CHANGES IN ANTIOXIDANT PROPERTIES OF FRUIT AND VEGETABLE CONCENTRATES UNDER THE EFFECT OF VACUUM DRYING

Anna Maria Nagy[1], Anett Veisz[2], Eva Stefanovits-Bányai[2]

[1]*Holi-Medic Ltd., H-1117 Budapest, Fehérvári Street 44, Hungary*
[2]*MATE* Institute of Food Science and Technology Department of Food Chemistry and *Analytics, H-1118 Budapest, Villány Street 29-43, Hungary,*
e-mail: holimedic@gmail.com

Abstract

During our experiment, we examined changes in the antioxidant capacity and total polyphenol content of 2 types of 65% vegetable juices (carrots, pumpkin) rich in polyphenols, minerals, and retinoids, as well as two kinds of fruit juice concentrates (lemons, oranges) rich in citrus flavonoids. In our studies, the antioxidant/reducing properties of the preparations were measured and compared using TEAC and FRAP methods.

Our various analytical measurements found significant differences between the antioxidant capacity values and total polyphenol content of each fruit-vegetable juice concentrate and the same instant powders prepared from them before and after vacuum drying.

Introduction

By regularly consuming vegetables and fruits rich in vitamins, minerals, polyphenols and antioxidants, the risk of developing civilisation diseases with the highest mortality rates can be significantly reduced [1,2,3,4.] as free radical reactions can be delayed or inhibited by antioxidants.

However, one of the biggest obstacles to this is that the population's consumption of vegetables and fruits is mostly non-regular, only occasional. This can be due to several everyday difficulties (e.g., regular purchase, storage, the time-consuming process of fresh fruit and vegetables, the lack of controlled quality fruits free of chemical residues, etc.). An excellent alternative to them is the regular consumption of instant powders from controlled cultivations produced by vacuum drying from fruit and vegetable concentrates while maintaining their beneficial organoleptic properties, retaining their high nutritional values for a long time so that their regular consumption can contribute to maintaining health.

Materials and methods

From the 65% vegetable juice and juice concentrates, GPS Powder Ltd. produced the fruit and vegetable instant powders with gentle vacuum drying. The samples used for our study were obtained from GPS Powder Ltd.

Fruit and vegetable instant powders were produced in the tray LMIM LP-405 vacuum oven with four parallel trays drying (by sensing temperature per tray), in a pressure range from 20 mbar to atmospheric pressure, at a temperature between 10°C and 40°C, with a short heating time of 240 minutes. The resulting solid was pulverised in a grinder and stored in a sealed polyethylene bag at a temperature below 20°C until measurements began. For analytical measurements, the 65% water concentrates were tested independently and prepared, if necessary, diluted with distilled water. We made an aqueous solution from the vacuum-dried powders, which was placed in a cooled ultrasonic water bath for 30 minutes, and then the samples were centrifuged at 13500 rpm. In all cases, the pure supernatant was used for the test.

Analytical methods

Determination of antioxidant capacities by TEAC (Trolox-equivalent antioxidant capacity) method: The total antioxidant capacity was measured with the Trolox-equivalent antioxidant capacity (TEAC) method described by Miller et al. (1993) [5.]. The method is based on ABTS+ free radical scavenging by antioxidants measured with a spectrophotometer. For the calibration Trolox (the hydrophilic analogue of vitamin E) was used.

