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Influence of the Pressing System on Pomegranate Juice Physical-Chemical Properties

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Pomegranate juice has many health properties as the fruits contain anticarcinogenic, antimicrobial and antiviral compounds. Its consumption has greatly increased throughout the world in recent years due to the potential of its different components, polyphenols and anthocyanins among all.
Many studies have been performed on the pomegranate juice yield demonstrating its influence on the organoleptic and physicochemical properties of the juice. Commercial pomegranate juice production involves pressing fruits procedures. As a consequence, there is a need to investigate the pressing machine types and optimization in order to achieve juice yield and enhance its health properties. The aim of this study was to assess the influence of the pressing systems on pomegranate juice yield and health properties after the extraction.
Pomegranate fruits of the Wonderful One variety were manually harvested in November 2014 and mechanically processed to extract juice. Two different pressing systems were used. The first one was an hydraulic pressing machine where the fruits were put after being sliced in half; the second extraction method consisted in using a destemming machine for the entire fruit followed by a pneumatic press, typically applied in grape processing. The juices obtained with the two systems were analyzed and compared in order to identify the extraction performances and quantitatively identify the health care of the juice properties.

1. Introduction

Several studies have been performed in the last years on pomegranate fruits. The plant (*Punica granatum,* L.), native to South Asia, belongs to the family of Punicaceae. The fruit is a berry with a very consistent peel. Pomegranate juice (PJ) has many health properties as the fruits contain anticarcinogenic, antimicrobial and antiviral compounds (Mphahlele et al., 2014a).
Polyphenols are natural components occurring ubiquitously in vegetative and regenerative plant parts. Thus, they also play an important role in maintaining fruit quality and determining their nutritive value. In particular, pomegranate fruits are a rich source of phenolic components, which has recently aroused great interest for their nutritional and antioxidant properties, thus meeting the soaring demand for high quality fruits both for fresh consumption and for processing into juices, syrups, wines and dried seeds, so-called anardana (Lansky and Newman, 2007; Jurenka, 2008; Miguell et al., 2010; Vicinanza et al., 2013; Viuda-Martos et al., 2010).
Several studies have documented the benefits of pomegranate juice consumption in individuals affected with various disorders (Asgary et al., 2014; Aviram et al., 2000 and 2001; Kelishadi et al., 2011; Faria et al., 2007, Shema-Didi et al., 2012). Its consumption have greatly increased throughout the world in recent years due to the potential of its different components, polyphenols and anthocyanins among all (Mphahlele et al., 2014b) as for other healthy products (Aiello et al., 2012, Catania et al., 2013). Many studies have been performed on pomegranate juice yield demonstrating its influence on the organoleptic and physicochemical properties of the juice (Fischer et al., 2013; Koppel et al., 2014, Türkyılmaz et al., 2013). The aim of this study was to assess the effects of two different plants, a Hydraulic Press (HP) and a Pneumatic Press (PP) on pomegranate juice yield and health properties after the extraction.
The effect of technological treatments on pomegranate juice characteristics, physicochemical properties such as pH, titratable acidity (TA), total soluble solids (TSS) and total phenolic content (TPC), total anthocyanins, and Free Radical-scavenging activity was studied in this paper.

