Fructans and antioxidants in leaves of culinary herbs from Asteraceae and Amaryllidaceae families

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Abstract

Culinary herbs were known and applied from ancient times in food production and for culinary purposes, as flavor enhancers and food preservation, because of the bioactive substances with antimicrobial and antioxidant properties. Therefore, they can successfully use as sources of natural antioxidants that improve consumer health and the nutritional value of foodstuffs. The aim of the current study was to evaluate the fructan content and antioxidant activity in leaves of four culinary herbs: tarragon (Artemisia dracunculus L.), chives (Allium schoenoprasum L.), wild garlic or ramson (Allium ursinum L.) and samardala (Nectaroscordum siculum Lindl.) used in Bulgarian traditional cuisine. The content of total chlorophylls, total carotenoids, phenols, derivatives of caffeic acids (DCA), flavonoids and fructans in culinary herb extracts were analysed. The antioxidant activity of the water extracts was evaluated by two reliable methods (DPPH and FRAP). It was found that chives dry leaves contained the highest total chlorophylls (2255 μg/g dw). Total carotenoids and DCA were detected only in tarragon leaves, where, in addition, the total phenol content was the highest (25 mg GAE/g dw). It possessed the highest antioxidant potential probably due to the high polyphenolic content. However, the leaves of samardala showed the highest total flavonoids content (7.87 mg QE/g dw), while chives possessed the highest total fructans (5.66 g/100 g dw). This is the first report that evaluated chives, wild garlic and tarragon leaves as natural sources of prebiotics from fructan family, especially 1-kestose found in them. The current study demonstrated the antioxidant potential and prebiotics content in four culinary herbs used as spices in nutritional habitats of Bulgarian consumers.

1. Introduction

Nowadays medicinal plants attract consumer’s attention as a natural source of antioxidants (Petkova et al., 2017). Many of them are used in culinary practice for flavoring dishes and as antibacterial agents during food preservation. According to European Spice Association, culinary herbs and spices are the edible parts of plants that are traditionally added to foodstuffs for either their natural flavoring, aromatic and/or visual properties (ESA, 2018). Consumer information is a very important decision-making factor when purchasing, but there are not always, on the packaging.

Among the great variety of spices consumed and used in food processing except for savory, attention deserves some representatives from Amaryllidaceae family, genus Allium, as chives (Allium schoenoprasum L.), ramson (Allium ursinum L.) and samardala (Nectaroscordum siculum Lindl.). Nevertheless, the genus Allium contains an estimated 750 species (Mathew, 1996) comprising onions, scallion, garlic, spring garlic, and leek are members of the Amaryllidaceae family (Jovanovic-Malinovska et al., 2014). Several of the species or varieties (as garlic, elephant garlic, onions, spring onions, shallots, leeks, welsh onions and chives) are well-known edible plants (Phillips and Rix, 1998). Some other representatives, as ramsons and crow garlic, are not usually cultivated, but wild growing, with minor culinary role. The detailed characteristics of culinary and medicinal application of the leaves from some culinary herbs were listed (Table 1).

Chives (Allium schoenoprasum L.) derive from the cold regions of Europe and Asia and it presents as a plant with slim, dark green leaves and pale purple flowers, used dried or in a frozen state. Drying procedure considerably reduces the characteristic aroma (Kmiecik and Lisiewska, 1999), while freezing often affects
Table 1. Culinary and medicinal application of the leaves from investigated culinary herbs

