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New Leafy Greens—Plant Age Effects on Perilla Leaves

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Abstract

Given that, not much is known about potential yields and nutritional quality of perilla [*Perilla frutescens* (L.) Britton, Lamiaceae] for production in eastern USA as food, we evaluated fresh leaves of five accessions during 2021. The seeds were germinated in a greenhouse and about 15-day old seedlings were transplanted to the field on black-plastic covered raised beds. Leaves were harvested for analyses at 69 and 85 days after transplanting. Four accessions with green-colored leaves performed better than one with purple leaves. Leaf fresh weights varied from 105 to 279 g per plant whereas number of leaves per plant varied from 368 to 465. Concentrations (g/100 g) of protein, fat, fiber, Ca, P, K, Mg, and S in fresh perilla leaves produced in Virginia contained 17.9, 4.2, 7.3, 1.3, 0.39, 2.0, 0.40, and 0.17, respectively whereas mean values (mg kg^{-1}) for Fe, Cu, Zn, and Mn were 291, 19.9, 40.5, and 56.2. Leaves of perilla produced in Virginia contained considerable more protein (about 4 times more), fiber and fat than literature values demonstrating location differences. Effects of plant age were significant on all plant and leaf physical traits—values from 85 day old plants were significantly higher than those from 69 day old plants. Based on our preliminary results, we have identified PI481701 as the optimal accession. We concluded that perilla is a potential niche crop for Virginia farmers.

Keywords: *Perilla frutescens* (L.), leaf fresh weight, leaf dry weight, composition of fresh leaves, plant age

1. Introduction

Perilla [*Perilla frutescens* (L.) Britton, Lamiaceae], also known as wild coleus, Chinese basil, perilla mint or purple mint, is a widely used flavoring herb. According to Ravindram et al. (2006), perilla's natural habitat extends from Northeast India to China, occurring up to an altitude of 1200 m. The major producing countries are China, Japan, Korea and India. In South Asia, perilla extends from Kashmir to Bhutan, and from Champaran in India to Myanmar. Perilla was introduced to Japan in the 8-9th century where it is grown extensively. Perilla is also widely grown in Korea, where there is also a strong research base for the improvement of the crop. The Asian immigrants introduced perilla into the USA in the 1800s. The Japanese brought perilla seeds with them to cultivate, and the cultivation began mainly on the West Coast. The plants spread to the Ozarks and the Appalachian mountains, where the species become naturalized and spread widely. It is now widely grown in the USA as an ornamental bedding plant but also has some important traditional uses.

Perilla frutescens var. frutescence, also known as wild sesame, is the source of perilla oil that is used in Korean cuisine and is a substitute for linseed oil in wood-finishing products. *Perilla frutescens* var. crispa, also known as "shiso" is cultivated as a culinary herb and is used in Asian cooking as a leafy green (Go Botany, 2024; Martinetti et al., 2017).

Perilla is an annual short day plant. Two types occur: green leaved and purple leaved varieties and each of them has several cultivated forms. Perilla has been described (Yu, 1997) as: *P. frutescens* (L.) Britt., *P. frutescens* var. acuta (Kudo) forma viridis (Makino); *P. frutescens* var. crispa (Decne) forma viridis (Makino); *P. frutescens* var. arguta (Benth.) Hand-Mazz; *P. frutescens* var. acuta f. albiflora; *P. frutescens* var. stricta f. viridifolia.

Perilla [*Perilla frutescens* (L.) Britton, Lamiaceae] is a common annual weed of the eastern United States but considered a commercial crop in Asia. In the United States, perilla food products are available in Korean ethnic markets, and purple-leafed cultivated plants are used in landscaping. The species has been used abroad in at least nine ways: seeds are sold as food for birds or human consumption; the seed oil is used as a fuel, a drying oil, or a cooking oil; the leaves are used as a potherb, for medicine, or for food coloring; and the foliage is distilled to produce an essential oil for flavoring (Brenner, 1993). Perilla, also known as beefsteak plant, produces edible

leaves. It has showy flowers and fragrant purple leaves that can resemble raw meat, hence the common name - beefsteak. The genus name Perilla comes from the Latin word pera meaning bag in reference to the shape of the fruiting calyx. While the specific epithet frutescens means shrubby or bushy (NCSU, 2024). This plant grows quickly and aggressively up to 1 m tall and 0.5 m wide. Pinching off the flowers before they go to seed will help slow the spread of its wind-dispersed seeds. When left to its own, it will self-seed prolifically. It grows best in full sun to partial shade in rich, moist to dry soil. This plant is very resistant to heat and drought.

