THE EXPERIMENTAL CONDITION INFLUENCE ON BIOACTIVE COMPOUNDS EXTRACTION IN FRESH AND PROCESSED TOMATOES

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RESEARCH ARTICLE

Abstract

Tomatoes are a widely consumed fruity vegetable presenting a lot of varieties which can be produced all year long in fields or greenhouses. At the same time, a lot of processed products are available, both domestic and industrially manufactured. The bioactive content of tomatoes such as phenols, anthocyanins, tannins, betalains, carotenoids represent an important contribution to human health by cardioprotective and hepatoprotectiven effects. The aim of this study is to assess the influence of different solvents and extraction conditions on the phenolic separation from fresh and processed tomatoes. Total phenolic (TPH) and flavonoids content (FL) from three tomato types and three tomatoes processed products were investigated. TPH was determined by Folin-Ciocalteu spectrophotometric method adapted for tomatoes and Fl by aluminum chloride spectrophotometric method. The used solvents were methanol or ethanol mixture 50:50 with water, meanwhile sonication, stirring and static extraction were the techniques used in this experiment. For fresh tomatoes phenols, the results emphasize the prevalence of sonication over stirring (max + 10.2%) and over static (max + 36.8%). Methanol based solvent ensures a better extraction then ethanol with a max rise of 26.9%. The flavonoids extraction diminishes only by using static conditions until 12.5%. Both solvent and extraction technique show a random influence referring to processed tomatoes products investigated in the present experiment.

Keywords: alcoholic extraction, phenols, sonication
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INTRODUCTION

Tomatoes (*Lycopersicon esculentum* Mill.) are a much demanded vegetable both in fresh and processed products all over the world due to its taste and high benefits for human health. (Walia et al., 2019)

The consumption of tomatoes also increased due to the possibility of production in green houses so they are available all year long and in different climate environments.

Tomatoes and tomato-based products account for over 85% of all the dietary sources of lycopene which is their main bioactive component (Pinela et al., 2016). Vitamins as vitamin C, βcarotene and phenolic compounds can be found also in tomatoes, tomatoes products and even tomatoes waste (Dos Santos Gomes et al, 2022, Savatović,et al., 2010).. The rich content of bioactives compounds lead to positive effect on health such are cardioprotection and hepatoprotection.

So that the assessment of those compounds is important and it is a subject of a lot of scientific researches. Analytical methods of antioxidants extraction and determination in vegetables were reviewed by Ignat et al, 2010, Garcia – Salas et al., 2010 and Gomez-Romero et al., 2007. In the same time different extraction techniques of extraction were investigated for tomatoes by Baltacıoğluet al., 2021), tomatoes products or tomatoes industrial waste by Sengkhamparn and Phonker, 2019, Perea-Domínguez, et al, 2018.

The aim of this study is to assess the influence of different extraction solvents and extraction conditions on the phenolic separation from different fresh and processed tomatoes.

MATERIAL AND METHOD

The tested materials comprise:

- Three tomato types: red cherry tomato (RC), yellow cherry tomato (YC) and autumn tomato (TA)
- Three tomatoes products: homemade tomato juice (HJ), commercial tomato juice (CJ) and tomato passata (P)

Experimental variants refer to used extraction solvents and to the specific extraction techniques applied in the present experiment, as follows.

The used extraction solvent were (A) methanol/water 1;1 (A variant) and ethanol/water 1;1 (B variant).

Extraction applied techniques were: (1) sonication, (2) magnetic stirring and (3) static.

Time and temperature were the same at all variants, respectively 30 minutes and 20^0C.

The specific solvents named bellow were used for the phenolic extraction in a 1:10 ratio for both Total Phenolic Content (TPH) and flavonoids (FL) determination, after an appropriate dilution. TPH was determined using Folin-Ciocâlteu spectrophotometric method developed by Singleton and Rossi (1965) and adapted for vegetables by Moigrădean et al, 2007. The reaction mixture contains the appropriate diluted extract, Folin-Ciocâlteu reagent and natrium carbonate 7.5%. After 2 hours the absorbance was read at 750 nm. Gallic acid, from 0.2 to 1.2 μM/mL was the used standard and results were expressed as mg GAE/100g FW.