| Common name                      | Family                  | Culinary purpose                                      | Medicinal Uses                                                                 |
|----------------------------------|-------------------------|-------------------------------------------------------|---------------------------------------------------------------------------------|
| Chives (Allium schoenoprasum L.) | Amaryllidaceae          | For culinary purposes as a flavoring herb, to garnish dishes | Stimulate digestion, treat anemia, to purify the blood, mild stimulant, diuretic, antiseptic properties, antioxidants, anti-inflammatory and antihypertensive (Haro et al., 2017). |
| Ramson (Allium ursinum L.)       | Amaryllidaceae          | Raw, pickled, salted or in brine with oil, in salads, soup, potatoes, cabbage, stewed vegetables, meat dishes (Piątkowska et al., 2015) or as an ingredient in a sauce, a substitute for pesto in lieu of basil. | Antioxidant, hunger-provoking agent, for intestinal problems, fungicidal and antibacterial properties (Blazewicz-Woźniak and Michowska, 2011; Tomšík et al., 2018) gastrointestinal tract or skin infections (Piątkowska et al., 2015). |
| Samardala (Nectaroscordum siculum Lindl.) | Amaryllidaceae | As a spice, in salads, sandwiches, roasted, fried, boiled potatoes, rice dishes, fried eggs, boiled meat, lamb, chicken, roasted mushrooms, cucumbers and tomatoes. Combines with cheese, spinach and nettle dishes. | For hypertension, anti-inflammatory properties help in various cardiovascular diseases, cancer and atherosclerosis, facilitates digestion and increases appetite. Helps against psoriasis and cough. Stimulates urination, cleanses the bladder and kidneys (Popova et al., 2014a, 2014b). |
| Tarragon (Artemisia dracunculus L.) | Asteraceae             | Chicken, fish, rice, meat and egg dishes. A flavouring component of Béarnaise sauce, in salads, soups, vegetables, pasta (Pripdeevech and Wongpornchai, 2004). Facilitates breathing, strengthens sleep and normalizes the acidity of gastric juice, strengthens appetite, for diseases of the blood and the cardiovascular system (Obolskiy et al., 2011). | |
Mariutti et al., 2018). French tarragon (also known as ‘German tarragon’) and Russian tarragon are the two main cultivars. French tarragon has a cool, sweet, liquorice-like aroma with slight bitter tones. Its taste is herbaceous, with anise- and basil-like notes, and it is considered to be more delicate than the Russian tarragon (Obolskyi et al., 2011). Tarragon is an important ingredient in sauces (as Hollandaise, Béarnaise and Tartar sauces), Dijon mustard, Montpellier butter and vinaigrettes (Pripdeevech and Wongpornchai, 2004). It was reported that essential oils, as well as acetone, chloroform, methanol and water extracts of tarragon, possessed well-pronounced antimicrobial activity. Ethanolic extracts of A. dracunculus possess anti-inflammatory, hepatoprotective activity. The analgesic effect of a French tarragon extract was reported (Obolskyi et al., 2011). Mariutti et al. (2018) established antioxidant activity of ethanolic extracts of dried tarragon by DPPH and ABTS methods. Moreover, Rajabian et al. (2017) determine the content of phenols, flavonoids and proanthocyanidins in methanol, dichloromethane, water, n-hexane, ethyl acetate and n-butanol extracts and their antioxidant activity, respectively. In addition, Abdel-Gawad et al. (2014) evaluated the total phenolic and flavonoid contents, as well as in vitro antioxidant activity, but in the defatted methanolic extracts of six Allium species, growing in Egypt. All these extracts were obtained by some solvents that are restricted for culinary purposes.

Despite the various investigations of different extracts of above mention culinary herbs information about inulin content, sugars and some pigments were absent or slightly studied. Moreover, for culinary purposes, water extracts are mainly used or the dried plant material, not acetone or non-polar solvents as hexane and ethyl acetate. Thus, the present study evaluates bioactive compounds in water extracts of selected culinary herbs.

The object of the current study was to evaluate the content of fructans and antioxidants in the leaves of commercially available four culinary herbs: tarragon (Artemisia dracunculus L.), chives (Allium schoenoprasum), ramson (Allium ursinum L.) and samardala (Nectaroscordum siculum L.) used in Bulgaria for culinary purposes.

2. Materials and methods

2.1 Reagents and standards

DPPH (1,1-diphenyl-2-picrylhydrazyl radical), TPTZ (2,4,6-tri-(2-pyridyl)-s-triazine), Trolox (6-hydroxy-2,5,7,8-tetramethylchroman-2-carboxylic acid), gallic acid, quercetin, Folin-Ciocalteu reagent, 1-kestose, nystose, sucrose, glucose, fructose and methanol were purchased from Sigma-Aldrich (Steinheim, Germany). All reagents were of analytical grade.

2.2 Plant materials

All culinary herbs used in this study are commercially available. They were purchased from local markets in Plovdiv. Chives were produced by Kotani. Ramson garlic has been obtained from Decrassin Ltd. (Bulgaria). Tarragon was produced by Bioset Ltd. Batch L1033 (Plovdiv). Samardala salt was consisted of dry samardala leaves mixed with salt and was produced by Mia Foods (Sofia). All culinary herbs were used as they were obtained.

