Journal of Ethnic Foods

ORIGINAL ARTICLE

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Scientific validation of traditionally used omija (*Schisandra chinensis*) extract mixture for postprandial glucose regulation

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Abstract

According to Dongeuibogam (東醫寶鑑), a UNESCO Memory of the World-registered medical text, Omigalsu (五味喝水) was a traditional Korean beverage formulated from *Schisandra chinensis* (Turcz.) Baill. (Omija, Schisandra) extract and soybean. It was historically prescribed for treating "sogal" (消渴), a condition characterized by symptoms analogous to diabetes mellitus, including polydipsia, polyphagia, and polyuria. This study aimed to scientifically validate its historical use through modern experimental analysis. To increase ligan contents from the traditional formulation, we developed Omija extract and soybean mixture (OSM) by combining 50% ethanol extract of Omija with cooked soybean powder (5:1, w/w). In vitro α-glucosidase inhibition assays demonstrated that OSM exhibited concentration-dependent inhibitory activity, reaching 39.8 ± 3.4% inhibition at 10,000 µg/mL. In Sprague–Dawley rats, oral sucrose tolerance testing (OSTT) was conducted using 2 g sucrose/kg body weight (BW) after OSM administration. The OSM group maintained significantly lower blood glucose levels compared to the control group, suggesting significantly inhibiting post-prandial blood glucose elevation. Area under the curve (AUC) analysis further confirmed OSM's glucose-regulating efficacy, with the OSM group exhibiting significantly lower AUC values than controls. These findings provide scientific validation for the traditional use of Omigalsu such as OSM in post-prandial blood glucose regulation, as documented in classical Korean medical texts. Furthermore, they suggest that OSM has the potential of a functional food ingredient for diabetes prevention and management.

Keywords Omija extract and soybean mixture, Omigalsu, Traditional Korean beverage, Blood glucose regulation, α-Glucosidase inhibition, Oral sucrose tolerance test, Dongeuibogam

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Introduction

Type 2 diabetes mellitus and its associated postprandial hyperglycemia represent significant global health challenges, with increasing prevalence particularly in Asian countries [1]. While pharmaceutical interventions remain the primary treatment approach, there is growing interest in traditional food-based interventions for their potential role in glucose management and minimal side effects. Among these traditional Korean remedies, Omigalsu (五味喝水), a traditional Korean beverage, has been documented in classical texts, particularly the United Nations Educational, Scientific and Cultural Organization (UNESCO)-registered "Dongeuibogam" (東醫寶鑑), as an effective remedy for "sogal" (消渴) [2]. The symptoms of sogal—severe thirst (polydipsia), excessive food intake (polyphagia), and frequent urination (polyuria)—closely parallel the clinical manifestations of diabetes mellitus, suggesting our ancestors' sophisticated understanding of this metabolic disorder [2].

Omigalsu is traditionally formulated by combining *Schisandra chinensis* (Turcz.) Baill. (Schisandra; Omija) and cooked soybean (*Glycine max)* [3]. The name "Omigalsu" itself reflects its composition and purpose: "Omi" refers to the five distinct flavors (salty, sweet, sour, astringent, and pungent) found in Schisandra berries, "gal" means thirst, and "su" denotes water or beverage [3]. This beverage has been documented in classical Korean medical texts for its therapeutic applications, particularly in treating "sogal" (消渴), a condition characterized by symptoms similar to diabetes including excessive thirst and frequent urination [2].

The scientific rationale for investigating Omigalsu's anti-diabetic potential lies in the established bioactive constituents of its primary ingredients. *Schisandra chinensis* contains various bioactive components, particularly lignan compounds such as schisandrin and gomisin, demonstrating antioxidant and anti-inflammatory properties [4]. These components have been shown to support glucose metabolism through multiple pathways, including the elimination of reactive oxygen species and modulation of enzymes involved in blood sugar regulation [5]. Complementarily, soybeans contain complex carbohydrates, proteins, and bioactive compounds such as isoflavones that have demonstrated positive effects on glucose metabolism by lowering glycemic index and improving insulin sensitivity [6]. Combining these ingredients suggests potential synergistic effects in glycemic control, warranting further investigation.