FL was determined using the spectrophotometric method based on the formation of chelated compounds between flavonons, flavonols and aluminum chloride in basic environement (Kroyer and Molnar, 2011, Bahorun et al, 2004). The absorption of the reaction mixture containing ethanol extract, NaNO 25%, 3 $AlCl_3$ $6H_2O$ 10% and NaOH 1M was read at 510 nm against a reagent blank. The used standard was quercetin from 0 to 100 mg/L in methanol and results were expressed as mg QE/100g FW.

The results represent the mean of two determinations at each sample for all tested parameters.

RESULTS AND DISCUSSIONS

The samples codification from the figures observes the experimental variants as they were named in the previous paragraph.

The influence of the extraction condition is presented separately for fresh and processed tomatoes referring to the TPC content (Figure 1 and 3) and referring to flavonoids content (Figure 2 and 4).

As for fresh tomatoes, the differences between sonication and stirring are from 2.5% (YCA) to 10.2% (RCB), meanwhile sonication versus static are from 10.9% (YCA) to 36.8% (TAA). As for flavonoids, sonication and stirring lead practically to the same results, for all tested samples but with static extraction they came down until 12.5% for RCB.

For the tested processed products, sonication also shows the best results and the static one the lowest for TPH, in the same area of decline as fresh vegetables. The loss of content is from 3.5% to 12.2% for tomatoes juices but higher for passata, until 19.2%, Static extraction leads to a higher loss of TPH until 30.3% in PB.

The flavonoids content of tested products are similar, no matter the applied technique, with the exception of passata for which static extraction shows lower results, until – 12.7% (PA)

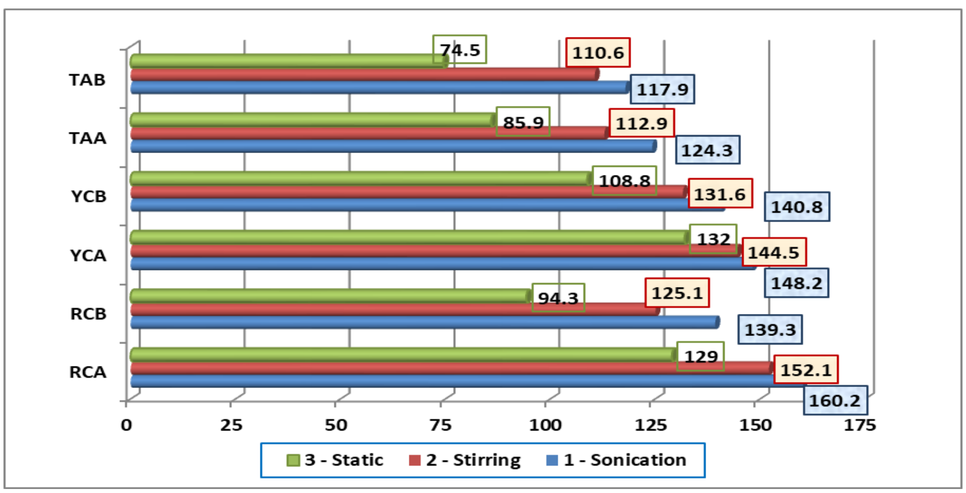

Figure 1 **– Extraction techniques influence on total phenol content, fresh tomatoes**

