EFFECT OF MICROWAVE TREATMENT AND TRADITIONAL PASTEURIZATION ON THE PROPERTIES OF FRUIT JUICES

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Abstract

During our research work, the main goal was to investigate the effects of microwave and traditional heat treatment, which was performed on fresh pressed apple and orange juice. Commercially available fruit-based drinks are always subjected to heat treatment for preservation purposes, but this process usually causes a loss of the valuable, heat-sensitive components of the fruit juice.

In addition to samples heat-treated at 80 and 90 °C, apple and orange juice samples treated at 700 W for 3 minutes were prepared, and their pH, refraction, colour, density, viscosity and total polyphenol content were examined during 6-month storage. Accordingly, to the results, the use of microwave (MW) treatment may be proposed as an alternative to traditional heat treatment in order to preserve the fruit juice quality.

Introduction

Apple and orange juice is one of the most popular beverages in Iraq as well as in the worldwide. During storage of these juices colour changes and gradually turns brown. However, it has been shown that the browning occurred in acidic fruit juices during storage was attributed mainly to nonenzymatic reactions [1; 2]. Commercial fruit juices have been traditionally heat-processed to destroy spoiling microorganisms and inactivate enzymes [3] Heat treatment often induces undesirable changes in the colour, flavour and nutritional value of the fruit juices [4] Furthermore, heat treatment can reduce organoleptic quality [5]. Researchers have emphasised the importance of optimising time/temperature profiles in order to minimise the exposure of food to heat. In order to mitigate the detrimental effects of heat treatments on food products, the food industry is calling for the development of alternative technologies capable of reducing the deteriorating impact at temperatures below those typically employed during thermal processing [6]. Consequently, non-thermal food treatment techniques are attracting significant interest due to their potential to reduce or even eliminate heat exposure. Fresh pressed fruit juices have emerged as a prominent candidate for non-thermal processing due to the degradation of its fresh flavour characteristics by the thermal processes currently employed for ready-to-drink products, such as pasteurisation. Electromagnetic heating, on the other hand, has been successfully used for the efficient pasteurization of fruit juices in the recent years [7; 8]. A number of studies have been conducted into the MW pasteurisation of fruit juices, which has been demonstrated to preserve the natural organoleptic characteristics of the juice while reducing the time of exposure to energy, thereby lowering the risk of losing essential thermolabile nutrients [7].

The aim of the present study is to examine the effect of MW treatment on the preservation of fresh pressed apple and orange juice in comparison with 80 and 90°C heat treatment.

Experimental

Apple (variety ‘Idared’) and orange (variety ‘Valencia’) were purchased from the local market. Juice was pressed using a laboratory pressing machine. Samples were then heat-treated in 200 ml bottles at 80 and 90 °C for 0.002-0.004 sterilization equivalents and microwaved at 700 watts (2450 Hz) for 3 minutes.

Determination of pH

Measurements were made with a TESTO 206-pH2 digital pH meter for each sample with three repetitions.

Water-soluble dry matter content (refraction) measurement

Determination of water soluable dry material content of the juices was performed by using a ATAGO DBX-55 refractometer, with three repetitions.

Colour measurements

Colour is a determining factor in the definition of the quality of any food. The colour of the samples were also measured with 3 parallels using a Konica Minolta CR400 chromameter. Results were expressed as L*, a*, and b* values. L* is a measure of the brightness from black (0) to white (100), while a* describes the redgreen color (a*> 0 indicates redness, a* < 0 indicates greenness), and b* describes yellow-blue color (b*> 0 indicates yellowness, b* < 0 indicates blueness). To determine the total color difference between two samples using all the three coordinates, the following formula was used: $\Delta E^* = \sqrt{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2}$

Density measurements

Density measurements were carried out by using DENDI-2 density meter.

Viscosity measurements

Measurements were performed with Physica MCR 51 (Anton Paar) rotary and oscillating viscometer with CC27 probe. RheoPlus software was used to record and evaluate the measurement results. The measurement profile was recorded by the software to increase the deformation rate from 500 1/s to 1200 1/s during the 90 second measurement time, while taking the measurement points every 5 seconds. Samples were tested at 20° C. From the flow curve, viscosity values (Pas) were determined.

