aluminum-flavonoid complex, having a maximum absorption at 430m. We put down, 1mL of juice diluted 1:10 with a water-methanol mixture (2:3) and 1mL of 2% aluminum chloride. The results are expressed in mg ER (Rutine Equivalent)/mL.

### III. RESULTS AND DISCUSSION

#### III.1. Effect of heat treatment on pH, °Brix and titrable acidity

Results on figure 1 show that the pH value of fresh juice varies between 2.77 and 2.9. According to [21] the latter is  $3.52 \pm 0.01$ ; this value remains lower than the pH of the other fruit juices, for example cladode juice 4.49 and 4.77 [22], pomegranate juice 2.75 and 4.14 [23] and 3.67 for grapefruit juice [24]. Regarding the pH of the pasteurized juice its value is between 4.03 and 4.37. By comparing the latter with [25] who obtained a pH of 3.85 for an orange juice pasteurized at a temperature of  $98^\circ\text{C}$  for 21 seconds, it is found that there is not a large variation. Furthermore, we notice a significant increase of the pH values after all treatments compared to the fresh juice (Fig.1).

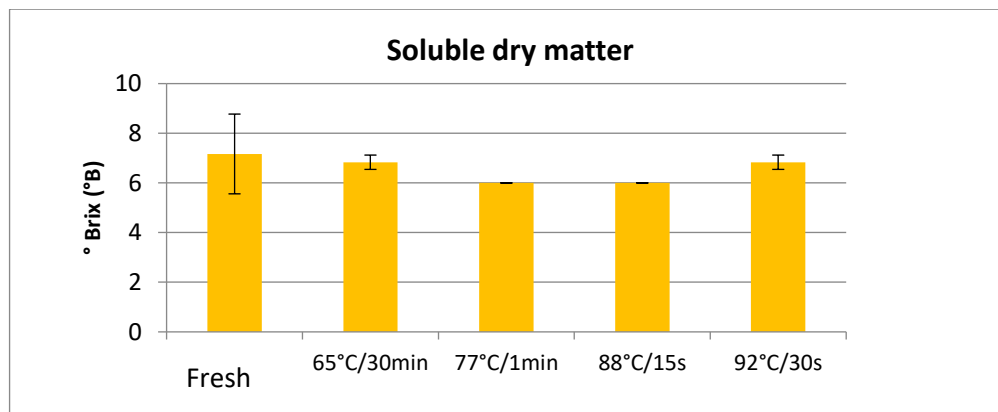
**Figure 1:**



*pH variation according to the thermal scales*

The results obtained for °Brix vary from 6 to 9; this value is more close to that reported by [25] which is 9.5 and that of cladode juice which varies between 5.1 and 11 [22]. By analyzing the results, we noticed that no significant variation of the °Brix values of due to pasteurization treatment with all thermal scales has been revealed (Fig.2).

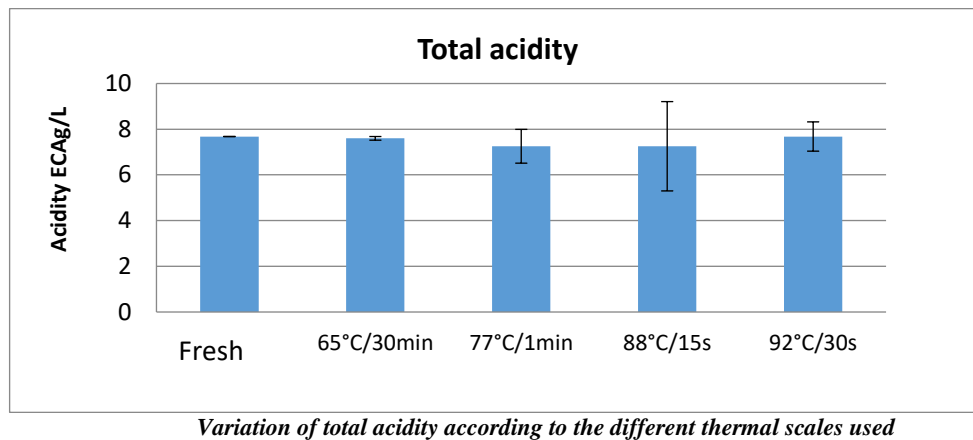
**Figure 2:**



*Variation of the °Brix according to the thermal scales*

The total acidity of fresh orange juice is 7.68 ECAg/L (Fig. 3). This value is very similar to those reported by [21] which is 7.8 and also comparable to other fruit juices (Grapefruit juice 0.94; lemon juices  $52.40 \pm 2.5$  ECAg/L) [26]. Orange juice has a slightly high pH but its total acidity is generally comparable to other fruit juices. By comparing the total acidity values of the pasteurized juice, we find that no important modification has been showed under the different treatment. The mean value of pasteurized juice is generally around 7.25 ECA g/L. This value is comparable to the acidity obtained by [25] for a pasteurized juice at a temperature of  $98^\circ\text{C}$  for 21 seconds (6.26ECAg/l).

