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Potential of Asian herbaceous plants as source of micronutrients

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Abstract

Deficiency of micronutrients is a major problem worldwide leading to increasing rates of several illnesses by reducing immune and non-immune defenses. Especially diets of poor people are based on few crops rich in macronutrients, whereas the nutritional value of other plants is not fully exploited. Previous studies at Humboldt University of Berlin already dealt with various herbaceous, nutraceutical Asian plants like *Oenanthe javanica*, *Ipomoea aquatica*, *Crysanthemum coronarium*, *Elsholtzia ciliata* and *Ocimum basilicum*. For this research project *Perilla frutescens* and *Persicaria odorata* have been selected due to their high content of antioxidants and their easy cultivation. Both plants are already used as basic ingredients and food additives in Asian cuisine and are known for their health improving and medicinal benefits. Aim of our research was to analyse and to evaluate the nutritional value of its micronutrients. Cultivated in a greenhouse in Berlin, *P. odorata* was harvested five weeks after planting the cuttings and *P. frutescens* ten weeks after sowing. Quantity of marketable fresh matter was about 2.5- 4.3 kg m^{-2} for *P. odorata* and about 4 kg m^{-2} for *P. frutescens*. Regarding micronutrients *P. odorata* had remarkable high contents of ascorbic acid (around 180 mg 100 g^{-1}) and flavonoids (around 500 mg 100 g^{-1}). Therefore, 55 g of *P. odorata* would be sufficient to comply dietary uptake recommendation for ascorbic acid by DACH organisation (Union of German, Austrian and Swiss food associations). *P. frutescens* was particularly rich in polyphenols (880 mg 100 g^{-1}) and
anthocyans (200 mg 100 g^{-1} FW). Analyses of mineral contents proved potassium as major constituent (40 mg g^{-1} DW for *P. odorata* and 30 mg g^{-1} DW for *P. frutescens*) and indicated high amounts of magnesium (7 mg g^{-1} DW for *P. odorata* and 5.6 mg g^{-1} DW for *P. frutescens*) and iron (0.15 mg g^{-1} DW for *P. odorata* and 0.14 mg g^{-1} DW for P. frutescens). Regarding recommendations of DACH organisation 100 g *P. odorata* could provide around 40% of recommended magnesium, 34% of recommended potassium and 25% of recommended iron uptake. Results demonstrate the potential of *P. odorata* and *P. frutescens* as micronutrient source to satisfy nutritional needs. Both Asian plants are cultivable under protected conditions also in temperate climate zones. Nevertheless, in further researches the influence of different growing conditions and cultivation systems on the yield and micronutrient content should be investigated.

Keywords: minerals, nutraceutical, *Perilla frutescens*, *Persicaria odorata*, vitamins

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Introduction

Approximately two billion people worldwide are affected by deficiency of micronutrients. Inadequate uptake of vitamins and minerals leads to increasing rates of several illnesses, such as anemia, by reducing immune and non-immune defenses. Beside essential nutrients like vitamins and minerals, many researches pointed out the importance of antioxidants for human health. As the consumption of fruit, vegetables and animal products is often income related, malnutrition is especially a problem of poor people, whose priority is to avoid hunger. Therefore, gravity of the situation is very high in developing countries. Some Asian countries are extremely affected by malnutrition, although they are known for their high biodiversity. Therefore, Asian herbaceous plants which are already used in cuisine and traditional medicine might be interesting regarding their nutritional value. Among them, *Persicaria odorata* is known for its particularly high polyphenol content and the associated antiradical efficiency. Comparing 20 local Thai vegetables, *Persicaria odorata* contained the highest polyphenols and the highest antioxidant activity too (Nanasombat and Teckchuen, 2009). While *P. odorata* is almost unknown in Europe, *Perilla frutescens* is already widely used in Vietnamese restaurants, although consumers might not recognise the plant. *P. frutescens* is also well known for its high content of polyphenols, flavonoids and anthocyanins (Grbic et al. 2016). Sato et al. (1996) found a total phenolic content of 727 mg 100 g^{-1} FW.

Beside the well-studied polyphenols and their subgroups, the nutritional value of plants is defined by the content of a variety of ingredients. Therefore, aim of our research was to analyse and to evaluate the nutritional value of *P. frutescens* and *P. odorata* as two potential sources of micronutrients.

Material and Methods

Persicaria odorata cuttings were obtained from mother plant cultivated in greenhouse. *P. odorata* was harvested five weeks after planting the cuttings**.** Ten weeks after sowing, *P. frutescens* was harvested. As growing substrate "Gramoflor" was used containing white peat (65%), black peat (20%) and perlite (0.2-6 mm) (15%). The basic composition of nutrient solution used during experiment was: N (110 ppm), P (50 ppm), K (225 ppm), Ca (120 ppm), Mg (80 ppm), HCO3 (90 ppm), SO_4 (60 ppm) and microelements, of which Fe (10 ppm). The EC value equalled 1.5 mS cm^{-1} and pH value 5.8 whereas pH value was adjusted with H_3PO_4 (85%).

For determination of fresh matter, all leaves were removed and weighed (FM). A part of each plant was dried (DM) for determination of minerals. Fresh leaves were used to determinate the organic compounds. To avoid influences of leaf age and shade- conditioned differences of light conditions, only the third leaf taken from the top of the shoots was used.

As references for uptake recommendations, data of DACH- organisation for males between 25 and 50 years were used. Polyphenol content was evaluated using calculation for polyphenol uptake complying 5-a-day- recommendation (Williamson and Holst, 2008). Ingredient contents of other plants as a comparison to the detected values were taken from USDA database.

