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Topic 2 - Product and process quality in Organic Agriculture: methods and challenges

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POMOLOGICAL, PHYSICO-CHEMICAL AND ORGANOLEPTIC CHARACTERIZATION OF ORGANIC AND CONVENTIONAL POMEGRANATES (PUNICA GRANATUM L.)

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Abstract: This work aims to assess the pomological, physico-chemical and organoleptic characteristics of organic and conventional pomegranates (*Punica granatum* L.) and to determine the effect of organic farming system on the quality of pomegranates production. The trial was set up in the South-East of Tunisia and more precisely in the region of “Gabès” which is well known by the pomegranate variety “Gabsi”. The production of this variety was monitored under the organic and the conventional farming systems with the same pedoclimatic conditions.
Quality of pomegranates’variety “Gabsi” was assessed in the two production systems by the pomological parameters (fruit weight, fruit size, peel thickness, juice yield ...), the physicochemical characteristics of the juice (pH, titrable acidity, soluble solids content (°Brix) reducing sugar content, polyphenols, anthocyanin content, antioxidant activity ...) and by the sensory aroma profile.
Results have revealed significant differences between organic and conventional pomegranates in several parameters. In fact, pomological descriptors have shown that organic pomegranate fruits were characterized by a thicker and a redder peel than those of the conventional ones. Physico-chemical characteristics were also influenced by the farming systems except for the parameter of reducing sugar content. Acidity, total soluble solids (°Brix) and dry matter content were higher in organic pomegranate juice than in the conventional one respectively with the values (0.61 vs 0.48, 16.17% vs 12.83% and 28.93% vs 25.73%). In addition, polyphenols and anthocyanins were more present in the Organic pomegranate juice compared to the conventional one (1287.63 vs. 1089.53 mg gallic acid / L and 52.88 vs 40, 04 mg cyanidin-3-glucoside / 100 ml respectively). For consumer panel test, descriptive sensory analysis have shown that organic pomegranate juice was bitter and more acid than the conventional one due to its higher richness on antioxidants, but not different in the other organoleptic parameters.

Keywords: conventional, organic, pomegranate, quality

1. Introduction:

With the increase of the healthy food trend, the interest in pomegranates has become deeper regarding to its health benefits. In fact, several researches have revealed many therapeutic activity of pomegranate including cardiovascular anticancer, anti-inflammatory, anti-diabetes, antioxidant and other health effects (Basu et Penugonda, 2009). They have also demonstrated that pomegranate is among the richest fruits in terms of bioactive compounds (antioxidants, polyphenols…) (Seeram et al., 2008).

Nowadays, Consumers are more interested in product's quality and there is a big tendency for the consumption of fresh and organic food especially for vegetables and fruits. For this reason, many countries like Tunisia are encouraging farmers to convert their conventional farming systems gradually to integrated systems then to organic ones. Yet, the intensive uses of chemicals (pesticides, fertlizers…) in conventional farms to enhance production for food processing, have caused more human health problems and more pollution for the environment (Alföldi et al., 2006). Therefore, a big range of consumers now targets organic products instead of conventional ones. In this context, various works have focused on comparing the quality of organic and conventional fruits and vegetables.

It is within this framework that we have been interested, during this work, in the determination of the pomological, nutritional and organoleptic quality of organic and conventional pomegranates, which could highlight the advantages related to the organic farming system.

2. Material and methods:

2.1. Plant material

Organic and conventional pomegranate fruits, "Gabsi" cultivar, were harvested at fruit ripening stage during November 2016. Fruits were collected from two close pomegranate fields; conventional and organic one localized on the region of Gabès (10°6' E, 33°52' N) in Tunisia. Ten kilos of pomegranates in total were harvested from each field and used for laboratory analysis.

2.2. Pomological descriptors

Ten pomegranate fruits of each farming system were randomly selected for pomological test. Fruit attributes were recorded using the mentioned methods of Zarei et al., (2011): pomegranate fresh weight PFW (g), pomegranate height PH (mm), pomegranate equatorial diameter PD (mm), peel thickness (mm) measured by a digital caliper with 0.001 mm accuracy, Peel color SC assessed according to grading scale (2: yellow greenish to 18: dark red purple) and aril yield (AY) as a percentage of edible part.

2.3. Juice extraction and characterization

The collected pomegranates from the conventional and the organic fields were washed under tap water and divided into two halves at the equatorial zone using a sharp knife. Then, arils were manually removed for juice extraction. 100 g of fleshy arils were pressed in a domestic squeezer and filtered through a cloth tissue to obtain the juice yield (%) (JY). Juice color (JC) was assessed visually according to grading scale of color intensity ranging 2 (light pink: the lightest color) to 18 (reddish purple: the darkest color). After extraction, the juice was stored at a temperature of -20°C for biochemical analysis. The evaluation of Physico-chemical and sensory aroma parameters were performed in three replicates.

