RELATIONSHIPS OF TOTAL POLYPHENOL CONTENT, ANTIOXIDANT CAPACITY AND ANTIBACTERIAL EFFECT IN FRUIT-VEGETABLE INSTANT POWDERS

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Abstract

Commercially available ***FlaViva Flavurin*** and ***FlaViva*** Vasgyúró instant drink powders produced by vacuum drying from vegetable and fruit juice concentrates, rich in flavonoids, polyphenols and other valuable components, was tested their ***total polyphenol content*** and ***antioxidant capacity*** by spectrophotometric method. In addition, the ***antibacterial effects*** of both products on strains of *bacteria Staphylococcus aureus, Pseudomonas aeruginosa*, and *Escherichia coli* were examined in vitro, by agar hole diffusion method.

Microbiological measurements have shown that *FlaViva FlavUrin* instant drink powder had a significantly higher antibacterial effect than *Vasgyúró for all three bacterias.*

An examination of the antioxidant capacity of the 2 food concentrates – measured by FRAP method – showed that the *antibacterial effect does not correlate with the iron content* of the products, as *the antioxidant capacity of the iron-rich Vasgyúró was 13.77 times higher than FlavUrin.*

The total polyphenol content of the 2 food concentrates did not differ significantly, so this factor alone could not have caused a significant antibacterial effect. Therefore we also measured the *TPC of each ingredients* in both products and we discovered highly *significant differences between them:* extremely high TPC values in rosehip powder and cranberry powder present only in FlavUrin, which may have contributed to the significantly higher antibacterial effect. The common ingredients of two food concentrates were elderberry-, blueberry- and blackcurrant powder. Since Vasgyúró also had a lower, but detectable antibacterial effect, these 3 components may have contributed to the antibacterial effects.

In addition to quantitative TPC differences between individual components, it is assumed that different varieties of qualitative individual components, as well as other bioactive components, may be responsible for the significant antibacterial effect and therefore their exploration requires further research.

Analytic and microbiological studies of functional food concentrates and the relationships between their results may draw attention to a number of health and therapeutic options and therefore require further research.

Introduction

It is a widely declared fact, the consumption of the right quantity and quality of fruits and vegetable is essential for a healthy life. At the same time, the inner values of different vegetables and fruits - and their consequent physiological effects - very significantly different from each other, that's why it is very important which one to choose for regular consumption.

The ingredients (cranberry, rosehips, elderberry, blueberry, blackcurrant, beetroot, sour cherry) of 2 complex food-concentrates (FlavUrin and Vasgyúró) we are investigating have very important internal values (carbohydrates, organic acids, minerals). In addition, the scavenger effect, which is their main health protection is due to flavonoids, vitamins and, in particular - secondary products of plant metabolism - their polyphenol components. Most of them also have a significant amount of anthocyanins [1-8] responsible for their beautiful color.

Many authors have confirmed that some fruits also have significant antimicrobial effects, which have been paralleled by their high polyphenol content. In some examples, a favorable antimicrobial effect was described for black currants [9], cranberries [10], elderberries [11] chokeberry [12], rosehips [13], beetroot [14], sour cherry [15] and blueberries [16].

Materials and methods

FlaViva FlavUrin and Vasgyúró instant fruit-powders produced by vacuum drying have been used for measurements (developed and marketed by Szanté Bt). The ingredients of FlavUrin are cranberry powder, rosehip powder, wild blueberry powder, black elderberry powder, blackcurrant powder. The ingredients of FlaViva Vasgyúró**:** blackcurrant powder, black elderberry powder, bio-beetroot powder, sour cherry powder, wild blueberry powder. (Figure 1).

Fig.1. FlaViva FlavUrin, Vasgyúró

Microbiological methods

The microba strains studied were *Staphylococcus aureus, Pseudomonas aeruginosa, Escherichia coli.*

Antimicrobial effect test by agar hole diffusion method: 50-50 μl samples were sampled in each of the holes in the culture medium containing TGE agar and evaluations were performed after 24 and 48 hours.

Analytical methods

Sample preparation for analytical tests: preparation of 25 mg/ml aqueous solution, 1 hour of UH exploration for 10000 rpm for 15 minutes, then working from the clear supernatant.

Determination of total phenolic contents (TPC) by Folin-Ciocalteu method: The Folin-Ciocalteu spectrophotometric method by Singleton and Rossi [17], at 760 nm is an electron transfer based 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 μMGA/g of powder.