Results and Discussion

Quantity of marketable fresh matter was about 2.5- 4.3 kg m^{-2} for *P. odorata* and about 4 kg m^{-2} for *P. frutescens*. Regarding ascorbic acid, both plants had high contents (177.37 and 171.37 mg 100 g^{-1} FW) (Table 1). Those contents were more than three times higher than in lemons (50 mg 100 g^{-1} FW) and nearly the same as in black currants (181 mg 100 g^{-1} FW). Therefore, 55 g of each plant would be sufficient to comply dietary uptake recommendation of ascorbic acid by DACH organisation. The group of carotenoids consists provitamin A active compounds and also substances with high antioxidant capacity. *P. odorata* contained 41.14 mg 100 g^{-1} FW, which is much higher than in carrots (Heinonen et al., 1989) and kale (de Azevedo and Rodriguez-Amaya, 2005). Total carotenoid content of *P. frutescens* is lower than in *P. odorata*. However, due to a

higher portion of β-carotene (around 38%, Schnitzler et al., 2007), 58% of daily uptake recommendation of provitamin A can be achieved by the consumption of 100 g of *P. frutescens*.
Both plants were particularly rich in polyphenols (774 mg 100 g^{-1} FW and 880 mg 100 g^{-1} FW) and flavonoids (501 mg and 413 mg 100 g^{-1} FW). *P. frutescens* also contained high anthocyans (201 mg 100 g^{-1} FW), as a polyphenolic subgroup. Total polyphenol uptake is assumed to be around 800 - 1200 mg per day (Ovaskainen et al., 2008), while consumption of fruit and vegetable accounts for 28% of daily polyphenol uptake (Brat et al., 2006). Since there are no official uptake recommendations for polyphenols, at least there is the '5-a-day' recommendation for consumption of fruit and vegetables. Calculated by typical consumed fruits and vegetables, daily polyphenol uptake would be around 800 mg per day by food, beverages excluded (Williamson and Holst, 2008). In terms of this estimation, around 100 g of the tested plants would provide 100% of the proposed polyphenol uptake.

Table 1: Measured values of ascorbic acid, carotenoids, polyphenols and subgroups [mg 100 g^{-1} FW] in *P. odorata* and *P. frutescens* and percentage of dietary uptake recommendation by DACH- organization (for man, 25-50 years)

	Persicaria odorata		*Perilla frutescens*	
	mg 100 g^{-1} FW	% Daily value	mg 100 g^{-1} FW	% Daily value
Ascorbic acid	177,37	177	171,37	171
Carotenoids	41,14	178*	9,27	58*
Polyphenols	774	97**	880,19	110**
Flavonoids	501,01		412,59	
Anthocyans	11,69		201,34	

* calculated by contents of β-carotene
**referred to dietary uptake by following '5-a-day'-compaign

Fruits and vegetables generally have moderate contents of inorganic constituents. Analyses of mineral contents proved potassium as major constituent (38.9 mg g^{-1} DW for *P. odorata* and 30 mg g^{-1} DW for *P. frutescens*). Although values are low compared to uptake recommendation, both plants provide more potassium than bananas (358 mg 100 g^{-1} FW) which are a fruit known for their high contents. Referring to uptake recommendations, 100 g FW *P. odorata* could provide around 39%, *P. frutescens* 31% of recommended calcium. Compared to kale (254 mg 100 g^{-1} FW), calcium content in *P. odorata* is about 50% higher. Both plants are also good sources for magnesium (32% and 27% of recommended magnesium) and prove high contents also compared to other vegetables like spinach (79 mg 100 g^{-1} FW). Iron is often part of deficiencies of micronutrients. With 1.78 and 2.35 mg 100 g^{-1} FW, *P. odorata* and *P. frutescens* are good sources for iron. However, compared to parsley (about 6 mg 100 g^{-1} FW), contents in other vegetables might be higher.
Phosphorus is mostly stored in seed. For vegetables, celeriac has high contents with about 115 mg 100 g^{-1} FW, almost as same as in *P. odorata* and more than 20% lower than in *P. frutescens*.

Table 2: Measured values for minerals in *P. odorata* and *P. frutescens* and percentage of dietary uptake recommendation by DACH- organization (for man, 25-50 years)

	Persicaria odorata			*Perilla frutescens*		
	mg g^{-1} DW	mg 100 g^{-1} FW	% Daily value	mg g^{-1} DW	mg 100 g^{-1} FW	% Daily value
Calcium	26.26	390.22	39	18.28	306.37	31
Potassium	38.9	578.05	14	30.06	503.81	13
Iron	0.15	1.78	18	0.14	2.35	23
Magnesium	7.48	111.15	32	5.64	94.53	27
Phosphorus	7.86	116.80	17	8.51	142.63	20

Conclusions and Outlook

Both plants provide high contents of a wide range of micronutrients. Therefore, consumption of *P. odorata* and/ or *P. frutescens* would increase micronutrient and antioxidant uptake significantly. This is of high interest especially in origin Asian countries, where the plants are already integrated in local cuisine and people are used to their taste. In tropical and subtropical climate zones, both plants can be easily cultivated in home garden or plantation. *P. odorata* and *P. frutescens* are also cultivable in Europe and could be a supplement to our diet. Beside *P. odorata* and *P. frutescens* there are much more plants with a potentially high nutritional value. Detecting and analysing those plants would be an interesting challenge for the future. However, the consumption of fruits and vegetables is not only limited by the income, but also by personal preferences. Therefore, an enhancement of nutritional valuable ingredients by cultivation conditions would also improve micronutrient uptake and is another research field.

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