# Total Polyphenol, Flavonoid Content and Antiradical Activity of Celery, Dill, Parsley, Onion and Garlic Dried in Conventive and Microwave-Vacuum Dryers

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**Abstract.** Celery, dill, parsley, onion and garlic are good source of polyphenols. They have also other positive effects on human health. The aim of current research was to study and compare an antiradical activity, total polyphenol content (TPC) and total flavonoid content (TFC) of dried celery (*Apium graveolens*), dill (*Anethum graveolens*), parsley (*Petroselinum crispum*), onion (*Allium cepa*) and garlic (*Allium sativum*) using conventive and microwave-vacuum driers. Samples were harvested in Latvia in 2012 and gathered during degree of readiness and then dried, for celery, dill, parsley and onion steaming was used as pretreatment using microwave-vacuum dryer. Analysis of TPC and TFC were made in Latvia University of Agriculture, Faculty of Food Technology laboratories. The total polyphenol and flavonoid content was determined using spectrophotometric method. Antiradial activity was analyzed by the 2,2- diphenyl-1- picrilhydrazyl

The results of experiments demonstrate that the total polyphenol content in analysed samples ranged from 349.28 (garlic dried in microwave- vacuum dryer) to 1651.20 (parsley steamed for 1.5 min and dried in microwave-vacuum dryer) mg gallic acid equivalent (GAE) 100 g<sup>-1</sup> in dry weight. Total flavonoid content ranged from 8.90 (garlic dried in conventive dryer) to 352.99 (celery steamed for 3.0 min and dried in microwave- vacuum dryer) mg catechin equivalent (CE) 100 g<sup>-1</sup> in dry weight. The value of DPPH antiradical activity of samples ranged from 11.98 (parsley dried in conventive dryer) to 88.84 (celery steamed for 3.0 min and dried in microwave- vacuum dryer) %.

**Keywords:** Dried celery, Dill, Parsley, Onion, Garlic, Polyphenols, Flavonoids, Antiradical activity

### 1. Introduction

Polyphenols have been identified in higher plants and several hundred are found in edible plants. Phenolic compounds are classified into different groups as a function of the number of phenol rings that they contain and of the structural elements that bind these rings to one another [1]. They are secondary metabolites of plants, currently known more than 8000 phenolic structures ranging from simple molecules such as phenolic acids to highly polymerized substances such as tannins. Plant phenolics are generally involved in protection against ultraviolet radiation or aggression by pathogens, parasites and predators, as well as contributing to plants [2].

According to molecular structures, flavonoids are divided into six classes: flavones, flavanones, flavonols, isoflavones, anthocyanidins and flavanols (or catechins) [3]. In addition to free radical scavenging and antioxidant power, flavonoids have multiple biological activities, including vasodilatory, anticancirogenic, anti- inflammatory, antibacterial, immune- stimulating, antiallergenic, antiviral and estrogenic effects, as well as being inhibitors of several enzymes. However, the use of flavonoids in several domains is limited by their low stability and solubility in the fatty and aqueous phases [4]. Flavonoids

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behave as antioxidants by a variety of way including trapping of reactive oxygen species, inhibition of enzymes responsible for superoxide anion production, chelation of transition metals involved in process forming radicals and prevention of the peroxidation process by reducing alcoxyl and peroxyl radicals [5].

Environmental factors have major effect on polyphenol content. These factors may be soil type, sun exposure, rainfall or agronomic (culture in greenhouses or fields, biological culture, hydroponic culture etc). the degree of ripeness considerably affects the concentrations and proportions of the various polyphenols. Polyphenols are easily oxidized- oxidation reactions result in the formation of more or less polymerized substances, which lead to changes in the quality of food, particularly in colour and organoleptic characteristics [1].

Drying is the one of the storage methods, which has the capability of extending the consumption period of products, maintaining their nutrition content. Drying is the process of removing the moisture in the product up to certain threshold value by evaporation. In this way product can be stored for a long period [6]. The drying time using conventive drier can be shortened by using higher temperatures, but it entails higher costs and may cause biochemical changes that degrade the dried product quality, for example, lowering of the product quality [7].

One of the oldest methods for the preservation of food is drying, which consists in removing water from the product in order to provide microbiological safety and the most popular drying method includes convection. In this method the drying agent supplies heat to the material and remove moisture (in the form of water vapour) from the material at the same time. The method has the disadvantage of entailing a time-consuming process. In contact with oxygen that is present in the air, the product becomes exposed to high temperatures for a long time: such exposure reduces the content of some valuable components which readily undergo oxidation at elevated temperature. Other flaw of the convective method is the concomitant substantial shrinkage [8].