Determination of antioxidant capacities by FRAP (Ferric Reducing Antioxidant Power) method: Measurement of ferric reducing antioxidant power of the fruit extracts was carried out based on the procedure of Benzie and Strain [18], at 593 nm. Ascorbic acid (AA) was used as a standard to prepare the calibration solutions. Results were expressed as μMAA/g of powder.

For microbiological and analytical measurements, all chemicals came from Sigma Aldrich Ltd.

Results and discussion

Agar hole diffusion test results

The largest and most complete inhibitory effect was observed *in staphylococcus* aureus and *escherichia coli* strains: the petri dish had a purification zone of 2 cm around the ***FlavUrin*** sample diffused into the agar gel***, indicating the degree of antibacterial inhibition,*** however, in the case of the Vasgyúró sample, the radius of the purification zone was only 1.5 cm, and the degree of antibacterial inhibition was only partial, because of the small number of bacteria developed within the zone (Table 1).

In *pseudomonas aeruginosa* strain, *the Vasgyúró* sample did not cause a purification zone. ***Similarly, FlavUrin*** was shown to have a purification zone with a ***radius of 2.5 cm, but***

in contrast to the above, the extent of this was only partial, so it inhibited the microbes completely only in the innermost part closest to the samples, but less and less at the edges of the purification zone, so there, in smaller numbers, bacteria had already developed (Table 1).

microbe strain	***FlavUrin*** **Purification zone (cm)**	***Vasgyúró*** **Purification zone (cm)**
Escherichia coli	2	1.5 (partial)
Staphylococcus aureus	2	1.5 (partial)
Pseudomonas aeruginosa	2.5 (partial)	-

Table 1. Agar hole diffusion test results

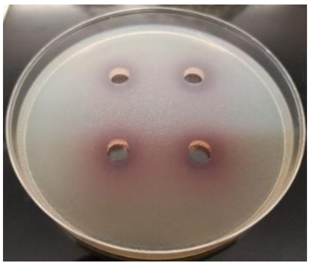

Figure 2. *E.coli* agar hole diffusion 48 hours (upper row: FlavUrin, lower row Vasgyúró)

Figure 3. *Staph. aureus* agar hole diffusion 48 hours (upper row: FlavUrin, lower row Vasgyúró)

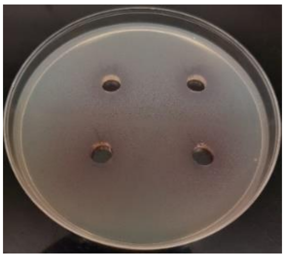

Figure 4. *P. aeruginosa* agar hole diffusion 48 hours (upper row: FlavUrin, lower row Vasgyúró)

Results of the analytical measurements

In determining the total polyphenol content ***(TPC)*** of *FlaViva FlavUrin* and *Vasgyúró* instant drink powders (Fig. 5) despite their different composition, similar results were measured: for *FlavUrin* we obtained values of 84.3 mMol and for *Vasgyúró* we obtained values for 77.9 mMol gallus acid from instant powders per gram.

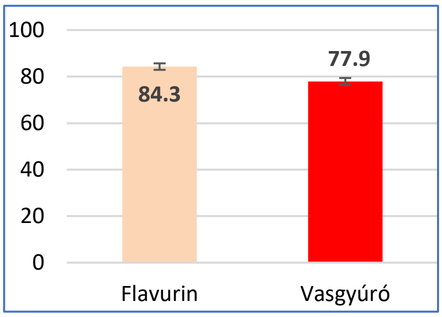

Figure 5*. Total polyphenol content of FlavUrin and Vasgyúró (µMGA/g)*

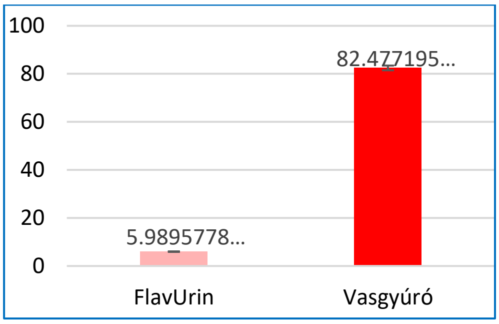

Figure 6*. Antioxidant capacity of FlavUrin and Vasgyúró by FRAP-method (µMAA/g)*

At the same time, the antioxidant capacity test (Fig. 6) measured by FRAP method demonstrated that ***Vasgyúró has 13.77 times more antioxidant capacity than FlavUrin***. Considering that the FRAP measurement method is based on the ability to reduce the iron content in the measured sample, this significant difference is due to the higher iron content of the components ***of the Vasgyúró.*** Since the antibacterial effects of Vasgyúró were significantly lower than FlavUrin, it can be concluded that ***the antibacterial effect is not due to the amount of iron in the ingredients.***

Significant differences were measured in the analysis of the total polyphenol content between the ingredients of two products (Fig.7). The common ingredients in both formulations were: elderberry powder, blueberry powder and blackcurrant powder (indicated in blue color in Fig.7). Since Vasgyúró also had a lower, but detectable antibacterial effect, these 3 components may have contributed to the antibacterial effects.