2.4. Physico-chemical properties

2.4.1. pH,Titrable acidity, Total soluble solids, Maturity index

The PH of each juice extract was measured by a pH meter (Jenway) at a temperature of 20°C. Following the method AOAC 22.060, titrable acidity (TA) was determined by titration to pH 8,1 with 0,1 M NaOH and expressed as g of citric acid/ 100 g of juice. Total soluble solids (TTS) were determined at a temperature of 20°C by a refractometer (Erma, Tokyo) and expressed by °Brix. Maturity index was then calculated by the ratio (TTS/TA).2.4.2. Dry matter, Viscosity and Reducing sugar content

Pomegranate samples were dried in the oven at a temperature of 70°C till a constant weight, then weighted. Total sugar was determined according to the reported method by Ranganna (2001) and expressed as g/ 100 g juice. Viscosity of pomegranate juice was measured by a viscosimeter RM180 Rheomat (Rheomatic scientific) at a temperature (25°C) and expressed by Ps.a.

2.4.3. Color quantification

Color measurements was performed by a Minolta CR410® spectrophotometer colorimeter. A quartz cell of 2 mm path length was filled with homogenized juice. CIE color data (L*, a*, b*) were recorded and processed using the Minolta Software Chroma control S, PC-based colorimetric data system. Hue angle (H*) was calculated from tan−1 (b*/a*) and Chroma (C*) from (a*2 + b*2)1/2. Data were obtained in triplicate.

2.4.4. Total phenolic content

Total phenolic content (TPC) was determined using Folin-Ciocalteu colorimetric method. Juice extracts (0.1 mL) were mixed with 0.2 mL of Folin-Ciocalteu reagent and 2 mL of ultra-pure water. After that, the obtained mixture was incubated at room temperature for 3 min and 1 mL of 20% sodium carbonate was added. TPC were determined after 1 h of incubation at an ambiant room temperature. The absorbance of the resulting blue color was measured at 765 nm using a Genesys 10S UV-Vis spectrophotometer. Results were expressed as gallic acid equivalents (GAE), mg GAE per liter of juice.

2.4.5. Total Anthocyanin content

Total anthocyanins were quantified by pH differential method using two buffer systems : potassium chloride buffer, pH 1.0 (25mM) and sodium acetate buffer, pH 4.5 (0.4M). The absorbance was calculated from the absorbance values obtained at 510 and 700 nm with the spectrophotometer (Genesys 10S UV-Vis) according to the following equation:

$$A= (A510 – A700)\ pH1.0 – (A510 – A\ 700)\ pH4.5$$

Anthocyanins content are therfore expressed by (mg cyanidin-3-glucoside/100 ml) and calculated according to the formula : $TAC= (A\times MM\times FD\times 100)\ /\ MA$

With : A (absorbance), MM (molecular weight 449.2 g/mol), FD (dilution factor 10), MA (molar absorptive coefficient 26,900).

2.4.6. Antioxydant activity

Antioxidant activity were determined by DPPH method described by Moon and Terao (1998). 0,1 ml of pomegranate juice was mixed with 0,9 ml of 100 mM Tris-HCl buffer (pH= 7,4) to which 100 ml DPPH (500 µM in ethanol) was added. The control sample was prepared by adding 0,1 ml of distilled water instead of pomegranate juice. Mixtures were shaken vigorously and left to stand for 30 min in a dark chamber. Absorbance was measured at 517 nm by a Shimadzu UV-1800 spectrophotometer.

2.5. Organoleptic properties and sensory aroma profile

Sensory profile was evaluated using a trained panel to compare fresh organic and conventional pomegranate juices. Ten trained panelists aged from 21 to 49 years (5 females and 5 males) were selected for the descriptive evaluation of pomegranate juices in the National Agronomic Institute of Tunisia. Panelists worked on the evaluation of the intensity of the following indexes : (1) aroma: earthy, fruited (2) flavor and basic tastes: earthy, sweet, sour, bitter and astringent (3) texture : earthy, pulp. Panelists used a scale from 0 to 7 for the evaluation, where 0 was low intensity, 4 was regular intensity, and 7 was extremely high intensity.

2.6. Statistical analysis

Statistical analyses were performed by Statistical Analyses System using a one-way analysis of variance ANOVA, and the significant difference between means was determined by Newman and Keul test. Differences at $P < 0.05$ were considered statistically significant.

3. Results

3.1. Pomological properties

Pomological descriptors of pomegranates have revealed significant differences (P<0.05) between the organic fruits and the conventional ones except in fresh weight, fruit diameter and juice yield. In fact, organic pomegranates were characterized by a smaller shape, a thicker peel and less arils than the conventional ones with the respective values (67,33 mm vs 72,00 mm; 4,60 mm vs 3,13 mm; 51,46% vs 59,41%). Whereas for juice yield and fresh weight, none the organic system neither the conventional one have affect these parameters.