Drying with the microwave method under vacuum is a modern, efficient method of food preservation. During microwave-vacuum drying the energy of microwave is absorbed by water located in the whole volume of the material being dried. This makes a large vapour pressure in the centre of the material, allowing rapid transfer of moisture to the surrounding vacuum and preventing structural collapse. As a result, the rate of drying is considerably higher than in traditional methods of dehydration. The decisive factor enchancing drying rate is the wattage of microwaves. Using this method, the rapid process of dehydration creates a pourus texture food sample and stimulates obtaining a crispy and delicate texture, this way reducing the product's density as well as shrinkage [9].

The present study was undertaken to investigate the changes of total polyphenol, flavonoid content and antiradical activity in dill, celery, parsley, onion and garlic dried in conventive drier and without and with steaming process for samples dried in microwave-vacuum drier.

#### 2. Materials and Methods

## **2.1.** Sample Preparation and Drying Process

Samples were grown and obtained from farm in Zemgale region, Latvia during seasoning. Analysis were made in Latvia University of Agriculture, Faculty of Food Technology laboratories. Samples were washed, removed nonedible parts, peeled, cuted in equal pieces. For each drying process was used about 1.00 kg of sample. One part of samples was dried in traditional conventive dryer (Memmert, Modell 100- 800) at 45±1 °C. Before microwave- vacuum drying all samples were steamed using a steam cooker (Tefal, Vitamin+, Model VC4003) and after that the samples were rapidly cooled in cool tap water. Celery, dill, parsley were steamed for 1.5 and 3.0 min, onion for 1.5 min and garlic was not steamed. Steaming time was chosen based on samples hardness condition [10]. The samples were dried using microwave-vacuum dryer (OOO Ingredient, Russia) at 35±1 °C. The necessary amount of microwave energy was calculated using empirical formulas when the initial moisture of all samples are known and the finally was estimated (9±1%) [9].

# **2.2.** Polyphenol Extraction and Total Polyphenol Content

Dried sample (3 g) was grounded using electronic grinder and then extracted with 30 mL pure acetone for 1 h at 18±1 °C. The solution was filtrated; residue was soaked in 30 mL ethanol- water (1:1) mixture and extracted for 30 min at 18±1 °C. Solvent was filtrated and extracts were stored at 4 °C until further analysis. The extraction process was carried out in triplicate for each sample [11].

Total polyphenols were determined according to the Folin- Ciocalteu reagent method (Pande et al., 2010) with some modifications. To 500  $\mu$ L of extracted sample were added 2.5 mL of 0.2 N Folin- Ciocalteu reagent and 2.0 mL 7.5% sodium carbonate solution. The resuling solution was mixed and allowed to stand for 30 min at 18±1  $\,^{\circ}$ C in dark place. Absorbtion was read at 760 nm using JENWAY 630 Spectrophotometer. [12]. Quantification was based on the standart curve generated with 120 mg L-1 of gallic acid (y=10.161x + 0.0805; R2= 0.9986). Results were expressed as miligram gallic acid equivalent per 100 gram dry weight (mg GAE 100 g-1 DW).

#### 2.3. Total Flavonoid Content

Total flavonoid content was determined by Olivera (2008) with modificatons. To 500  $\mu$ L of extracted sample were added 2.0 mL destiled water and 150  $\mu$ L 5% NaNO2 and left to incubate for 5 min. After that was added 150  $\mu$ L 10% AlCl3 and incubate for 6 min. Then 1 mL 1 M NaOH and 1.2 mL destiled water was added. Solution was mixed and incubated at 18±1  $^{\circ}$ C in dark for 20 min. Absorbance was measured at 510 nm using JENWAY 630 Spectrophotometer. A standart curve was constructed based on a range of catechin concentrations (400 mg L-1 ) (y=0.0030x - 0.0362; R2=0.9980). Results were expressed as miligram catechin equivalent per 100 gram in dry weight (mg CE 100 g-1 DW) [13].

#### **2.4.** Determination of Antiradical Activity

The antiradical activity of extracts was determined on the radical scavenging ability in reacting with stable 2,2-diphenil-1-picrylhydrazyl (DPPH) free radical according to Afify (2012) with modifications. 4 mg of DPPH was disolved in 100 mL pure ethanol and 3.5 mL of this solution was added to 0.5 mL extract. This mixture was shaken and kept in dark at 18±1 °C for 30 min, absorbance was measured at 517 nm using JENWAY 630 Spectrophotometer. The radical percentage was calculated using the following equation:

% Antiradical activity= ((Ablank – Asample)/ Ablank) · 100

Where Ablank was the absorbance of the control reaction (full reaction, without analyzed sample extract) and Asample was the absorbance of the analyzed samples [14].