This study aimed to validate the postprandial glucose-regulating effects of Omigalsu by developing a standardized formulation called Omija 50% ethanol extract and soybean mixture (OSM). The formulation was based on our previous study [7] which demonstrated that 50% ethanol was optimal for extracting bioactive compounds from Omija, particularly schisandrin and gomisin N, while maintaining stability and bioavailability. The 5:1 ratio of Omija extract to soybean powder was determined through preliminary experiments that showed α-glucosidase inhibition while preserving the traditional therapeutic principles of Omigalsu [8]. This standardized approach allows for consistent quality control while retaining the synergistic effects of the traditional formulation. The efficacy of OSM was evaluated through both in vitro α-glucosidase inhibition assays [6] and in vivo oral sucrose tolerance tests (OSTT), providing a comprehensive analysis of its blood glucose-regulating properties. Through this systematic investigation, we sought to provide scientific validation for the traditional use of Omigalsu in managing sogal (消渴), a condition historically recognized as analogous to diabetes, while exploring its potential as a functional food ingredient for modern diabetes management (Fig. 1).

Methods

Preparation of OSM (omija extract and soybean mixture)

Mature red Omija berries (Schisandra chinensis (Turcz.) Baill.) were harvested from plants grown at 400 m altitude in Mungyeong, Gyeongbuk (Fig. 2A, B). The dried berries (obtained from Mungyeong Agricultural Technology Center, Mungyeong, Korea) were extracted with 50% ethanol at 70 °C for 3 h. This extraction method was selected based on our previous study [7], which demonstrated that 50% ethanol extraction yielded the highest lignan content among various extraction methods. The extract was subsequently concentrated under reduced pressure. Soybean powder was prepared through a sequential process: hydration with purified water, dehulling, steaming, drying, and homogenization. Based on preliminary activity studies [7], OSM was formulated by combining the Omija extract with

Fig. 1 Dried *S. chinensis* **A**, Fresh *S. chinensis* **B**, *S. chinensis* juice **C**

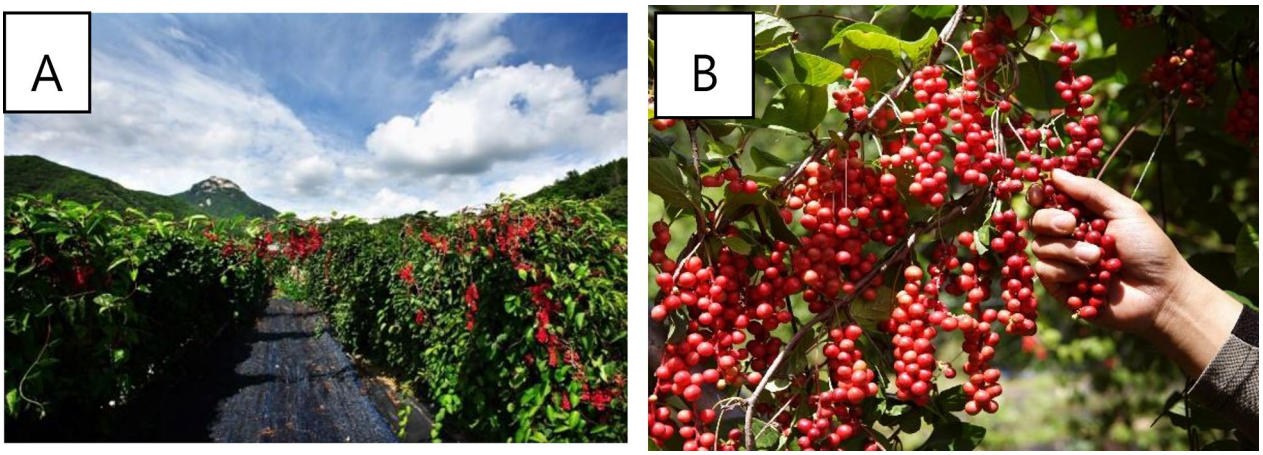

Fig. 2 **A** *S. chinensis* cultivation site during harvest season at 400 m altitude in Mungyeong, Gyeongbuk **B** Mature red fruits

processed soybean powder at a 5:1 ratio (based on solid content). The final mixture was freeze-dried to obtain a powder form.