3.2. Physico-chemical properties

Comparing the different physico-chemical parameters of conventional and organic pomegranate juices, significant differences (p< 0,005) were identified (Table 2). Juices were acidic especially in conventional pomegranates (3,8 vs 3,95). The total soluble solids content was significantly higher (p<0.001) in the conventional fruit juice compared to the organic one (16,17°Brix vs 12,83°Brix). As shown in table 2, titrable acidity of organic pomegranate juice was lower than this of the conventional one, which is the inverse for viscosity parameter. Chemical properties such as total reducing sugars, maturity index and antioxidant capacity were not affected by the two agricultural practices. Only the levels of anthocyanins and polyphenols were influenced by the farming systems. These two bioactive compounds were more concentrated in organic juice than in the conventional one respectively with the values 52,88 mg/100g vs 40,07 mg/100g of arils and 1259 mg GAE/ l vs 1089 mg GAE/ l juice.

Table 2: Physico-chemical parameters of organic and conventional pomegranates

Physico-chemical parameters	Organic pomegranates	Conventional pomegranates	Significance
pH	3,80± 0,02	3,95± 0,07	*
Total soluble solids (°Brix)	16,17± 0,15	12,83± 0,16	***
Titrable acidity (mg/100g)	0,60± 0,05	0,48± 0,02	**
Maturity index	26,5± 1,40	26,9± 0,60	NS
Dry juice matter (%)	28,93± 0,92	25,73± 0,70	**
Viscosity (Ps. a)	0,28± 0,02	0,14± 0,02	***
Total reducing sugars (g/100g)	15,56± 0,7	15,84± 0,3	NS
Total phenolics (mg GAE/ l)	1259,00± 41,02	1089,53± 20,10	***
Total anthocyanins (mg/100g)	52,88± 7,10	40,07± 4,80	*
Antioxidant activity (%)	33,33± 1,40	29,06± 2,02	NS

NS : not significant ; * P <0,05 ; *** P <0,001

3.3. Organoleptic and sensory profile

The evaluation of juice colour intensity has revealed significant differences (P<0.001) for the three colour indicators. In fact, organic pomegranates have marked a higher values in a*(18,29 vs 14,76), b* and L* indicators compared to the conventional ones. The organic juice was redder than the conventional one which was appreciated by panelists from organoleptic point. About the sensory profile, Organic and conventional pomegranate Juices did not exhibited a huge diffrence in their attributes. In fact,both of them were characterized by an intense fruity taste, an overall sweet flavour and an earthy aroma. The only remarkable criterias were in the astringent and acidic taste in the organic juice.

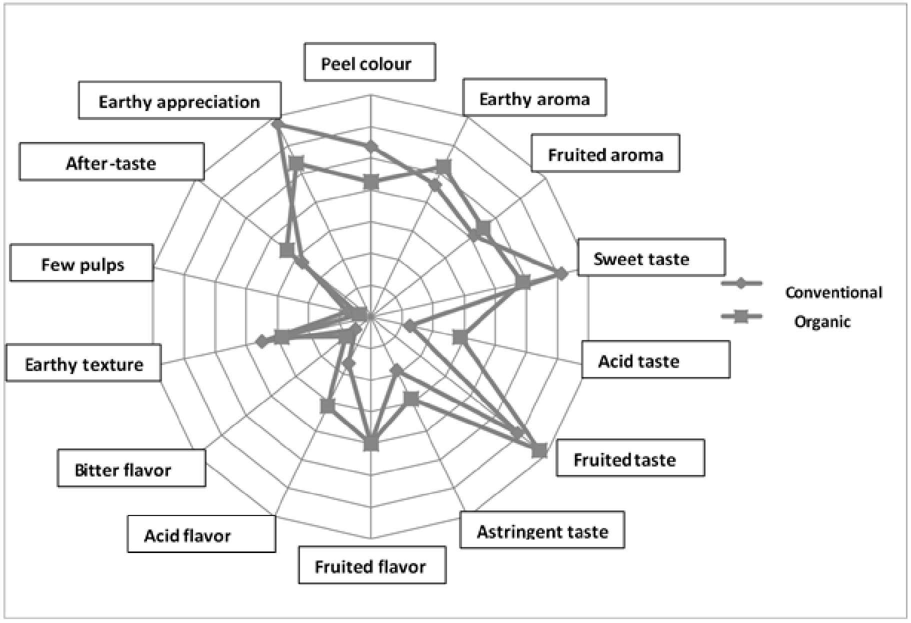

Figure 1: Descriptive Sensory Analysis by a trained panel of pomegranate peel and juices obtained from conventional and organic farming systems.

