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Research Article

Nutritional Composition, α-Glucosidase Inhibitory and Antioxidant Activities of *Ophiopogon japonicus* Tubers

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Ophiopogon japonicus tubers have been widely used as food and traditional Chinese medicine in China. However, their nutritional composition has not been fully reported yet. This study aimed to analyze the nutritional composition of *O. japonicus* tubers. The α-glucosidase inhibitory and antioxidant activities of the extracts obtained from *O. japonicus* tubers were also evaluated by *in vitro* assays. The results indicated that *O. japonicus* tubers are rich in carbohydrates, proteins, minerals, and amino acids. Among four extracts, the n-butanol fraction (nBF) and chloroform/methanol extract (CME) of *O. japonicus* tubers had high amounts of total phenolic and flavonoid contents and exhibited good α-glucosidase inhibitory and antioxidant activities. The α-glucosidase inhibition of nBF was higher than acarbose. Overall, *O. japonicus* tubers are full of nutritional compounds and have good α-glucosidase inhibitory and antioxidant activities.

1. Introduction

Ophiopogon japonicus (L.f.) Ker-Gawl is an evergreen perennial plant, widely distributed in Southeast Asia. In China, the tubers of *O. japonicus* are widely used as food and traditional Chinese medicine. As food, the tubers of *O. japonicus* could essentially be taken as root decoctions or teas. As a traditional Chinese medicine, it has been used to cure inflammation and cardiovascular diseases [1, 2].

Diabetes mellitus which reduces quality of life and shortens lifespan is a chronic condition characterized by high glycemic levels [3]. It is classified as either type I or type II. Type II diabetes is considered to be a preventable disease and is caused by an imbalance between blood sugar absorption and insulin secretion [4]. α-glucosidase is the key enzyme involved in intestinal glucose absorption. It catalyzes the release of α-glucosides from the nonreducing end of carbohydrates [5, 6]. Hence, its inhibition is considered an effective measure to regulate type II diabetes. Nowadays, acarbose and voglibose are the two widely used α-glucosidase inhibitors to treat diabetes by affecting blood glucose levels. Although effective, they usually exhibit some side effects such as flatulence, abdominal distension, and diarrhea [7, 8]. Therefore, it is very important to investigate functional foods with α-glucosidase inhibitory activity and without side effects.

Natural antioxidants present in the dietary and medicinal plants could help reduce oxidative damage. Therefore, there is an increasing interest in researching on natural compounds with antioxidant properties in recent years. The extracts of plant, containing flavonoids and phenolic compounds, are characterized by higher antioxidant activity than many pure antioxidant compounds [9]. In this context, many spontaneous and cultivated plants were evaluated for antioxidant activities [10–13].

Currently, studies on *O. japonicus* tubers are mainly focused on the pharmacologically active components such as saponins, homoisoflavonoids, and polysaccharides [14–17]. However, as food, the information of *O. japonicus* tuber in terms of its nutritional composition and α-glucosidase inhibitory and antioxidant activities is lacking. Thus, the aim of this study was to evaluate the nutritional composition and α-glucosidase inhibitory and antioxidant activities of *O. japonicus* tubers and provide support data for

the utilization of *O. japonicus* tubers as nutritive and functional food.

2. Materials and Methods

2.1. Materials, Chemicals, and Reagents. The tubers of *Ophiopogon japonicus* were collected from Mian Yang, Sichuan Province, China, in March 2012. Folin-Ciocalteu reagent, gallic acid, rutin, 2,2-diphenyl-1-picrylhydrazyl (DPPH), 2,4,6-tri(2-pyridyl)-s-triazine (TPTZ), 2,2-azinobis(3-ethylbenzothiazoline-6-sulfonic acid) (ABTS), 6-hydroxy-2,5,7,8-tetramethylchroman-2-carboxylic acid (trolox), neocuproine, α-glucosidase, *p*-nitrophenyl-α-D-glucopyranoside, amino acids, and fatty acids were purchased from Sigma-Aldrich (St. Louis, MO, USA). All other reagents and chemicals were either of analytical grade or of the highest quality available.