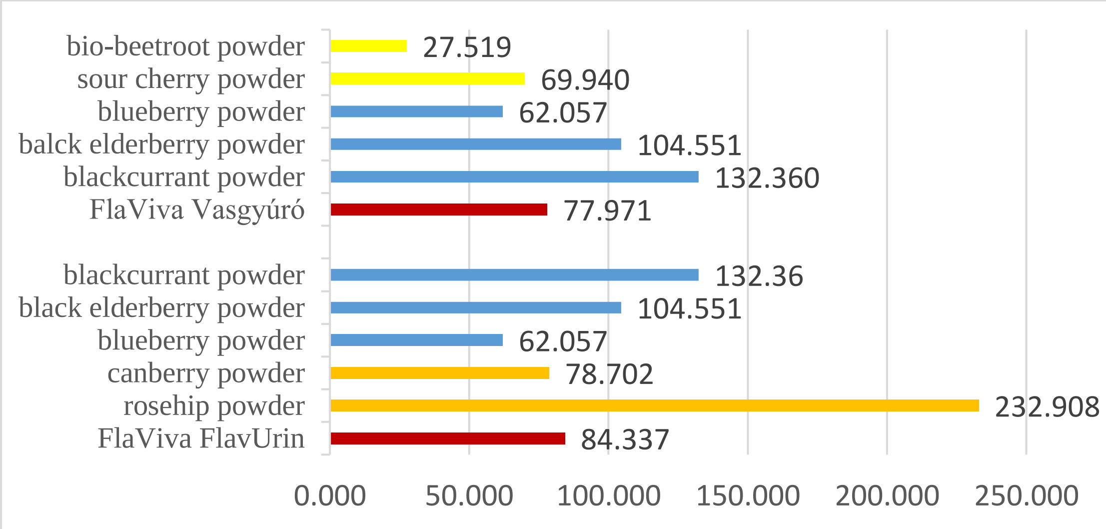

Figure 7. Total polyphenol content of FlaViva FlavUrin and Vasgyúró and their ingredients (uMGS/g)

Sour cherry powder and bio-beetroot powder are only present in the Vasgyúró, while rosehips powder and cranberry powder are exclusively present in the FlavUrin. The latter 2 ingredients have a significantly higher total polyphenol content (rosehips powder of 232.91 uMGS/g, cranberry powder 78.7 uMGS/g) compared to sour cherry powder in Vasgyúró (69.9 uMGS/g) and beetroot (27.5 uMGS/g) ***and therefore these significant differences in TPC may have contributed to a significantly higher antibacterial effect of FlavUrin.***

However, it should be highlighted that since the total polyphenol content (TPC) of the two products do not differ significantly (Fig.5), the antibacterial effect of FlavUrin is not only due to total polyphenol quantitative contents, but presumably also to their different kinds of components (so ***not quantitative, but qualitative differences***) and other bioactive components in its ingredients, the exact detection of which requires further investigations.

Conclusion

FlaViva FlavUrin and *Vasgyúró*, produced by vacuum drying, rich in flavonoids, polyphenols and other valuable components, have been subjected to analytic and microbiological investigations of commercially available products. In our studies, it was found that FlavUrin inhibited the growth of the 3 bacteria tested with significantly higher antibacterial effects *in vitro* (in agar hole diffusion) than Vasgyúró. In the analytic measurements, the antioxidant capacity test measured by FRAP-method gave the Vasgyúró a value more than 13 times higher, which arises from the higher iron content of its components. At the same time, this result also highlights that the antibacterial effect does not correlate with the iron content of food.

Since both products measured almost the same total polyphenol content (TPC, Fig 5.), FlavUrin's significantly higher antibacterial effect ***is not solely due to the quantitative amount of polyphenols***, but also to their ***qualitative different kinds of poliphenols***, and other bioactive components of the ingredients, therefore their accurate exploration requires further research.

Acknowledgements
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