4. Discussion:

4.1. Effect of farming system on pomological and physico-chemical properties of pomegranates

The study of physical characteristics showed that organic pomegranates were smaller, thicker in peel and contained and less arils than the conventional ones, but this did not affect the juice content of pomegranates, which is a key factor for industrial juice production. Indeed, this characteristic indicates the higher resistance of fruits to dropping and to long distance transport and commercialization, which make it more suitable for export. These results are in accordance with the findings of Jalikop and Kumar's (1998) who proved that smaller pomegranates are juicier and have softer arils.

The quantity of arils in both types of "Gabsi" pomegranates ranged between 51,46% and 59,41% which are in the same range of values reported by Zouay et al., (2012) (56,7% and 57%). These results are quite similar to those indicated for the grown pomegranate varieties in Iran (Zarei et al., 2010). Dry matter percentages of pomegranate juices revealed that organic juice was more concentrated than the conventional one, so it indicates a higher nutritional density. This is in agreement with the results found by De Conti et al. (2014) who reported a higher percentage of dry matter in organic strawberries compared to conventional ones. In addition, the variety "Gabsi" has exhibited a higher content in dry matter if compared to Iranian cultivars that their dry matter didn't exceed 14,41%.

The content of total soluble solids (°Brix) has increased under the organic agricultural practices reaching the value of 16°Brix that is more or less required for food processing and get into the range of others cited pomegranate cultivars grown in Italy (Barone et al., 2001)

One of the main searched criteria in pomegranate fruits is their juice content which has accrossed in our case 63,5 % in organic fruits and 62% in conventional ones. This diffrence can make the organic pomegranate more advantageous in juice processing for food industry. Indeed, there were no significant diffrences in total reducing sugar between the two types of juices which which promotes more its processing. In addition, values of reducing sugar content in organic and conventional pomegranates were between 15.56 g / 100ml and 15.84 g / 100ml respectively. These averages are closer to those found by Basker (1992) who reported an equivalent sugar content in carrots, pineapples, tomatoes, mangoes and potatoes in relation to both organic and conventional agricultural practices.

Concerning juice pH, mean values were between 3,80 and 3,95 with a slight significant diffrence between the organic and the conventional pomegranates. These values are among the reported pH averages of 13 Tunisian pomegranate cultivars that ranged from 2,72 and 4, 24 (Zouay et al., 2012).

4.2. Effect of farming system on nutritional properties of pomegranates

Biochemical analysis of the content of bioactive compounds in pomegranate juices showed a significant effect of the farming system in polyphenols and anthocyanin contents but not in antioxidant activity. In fact, polyphenols were more presented in organic pomegranates than in conventional fruits. In the same context, Jin and el. (2011 indicated that organic strawberries, blueberries and tomato had higher levels of polyphenols than conventional ones. This property is so important in healthy diets even if it gives more astringent flavor to the fruit. The highest content of anthocyanins in organic pomegranates resulted in an intense red juice color compared to the conventional one. These results confirm those of Drogoudi et al. (2005) who suggest that fruits with the smallest and with a redder peel colour contain more anthocyanins.
From another nutritional aspect linked to antioxidants, farming systems didn't affect antioxidant capacity of pomegranates and this result was totally different from the reported results of Nuncio-Jauregui et al., (2015). This could be explained by the different response to each pomegranate variety to agricultural treatments and growth conditions.Effect of farming system on organoleptic properties and sensory profile of pomegranates
Juice color is always an important quality attribute that is targeted in food-industry. The reddness color of pomegranate juice is taken in account for commercial classification of the product in relation to its quality. The intensive red color that was obtained in organic juice has made it more appreciated by panelists.
For flavor, aroma and texture descriptors, Organic and conventional pomegranate Juices did not exhibited a huge diffrence in their attributes. In fact,both of them were characterized by an intense fruity taste, an overall sweet flavour and an earthy aroma. Organic juice were more astringent and acid in taste than the conventional one. This result was actually predictible since the organic pomegranates were richer in terms of polyphenols (Anderson et al., 2015).

5. Conclusion

This study revealed the effect of farming systems on the quality of pomegranates in pomological, physico-chemical and organoleptic properties. From one side, Organic farming system has improved several physical and nutritional characteristics of pomegranates. In fact, organic pomegranates seemed to be more resistant for shocks and more suitable for long distance transport due to its higher peel thickness and with the same juice yield as the conventional ones. For nutritional properties, the juice of organic pomegranates was richer in terms of bioactive compounds such as anthocyanin and polyphenols, and more appreciated with its intensive red colour by panellists. From another side, Conventional farming system has preserved the sweetest flavour and aroma of pomegranates and the same antioxidant level as the organic ones.

6. References

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