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2. Materials and methods

Pomegranate fruits of the Wonderful One variety were manually harvested in November 2014 and mechanically processed to extract juice within 24 hours of harvesting. Before juice extraction, pomegranates were washed in cold tap water and drained. Average fruit weights ranged from 350 to 750 g.
Two different plants systems were used.
Plant 1: hydraulic pressing (HP) machine (T1). The machine, formed by a single block, has got a hydraulic pressing system consisting of an oil tank, a pump, four hydraulic actuators, supply and return pipes, equipped with individual housing on which the fruits are placed, previously manually cut in half. The maximum operating pressure applied by the hydraulic system was 100 bar.
Plant 2: pneumatic press (PP). It consists in a Drain Membrane Press SF22. It was designed and realized by Puleo Srl Company, Marsala (Italy). It was equipped with a stainless steel cover and a stainless steel tank, door and frame, a heavy-duty membrane, an axial feed valve and had no minimum load requirement.
The machine was set up to make 6 pressing cycles, named from T2C to T2I. Each extraction cycle was maintained for 3 minutes. Before applying the pressure levels, two juice samples were taken respectively after drainage (T2A) and after settling of the previous one (T2B). A whole sample was taken at the end of the process, coming from the whole juice extracted by the entire process using plant 2 (T2).
The amounts of extracted pomegranate juice (PJ) yield (%) was calculated by the following expression:

$$\text{Juice yield}(\%) = \frac{\text{Weight of PJ}}{\text{Weight of whole pomegranates}} \text{ x } 100 \quad (1)$$

2.1 Chemical Analyses

The pH values were determined on the homogenized samples using a pH meter (METTLER TOLEDO mod. MP 220), the samples temperature was standardized at 25 °C. certificated buffer solution at pH 2.7, 6 and 9 were used in order to achieve a proper instrumental calibration.
Determinations of total soluble solid (TSS) express as °Brix were performed on the homogenizing and filtering the juice of pomegranate samples. The filtered samples were subjecting at the reading with an Optical Refractometer (ATAGO Hand Refractometer N-50 E).
The titratable acidity (TA) orfeach sample was also determined. 6 g of juice was put into a 100 ml beaker and added with 50 mL of water. Each sample was titrate with 0.1 N NaOH to an end point of 8.2 (measured with the pH meter). TA was expressed as g of citric acid per 100 g of juice. The titratable acidity was calculated using the following formula:

$$\% \text{ acid} = \frac{[\text{mL NaOH}] \text{ x } [0.1 \text{ N NaOH}] \text{ x } [0.064] \text{ x } [100]}{\text{grams of sample}} \quad (2)$$

Total phenolic content were determined. 2 g of homogenized sample were added with 10 ml of pure ethanol. The extraction was done by using a vortex mixer mod. RX3 for 60 seconds. The mixture was filtered and the filtrate was taken into a test tube. The Folin-Ciocalteau micro method of Waterhouse (Brand-William et al., 1995) was used to determinate the total phenolic content (TPC). 60 µl of the filtrate were diluted in 4,8 mL of Milli-Q grade water, and 300 µl of Folin-Ciocalteau reagent was added and shaken. After 8 min, 900 µl of 20% sodium carbonate solution was added with mixing. After reaction at 40°C for 30 min, absorbance was measured at 765 nm using SHIMADZU UV mini- 1240 spectrophotometer. A calibration curve of gallic acid (3, 4, 5- trihydroxybenzoic acid) was prepared (0 - 50 µg) and used as standards. The results were expressed as mg gallic acid equivalent per gram of fresh weight.
Total anthocyanins were also determined. An aliquot of sample was diluted with a buffered solution of pH 1 (125 mL of 0.2 M KCl and 375 ml of HCl 0.2 M). A second aliquot was diluted with a buffered solution of pH 4.5 (400 ml of 1 M CH_3CO_2Na, 240 ml of 1 M HCl and 360 mL of H_2O). The absorbance of the solutions was measured at 510 nm, the concentration of anthocyanin was expressed in terms of cyanidin-3-glucoside according to the formula: C mg / L = (Abs pH1 – Abs pH4.5) x 484.82 x 1000 / 24825 x DF (dilution factor).
The free Radical-scavenging activity of 1,1-diphenyl-2-picrylhydrazyl radical (DPPH) were measured in terms of their radical-scavenging ability (RSA), using the DPPH method (Brand-Williams et al., 1995; Padmanabhan et al., 2012). Aliquots of the whole pomegranate juice were mixed with an ethanol solution of DPPH (3 mM), namely 2.37 mg DPPH in 2 mL ethanol. For the sample solution, 28 µL whole juice was mixed with 28 µL DPPH solution and 944 µL ethanol. After incubation in the dark at room temperature for 10 min, the