2.3 Extracts preparation

Culinary herbs were extracted with distilled H2O in solid to liquid ratio 1:10 (w/v). The extraction procedure was performed in an ultrasonic bath (SIEL, Gabrovo, Bulgaria, 35 kHz and 300 W) for 20 mins, at 75°C. The obtained extracts were filtered, and the residues were extracted once again under the above mentioned conditions. The combined extracts were used for further analysis.

2.4 Total chlorophylls and carotenoids

Total chlorophylls and carotenoids were spectrophotometrically determined in 95% ethanol extracts at three wavelengths (664, 648 and 470 nm) and calculated according to Lichtenthaler and Wellburn (1983). The results were presented as μg/g dry weight (dw).

2.5 Total phenolic contents

Total phenolic content was measured using a Folin-Ciocalteu reagent. Briefly, 1 mL Folin-Ciocalteu reagent (diluted five times) was mixed with 0.2 mL culinary herb water extracts and 0.8 mL 7.5% Na2CO3. The reaction was performed for 20 mins at room temperature in darkness. The absorbance was measured at 765 nm against the blank, prepared with distilled water. The results were expressed as mg equivalent of gallic acid (GAE) per g dried weight (dw), according to Ivanov et al. (2014).

2.6 The total flavonoids content

The total flavonoids content was analysed by Al (NO3)3 reagent as previously described (Kivrak et al., 2009). After 40 mins the absorbance was measured at 415 nm against the blank. The results were presented as mg equivalents quercetin (QE) per g dry weight (dw) according to the calibration curve (Ivanov et al., 2014).
2.7 Total caffeic acid derivatives

The culinary herb water extracts (1 mL) were mixed with 2 mL 0.5 M HCl, 2 mL Arnow’s reagent, 2 mL NaOH (2.125 M) and 3 mL distilled water. The blank sample was prepared using all the reagents only without Arnow’s reagent. The absorbance was measured at 525 nm. Total dihydroxy cinnamic acid content (including caffeoyl derivatives) was presented as mg chlorogenic acid (CAE) per g dw (Fraisse et al., 2011).

2.8 The DPPH radical-scavenging ability

Culinary herb extract (0.15 mL) was mixed with 2.85 mL 0.1 mM solution of DPPH in methanol. The sample was incubated for 15 mins at 37°C. The reduction of absorbance was measured at 517 nm in the comparison to the blank containing methanol and % inhibition was calculated (Ivanov et al., 2014).

2.9 Ferric reducing antioxidant power (FRAP) assay

The assay was performed according to Benzie and Strain (1996) with slight modification. The FRAP reagent was freshly prepared by mixing 10 parts 0.3 M acetate buffer (pH 3.6), 1 part 10 mM 2,4,6-tripyridyl-s-triazine (TPTZ) in 40 mM HCl and 1 part 20 mM FeCl₃·6H₂O in distilled H₂O. FRAP (3.0 ml) reagent was mixed with 0.1 mL culinary herbs water extract. After 10 mins at 37°C in darkness, the absorbance was measured at 593 nm against blank prepared with water. Antioxidant activity was expressed as mM Trolox® equivalents (TE) per g dry weight (dw) (Ivanov et al., 2014).

2.10 Analysis of total fructans

The fructans content was determined spectrophotometrically by resorcinol-thiourea reagent. The hundred microliters water extract was mixed with 0.1 mL resorcinol (1% solution in 95% ethanol), 0.1 mL thiourea (0.1% ethanol solution), 0.8 mL 95% ethanol and 0.9 mL concentrated HCl, heated for 8 mins at 80°C, cooled at 25°C and filled with water until 10 mL. Then the absorbance was measured at 480 nm against a blank sample prepared with distilled water (Petkova et al., 2017).

2.11 HPLC-RID analysis of inulin and sugars

Chromatographic separations and determination of presented inulin and sugars were performed on an HPLC instrument Elite Chrome Hitachi (Japan), coupled with refractive index detector (RID) Chromaster 5450 operating at 35°C. The separation was done with mobile phase distilled H₂O on a column Shodex® Sugar SP0810 (300 mm × 8.0 mm i.d.) with Pb²⁺ and a guard column Shodex SP - G (5 μm, 6 × 50 mm) at 85°C, with a flow rate 1.0 mL/min and the injection volume 20 μL (Petkova et al., 2014).

2.12 Statistical analysis

All analyses were performed in triplicate (n = 3) and replicated at least twice. The results were calculated as mean values ± standard deviation using Excel (Microsoft Inc., USA).