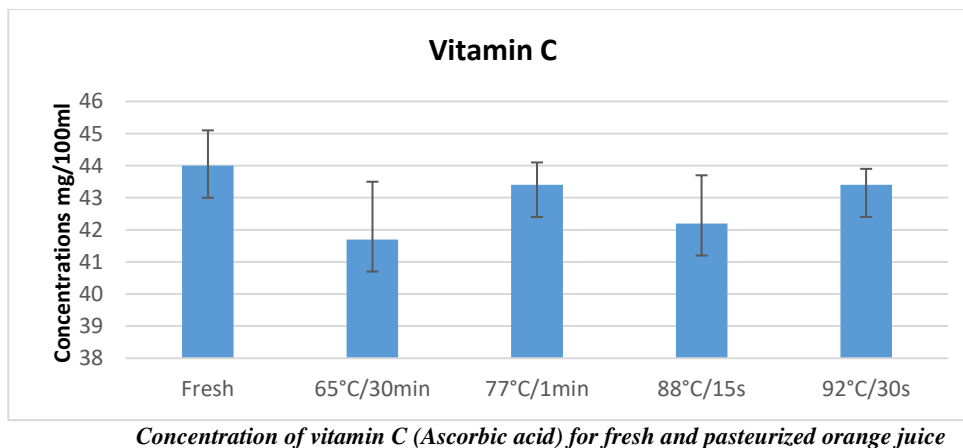
Figure 3:



### III.2. Effect of heat treatment on Vitamin C

The values of vitamin C concentration of fresh and pasteurized juice are presented in Figure 4. According to the results, the stability of the ascorbic acid content for fresh and pasteurized orange juice has been noted to be between 41.7 and 44mg/100mL of juice. Compared with other juices, lower values were reported: apple (11mg/100mL), pineapple (95mg/100mL), tomato (16.6mg/100mL) [27], grapefruit (22mg/100mL) [24].

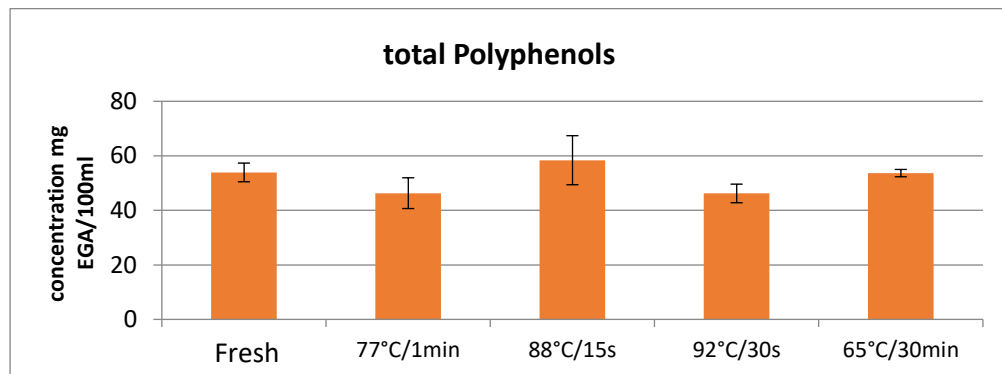
Figure 4:



### III.3 Effect of heat treatment on polyphenols

Figure 5 illustrates the variation of the polyphenol content according to the heat treatments. The total polyphenols content for fresh orange juice is  $53.91 \pm 3.4$  mg EGA/100mL; this value is comparable to that of [28] which is  $45.5 \pm 2$  mg EGA/100mL. The total phenol compounds content for other juices are: apple ( $33.9 \pm 4$  mg EGA/100mL), grapefruit ( $53.5 \pm 1$  mg EGA/100mL), pineapple ( $35.8 \pm 3$  mg EGA/100mL), plum ( $44.1 \pm 6$  mg EGA/100mL) and grape (51.9 mg EGA/100mL) [28]. Considering the results above, we noticed that orange juice is richer in polyphenols compared to other fruit juices. It can be compared to grape juice which is known for its richness in polyphenols. For the pasteurized juice the value of the total polyphenols varies from 46.3 and 58.3 EGA/100mL and there is a significant increase in the polyphenols content for the juice treated at a temperature of 88°C for 15seconds. Concerning the impact of heat treatment on the content and composition of fruit polyphenols, the data are currently rare and sometimes contradictory [29]. [30] Studied in the laboratory the impact of processing red barriers, a slight increase in the polyphenols content was observed. According to these authors, this increase would be due to a release of phenolic compounds initially associated with cell walls, induced by heating and therefore related to the degradation of these walls.