α-Glucosidase inhibition assay

Yeast α-glucosidase (0.5 U; Sigma-Aldrich, Saint Louis, MO, USA) dissolved in 100 mM sodium phosphate buffer (pH 6.9) was mixed with various concentrations of OSM. After incubation at 37 °C for 10 min, 3 mM p-nitrophenyl-α-d-glucopyranoside was added. The reaction was further incubated at 37 °C for 30 min and then stopped by adding 0.1 M Na_2CO_3. The absorbance of resulting p-nitrophenol was measured at 405 nm. The control contained a reaction mixture, without OSM. Mixtures without enzyme, extract served as a blank. The percent inhibition of α-glucosidase was calculated as [(absorbance of sample—absorbance of blank) / absorbance of control] × 100.

Experimental animal and OSTT

All the experiments were conducted following the National Institutes of Health Guidelines for the Care and Use of Animals. This study was approved by the Institutional Animal Care and Use Committee of Hoseo University (HSUIACUC-24–021). The animals adapted to the following conditions for 7 days; 12 h light/12 h dark cycle, temperature; 23 ± 1 °C, humidity; 50 ± 5%, and illumination, 150–300 lx. The animals allowed ad libitum access to food (Purina diet; Purina Korea, Seongnam, Korea) and water. After a week of acclimatization, an Oral Sucrose Tolerance Test (OSTT) was conducted to evaluate the effect of OSM on α-glucosidase activity in vivo. After 16 h of fasting, Sprague Dawley rats were orally administered OSM at 60, 120, and 240 mg/kg body weight (low, middle, and high dosage). Sucrose (2 g/kg bw) was orally administered to assess how OSM influences sucrose digestion and glucose absorption. Since sucrose must be hydrolyzed into glucose and fructose by α-glucosidase in the small intestine before absorption, changes in postprandial blood glucose levels reflect α-glucosidase activity. If α-glucosidase is inhibited by OSM, sucrose breakdown is reduced, leading to a slower or lower rise in blood glucose than controls. Blood samples were collected from the tail vein every 10 min until 90 or 120 min, and blood glucose levels were measured using a blood glucose meter (Autocheck, Diatech Korea Co., Ltd.). The area under the curve (AUC) of blood glucose concentration was calculated to quantify glucose absorption and assess the inhibitory effect of OSM on α-glucosidase-mediated sucrose digestion. After completing the OSTT, the rats were euthanized using CO_2 asphyxiation.

Statistical analysis

All data are expressed as the mean ± standard deviation, and differences between groups were analyzed using one-way ANOVA (Duncan's multiple-range test). All analyses were performed using SPSS 23.0 (SPSS Inc., USA). Each value represents the mean of at least three independent experiments for each group. Statistical significance was set at $p < 0.05$.

Results

In vitro α-glucosidase inhibition activity of OSM

The α-glucosidase inhibition activity was investigated to evaluate the potential of OSM in the inhibition of blood

glucose elevation (Fig. 3). At concentrations of 100 to 500 μg/mL, OSM was investigated inhibition activity of approximately 10%, and the inhibition activity increased at concentrations above 1000 μg/mL. At 1000 μg/mL of OSM, it exhibited 13.6 ± 0.8% inhibition, 13.9 ± 0.6% at 3000 μg/mL, 18.6 ± 1.9% at 5000 μg/mL, and 39.8 ± 3.4% at 10,000 μg/mL. In Fig. 3, the substrate digestion was inhibited in a concentration-dependent manner of OSM. These results suggest that increased α-glucosidase inhibition activity may slow the absorption of carbohydrates and prevent a rapid rise in blood glucose levels.

OSTT after OSM intake

Post-prandial blood glucose suppression was validated in vivo through an OSTT (Fig. 4). Blood glucose changes were measured at 10 min intervals. All groups reached the peak of blood glucose at 30 min (Fig. 4A). The control group exhibited the highest blood glucose level at 161.0 ± 4.3 mg/dL and the Low-dose group showed a lower blood glucose level 155.0 ± 5.2 mg/dL than the control group at 30 min, while the Middle- group and High-dose group had significantly lower blood glucose level of 146.8 ± 4.3 mg/dL and 146.0 ± 1.7 mg/dL, respectively (Fig. 4A). After the highest blood glucose level (at 30 min), blood glucose level gradually decreased; however, until 60 min., the differences between the groups maintained. These results explained that the OSM administration effectively suppressed postprandial blood glucose elevation.