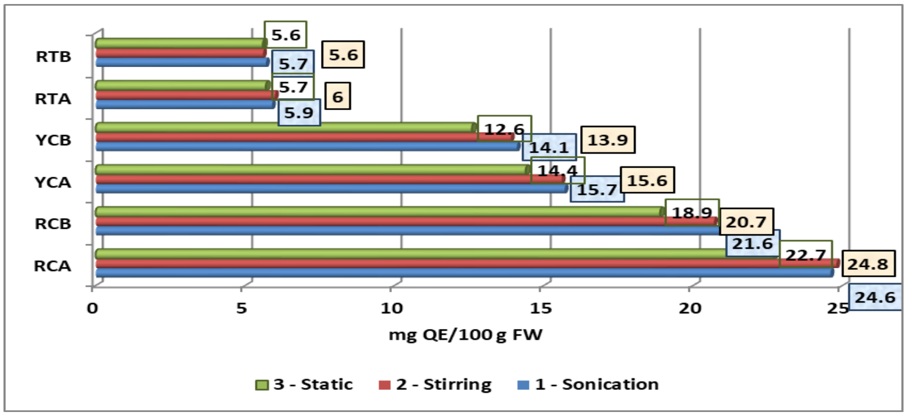

Figure 2 – Extraction techniques influence on flavonoids content, fresh tomatoes

Legend figure 1 and 2:
RCA – Red Cherry, A solvent; RCB – Red Cherry, B solvent
YCA – Yellow Cherry, A solvent; YCB – Yellow Cherry, B solvent
TAA – Autumn tomato, A solvent;T AB – Autumn tomato, B solvent

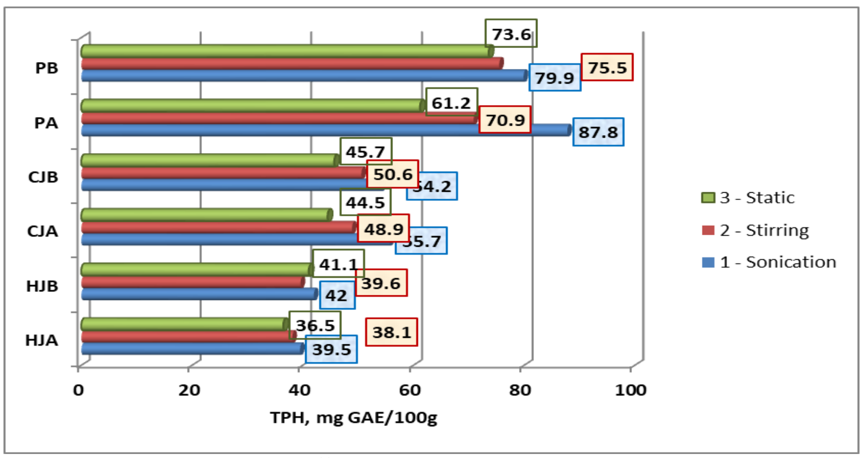

Figure 3 – Extraction condition effect on TPH content, processed tomatoes products

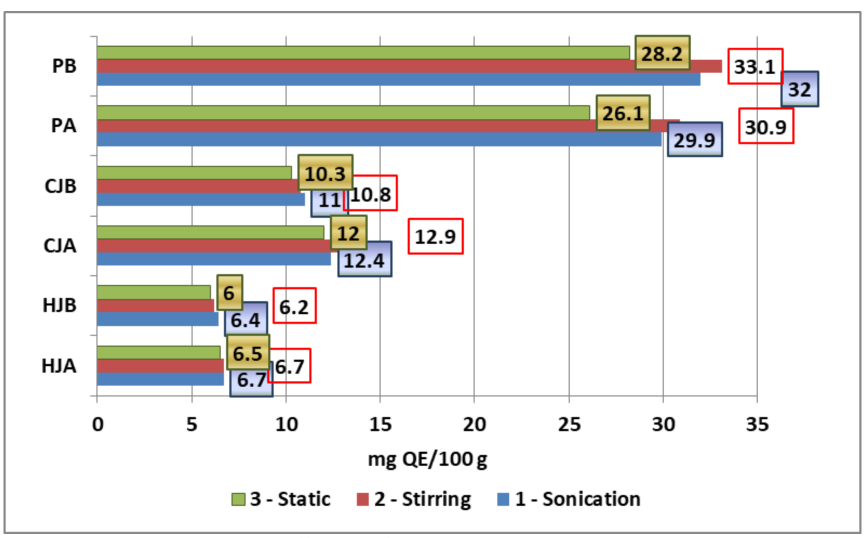

Figure 4 – Extraction condition effect on flavonoids content, processed tomatoes products

Legend figure 3 and 4:
HJA – Homemade tomato juice, A solvent; HJB – Homemade tomato juice, B solvent
CJA – Commercial tomato juice, A solvent; CJB – Commercial tomato juice, B solvent
PA – Tomato passata, A solvent; PB - Tomato passata, B solvent

The solvent influence on the phenols extraction is presented in Figure 5 and 6 for fresh tomatoes and in figure 7 and 8 for the processed tomatoes products.