Perilla is a species rich in antioxidants, polyunsaturated fatty acids and other bioactive compounds. It is very common in Japan, China and Korea, and used both as food plant (as leafy vegetables, oil plant extracted from seeds, spice, or dyeing plant), cosmetic and medicinal plant, for it has antioxidant, detoxicating, anti-inflammatory, and anti-allergic properties. Neuroprotective, anti-obesity, and anti-tumor effects of perilla have been reported (Martinetti et al., 2017). The perilla plant contains many phenolic compounds that have positive effects on human health; among them, anthocyanins are also used as natural dyeing, above all in foods (Meng et al., 2009). Perilla is receiving increasing attention in the west for the medicinal properties and as a new potential leafy vegetable to be mainly used in mix salads, for its characteristic taste due to a typical essential oil (Martinetti et al., 2012). Additionally, perilla can be helpful for honeybee as it is a nectariferous and a polliniferous plant (Barbieri & Ferrazzi, 2011). Martinetti et al. (2017) suggested that perilla could be a new potential ready-to-eat leafy vegetable to be used alone or in mix with other salad species even in the western diet.

Not much is known about potential yields and nutritional quality of perilla grown in eastern USA as food. Therefore, the New Crops of Virginia State University got interested in this crop in order to diversify cropping system and to provide food for immigrants. United States is a land of immigrants, thus, food preferences vary depending upon the areas from which immigrants came to the United States. In addition, there is a large population of Americans that appreciate different cuisine types. Our specific objectives were to determine production potential of perilla and to characterize effects on plant age on leaf composition to facilitate harvest over an extended period.

2. Materials and Methods

2.1 Plant Materials

This study involved five perilla accessions (Table 1), received from U.S. National Plant Germplasm System.

2.2 Plant Production and Sampling

Five perilla accessions were planted in the greenhouse on April 16, 2021 in trays filled with pre-moistened potting soil. Seeds were spread on top of the potting soil and all trays were watered from bottom. About 15 seedlings of each line were transplanted to the field on May 12, 2021 on a black plastic covered raised bed in a single row. The plants were 0.6 m apart. Each plant received 50 grams of 10-10-10 fertilizer one month after transplanting. Two plants of each accession were cut at soil level on July 20 (69 days after transplanting) and August 5 (85 days after transplanting) to record plant weights, total leaf fresh weights, and number of leaves. Plants and leaves were dried for 48 hours at 60° C. Each plant was considered a replication.

2.3 Analysis of Leaves

Perilla leaves from both plants were combined and were analyzed by Waypoint Laboratory, Richmond, Virginia for N, P,K, Mg, Ca, S, Fe, Mn, Cu, Zn, and B. Protein concentrations were determined as N·6.25.

2.4 Statistical Analysis

All data were analyzed using SAS (2014). We used ANOVA to obtain mean squares for accessions and plant age and used 5% as level of significance.

3. Results and Discussion

These preliminary results demonstrate that perilla is a potential crop for Virginia farmers that can be developed as a niche crop to meet consumer demands. Significant differences existed among five perilla accessions (Table 1) except for number of leaves and stem dry weight. All four accessions with green colored leaves out-yielded the purple-leaf colored accession for leaf fresh weight. PI481701 and PI481703 had similar plant fresh weights (674 and 561 g/plant, respectively) which were significantly greater than PI572264 and PI599684. Similar to fresh leaf weights, all four green-leafed perilla accessions also out-yielded the purple-leafed accession for leaf dry weight. Even though, most perilla is consumed as fresh, leaves there is a possibility that dried leaves may be stored for periods when fresh leaves may not be available. Based on our overall results, purple-leafed perilla accession performed poorly. However, some immigrants, when author approached them in an Asian store, expressed a personal likening to purple perilla. It is also possible that purple-leafed perilla may have more

anthocyanins. We did not study this aspect of perilla but suggest that availability of such information may be desirable. Di Gioia et al. (2020) observed that due to their color diversity, leafy vegetables are invaluable ingredient in human diet, as they possess beneficial health effects due to their content of various phytochemicals such as flavonoids, betalains and carotenoids and their high antioxidant capacity. Consumption of purple/blue fresh produce is associated with increased nutrient intake and reduced risk for metabolic syndrome (McGill et al., 2011).