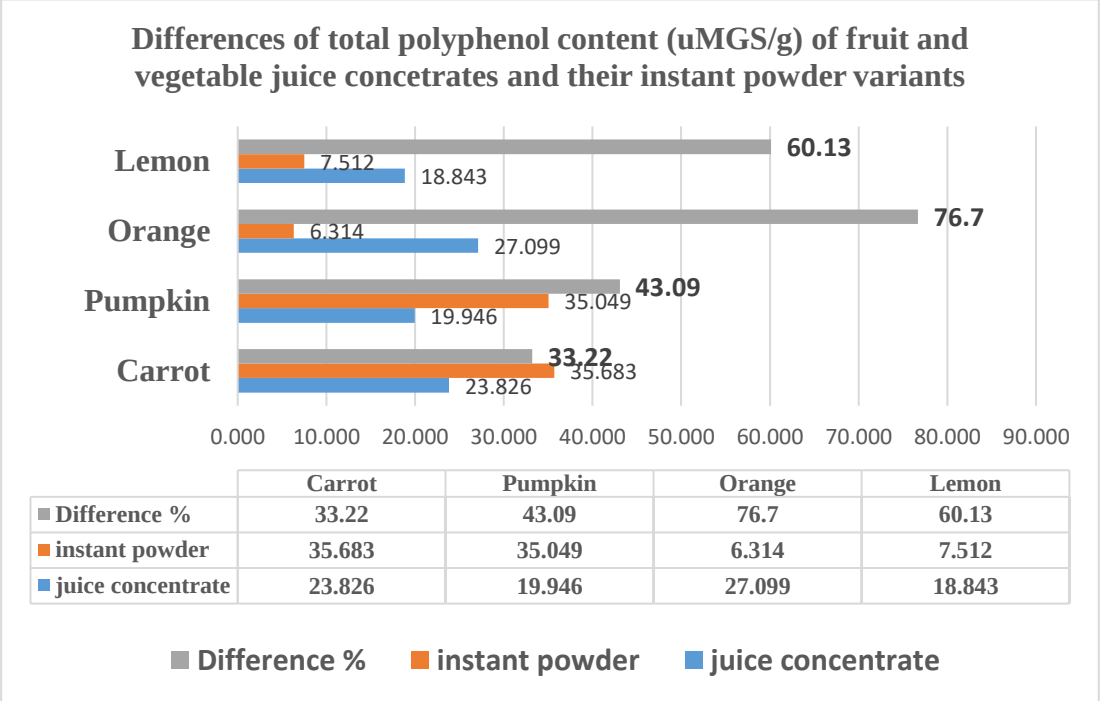
Determination of antioxidant capacities by FRAP (Ferric Reducing Antioxidant Power) method: Measurement of ferric reducing antioxidant power of the peel extracts was carried out based on Benzie and Strain's procedure [6.]**,** at 593 nm. Ascorbic acid (AA) was used as a standard to prepare the calibration solutions. Results were expressed as µMAA/g DM.

Determination of total phenolic contents (TPC) by Folin-Ciocalteu method: The Folin-Ciocalteu spectrophotometric method by Singleton and Rossi [7], at 760 nm is an electron transfer based on assay and shows the reducing capacity, which is expressed as phenolic content. Gallic acid (GA) was used to prepare the standard curve. The results were expressed as µM GA/g of dry matter (DM).

Results and discussion

I.) Total phenolic contents (TPC) measurement results

The analysis of the total polyphenol content of the four types of water concentrates and the instant powders, obtained from them by gentle vacuum drying, showed that ***vacuum drying*** resulted in a ***significant increase*** in the ***total polyphenol content*** of vegetable powders (carrot powder: 33.22%, pumpkin powder 43.09%), while ***citrus fruit*** powders ***decreased significantly*** (lemon powder 60.13%, orange powder 76.7%) (Fig.1).



	Carrot	Pumpkin	Orange	Lemon
Difference %	33.22	43.09	76.7	60.13
instant powder	35.683	35.049	6.314	7.512
juice concentrate	23.826	19.946	27.099	18.843

Figure 1. Total polyphenol content (uMGS/g) of fruit and vegetable juice concentrates and the differences between their instant powder variants.

II.) Measurement results of antioxidant capacity by TEAC and FRAP methods

Antioxidant capacity can be defined as the combined effect of all antioxidant compounds found in a system, for which more than one hundred methods have been developed [8]. All test methods have their advantages and disadvantages. Still, we cannot correctly model the

biochemical processes in the body with any of them, so it is of the utmost importance to draw conclusions about the sample examined not only based on one but several methods of analysis. Our test results showed that in the study of antioxidant capacity by the TEAC and FRAP methods of 65% juice concentrates, a significantly higher value could be measured in all juice concentrate samples using the TEAC method than with the FRAP method (Fig.2). Particularly significant for pumpkin juice, where the difference is 91.26% (Fig.2).

On the opposite, for instant powders made by vacuum drying, the antioxidant capacity values measured by the FRAP method were higher than by TEAC method. Only oranges are the exception, for which the difference is only 10.46% (Fig.3).

Comparing vegetable juice concentrates with fruit juice concentrates, we found that the TEAC method measured a higher antioxidant capacity in vegetable juice concentrates than fruit juice concentrates rich in citrus flavonoids. The highest antioxidant capacity was measured in the pumpkin (30.08), followed by carrot juice (26.37), followed by orange juice (24.72) and lemon juice (15,21 uMtrolox/g) with a more significant difference (Fig.2.).

At the same time, we saw the opposite results with the FRAP study: in fruit juice concentrates, the FRAP method measured higher antioxidant capacity values than vegetable juice concentrates: significantly the lowest value for pumpkin juice (2.62 uMAS/g). Lemon juice (11,76) and carrot juice (11,10) showed nearly identical values, with the highest FRAP measured for orange juice concentrate (14,72uMAS/g) (Fig.2).