3. Results and discussion

3.1 Total chlorophylls and carotenoids

In many cases, the quality of culinary herbs depends on the preservation of the green colour of dried herbs. Additionally, in leaves of plants, many carotenoids were also accumulated, and their amount is also important as compounds with antioxidant effect. However, there is very limited information in the literature regarding the content of carotenoids from commonly consumed herbs. Therefore, the content of natural pigments as carotenoids and chlorophylls is important to be evaluated.

The content of total chlorophylls and carotenoids were summarized (Table 2). From the obtained results chives leaves demonstrated the highest values of total chlorophylls 2255.5 μg/g dw. The content of total chlorophylls in leaves of culinary herbs lowered in the following order: chives>ramson>tarragon>samardala. In the current study, carotenoids were only found in tarragon leaves in minor amounts (9.4±1.1 μg/g dw). Moreover, chives leaves seem to be relatively abundant in pigments in comparison to other studied Allium plants. However, our reports for total chlorophylls in chives leaves were higher than 1.2 mg/g dw (Viña and Cerimele, 2009). Only, Egert and Tevini (2002) found higher total chlorophylls in chives leaves (6.7 mg/g dw). Moreover, this is the first study that evaluated the content of chlorophylls in commercially available samardala (Nectaroscordum siculum Lindl.) mixed with salt. The obtained results for chlorophyll (a) and chlorophyll (b) in ramsoms leaves were higher than the presented inulin and sugars were performed on an HPLC instrument Elite Chrome Hitachi (Japan), coupled with refractive index detector (RID) Chromaster 5450 operating at 35°C. The separation was done with mobile phase distilled H₂O on a column Shodex® Sugar SP0810 (300 mm × 8.0 mm i.d.) with Pb²⁺ and a guard column Shodex SP - G (5 μm, 6 × 50 mm) at 85°C, with a flow rate 1.0 mL/min and the injection volume 20 μL (Petkova et al., 2014).

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Table 2. Concentrations of total chlorophylls and total carotenoids in 95% ethanol extract from culinary herbs μg/g dw

| Sample                        | Chlorophyll (a) | Chlorophyll (b) | Chlorophyll (a+b) | Total carotenoids |
|-------------------------------|----------------|----------------|-------------------|------------------|
| Chives (Allium schoenoprasum L.) | 1043.5±0.5   | 1048.5±0.3     | 2255.5±0.5        | Not detected     |
| Ramson (Allium ursinum L.)    | 777.2±1.2     | 311.1±2.3      | 1088.3±1.2        | Not detected     |
| Samardala (Nectaroscordum siculum Lindl.) | 106.2±2.2  | 46.2±0.2       | 152.3±0.4         | Not detected     |
| Tarragon (Artemisia dracunculus L.) | 74.1±0.2    | 284.9±1.8      | 359.1±1.1         | 9.4±1.1          |

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reported values (Štajner et al., 2008; Manukyan et al., 2017). However, the content of carotenoids is too low to be detected, due to the sensitivity of the used method. In another study, Štajner and Varga (2003) reported higher than our results for natural pigment in ramson leaves (2.87±0.03 mg/g of chlorophyll (a), 1.35±0.01 mg/g of chlorophyll (b), and 9.99 ± 0.01 mg/g of carotenoids, respectively). In addition, detected total carotenoids in *Artemisia dracunculus* L. were lower than the report of Daly et al. (2010) who reported 11.1 mg/100 g of culinary herbs. These differences in comparison with our results could be explained with harvest time and storage conditions.

### 3.2 Total phenolic compounds

The values of total phenol, total flavonoids, caffeic acid derivatives, as well as antioxidant activity of culinary herbs were summarized (Table 3). The highest values of total phenolic content were found in tarragon leaves (25 mg GAE/g dw), followed by ramson leaves (16.91 mg GAE/g dw). Caffeic acid derivatives were detected only in tarragon leaves. Contrary to the lowest levels of total phenols (only 0.77 mg GAE/g) in samardala sample, only in them were detected the highest content of total flavonoids (7.87 mg QE/g dw).

Total phenols in chives leaves were higher than reports of Zheng and Wang (2001) (1.5 mg GAE/g fw). Some Bulgarian authors (Alexieva et al., 2013; Popova et al., 2014a, 2014b) reported that total phenolic contents in microwave extracts, infusions and decoction from samardala (0.20 to 0.6 mg GAE/g fresh weight and from 9.1 to 22.9 mg GAE/g dry leaves, respectively). However, they used pure leaves, not mixed with salt, as typically consumed as a culinary herb. Therefore, this explained the obtained by us result for total phenolic content in samardala (leaves, ground with salt) – 0.77 mg GAE/g dw.