The TPH content extracted with A solvent is higher than the one obtained with B solvent for all the samples, Red Cherry presenting the most significant differences, up to 26.9% (RC3), and Autumn tomatoes the lowest (-2% TA2). The extracts obtained in static conditions (RC3. YC3, TA3) are the most affected, no matter the tomatoes tested type.

The FL content is less influenced then TPH by the used solvent (figure 6), with a maximum loss of - 16.7% RC3. As for TA the results are quite identic for A and B solvent.

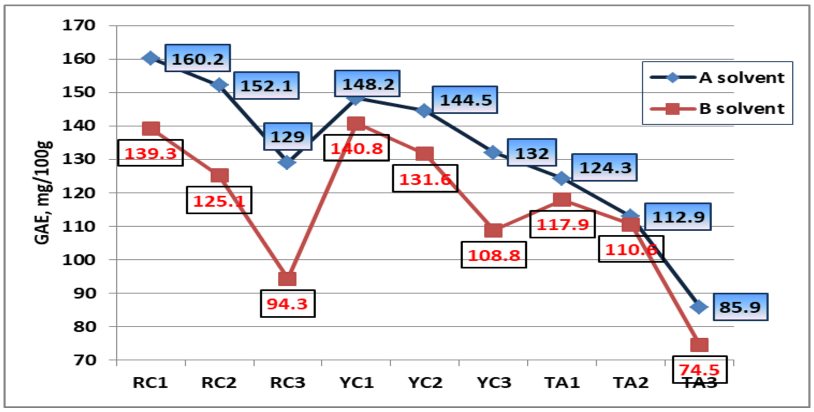

Figure 5 – Extraction solvent influence on TPH content of fresh tomatoes

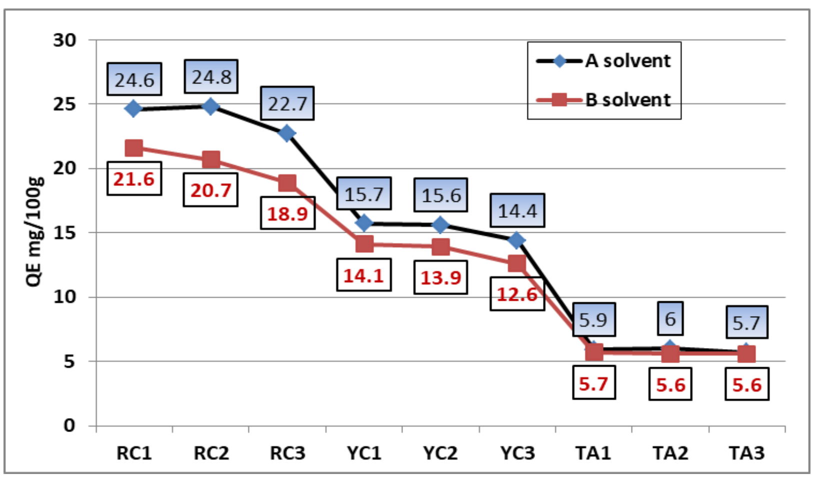

Figure 6 – Extraction solvent influence on flavonoids content of fresh tomatoes

Legend figure 5 and 6:
RC1 - Red Cherry, sonication; RC2 - Red Cherry, stirring; RC3 - Red Cherry, static
YC1 – Yellow Cherry, sonication; YC2 – Yellow Cherry, stirring; YC3 - Yellow Cherry, static
TA1 - Autumn tomato sonication; TA2 - Autumn tomato stirring; TA3 - Autumn tomato, static

The solvent effect on phenolic compounds extraction of the tested processed tomatoes products is aleatory for both investigated parameters. Moreover, neither of the used solvents ensures a better extraction for all tested products. In the case of TPH content (Figure 7) the disparities go from -9%(P1) to +20.6%(P2) as for flavonoids (Figure 8) from -25%(CJ3) to +8%(P3).