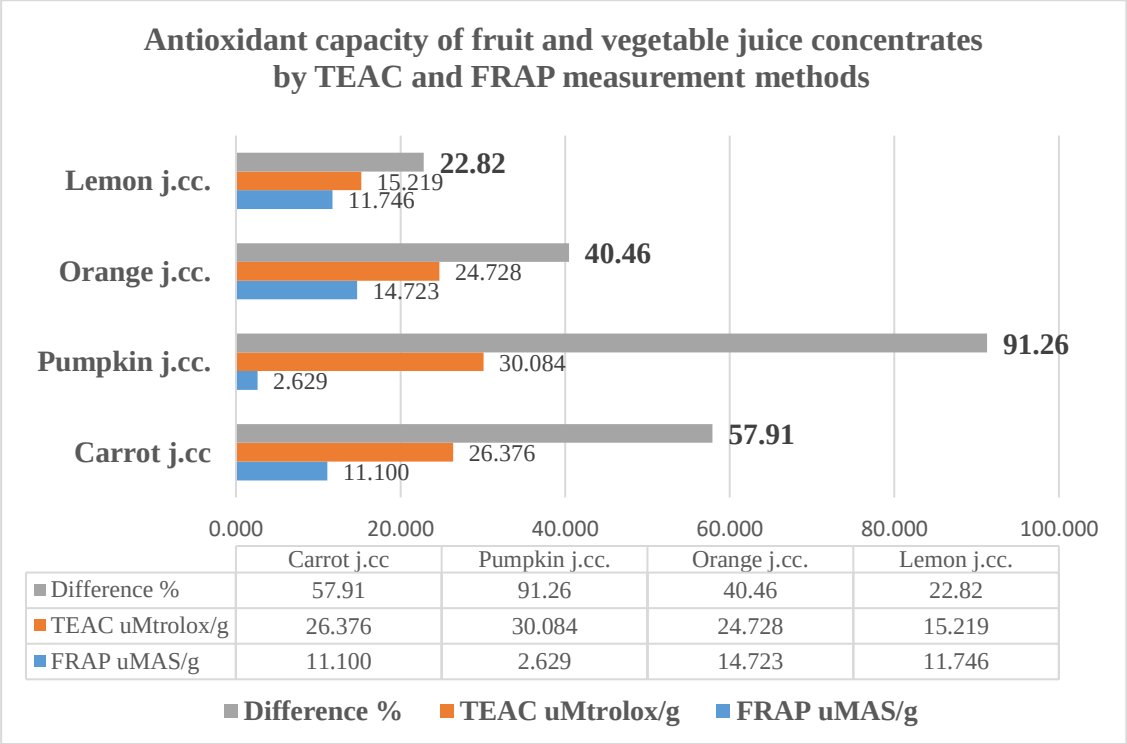
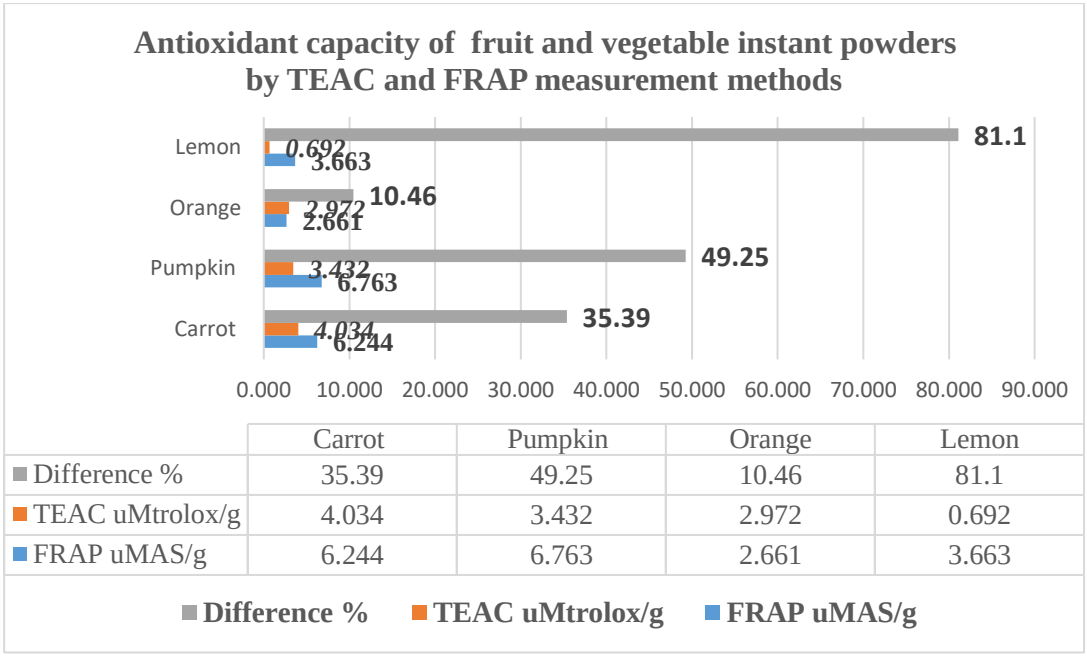