spectrophotometric determination was assayed at 515 nm using a spectrophotometer (CELL, model CE 1020). A freshly prepared DPPH blank solution (containing 972 μL ethanol and 28 μL DPPH solution) was used. The DPPH solution was stored in a flask covered with aluminum foil, and kept in the dark at 4°C between measurements. The percentage decrease in absorbance was recorded for each sample, and percentage quenching of DPPH radical was calculated on the basis of the observed decrease in absorbance according to the formula: % Inhibition =[(A0 – A1) /A0] x 100 where A0 is the absorbance value of the DPPH blank solution and A1 is the absorbance value of the sample solution.

2.2 Statistical analysis

Chemical analyses of Pomegranate Juice (PJ) were performed on three samples for each case of studies within one week from extraction. The data were subjected to ANOVA and Tukey's test to evaluate the statistical significance of the tests at the 95 % confidence level (Statgraphics Centurion, Statpoint Inc., USA, 2005).

3. Results and Discussion

PJ samples obtained from the two extraction systems are reported in Table 1, both from hydraulic (T1) and pneumatic (T2) presses.
The samples obtained from the two extraction systems, as reported in Table 1.

Table 1: Samples description and extraction pressures during the tests

Sample	Extraction pressure [bar]
T1	100
T2	0-1.8
T2-A	0 (after drainage)
T2-B	0 (after settling)
T2-C	0.3
T2-D	0.5
T2-E	0.7
T2-F	1.2
T2-G	1.4
T2-H	1.6
T2-I	1.8

The plant with the PP gave a PJ yield about 15 % higher than the system which involves the use of the HP. The increased yield of PP (T1) is due both to the low operating pressure applied by the membrane on the arils and to the longer time spent by the machine for the extraction of the juice. pH, ° Brix and titratable acidity showed the same values for both types of machines. Antioxidant power inhibition (%), total phenolic content (mg/g) and total anthocyanins (mg/L) values obtained by the use of the two extraction plants HP and PP are reported in Table 2 for the considered extraction procedures. For these parameters, the results are statistically different with a higher nutraceutical value for the PP (T2) better described by the values of Free Radical-scavenging activity and AT. The PJ quality is improved with the use of PP compared to HP. Antioxidant power inhibition of PJ coming from PP is 28 % higher than PJ coming from HP. Total phenolic content of PJ obtained with HP is higher than PP with statistically significant differences. This is due both to the high operating pressure applied by the hydraulic pressing machine and to the fact that the extraction was performed both in the presence of the epicarp and the mesocarp (Fischer et al., 2011).
Moreover, in order to study the influence of pressure on the extraction procedures, different pressures were investigated and the results are shown in Figure 1; they appear very promising.

The influence of pressure appears not linear in the increase of nutraceutical properties of the juice. Moreover following the meaning of results obtained for AT and TCP, the higher pressure in the range between 1.2 and 1.8 are more convenient. The study revealed as, by using an PP extraction procedures and different low pressure, is possible to obtain an increase of antioxidant capacity of juice products moreover a significant increasing of anthocyanins concentration determine a great concern about the relation of these compounds on radical activities.