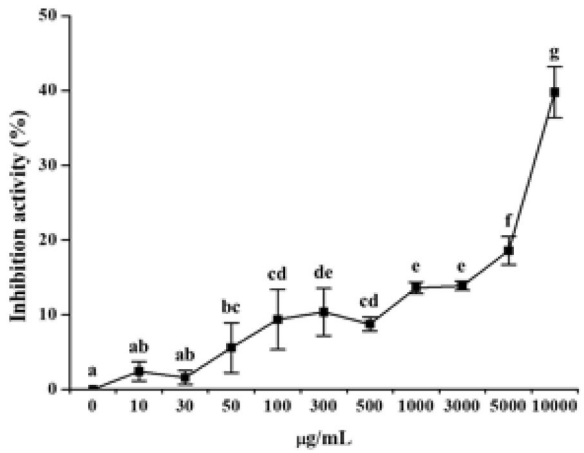

Fig. 3 Anti-diabetic effect (α-glucosidase inhibition activity) of OSM. Data are presented as means ± standard errors ($n = 3$). Bars labeled with different superscripts have significantly different values at 5% using Duncan's Multiple Range Tests ($p < 0.05$) a–c, the different letters indicated significant differences among the groups by a Tukey test in each time point at $P < 0.05$

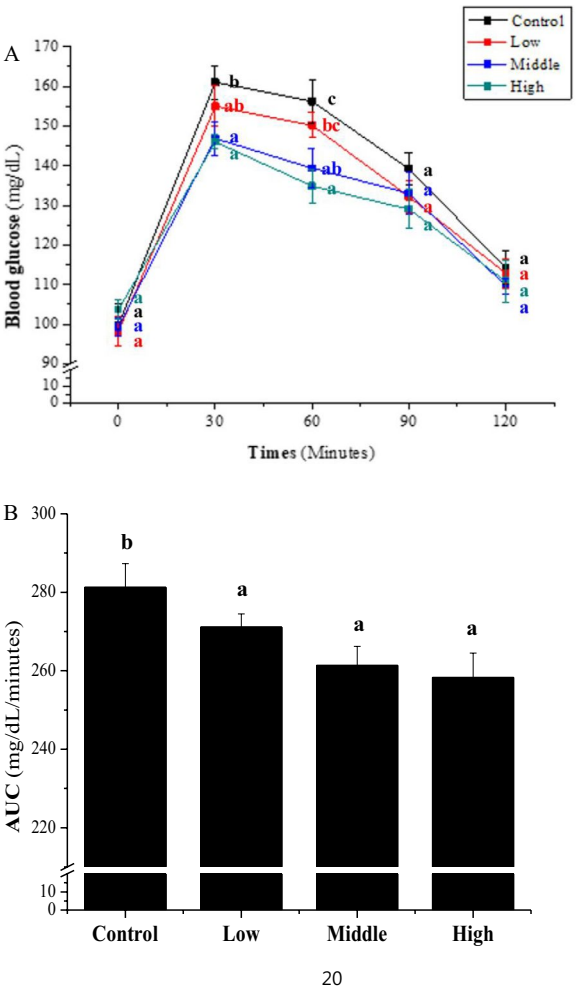

Fig. 4 Oral sucrose tolerance tests of OSM. **A** blood glucose concentrations and **B** area under curve (AUC) during oral glucose tolerance tests in 16 h-fasted rats. Areas under the curve of blood glucose were compared. Data are presented as means ± standard deviation ($n = 6$). Bars labeled with different superscripts have significantly different values at 5% using Duncan's Multiple Range Tests (DMRT, $p < 0.05$). a–c, the different letters indicated significant differences among the groups by a Tukey test in each time point at $P < 0.05$

In Fig. 4B, the result of the AUC value referred to the area under the blood glucose change was calculated using the result of OSTT. The control group showed the highest AUC at 281.3 ± 6.0 mg/dL/min, while the Low-dose group showed 271.1 ± 3.4 mg/dL/min, the Middle dose-group showed 261.4 ± 4.8 mg/dL/min, and the High-dose group showed 258.3 ± 6.2 mg/dL/min. A larger AUC value suggests a greater blood glucose increase, while a smaller AUC value indicates better suppression of blood glucose elevation. These results showed that the Middle- and High-dose groups had significantly lower values than the control group.