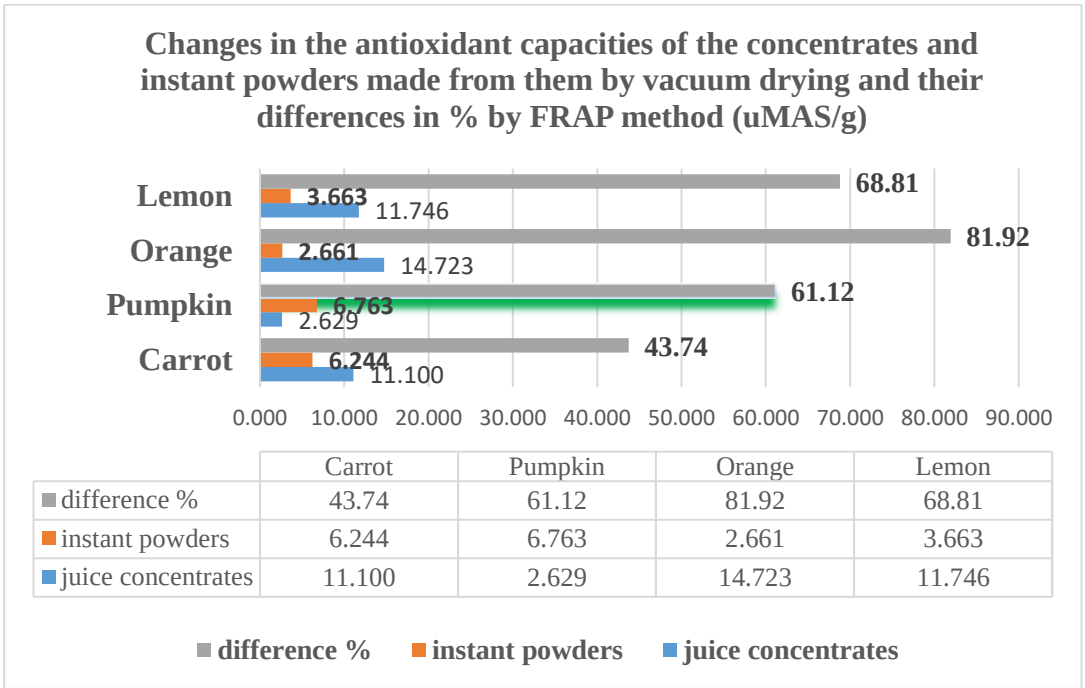
Figure 2. Antioxidant capacity of fruit and vegetable juice concentrates (j. cc.) by TEAC and FRAP measurement methods



	Carrot	Pumpkin	Orange	Lemon
Difference %	35.39	49.25	10.46	81.1
TEAC uMtrolox/g	4.034	3.432	2.972	0.692
FRAP uMAS/g	6.244	6.763	2.661	3.663

