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学 位 論 文 要 旨
Dissertation Abstract

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学位論文題目： Study on the Functionality of *Polygonum Cuspidatum*
Title of Dissertation （イタドリの機能性に関する研究）

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Polygonum cuspidautm, commonly known as Japanese knotweed is a rhizomatous perennial geophyte of the family Polygonaceae, native to Eastern Asia in Japan, China and Korea. It is known as one of the most invasive species worldwide due to its strong viability. In China, the rhizome of *P. cuspidatum* is called Hu Zhang, a listed ingredient as Chinese Traditional Medicine, and has been used to treat various diseases. On the other hand, in some areas of Japan, *P. cuspidatum* called Itadori is a familiar food ingredient. However, its edible portions, stems and leaves, are less commonly used than rhizome so that few research data is available for health effects of the edible parts. In this study, resveratrol which is a functional phenolic compound found in *P. cuspidatum* was first quantified for each part. The extracts of *P. cuspidatum* were further tested by different assays, and the related compounds were identified in order to find its beneficial effects on human health.

Resveratrol (*trans*-3,5,4'-trihydroxystilbene) (**1**), is a well-known polyphenol compound which promotes human health and is found abundantly in *P. cuspidatum*. Resveratrol content in each part of fresh *P. cuspidatum* is compared among their seasonal and regional differences. Hydrolysis using *β*-glucosidase was used to release resveratrol glucoside to determine the total available amount of resveratrol for body use. In all parts, the rhizomes were the richest in content (~ 5260 µg/g f.w.eq.) and small or trace amount was found in stems and leaves (~ 0.63 µg/g f.w.eq. and ~ 7.35 µg/g f.w.eq., respectively). The seasonal differences varied depending on the plant's growing environments. The antioxidant activity of each part was evaluated by 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging activity and superoxide anion scavenging activity, which revealed resveratrol contributed little to antioxidant activity among the crude extracts (above ground: < 0.01%, subterranean: < 5%).

Because resveratrol accounted for a small part of antioxidant capacity of *P.*

cuspidatum, the predominant antioxidant was sought. The antioxidant activity of the leaf was highest among the different parts, and the predominant antioxidant was present in the ODS 20% MeOH fraction of the aqueous layer of the leaf. As a result of NMR and LC-MS analysis, the structure of predominant antioxidant consisted of caffeic acid and quinic acid moieties, and it was identified as 3-caffeoylquinic acid (neochlorogenic acid) (**2**). This compound was contained at 2.31 mg/g f.w.eq. which accounted for 12.8% of the total phenolic content of the leaf measured by Folin-Ciocalteu method. The antioxidant contribution was found to be 16.5% of DPPH radical scavenging activity and 36.5% of superoxide anion scavenging activity.

Tyrosinase inhibitory activity was found in the leaf at 100 mg f.w.eq./mL. The inhibitory pattern of this leaf extract was non-competitive inhibition according to Lineweaver-Burk plot. The inhibitors were found to be < 10 kDa and present in the ODS 20% MeOH fraction of the BtOH layer. In this active fraction, three flavonoid C-glycosides were isolated and identified as luteolin 8-*C*-β-D-glucopyranoside (orientin) (**3**), luteolin 6-*C*-β-D-glucopyranoside (isoorientin) (**4**), and apigenin 8-*C*-β-D-glucopyranoside (vitexin) (**5**). One gram of fresh *P. cuspidatum* leaves contained 2.40, 1.99 and 1.82 mg/g f.w.eq. of orientin, isoorientin and vitexin, respectively. However, among these compounds, only isoorientin showed tyrosinase inhibitory activity. The position of the glycosidic linkage in a flavonoid C-glycoside compound may be an important factor for suppression of tyrosinase activity.

In hyaluronidase inhibitory activity, *P. cuspidatum* leaves exhibited a strong inhibitory activity at 50 mg f.w.eq./mL (98.5%). The inhibitor was found in ODS 50% MeOH fraction of the precipitate of the aqueous layer and was a > 10 kDa compound. The active compound was found to be proanthocyanidin which was composed of epicatechin units bonded with B type linkage of 4β→8 bonds. The number and weight average molecular weights were 2.82×10^4 and 6.97×10^4, respectively, and the mean degree of polymerization was determined to be 97.2. The content of proanthocyanidins was 9.03 mg/g f.w.eq. which accounted for 24.6% of contribution rate for hyaluronidase inhibitory activity of the original leaf crude extract. Anti-allergic effect was tested using anti-DNP IgE-sensitized RBL-2H3 cells. Both *P. cuspidatum* leaves and the isolated proanthocyanidins significantly reduced granulation of RBL-2H3 cells, suggesting they can alleviate type I allergic symptoms.

In this study, the edible portions of *P. cuspidatum* were analyzed in order to reveal their functionalities. The resveratrol was contained in each part of *P. cuspidatum*. In *P. cuspidatum* leaves, antioxidant, tyrosinase inhibitory, hyaluronidase inhibitory, and anti-allergic effects were found. Neochlorogenic acid, isoorientin and proanthocyanidins were newly found in this plant as the compounds involved in these functions. With these compounds, *P. cuspidatum* leaves which are often unused have potentials to provide beneficial effects to human health such as antioxidant, skin whitening and anti-allergic agent.