Figure 5:

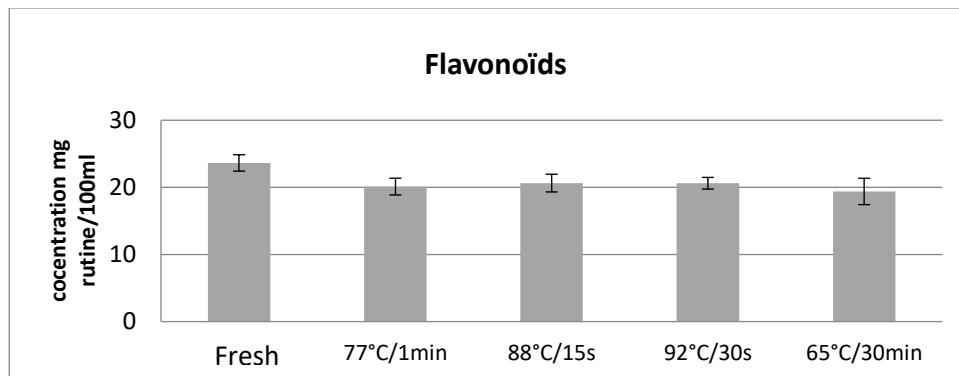


*The variation of the polyphenol content according to the different thermal scales*

#### III.4 Effect of heat treatment on flavonoids

The variation of the flavonoid content according to the thermal scale is presented in Figure 6. The content of flavonoids is an average of 23.64 mg ER/100mL this value remains much higher compared to that of the cladode juice which varies from  $0.36 \pm 0.04$  to  $1.18 \pm 0.01$  mg ER/100mL [22]. Grape juice flavonoid content is 7.24 mg ER/100mL [31]. The results show that the pasteurized juice values are between 19.39 and 20.36 mg ER/100mL and do not exceed those of the fresh orange juice. Also, a considerable decrease of the rate of the flavonoids is observed especially at thermal scale 77°C/1min and 65°C/30min. this variation could be due to the important time of heating especially at 65°C/30min.

Figure 6:

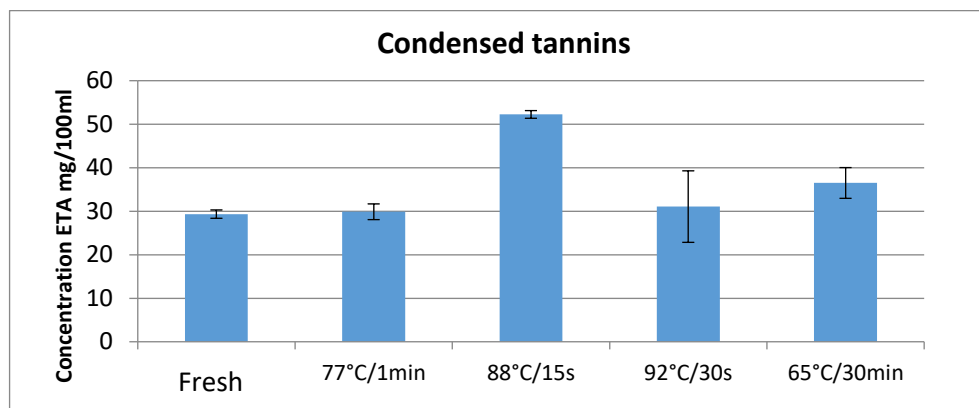


*The variation of the flavonoid content according to the different thermal scale*

#### III.5 Effect of heat treatment on condensed tannins

The variation of the condensed tannins according to the different thermal scales is reported in Figure 7. Orange juice is less rich in condensed tannins ( $29.33 \pm 0.95$  mg ETA/100mL) compared with pomegranate juice ( $43.20 \pm 0.7$  mg ETA/100mL) [32]. While cladode juice ( $18.23 \pm 0.6$  mg ETA/100mL) [22] has a lower value than orange juice. For pasteurized orange juice, an increase in condensed tannins compared to fresh orange juice is remarkably noted, especially for the thermal scale of 88°C for 15 seconds and 65°C for 30 minutes.

Figure 7:



*The variation of condensed tannins according to the different thermal scales*

#### IV. CONCLUSION

The evolution of quality parameters of heat treated orange juice as function of time and temperature of pasteurization treatments according to thermal scale used in food processing industries were studied in this research paper. The thermal effect on total acidity and soluble dry matter, or Brix analysis showed insignificant modifications due to all pasteurization treatments. However, the pH values increased considerably for all pasteurization treatments. Furthermore, the contents of total polyphenols, flavonoids and condensed tannins revealed significant modifications due to thermal scale. The changes were thermal scales dependent. During treatments, orange juice maintained the same concentration of vitamin C.

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