J. Food Sci. Nutr.
Vol. 5, No. 3, p. 174~176 (2000)

Alpha-glucosidase Inhibitory Activities of Some Wild Vegetable Extracts

Jong-Sang Kim†, Chong-Suk Kwon*, Kun Ho Son* and Jung-In Kim**

Department of Animal Science and Biotechnology, Kyungpook National University, Taegu 702-701, Korea
**Department of Food Science and Nutrition, Andong National University, Andong 760-749, Korea*
***School of Food Science, Inje University, Kimhae 621-749, Korea*

Abstract

Seventeen wild vegetables consumed commonly in Korea were tested for inhibitory activities against alpha-glucosidase (EC 3.2.1.20). Among the methanol extracts, *Hosta longipes* showed the highest inhibitory activity against alpha-glucosidase, followed by *Bupleurum longeradiatum* and *Angelica decursiva*. The hexane-soluble fractions of *Hosta longipes*, *Ainsliaea acerifolia*, *Pedicularis resupinata*, *Bupleurum longeradiatum*, and *Angelica decursiva* all at the concentration of 5 mg/ml, inhibited enzyme activity by greater than 50%, and the ethylacetate-soluble fractions of *Hosta longipes*, and *Codonopsis lanceolata*, and *Bupleurum longeradiatum* had relatively strong inhibitory activity against the enzyme. These results suggest that some edible plants merit further evaluation for clinical usefulness as anti-diabetic drugs.

Key words: alpha-glucosidase inhibition, wild vegetables, diabetes

INTRODUCTION

Diabetes mellitus affects some 250 million people worldwide and is the leading cause of blindness, kidney failure, and amputation among adults (1). Achieving blood glucose levels as close to normal as possible has been considered as one of the major goals of therapy for those with diabetes mellitus, as high blood glucose level is implicated in the development of macro- and microvascular complications associated with diabetes (2). However, in clinical practice, normalizing blood glucose levels is a formidable challenge. Even more difficult is the control of postprandial hyperglycemia (PPHG). Both dietary and pharmacological tools are now available for the management of PPHG. The pharmacological agents with the greatest effect on PPHG include insulin lispro, amylin analogues, and alpha-glucosidase inhibitors (3).

The enzyme alpha-glucosidase catalyzes the final step in the digestive process of carbohydrates, and hence alpha-glucosidase inhibitors could retard the digestion of dietary carbohydrates to suppress PPHG (4). Alpha-glucosidase inhibitors such as acarbose, miglitol, and voglibose are known to reduce PPHG primarily by interfering with the carbohydrate-digesting enzymes and delaying glucose absorption (3). In addition, numerous alpha-glucosidase inhibitors have been screened from natural resources and some of them are of clinical importance (4-8).

Although several drugs targeted for carbohydrate-hydrolyzing enzymes are in clinical use, it is necessary to have a large inhibitor pool as diabetic patients can develop resistance to current regimens. Alpha-glucosidase appeared to be inhibited by some flavonoids and polyphenol as well as sugar derivatives (8,9). As edible wild plants are good sources of these compounds, we investigated the alpha-glucosidase inhibitory activities of extracts prepared from some wild vegetables commonly consumed in Korea.

MATERIALS AND METHODS

Reagents

Para-nitrophenyl-alpha-D-glucopyranoside and yeast alpha-glucosidase were purchased from Sigma (St. Louis, MO, USA).

Preparation of sample extracts and solvent fractionation

Seventeen wild vegetables used in this study are shown in Table 1. Freeze-dried wild vegetables were powdered and

Table 1. Wild vegetables used in this study

General name	Scientific name
Surichwi	*Synurus deltoides*
Gunggungui	*Angelica polymorpha*
Dureup	*Aralia elata*
Deoduck	*Codonopsis lanceolata*
Danpungchwi	*Ainsliaea acerifolia*
Chamchwi	*Aster scaber*
Jungyoung-Unggungqui	*Cirsium chanroenicum*
Matari	*Patrinia scabiosaefolia*
Haneulmatari	*Lilium tsingtauense*
Vivichu	*Hosta longipes*
Majusongipul	*Pedicularis resupinata*
Johuipul	*Clematis heracleifolia*
Gasiho	*Bupleurum longeradiatum*
Badinamul	*Angelica decursiva*
Gyeusari	*Visscum album var. Coloratum*
Jilgyeongui	*Plantago asiatica*
Yeoro	*Veratrum maackii var. Japonicum*