Table 2: pH; TSS (g/100g); TA (%); TPC (mg/100g); AT (mgL^{-1}); free Radical-scavenging activity (%).Hydraulic Press (T1) =; Pneumatic Press (T2) of the PJ

	T1 (HP)	T2 (PP)
Yield (%)	28.2	33.3
pH	2.95±0.15	3.10±0.15
TSS (g/100g)	22.38±1.12	16.37±0.82
TA (%)	2.53±0.12	1.93±0.09
TPC (mg/100g)	233.07±11.65	225.26±11.26
AT (mg/L)	313.45±15.67	334.54±16.73
Free Radical-scavenging activity (%)	21.63±1.08	87.94±4.40

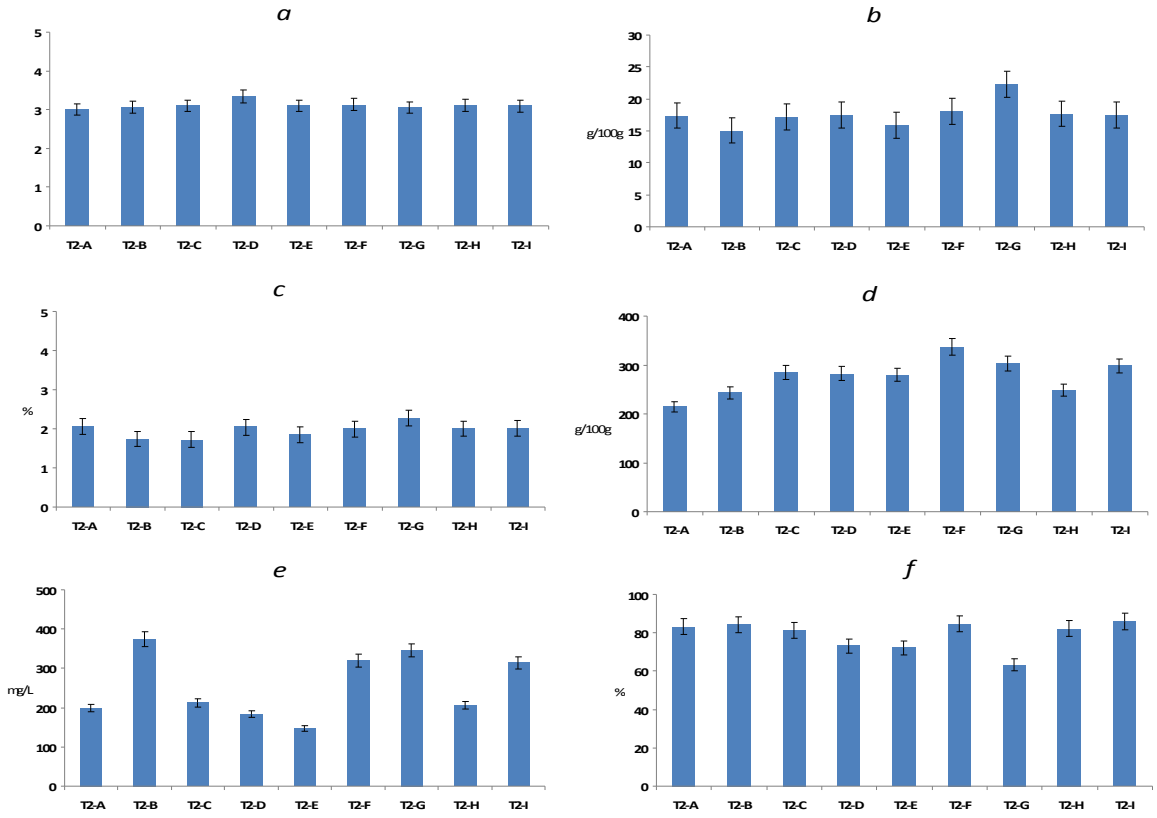

Figure 1: a (pH); b (TSS); c (TA); d (TCP); e (AT); f (free Radical-scavenging activity)

4. Conclusions

This study aimed at evaluating the performance of two different industrial scale plants for pomegranate juice extraction. Chemical analyses on the pomegranate juices obtained by the use of the different plants, a hydraulic press and a pneumatic press, showed that the pneumatic press gave better qualitative and nutraceutical results. Moreover, the results obtained with the two extraction systems suggest new research scenarios concerning pomegranate juice extraction performance to improve its yield, quality and nutraceutical properties.

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