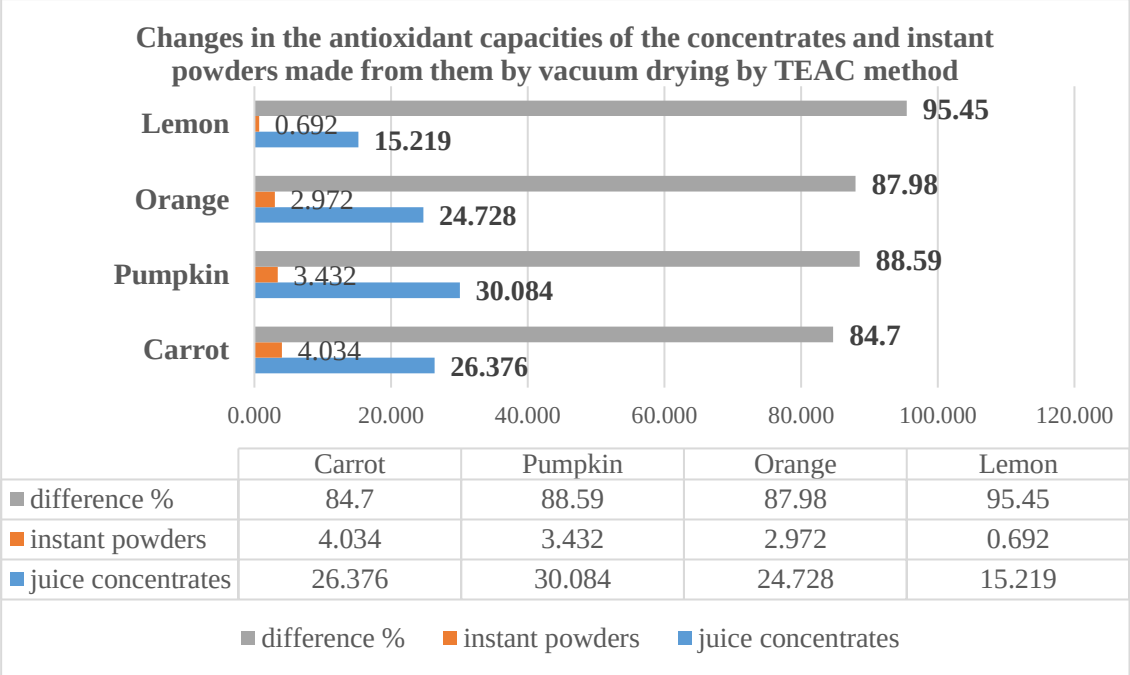
Figure 3. Antioxidant capacity of fruit and vegetable instant powders by TEAC and FRAP measurement methods.

Vacuum drying resulted in a significant reduction in antioxidant capacity in instant fruit and vegetable powders compared to the juices using both TEAC and FRAP methods, except in the case of pumpkin powder, where the antioxidant capacity measured by the FRAP method increased by 61.12 % (from 2,6 to 6,7 uMAS/g) (Fig.4-5).



	Carrot	Pumpkin	Orange	Lemon
difference %	43.74	61.12	81.92	68.81
instant powders	6.244	6.763	2.661	3.663
juice concentrates	11.100	2.629	14.723	11.746

Figure 4. Changes in the antioxidant capacities of the concentrates and instant powders made from them by vacuum drying and their differences in % by FRAP method (uMAS/g)



	Carrot	Pumpkin	Orange	Lemon
difference %	84.7	88.59	87.98	95.45
instant powders	4.034	3.432	2.972	0.692
juice concentrates	26.376	30.084	24.728	15.219

Figure 5. Changes in the antioxidant capacities of the concentrates and instant powders made from them by vacuum drying and their differences in % by TEAC method (uMTrolox/g).

Conclusion

Considering the wide-ranging and very beneficial physiological effects of polyphenols in our body, significant changes in all polyphenol content due to vacuum drying (increase in carrots powder and pumpkin powder and decrease in lemon powder and orange powder) can be important clues for food manufacturers and product developers in the development, production and use of each combined final product.

The importance of appropriately choosing antioxidant capacity testing methods is highlighted by the fact that in our various analysis studies (FRAP and TEAC), we found significant differences between the antioxidant capacity values of the same vegetable juice and fruit concentrates and the same instant powders**.**

Knowledge of the changes in total polyphenol content and the significant differences in antioxidant capacity under the effect of vacuum drying could determine which fruits and vegetables are the best suited for vacuum drying technology to preserve their content values.

References

[1] G. Block, B. Patterson, A. Subar, Nutr. Cancer Int. J. 18 (1992)1-29.
[2] H.C. Hung, K.J. Joshipura, R. Jiang, F. Hu, D. Hunter, S.A. Smith-Warner, G.A. Colditz, B. Rosner, D. Spiegelman, W.C. Willett, J. National Cancer Ins. 96 (2004) 1577-1584.
[3] V. Lobo, A. Patil, A. Phatak, N. Chandra, Pharmacog. Rev. 4 (2010) 118-126.
[4] S.H. Nile, S.W. Park, Nutr. 30 (2014) 2.134-144.
[5] N.J. Miller, C. Rice-Evans, M.J. Davies, V. Gopinathan, A. Milner, Clinic.Sci. 84 (1993) 407-412.
[6] I.F.F. Benzie, J.J. Strain, Anal.Biochem. 239 (1) (1996) 70-76.
[7] V.L. Singleton, J. A. Rossi, Am. J.Enol. Viticult. 16 (3) (1965) 144-158.
[8] U. Cornetti, Clinics Dermatol. 27 (2009) 175-194.