2.2. Proximate and Mineral Analyses. Moisture, ash, fat, dietary fiber, and protein contents were determined by AOAC methods (Association of Official Analytical Chemists, 2010) [18]. Carbohydrate content was calculated by subtracting the total percentage of the other constituents from 100. Minerals were determined according to AOAC method (2010) with a Model Z-2000 Series Polarized Zeeman Atomic Absorption Spectrophotometer (Hitachi, Japan).

2.3. Amino Acid Analysis. Amino acids were analyzed using AOAC (1995) method with some modifications [19]. Samples were hydrolyzed with 25 mL of a 6 N HCl solution at 110°C for 24 h. Amino acid analysis was carried out by employing sodium citrate buffers as step gradients with the cation exchange postcolumn ninhydrin derivatization method with a Hitachi L-8800 amino acid analyser (Hitachi, Japan).

2.4. Fatty Acid Analysis. Total lipids of *O. japonicus* tubers were extracted and esterified according to the method described by Sun et al. [20]. Methylated fatty acids were extracted with 1 mL of hexane and 1 mL of water and then evaporated to dryness under nitrogen and redissolved in 100 μL of chloroform before injection. Fatty acid analysis was performed by GC-MS with a Shimadzu GC/MS-QP 2010 Ultra (Shimadzu, Japan). An rxi-5MS capillary column (30 m × 0.25 mm inner diameter) was coated with a 0.25 μm film. The injection volume was 1 μL. The split ratio was 1 : 100. The oven temperature was increased from 80°C to 280°C at a rate of 8°C/min and held at 280°C for 10 min. Helium was used as the carrier gas at a flow rate of 0.80 mL/min. The ion source temperature was set at 230°C. The interface temperature was set at 270°C. The mass range was m/z 40~460 amu.

2.5. Preparation of the Extracts of O. japonicus Tubers. *O. japonicus* tubers were oven-dried at 50°C until constant weight and pulverized to powder. The dried powder of *O. japonicus* tubers was extracted with methanol, chloroform/methanol (1 : 1, v/v), 70% ethanol, or water (20 g powder/200 mL solvent) three times by heat reflux for 2 h. The extracted solutions of methanol, chloroform/methanol and 70% ethanol were combined and filtered, respectively. The filtrates were evaporated to dryness to obtain the methanol extract (ME), chloroform/methanol extract (CME), and 70% ethanol extract. The 70% ethanol extract was redissolved in distilled water (100 mL) and then partitioned with water-saturated n-butanol (100 mL) three times to obtain the n-butanol extract. The n-butanol extracts were combined and evaporated to dryness to yield the n-butanol fraction (nBF). The extracted solution of water was filtered and condensed to the concentration of 0.2 g dried powder per milliliter. The concentrate was precipitated in 80% ethanol and kept overnight at 4°C. Then, after filtering, the precipitate was dried in vacuum at 50°C to obtain the crude polysaccharides (OJP).

2.6. Determination of Total Phenolic and Flavonoid Contents. The total phenolic content was determined according to the Folin-Ciocalteau method [21]. The reaction mixture consisted of 0.1 mL of the extract, 0.4 mL of deionized water, 2.5 mL of a 2 N Folin-Ciocalteau reagent, and 2 mL of a 7.5% (w/v) Na_2CO_3 solution. The mixture was incubated at room temperature for 1 h in the dark. The absorbance was determined at 765 nm. Gallic acid was used as reference standard. The total phenolic content was expressed as mg gallic acid equivalent (GAE)/g dry weight sample.

