Antidiabetic Components Contained in Vegetables and Legumes

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Abstract: Epidemiological analyses in a large Chinese population have revealed that consumption of vegetables and legumes is inversely associated with the risk of type 2 diabetes (T2D). However, the health benefits of these plants have not been fully explained, which stimulated our interest to identify antidiabetic components from vegetables and legumes through searching medicinal databases, especially those containing traditional Chinese medicines. The results not only provide meaningful clues to understanding the antidiabetic potentials of these plants but also display the possibility of pinpointing food component functions by searching medicinal databases.

Keywords: Type 2 diabetes, vegetables, legumes, antidiabetic components, medicinal database

Introduction

It is well known that certain foods may have the potential to prevent diseases [1,2]. For instance, the Mediterranean diet is helpful to lowering the risks of coronary heart disease, cancer and cognitive impairment [3-5]. Consumption of green tea is beneficial for preventing cancer and Alzheimer’s disease (AD) [6-8]. Recently, Villegas and co-workers reported that adherence to vegetables (including cruciferous vegetables, green leafy vegetables, yellow vegetables, allium vegetables, tomatoes and others) and legumes (including soybean, peanut, etc.) is inversely associated with the risk of type 2 diabetes (T2D) in a large Chinese population [9,10]. However, the health benefits of
these plants have not been fully explained, which stimulated our interest to address this issue further. Considering the fact that some foods have been recognized as natural medicines, in particular some vegetables and legumes have been used as traditional medicines in China for many years, we speculated that it is highly possible to pinpoint food component functions by searching medicinal databases, especially those containing traditional Chinese medicines.

**Figure 1.** TCMD-documented vegetable and legume components with aldose reductase inhibitory or hypoglycemic activity.

**Results and Discussion**

Primarily, we searched the Traditional Chinese Medicine Database (TCMD), which documents ~10,000 components extracted from ~4,600 traditional medicinal agents [11]. Hundreds of components were identified from vegetables and legumes that are recorded in the TCMD. According to the pharmacological activity annotations, we found that some components (Figure 1) are directly
associated with prevention and/or treatment of T2D, because of their aldose reductase inhibitory or hypoplycemic activity.

Besides, the functions of many other vegetable and legume components (e.g., antiatherosclerotic, antihypertensive, antilipemic, antithrombotic, lipase inhibitory, lipid peroxidation inhibitory, lipoxygenase inhibitory and platelet aggregation inhibitory) are also associated with ameliorating T2D (Table 1) [12-16].