Discussion

Integration of traditional and modern perspectives on omigalsu with OSM

This study validated the glucose-regulating efficacy of OSM through both in vitro α-glucosidase inhibition and in vivo oral sucrose tolerance testing. Our research combines traditional Korean medicinal knowledge with modern scientific methods, examining Omigalsu not only for its pharmacological effects but also within its historical therapeutic context. To enhance the glucose-lowering potential of traditional Omigalsu, we developed OSM using 50% ethanol extract of Schisandra, optimizing the extraction of bioactive compounds while maintaining the beverage's traditional composition.

Historical significance of omigalsu in Korean traditional medicine

The medicinal use of Omigalsu has been well documented in classical Korean texts, including the UNESCO-registered Dongeuibogam (東醫寶鑑) [2], where it was prescribed for the treatment of "sogal" (消渴). The symptoms of sogal—severe thirst (多飮, polydipsia), excessive food intake (多食, polyphagia), and frequent urination (多尿, polyuria)—closely resemble those of diabetes mellitus, suggesting an advanced historical understanding of metabolic disorders.

According to research by Yang et al. [8], historical documents from the Joseon Dynasty frequently mention Schisandra (Omija) as a commonly used medicinal ingredient in Korean households. Lee and colleagues further confirmed that records from the Annals of the Joseon Dynasty indicate that Schisandra was often prepared as decoctions and teas and prescribed to royalty to alleviate heat and excessive thirst [9]. In contemporary times, Schisandra cultivation has expanded significantly, with Mungyeong in Gyeongsangbuk-do emerging as the largest Schisandra-producing region in South Korea [10].
Omigalsu, a traditional Korean beverage composed primarily of Schisandra and soybeans, is also described in several historical texts. The Sanlimgyeongje (山林經濟, 1715) details a preparation method involving a highly concentrated soybean extract, clear enough to reflect one's face, with honey added for taste adjustment [11]. Similarly, the Imwonsipyukji (林園十六志, 1827) outlines a formulation where equal parts of Schisandra juice and mung bean or soybean juice were gently boiled for about one hour [12]. These historical preparations align with the fundamental principles of functional food development, in this study, where bioactive compounds are extracted and concentrated to maximize their therapeutic effects.

In traditional Korean medical literature, sogal has been classified as a syndrome analogous to diabetes in contemporary clinical medicine [8]. The recommended treatment often involves dietary regulation and lifestyle modifications, which closely parallel modern diabetes management strategies [13]. Given the rising global prevalence of diabetes, empirical investigations into the glucose-regulating effects of Omigalsu hold significant potential for developing functional food products aimed at diabetes prevention and management.

Validation of Postprandial Blood Glucose-Regulating Effects of OSM Effectively Mimicking Omigalsu

The observed α-glucosidase inhibitory activity of OSM provides a scientific basis for its traditional use. α-Glucosidase, an intestinal enzyme crucial for carbohydrate digestion [14, 15], when inhibited, can effectively slow carbohydrate absorption and prevent rapid postprandial glucose elevation [15, 16]. Our findings demonstrated significant concentration-dependent inhibitory activity. This finding aligns with historical preparation methods, such as *Sanlimgyeongje*'s recommendation for a highly concentrated soybean extract [11], suggesting an empirical understanding of optimal extraction techniques.

Furthermore, in vivo OSTT results further substantiated these findings, the OSM group (120 and 240 mg/kg bw) maintaining significantly lower blood glucose levels than controls. This glucose-regulating efficacy, confirmed through AUC analysis [17], provides scientific validation for historical applications. Historical records from the Joseon Dynasty support this scientific evidence, indicating that Schisandra was commonly prescribed to relieve heat and excessive thirst—symptoms now recognized as manifestations of hyperglycemia [9].