Determination of total polyphenol content

Total phenolics were determined using the Folin–Ciocalteu colorimetric method as described by Singleton and Rossi (1965) [9]. The results were expressed in gallic acid equivalents (GAE, mg L^{-1} juice).

Results and discussion

The average water-soluble solid content of the tested juices is shown in Figure 1. The refraction % of orange juice in all three samples treated shows an increasing trend. The highest increase in water soluble solids was observed in the microwave-treated orange juice, from 11,07 % to 11,97 %. This sample had the highest refraction %, already at time 0. While the dry matter content of the other two samples decreased or stagnated, the microwaved sample was higher than the raw sample. At the end of the storage experiment, was measured the same for orange juice treated at 80 and 90 °C, 11 %. The refraction results of the apple juice samples also show that there was an increase in all cases compared to measurement time 0. As with the oranges, the microwaved apple juice had the highest dry matter content.

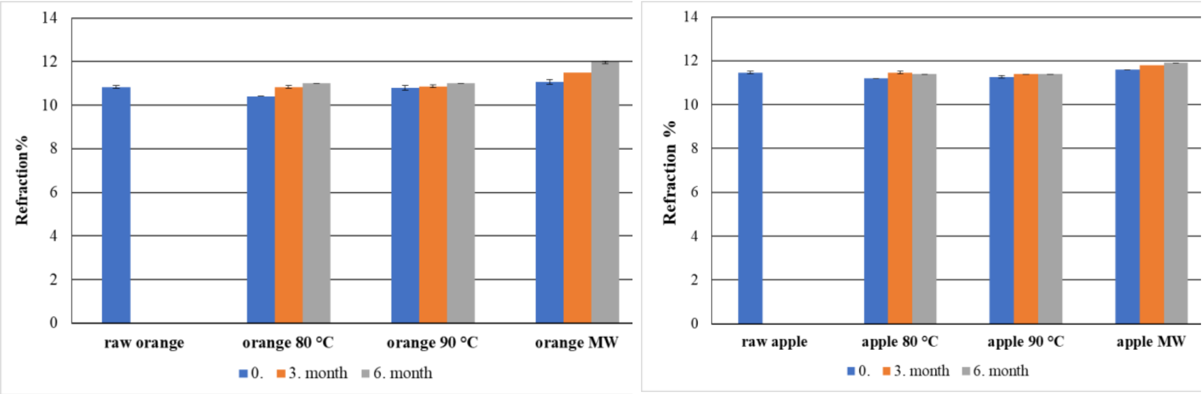

Figure 1. Water soluble dry matter content of orange and apple juices

The ΔE* values of the samples are shown in Figure 2. On the 0. day the samples were compare to the raw apple and orange juice, and after during the storage 3-month samples and 6 moths stored samples were compare to the 0. day (freshly produced) samples.
In case of orange juice, the smallest colour difference was shown by 80°C heat treated sample, and the largest by orange MW 6-month stored compared to the 0. day MW.
In case of apple juice, the smallest colour difference was shown by MW treated sample, and the largest by apple 80°heat treated compared to the 0. day raw apple juice.
The colour stimulus difference shows the extent of the visible difference between the colours of two tested samples: below 0.5 it is not noticeable; between 0.5 and 1.5 slightly noticeable; noticeable between 1.5 and 3.0; 3.0 to 6.0 clearly visible and in the case of a value above 6.0, we are talking about a great visibility [9].