**Table 1.** TCMD-documented vegetable and legume functional components associated with ameliorating type 2 diabetes.

| Compound           | Activity                                      | Source                                                                 |
|--------------------|-----------------------------------------------|------------------------------------------------------------------------|
| Aframodial         | Antilipemic                                   | Zingiber (Zingiber officinale Rosc.)                                  |
| Agavasaponin C     | Platelet aggregation inhibitory               | Garlic (Allium sativum L.)                                            |
| Allicin            | Antihypertensive; Antithrombotic               | Shallot (Allium fistulosum L.); Garlic (Allium sativum L.)            |
| Alliin             | Antithrombotic; Platelet aggregation inhibitory| Onion (Allium cepa L.); Garlic (Allium sativum L.)                     |
| Bergapten          | Antihypertensive                              | Tomato (Lycopersicon esculentum Miller)                               |
| beta-Sitosterol    | Antilipemic                                   | Black soybean (Glycine max (L.) Merr.)                                |
| Camphene           | Antilipemic                                   | Zingiber (Zingiber officinale Rosc.); Mint (Mentha haplocalyx Briq.)  |
| Daidzein           | Lipase inhibitory                             | Black soybean (Glycine max (L.) Merr.); Onion (Allium cepa L.)         |
| Ferulic acid       | Platelet aggregation inhibitory               | Black soybean (Glycine max (L.) Merr.); Onion (Allium cepa L.)         |
| Genistein          | Lipase inhibitory                             | Black soybean (Glycine max (L.) Merr.); Onion (Allium cepa L.)         |
| Glycitein          | Lipoxygenase inhibitory                       | Black soybean (Glycine max (L.) Merr.); Garlic (Allium sativum L.)     |
| Isoeruboside B     | Platelet aggregation inhibitory               | Cress (Oenanthe javanica (B1.)DC.)                                    |
| Isorhamnetin       | Antilipemic; Platelet aggregation inhibitory   | Wild pea (Vicia amoena Fisch. ex DC.); Groundnut (Arachis hypogaea L.)|
| Kaempferol         | Δ-5-lipoxygenase inhibitory                   | Tomato (Lycopersicon esculentum Miller); Bitter gourd (Momordica charantia L.) |
| Leucocyanidin      | Platelet aggregation inhibitory               | Garlic (Allium sativum L.)                                            |
| Lycopene           | Antiatherosclerotic                           | Wild celery (Apium graveolens L.); Potato (Solanum tuberosum L.)       |
| Methyl allyl trisulfide | Platelet aggregation inhibitory               | Garlic (Allium sativum L.); Wild celery (Apium graveolens L.)         |
| Myristicin         | Platelet aggregation inhibitory               | Wild celery (Apium graveolens L.); Potato (Solanum tuberosum L.)       |
| p-Coumaric acid    | Antilipemic                                   | Garlic (Allium sativum L.); Mint (Mentha haplocalyx Briq.)            |
| Proto-iso-eruboside B | Antithrombotic; Platelet aggregation inhibitory| Capsicum (Capsicum annuum L.); Eggplant (Solanum melongena L.)         |
| Rosmarinic acid    | Antithrombotic; Platelet aggregation inhibitory| Black soybean (Glycine max (L.) Merr.); Black soybean (Glycine max (L.) Merr.) |
Furthermore, through comparing the structures of these components with those recorded in the Comprehensive Medicinal Chemistry (CMC) database (which records ~8,000 clinically used drugs) [17] and the MDL Drug Data Report (MDDR) database (which collects ~145,000 drug candidates) [18], we found that some of these agents have been recognized by modern Western medicine (Table 2). Although some activities annotated in CMC and MDDR are not the same as displayed in TCMD, they are also associated with combating T2D. Taken together, the present analysis clearly indicates that vegetables and legumes indeed contain many antidiabetic components, which provide new clues to understanding the beneficial effects of vegetable and legume consumption on the risk of T2D [9,10].

**Table 2. CMC- and MDDR-documented vegetable and legume functional components associated with ameliorating type 2 diabetes.**

| Compound             | Activity                                      |
|----------------------|-----------------------------------------------|
| Allicin              | Hypolipidemic (CMC/MDDR);                      |
|                      | Hypocholesterolemic (CMC);                     |
| 6-Shogaol            | Platelet aggregation inhibitory (MDDR)        |
|                      | Cyclooxygenase inhibitory (MDDR);              |
| beta-Sitosterinum    | Lipoxynage inhibitory (MDDR)                  |
| beta-Sitosterol      | Hypolipidemic (CMC)                           |
| Stigmasterin         | Antiatherosclerotic (CMC)                      |
| Stigmasterol         |                                               |

**Conclusions**

Since only a small part of natural medicinal components have been documented in medicinal databases, the presently identified vegetable and legume functional components are only the tip of the iceberg. It is expected that with the progress of medicinal chemistry and pharmacology, more and more antidiabetic agents will be identified from foods. In fact, in a very recent study, it was reported that some triterpenoids derived from bitter melon are promising antidiabetic agents [19].
In nutrition studies, it is always a challenge to pinpoint the functions of food components to elucidate the epidemiological discoveries. The present study indicates that it is possible to explain (although partially) the health benefits of foods from the activities annotated in medicinal databases, which is of great significance to the study of food science and technology and even drug discovery.

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