†Corresponding author. E-mail: vision@knu.ac.kr
Phone: 82-53-950-5752, Fax: 82-53-950-6750

extracted with ten volumes of methanol (MeOH) for 12 h at room temperature. MeOH extract was subsequently subjected to sequential fractionation with hexane, ethylacetate, and water. Solvent from each fraction was removed by rotary evaporation at 40°C while water-soluble fraction was subjected to additional freeze drying. The sample was dissolved in dimethylsulfoxide (DMSO) for hexane- and ethylacetate-soluble fractions or distilled water for water-soluble fractions for experimental use.

Enzyme inhibitory assay

The alpha-glucosidase inhibitory assay was done by the chromogenic method described by Watanabe et al. (4) using a readily available yeast enzyme. Briefly, yeast alpha-glucosidase (0.7 U, Sigma) was dissolved in 100 mM phosphate buffer (pH 7.0) containing 2 g/L bovine serum albumin and 0.2 g/L NaN_3 and used as an enzyme solution. 5 mM para-nitrophenyl-alpha-D-glucopyranoside in the same buffer (pH 7.0) was used as a substrate solution. 50 µl of enzyme solution and 10 µl of test extracts dissolved in dimethylsulfoxide or distilled water at a concentration of 5 mg/ml were mixed in a well of a microtiter plate and measured for titer (Abs 405 nm) at zero time with microplate reader (model 550, BioRad, Hercules, California, USA). After incubation for 5 min, the substrate solution (50 µl) was added and incubated for another 5 min at room temperature. The increase in absorbance from zero time was measured. Inhibitory activity was expressed as 100 minus relative absorbance difference (%) of test compounds to absorbance change of the control where test solution was replaced by carrier solvent.

RESULTS AND DISCUSSION

In this study seventeen wild vegetables were evaluated for the inhibitory activity against yeast alpha-glucosidase. The methanol (MeOH) extracts of wild vegetables showed inhibitory activity against the enzyme ranging from 0 to 62% at a concentration of 5 mg/ml (Fig. 1). Among 17 samples the enzyme inhibitory activity of the MeOH extract of *Hosta longipes* was the greatest, followed by *Bupleurum longeradiatum*, and *Angelica decursiva*. The hexane fractions of *Hosta longipes*, *Pedicularis resupinata*, *Bupleurum longeradiatum*, and *Angelica decursiva* showed similar inhibitory activities on alpha-glucosidase, inhibiting the enzyme activity by 50 to 70% (Fig. 2). *Synurus deltoides* and *Angelica polymorpha* enhanced the enzyme activity maybe through the induction of structural change. Among ethylacetate-soluble fractions, that of *Hosta longipes* inhibited the enzyme the most potently and those of *Synurus deltoides*, *Codonopsis lanceolata*, *Bupleurum longeradiatum*, and *Plantago asiatica* also showed relatively strong inhibitory activities on alpha-glucosidase (Fig. 3). Alpha-glucosidase was inhibited less by water-soluble fractions, compared to other solvent fractions (Fig. 4). The water-soluble fraction of *Cirsium chanroenicum* was the most potent in the inhibition of the enzyme, followed by *Ainsliaea acerifolia*.