However, our finding for Bulgarian ramson leaves was in agreement with Sapunjieva et al. (2012) - 16 mg GAE/g dw, close to some values of leaf extracts of *Allium ursinum* L. from Montenegro and Bosnia and Herzegovina – 1305.55 to 1833.33 mg GAE/100 g DW (Pejatović et al., 2017). Our results were higher than those reported by Piątkowska et al. (2015) Polish ramson and more than two times higher than average amounted to 713.7 mg/100 g dw of ramson leaves in three different ecotypes (Błażewicz-Woźniak and Michowska, 2011).

The total flavonoids content in ramson was 5.31 mg QE/g dw. Our results were close *Allium ursinum* L. to ecotype Gornje Lipovo (2.50 to 6.87 mg QE/g DW) (Piątkowska et al., 2015), higher than 3.24 mg/g dw reported by Djurdjević et al. (2004) and Błażewicz-Woźniak and Michowska (2011). However, in our water extracts DCA, expressed as caffeic acid equivalents were not found. In some reports, their content reached to 788.2 mg/100 g dw (Błażewicz-Woźniak and Michowska, 2011).

### 3.3 Antioxidant activity

The antioxidant activity of culinary herbs was evaluated by two methods (Shannon et al., 2018), based on different mechanisms (Table 3). The highest value of antioxidant activity was demonstrated by tarragon leaves 102.88±0.10 mM TE/g dw (DPPH assay) and 175.00±0.50 mM TE/g dw (FRAP assay). From *Allium* genus chives and ramson, two representatives showed close radical scavenging activity – 11.25 and 10.10 mM TE/g dw. The lowest antioxidant activity was evaluated for samardala leaves 2.19±0.20 mM TE/g dw (DPPH method) and 0.08±0.01 mM TE/g dw (FRAP assay). A more recent study found that extract of the leaves of *A. ursinum* L. had a strong antioxidant activity, especially due to the high content of flavonoids (Pejatović et al., 2017). Štajner et al. (2004) have found that leaves have the highest antioxidant activity in comparison with bulbs and stalks because of the high activity of enzymes related to the antioxidant system and the high levels of antioxidants. However, our DPPH antioxidant activity was higher than reported values from Bulgarian plants - 9.94 µg TE/g (Sapunjieva et al., 2012). Stanciu et al. (2017) also evaluated the total phenols and antioxidant capacity of ethanol extracts of dried tarragon. Our results for tarragon were higher than those of Rajabian et al. (2016) for water fraction total phenols (9.3 tannic acid equivalent) and total flavonoids - 1.6 QE/ g dw. However, our data were in accordance with Behbahani et al. (2017) - 24 mg GAE/g dw, but our total flavonoids were lower than 20 mg QE/g dw. In addition, our values for total phenols were higher in ramson and chives than reported values by Lenková et al. (2016).