The therapeutic effects of OSM on postprandial blood glucose can be attributed to the synergistic action of bioactive compounds from both primary ingredients. Schisandra's lignans, particularly schisandrin and gomisin, contribute antioxidant and anti-inflammatory properties [18, 19], while soybean's complex carbohydrates, proteins, and isoflavones improve glucose metabolism and insulin sensitivity [20]. This combination appears particularly judicious given experimental evidence by Kim et al. [3] showing that Schisandra lignans and soybean isoflavones synergistically enhance hormone regulation and metabolic function [3].

The standardized preparation method of OSM developed in this study (5:1 ratio of Schisandra 50% ethanol extract to soybean powder) offers a practical approach for potential commercial development while respecting traditional principles. This standardization is particularly relevant given the growing commercial cultivation

of Schisandra, with Mungyeong in Gyeongsangbuk-do emerging as South Korea's largest cultivation area [10]. The therapeutic approach to sogal in traditional medicine, emphasizing dietary control and lifestyle modifications [13], shows remarkable similarity to contemporary diabetes management strategies, suggesting the enduring relevance of traditional wisdom.

Future Directions and Limitations

Despite the promising results, several limitations should be acknowledged. While our results demonstrate significant glucose-regulating effects, further research is needed to elucidate the precise molecular mechanisms involved. Additional investigation of the various preparation methods documented in historical texts, such as the alternative formulation described in "Imwonsipyukji" (林園十六志, 1827) using mung bean extract [12], could potentially yield insights into optimizing therapeutic efficacy.

Future studies should also investigate additional bioactive compounds present in Omigalsu, refine extraction techniques based on historical documentation, and assess long-term safety and efficacy through clinical trials. Given the growing prevalence of diabetes in modern society, functional food-based interventions inspired by traditional wisdom may offer valuable complementary strategies for diabetes prevention and management.

Conclusion

This study provides scientific validation for the traditional use of Omigalsu in glucose regulation through the development and testing of OSM. Our findings demonstrated that OSM significantly reduced post-prandial blood glucose, supporting the historical documentation of Omigalsu's therapeutic properties in classical Korean medical texts. The observed glucose-regulating effects at physiologically relevant doses suggest that OSM has the potential as a functional food ingredient for diabetes management. Through the integration of traditional knowledge with modern scientific methodologies, our research not only validates historical therapeutic applications but also contributes to the development of evidence-based functional foods for contemporary health challenges.

Abbreviations

ANOVA	Analysis of variance
AUC	Area under the curve
BW	Body weight
OSTT	Oral sucrose tolerance test
OSM	Omija 50% ethanol extract + dried cooked soybean = 5:1
UNESCO	United Nations Educational, Scientific and Cultural Organization

Acknowledgements

We would like to express our gratitude to the Mungyeong City Hall and the staff of Mungyeong Agricultural Technology Center for providing samples of Omija (Schisandra chinensis (Turcz.) Baill.) and soybeans, as well as photographs necessary for this research, and for their cooperation. This work was supported by the "Food Functionality Evaluation Program" under the Ministry of Agriculture, Food, and Rural Affairs and the "Research Program" of the Korea Food Research Institute.

Author contributions

Yang and Kim contributed to the methodology and data collection, Lee conducted experimental verification and statistical analysis, Park performed animal experiments, experimental verification and supervision, and Jang contributed to the conceptualization, drafting of the manuscript, and resource provision. All authors read and approved the final manuscript.

Availability of data and materials

All data generated or analyzed during this study are included in this published article.

Declarations

Ethics approval and consent to participate

Animal experiments in this study were conducted with prior approval from the Institutional Animal Care and Use Committee of Hoseo University (HSUIACUC-24–021).

Consent for publication

Figures 1 and 2 were provided by Mungyeong Agricultural Technology Center, and permission for publication was obtained from the institution.

Competing interests

None of the authors of the manuscript have competing interests.

Received: 11 February 2025 Accepted: 6 March 2025
Published: 7 April 2025

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