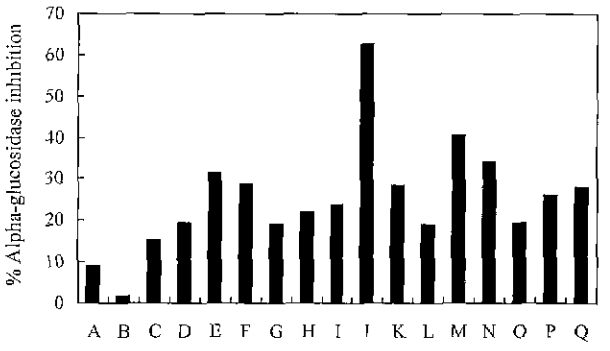

Fig. 1. Alpha-glucosidase inhibitory activities of MeOH extracts of wild vegetables. A, *Synurus deltoides*; B, *Angelica polymorpha*; C, *Aralia elata*; D, *Codonopsis lanceolata*; E, *Ainsliaea acerifolia*; F, *Aster scaber*; G, *Cirsium chanroenicum*; H, *Patrinia scabiosaefolia*; I, *Lilium tsingtauense*; J, *Hosta longipes*; K, *Pedicularis resupinata*; L, *Clematis heracleifolia*; M, *Bupleurum longeradiatum*; N, *Angelica decursiva*; O, *Visscum album var. Coloratum*; P, *Plantago asiatica*; Q, *Veratrum maackii var. Japonicum*. Results are the mean of duplicate measurements.

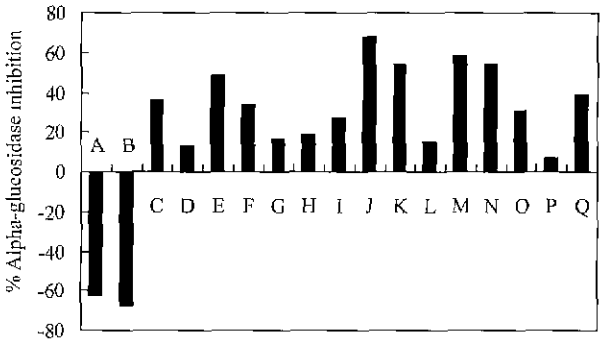

Fig. 2. Alpha-glucosidase inhibitory activities of hexane-soluble fractions of wild vegetable extracts. Abbreviations are as described in Fig. 1.

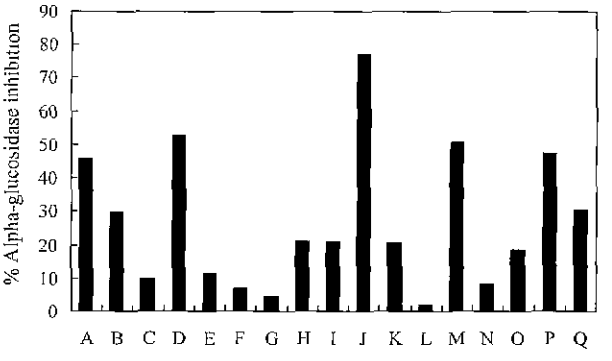

Fig. 3. Alpha-glucosidase inhibitory activities of ethylacetate-soluble fractions of wild vegetable extracts. Abbreviations are as described in Fig. 1.

The inhibition of alpha-glucosidase activity in the digestive tract appears to be one effective way to control PPHG, which has been implicated both in the development of type II dia-

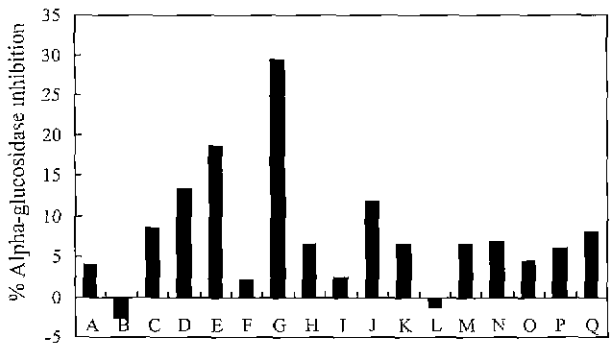

Fig. 4. Alpha-glucosidase inhibitory activities of water-soluble fractions of wild vegetable extracts. Abbreviations are as described in Fig. 1.

betes, pancreatic beta-cell dysfunction, and cardiovascular disease.