## 2.5. Statistical Analysis

All analysis was triplicated and results of total polyphenol, flavonoid content and antiradical activity are presented as a mean value  $\pm$  standart deviation (SD) and analyzed using Microsoft Office 2007 software. Statistically significant differences between drying methods and steaming times were calculated at the level of confidence  $\alpha$ =0.05. In order to find out if the differences in mean values estimated were statistically significant, the one- way analysis of variance was applied.

#### 3. Results and Discussion

In the present experiment it was detected, that total polyphenol content in samples ranges from 272.28 (garlic dried in microwave- vacuum dryer) to 1812.81 (parsley steamed for 1.5 min and dried in microwave-vacuum dryer) mg GAE 100 g-1 in dry weight. The higher content was obtained using conventive drying for all samples comparing with microwave- vacuum drying (Fig. 1).

Using steaming as pretreatment, polyphenol content in samples increases by 1.68 to 2.85 times. The highest content was obtained in steamed parsley, lowest content was determined in garlic samples. According to V.Perla steaming for 15 min of developmentally young potatoes increase in recoverable amounts of the total phenolics, chlorogenic acids, rutin, kaempferol-rutinose and vitamin C, and steaming suggests The Maillard reaction [15].

Fruits and vegetables, as well as spices are an essential part of human diet, partly because of their content in natural antioxidants, mostly flavonoids, which may play a beneficial role in the maintenance of normal physiological functions [16].

Total flavonoid content in samples ranges from 8.90 (garlic dried in conventive dryer) to 352.99 (celery steamed for 3.0 min and dried in microwave- vacuum dryer) mg CE 100 g-1 in dry weight (Fig.2.).

Using steaming as pretreatment, flavonoid content in analyzed samples increases by 0.70 to 3.70 times. Significant differences in concentration depend on exposure to sunlight and heat also. A large part of

flavonoids exist as dimers, oligomers and contain C- glycosides. During the industrial processing, heat results the hydrolysis of glycosides and releases flavonoid monomers [1]. Heat increases chemical extraction in samples and may be induced by the steaming, microwave- vacuum drying process too [13].

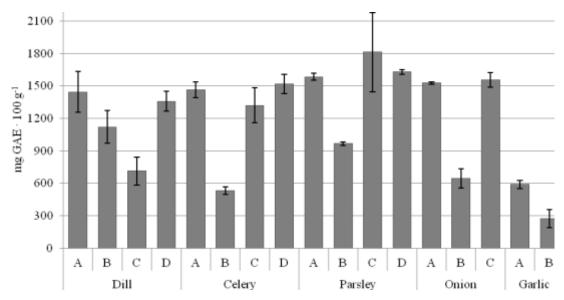


Fig. 1: Total polyphenol (TPC) content in selected samples

(A-conventive drying; B- microwave-vacuum drying; C- steaming 1.5 min and dried in microwave-vacuum dryer; D-steaming 3.0 min and dried in microwave-vacuum dryer)

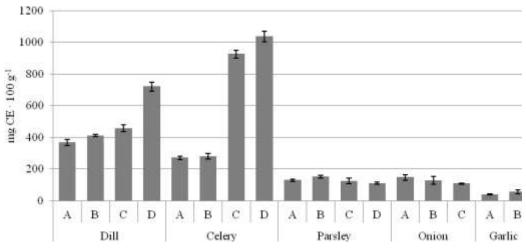


Fig. 2: Total flavonoid (TFC) content in selected samples

(A-conventive drying; B- microwave-vacuum drying; C- steaming 1.5 min and dried in microwave-vacuum dryer; D-steaming 3.0 min and dried in microwave-vacuum dryer)

Stable organic radical DPPH has been used widely for determination of antiradical activity for all kind of products. For evaluation of antiradical activity of selected samples, all extracts were measured and compared with their DPPH radical scavenging activities. The values of DPPH scavenging activity in dill, celery, parsley, onion and garlic ranges from 11.98 (parsley dried in conventive dryer) to 88.84 (celery steamed for 3.0 min and dried in microwave- vacuum dryer) percentes (Fig.3).

The highest antiradical activity celery, steaming process increase their antiradical activity and it is closely related with increased flavonoid content. According to Olivera (2008) boiling (5 min), microwave cooking and steaming over boiling water induced significant increases in total antiradical activity on green vegetables.