Table 1. Characteristics of Perilla grown in Virginia during 2021

Trait	Perilla accessions				
	PI481701	PI481703	PI481705	PI572264	PI599684
Leaf color	Green	Green	Green	Green	Purple
Plant fresh weight (g)	674 a*	561 ab	500 b	463 b	232 c
Leaf fresh weight (g)	279 a	228 a	224 a	213 a	105 b
Number of leaves	465 a	451 a	368 a	423 a	460 a
Stem dry weight (g)	64 a	70 a	43 a	41 a	34 a
Leaf dry weight (g)	52 a	44 a	47 a	48 a	22 b
Protein (%)	18.9 a	18.8 a	16.1 a	16.7 a	19.1 a
Fat (%)	4.4 a	4.5 a	4.2 a	3.7 a	4.1 a
Fiber (%)	10.1 a	7.1 bc	7.6 b	5.7 c	5.9 c
Ca (%)	1.6 a	1.5 a	1.4 a	1.1 b	1.1 b
P (%)	0.51 a	0.45 ab	0.36 ab	0.30 b	0.32 b
K (%)	2.1 a	2.0 a	1.9 a	2.0 a	2.1 a
Mg (%)	0.47 a	0.43 a	0.39 a	0.29 b	0.38 ab
S (%)	0.19 a	0.16 a	0.15 a	0.15 a	90.16 a
Fe (mg kg^{-1})	246 bc	335 b	252 bc	155 c	466 a
Cu (mg kg^{-1})	20. 4 ab	21.7 ab	17.1 b	14.7 b	25.7 a
Zn (mg kg^{-1})	47.0 a	38.9 a	37.3 a	32.9 a	46.3 a
Mn (mg kg^{-1})	77.0 a	73.3 a	59.0 ab	36.6 b	34.8 b

Note. *: Means of accessions followed by similar letter within leaf traits and within composition traits were not significantly different at 5% level.

We were not able to find much information in the literature about composition of perilla leaves. Shared Foods (2024) indicated that perilla leaves contain 4.46% protein, 6% fiber, and 1% fat in perilla leaves. Chemical composition of perilla leaves (Table 1) was not effected by accessions relative to concentrations of protein, fat, potassium, sulfur, and zinc. Mean values (g/100 g) for perilla leaves in our study for protein, fat, fiber, Ca, P, K, Mg, and S were 17.9, 4.2, 7.3, 1.3, 0.39, 2.0, 0.40, and 0.17, respectively whereas mean values (mg kg^{-1}) for Fe, Cu, Zn, and Mn were 291, 19.9, 40.5, and 56.2. Leaves of perilla produced in Virginia contained considerable more protein (about 4 times more), fiber and fat demonstrating location differences. Concentrations of Fe, Cu, Zn, and Mn in leaves of perilla produced in Virginia were also greater than those reported by Shared Foods (2024). Concentration of iron in perilla leaves was significantly highest in purple-leafed accession (466 mg kg^{-1}) as compared to that in four green-leafed accessions. In general, leaves of purple-leafed perilla contained highest or close to highest concentrations of all traits under consideration except for fiber. Concentration of fiber in PI481701, a green-leafed perilla accession, was almost double that in the PI599684, the purple-leafed perilla accession.

Based on our preliminary results based on leaf fresh yield and concentration of protein, fat, iron and zinc, we have identified PI481701 as the optimal accession However, this observation is based on limited and needs to be confirmed with future studies involving a larger array of perilla germplasm.

Effects of plant age were significant on all plant and leaf physical traits—values from 85 day old plants were significantly higher than those from 69 day old plants (Table 2). In general, values from 85 day old plants were 2-3 times greater than those from 69 day old plants. Given that concentrations of most leaf compositional traits were essentially similar, we suggest that perilla be harvested from older pants. The perilla plants in our field

studies started to flower approximately when 100 days old. We understand that perilla leaves for consumption should be harvested before these plants start flowering.

4. Conclusion

Results from this preliminary study demonstrate that perilla is a potential "niche" crop for Virginia farmers. Small farmers, who operate roadside stands or participate in framer markets, could easily adopt this crop for local marketing. Farmers who farm close to metropolitan areas like Washington, D.C. can also produce perilla and market leaves in these areas.

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Authors Contributions

Both authors contributed towards conceptualization, study design and execution, data recording and analysis, manuscript preparation, and revising.

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Competing Interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data Sharing Statement

No additional data are available.

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