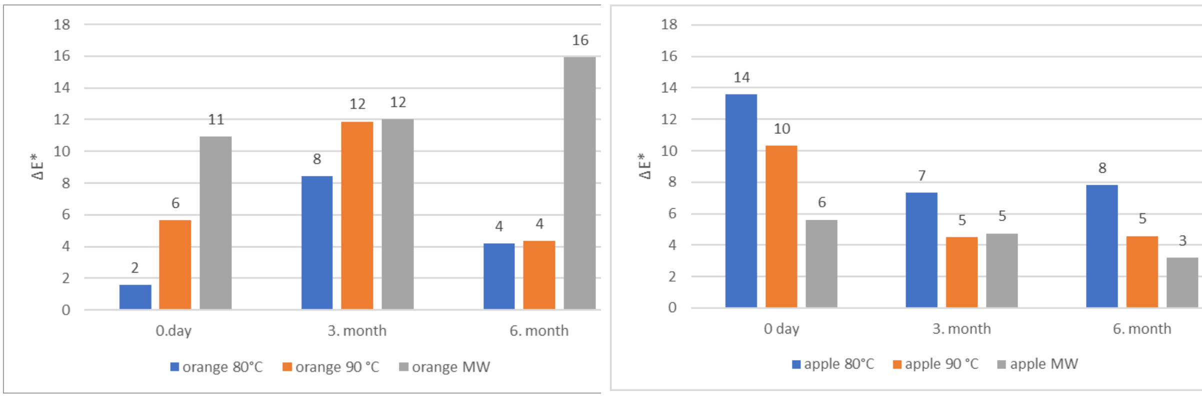

Figure 2. Inger color difference between the orange and apple juices

Rheology studies of pressed fruit juice samples were performed at 20° C. In each case, from the flow curves viscosity values were determined and the results are shown is Table 1.

Viscosity values (Pas)			
	0. day	3. month	6. month
raw orange juice	0,01	-	-
orange 80 °C	0.0107	0.0087	0.009
orange 90 °C	0.0103	0.0085	0.0087
orange MW	0.0104	0.0098	0.0092
raw apple juice	0.0083	-	-
apple 80°C	0.0089	0.0088	0.0085
apple 90 °C	0.0087	0.0085	0.0081
apple MW	0.0087	0.0086	0.0082

It can be seen, that at the 0. day, after the treatments, there were not differences between the samples, but during the storage, viscosities were decreasing a little bit.

The polyphenol content of the samples is shown in Figure 3. It can be seen, that after the treatments, and during the storage polyphenol content were decreasing continuously, especially in case of the apple juice. Unfortunately, in case of apple juice, microwave treatment had a negative effect, because the microwave-treated samples showed the greatest reduction in polyphenol content. Total polyphenol values in case of orange were between 151 mg GSE L^{-1} g and 198 mg GSE L^{-1} The lowest total polyphenol content was in case of the 6 month stored apple juices (56-63 mg GSE L^{-1}), which is significantly ($P<0.05$) difference compared to the other samples. In the case of apple juice,

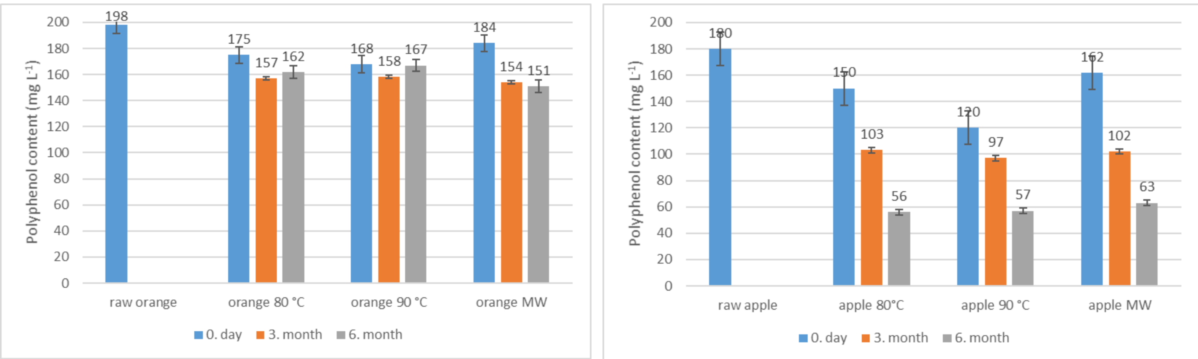

Figure 3. Total polyphenol content of the orange and apple juices

Conclusions

In all cases, heat preservation causes a loss of valuable materials, and it is important to choose the right temperature and treatment time to reduce this. This is why next to the microwave treatment, pasteurised samples at 80 and 90 °C were also prepared. The measured characteristics were compared with the raw sample without heat treatment and the juices subjected to the different methods were also compared with each other in terms of the characteristics tested. Based on the work, can be stated, that the microwave treatment showed very similar results, compare to the heat treatment in case of orange juice. Using MW process shas shown promising results for improving product quality and, particularly for shortening the treatment times.

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