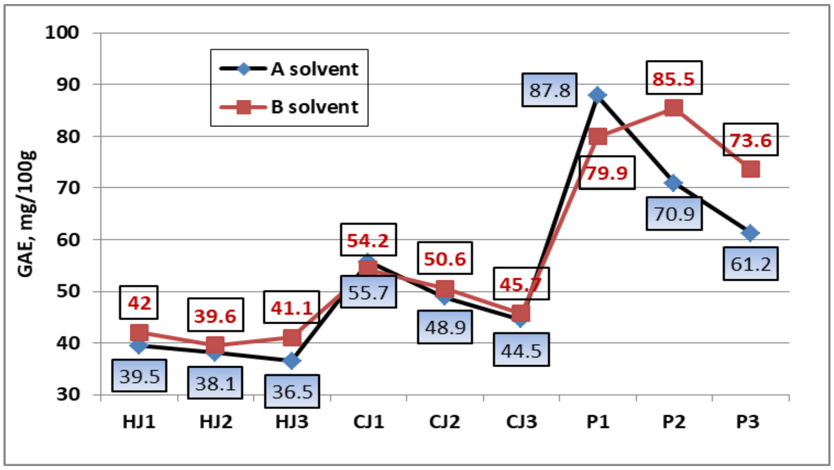

Figure 7 – Extraction solvent influence on TPC content of processed tomatoes

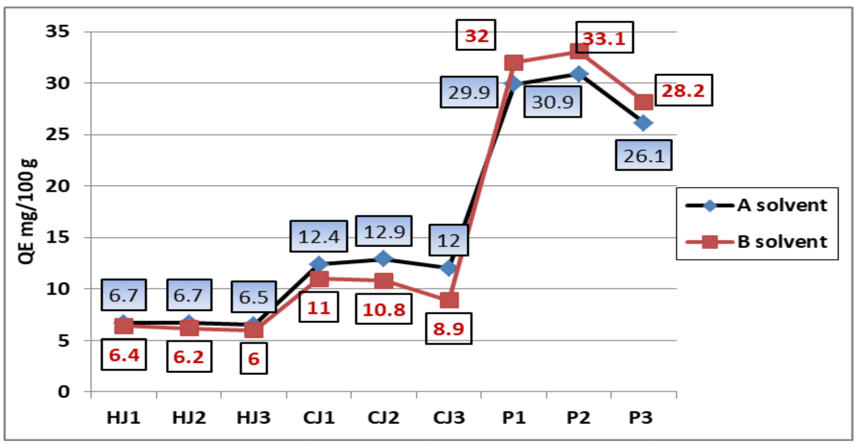

Figure 8 - Extraction solvent influence on flavonoids content of processed tomatoes

Legend figure 7 and 8:
HJ1 - Homemade tomato juice, sonication; HJ2 - Homemade tomato juice, stirring; HJ3 - Homemade tomato juice, static
CJ1 - Commercial tomato juice, sonication; CJ2 - Commercial tomato juice, stirring, CJ3 - Commercial tomato juice, static
P1 - Tomato passata sonication; P2 - Tomato passata stirring; P3 - Tomato passata, static

CONCLUSIONS

Regarding the influence of extraction techniques on the tested parameters we can note that on all tested samples sonication ensures the best results and static extraction the lowest. The loss of extracted compounds by stirring is plain regarding the TPH content, but for flavonoids the differences are not significant.

Referring to the influence of the used extraction solvents on tested parameters we can take notice of the fact that methanol/water mixture is more efficient than ethanol /water on all fresh products for both parameters. meanwhile for the processed products ethanol/water mixture extracted better TPH, but for flavonoids the influence depends on the type of tested parameter.

As a general conclusion, we can see that in order to make proper comparison between bioactive content of different types of tomatoes, it is mandatory to apply strictly the same protocol regarding the extraction technique and used extraction solvents. In the case of processed products, the influence is not relevant if refer to different products obtained by different procedures. Further experiments on the same product originate from the same technology could bring clarification on the matter.

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