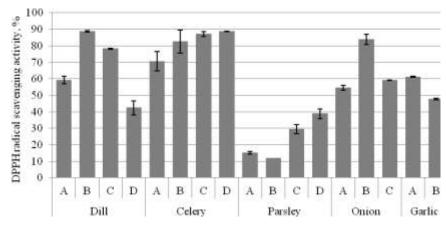


Fig. 3: DPPH antiradical activity in samples

(A-conventive drying; B- microwave- vacuum drying; C- steaming 1.5 min and dried in microwave-vacuum dryer; D- steaming 3.0 min and dried in microwave-vacuum dryer)

#### 4. Conclusions

Higher total polyphenol content was reached using conventive drying in all samples, higher total flavonoid content was reached using microwave-vacuum drying on dill and celery. Using steaming before microwave-vacuum drying, polyphenol content increases by 1.68 to 2.85 times, total flavonoid content increases from 0.72 to 3.70 times. Steaming had positive effect on total polyphenol in all samples, negative effect on total flavonoid content had in parsley and onion. Steaming process and microwave-vacuum drying has positive effect on antiradical activity and may be considered as useful tool in improving nutritional and phytochemical properties of spices and vegetables.

#### 5. References

- [1] Manach C., Scalbert A., Morand C., Remesy C., Jimenez L. Polyphenols: food sources and bioavailability. *American Journal of Clinical Nutrition*, 2004, 79 (5), pp. 727-747.
- [2] Dai J., Mumper R.J. Plant phenolics: extraction, analysis and their antioxidant and anticancer properties. *Molecules*, 2010, 15, pp.7313-7352.
- [3] Tripoli E., La Guardia M., Giammanco S., Di Majo D., Giammanco M. Citrus flavonoids: molecular structure, biological activity and nutritional properties: a review. *Food Chemistry*, 2007, 104, pp. 466-479
- [4] Chebil L., Humeau C., Falcimaigne A., Engasser J.M., Ghoul M. Enzymatic acylation of flavonoids. *Processs Biochemistry*, 2006, 41, pp. 2237-2251.
- [5] Biesaga M. Influence of extraction methods on stability of flavonoids. *Journal of Chromatography A*, 2011, 1218, pp.2502-2512.
- [6] Alibas I. Microwave, air and combined microwave- air- drying parameters of pumpkin slices. *LWT- Food Science and Technology*, 2007, 40, pp.1445- 1451
- [7] Figiel A. Drying kinetics and quality of vacuum- microwave dehydrated garlic cloves and slices. *Journal of Food Engineering*, 2009, 94, pp.98- 104.
- [8] Nawirska A., Figiel A., Kucharska A.Z., Sokol-Letowska A., Biesiada A. Drying kinetics and quality parameters of pumpkin slices dehydrated using different methods. *Journal of Food Engineering*, 2009, 94, pp. 14- 20.
- [9] Rakcejeva T., Galoburda R., Cude L., Strautniece E. Use of dried pumpkins in wheat bread production. *Procedia Food Science*, 2011, 1, pp. 441- 447.
- [10] Turkmen N., Sari F., Velioglu S. The effect of cooking methods on total phenolics and antioxidant activity of selected green vegetables. *Food chemistry*, 2005, 93, pp. 713-718.
- [11] Sulaiman S.F., Sajak A.A.B, Ooi K.L. Effect of solvents in extracting polyphenols and antioxidants of selected raw vegetables. *Journal of Food Composition and analysis*, 2011, 24, pp. 506-515.
- [12] Pande G., Akoh C.C. Organic acids, antioxidant capacity, phenolic content and lipid characterisation of Georgia-grown underutilized fruit crops. *Food Chemistry*, 2010, 120, pp.1067-1075.

- [13] Olivera F.D., Vina S.Z., Marani C.M., Ferreyra R.M., Mugridge A., Chaves A.R, Mascheroni R.H. Effect of blanching on the quality of Brussels sprouts (*Brassica olearacea* L. *gemmifera DC*) after frozen storage. *Journal of Food Engineering*, 2008, 84, pp. 148-155.
- [14] Afify A.E., El-Beltagi H.S., El-Salam S.M., Omran A.A. Biochemical changes in phenols, flavonoids, tannins, vitamin E, β-carotene and antioxidant activity during soaking of three white sorghum varieties. *Asian Pacific Journal of Tropical Biomedicine*, 2012, pp. 203-209.
- [15] Perla V., Holm D.G., Jayanty S.S. Effects of cooking methods on polyphenols, pigments and antioxidant activity in potato tubers. *LTW-Food Science and Technology*, 2012, 45, pp.161-171
- [16] Huma Z.E., Vian M.A., Fabiano- Tixier A.S., Elmaataoui M., Dangles O., Chemat F. A remarkable influence of microwave extraction: Enchancement of antioxidant activity of extracted onion varieties. *Food Chemistry*, 2011, 127, pp.1472- 1480.