### 3.4 Fructan and sugar composition

The carbohydrate composition of investigated culinary herbs was presented (Table 4). Most of the studies reported values for fructooligosaccharides and inulin in the bulb of *Allium* representatives (Van Loo et al., 1995; Jovanovic-Malinovska et al., 2014). It was found that carbohydrates in *Alliums* bulbs account for a major portion (from 65 to 80% of the dry weight). The main constituent of the non-structural carbohydrates is fructose, glucose, sucrose and a series of fructooligosaccharides (fructosyl polymers) with different degrees of polymerization (DP) in most of the cases around 12 (Benkeblia and Shiomi, 2006). A medium level of fructooligosaccharides in bulbs of scallion, onion, garlic, leek, spring garlic varied from 0.51±0.019 to 0.84±0.023 g/100 g dw (Jovanovic-
Malinovska et al., 2014). To the best of our knowledge, this is the first detailed study that evaluated the content of fructooligosaccharides and inulin in the leaves of these spices. Fructan content in chives (Allium schoenoprasum L.) leaves was mainly due to the presence of 1-kestose (3.86±0.25 g/100 dw). However, in ramson leaves (Allium ursinum L.) inulin, nystose and 1-kestose were detected, but their content did not high 0.60 g/100 dw. Inulin and 1-kestose were also detected in tarragon leaves. In general, fructose was found in all investigated culinary herbs, as its content in samardala and chives was higher than other herbs. Sucrose was found only in ramson leaves. Glucose was dominating sugar in chives, but absolutely absent in ramson. The detected content of 1-kestose as the main representatives from fructooligosaccharides in chives and ramson leaves was higher than reported values for fructooligosaccharides (DP 3-5) in Chinese chive and leek (0.1 to 0.9 mg/g fresh weight) (Benkeblia and Shiomi, 2006). Our values were comparable with fructooligosaccharides content for dry weight in Thai foods as leek and Chinese chive (Allium chinense G. Don) (Judprasong et al., 2011). In addition, Campbell et al. (1997) also detected 0.11 g/100 g fructooligosaccharides in Chinese chives. Judprasong et al. (2011) reported for the presence of fructooligosaccharides, fructose, glucose and sucrose in spice garlic, great-headed (Allium ampeloplasum Linn) 1.63, 0.15, 0.14 and 1.14 g/100 g, respectively. In the current study, sucrose was not detected in chives leaves. The levels of fructose and oligofructoses in leaves of other representatives of Allium, as onion drooping (Allium nutans L.) and wild leek or onion winning (Allium victorialis L.) reached 15.5 and 9.3% dw, while polyfructans in them were 2.2 and 1.8% dw, respectively (Bagaoutdinoiva et al., 2001). In our case, the content of fructose and fructooligosaccharides lowed in the following order chives>samardala>tarragon>ramson, as their sum did not exceed 7 g/100 g dw.

### 4. Conclusion

The current study evaluated the content of biologically active substances and antioxidant potential of some plants used in culinary purpose. From the investigated culinary herbs, tarragon demonstrated the highest antioxidant activity, followed by ramson. The highest levels of total carotenoids and caffeic acid derivatives were found only in tarragon leaves. Chives, ramson and tarragon leaves were evaluated as sources of prebiotics as 1-kestose, nystose and inulin. The current investigation enriches the information about these edible plants used in human nutrition and demonstrates their health beneficial properties.

### Conflict of Interest

The authors declare no conflict of interest.

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Table 3. Total phenolic content, total flavonoids, caffeic acid derivatives (DCA) and antioxidant activity

| Sample     | Total phenolic content, mg GAE/g dw | Total flavonoids, mg QE/g dw | DCA, mg CAE/g dw | Antioxidant activity, mM TE/g dw |
|------------|-------------------------------------|-----------------------------|-----------------|---------------------------------|
|            |                                     |                             |                 | DPPH                            |
| Chives     | 6.93 ±0.15                          | 0.98 ±0.15                  | Not detected    | 11.25 ±0.50                     |
| Ramson     | 16.91 ±0.5                          | 5.31 ±0.20                  | Not detected    | 10.10 ±0.10                     |
| Samardala  | 0.77 ±0.15                          | 7.87 ±0.20                  | Not detected    | 2.19 ±0.20                      |
| Tarragon   | 25.00 ±0.15                         | 6.46 ±0.15                  |                  | 102.88 ±0.10                    |

| Sample     | Total phenolic content, mg GAE/g dw | Total flavonoids, mg QE/g dw | DCA, mg CAE/g dw | Antioxidant activity, mM TE/g dw |
|------------|-------------------------------------|-----------------------------|-----------------|---------------------------------|
|            |                                     |                             |                 | FRAP                            |
| Chives     |                                     |                             |                 |                                 |
| Ramson     |                                     |                             |                 |                                 |
| Samardala  |                                     |                             |                 |                                 |
| Tarragon   |                                     |                             |                 |                                 |

Table 4. Total fructans, inulin and sugars content in culinary herbs, g/100 g dw

| Plant       | Total fructans | Inulin | Nystose | 1-Kestose | Sucrose | Glucose | Fructose |
|-------------|----------------|--------|---------|-----------|---------|---------|----------|
| Chives      | 5.66 ±0.05     | Traces | Absent  | 3.86 ±0.25| Absent  | Absent  | Absent   |
| Ramson      | 2.20 ±0.31     | 0.60 ±0.20| 0.35 ±0.11| 0.40 ±0.11| 0.70 ±0.20| Absent  | Absent   |
| Samardala   | 2.31 ±0.48     | Traces | Absent  | 0.98 ±0.05| Absent  | Absent  | Absent   |
| Tarragon    | 0.58 ±0.01     | 0.41 ±0.05| Absent  | 0.33 ±0.02| 0.94 ±0.10|         |          |
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