Meanwhile alpha-glucosidase inhibitors are currently the most commonly used oral agents for improving PPHG due to their lack of a hypoglycemic threat, and more importantly the prospect of blood glucose control without hyperinsulinemia and body weight gain (3). Inhibition of glucosidase and amylases should result in delayed carbohydrate digestion and glucose absorption with attenuation of postprandial hyperglycemic excursions. It has been reported that alpha-glucosidase inhibitors usually do not alter the total amount of carbohydrate absorbed and therefore do not cause any net nutritional caloric loss although they slow down carbohydrate digestion. As mentioned, three glucosidase inhibitors including acarbose, miglitol, and voglibose, are at present available for the treatment of patients with type II diabetes mellitus. In addition to these drugs, flavonoids, N-para-coumaroyl tyramine and kotalanol isolated from plants have been reported to strongly inhibit alpha-glucosidase although their clinical significance is not clear (6,7). Nishioka *et al.* (8) also screened 27 Chinese medicinal herbs for the inhibitory activities of rat intestinal sucrase, and isolated an active component from *Scutellaria baicalensis*.

While many studies in screening alpha-glucosidase inhibitors were performed with yeast enzyme, there is a controversy regarding the use of yeast alpha-glucosidase in screening potential agents of clinical importance, since yeast alpha-glucosidase inhibitors may not work on mammalian enzymes as much as they do for the yeast enzyme (10).

In vivo efficacy and the clinical usefulness of the wild vegetables showing strong inhibitory activity in this study remain to be evaluated. Also it might be worthwhile to evaluate the inhibitory activities of plant extracts against other carbohydrate-degrading enzymes such as amylase, sucrase and isomaltase. The identification of active component(s) from the ethylacetate-soluble fraction of *Hosta longipes* is in progress.

ACKNOWLEDGMENTS

We express our thanks to Sung Hee Kim and Jung Soon Lee for invaluable assistance, and Bayer-Korea for providing acarbose standard. This work was supported by Kyungpook National University Research Fund, 2000.

REFERENCES

1. Alper, J. : New insights into type 2 diabetes. *Science*, **289**, 37 (2000)
2. Baron, A.D. : Postprandial hyperglycaemia and alpha-glucosidase inhibitors. *Diabetes Res. Clin. Pract.*, **40**, 51S (1998)
3. Mooradian, A.D. and Thurman, J.E : Drug therapy of postprandial hyperglycemia. *Drugs*, **57**, 19 (1999)
4. Watanabe, J., Kawabata, J., Kurihara, H and Niki, R : Isolation and identification of alpha-glucosidase inhibitors from Tochucha (*Eucommia ulmoides*). *Biosci. Biotechnol. Biochem.*, **61**, 177 (1997)
5. Uchida, R., Nasu, A., Tokutake, S., Kasai, K., Tobe, K. and Yamaji, N : Synthesis of new N-containing maltooligosaccharides, alpha-amylase inhibitors, and their biological activities. *Chem. Pharm. Bull.*, **47**, 187 (1999)
6. Nishioka, T., Watanabe, J., Kawabata, J. and Niki, R. : Isolation and activity of N-para-coumaoyltyramine, an alpha-glucosidase inhibitor in Welsh onion (*Allium fistulosum*). *Biosci. Biotechnol Biochem.*, **61**, 1138 (1997)
7. Yoshikawa, M., Murakami, T., Yashiro, K. and Matzuda, H. : A potent alpha-glucosidase inhibitor with thiosugar sulfornium sulfate structure, from antidiabetic Ayurvedic medicine *Salacia reticulata*. *Chem. Pharma. Bull.*, **46**, 1339 (1998)
8. Nishioka, T., Kawabata, J. and Aoyama, Y. : Baicalein, an alpha-glucosidase inhibitor from *Scutellaria baicalensis J. Nat. Prod.*, **61**, 1413 (1998)
9. Kim, J.S., Kwon, C.S. and Son, K.H. : Inhibition of alpha-glucosidase and amylase by luteolin, a flavonoid. *Biosci. Biotechnol. Biochem.* (in press)
10. Oki, T., Matsui, T. and Osajima, Y. : Inhibitory effect of alpha-glucosidase inhibitors varies according to its origin. *J. Agric. Food Chem.*, **47**, 550 (1999)

(Received July 11, 2000)