The total flavonoid content was estimated by the method of Sun et al. with some modifications [22]. In brief, 0.5 mL of sample was mixed with 0.2 mL of a 5% $NaNO_2$ solution. After 6 min, 0.2 mL of 10% $AlCl_3$ solution was added. After 5 min, 2 mL of 1 mol/L NaOH solution was added. The mixture was adjusted to 5 mL with methanol and measured at 510 nm. Rutin was used as reference standard. The total flavonoid content was expressed as mg rutin equivalent (RE)/g dry weight sample.

2.7. Determination of α-Glucosidase Inhibitory Activity. α-glucosidase inhibitory activity was evaluated according to a modified method described by Liu et al. [23]. Three concentrations (1 mg/mL, 2 mg/mL, and 4 mg/mL) of ME, CME, nBF, and OJP obtained from *O. japonicus* tubers were tested. Briefly, 50 μL of α-glucosidase (400 U/L) was mixed with 50 μL of sample and 50 μL phosphate buffer (100 mmol/L, pH 6.9). After preincubation for 10 min at 37°C, 50 μL of *p*-nitrophenyl-α-D-glucopyranoside (5 mmol/L) was added. The mixture was incubated for 10 min at 37°C. Then, 1.2 mL of a 0.1 mol/L Na_2CO_3 solution was added to stop the reaction. The absorbance was measured at 405 nm using a spectrophotometer. Acarbose was used as positive control. The inhibition percentage (%) of α-glucosidase was calculated as follows: Inhibition (%) = $[1 - (A_{\text{sample}}/A_{\text{control}})] \times 100$.

2.8. Determination of Antioxidant Activity. DPPH radical scavenging activity was evaluated according to the method described by Sarikurkcu et al. with slight modifications [24]. Briefly, 0.5 mL of the sample solution was mixed with 3 mL of DPPH solution (0.06 mmol/L). The absorbance of the mixture was measured at 517 nm after 30 min incubation in the dark at room temperature. Trolox was used as the reference compound, and the results are expressed as mmol trolox equivalents (TE)/kg dry weight sample.

Table 1: Proximate composition of *O. japonicus* tubers (g/100 g DW).

Moisture	Ash	Dietary fiber	Fat	Protein	Carbohydrate
9.19 ± 0.64	2.48 ± 0.06	4.02 ± 0.37	0.23 ± 0.02	23.05 ± 0.33	63.52 ± 1.27

Values are expressed as mean ± SD of three determinations.

ABTS radical scavenging activity was determined using the method described by Re et al. with some modifications [25]. Potassium persulfate was mixed with an ABTS solution (7 mmol/L) at final 2.45 mmol/L concentration. After keeping for 12–16 h in the dark at room temperature, the $ABTS^{+\bullet}$ solution was diluted with ethanol to achieve an absorbance value of 0.7 ± 0.02 at 734 nm before use. Then, 0.5 mL of sample was added to 2 mL of diluted $ABTS^{+\bullet}$ solution. After 5 min incubation at room temperature, the absorbance of the mixture was measured at 734 nm. The results are expressed as mmol trolox equivalents (TE)/kg dry weight sample.

Ferric reducing antioxidant capacity (FRAP) was evaluated using a modified method reported by Benzie and Strain [26]. FRAP reagent was prepared freshly by mixing 50 mL of acetate buffer (300 mmol/L, pH 3.6), 5 mL of TPTZ (10 mmol/L) in HCl (40 mmol/L), and 5 mL of a $FeCl_3$ solution (20 mmol/L). The FRAP reagent was incubated at 37°C. Then, 0.05 mL sample solution was mixed with 3 mL of FRAP reagent. The absorbance of the solution was recorded at 593 nm after 4 min incubation at 37°C. The FRAP absorbance was determined by calculating the difference in absorbance of the sample and the control. The final results are reported as mmol trolox equivalents (TE)/kg dry weight sample.

Cupric reducing antioxidant capacity (CUPRAC) was determined using a modified method described by Apak et al. [27]. Briefly, 0.5 mL of sample and 1 mL of 1 mol/L NH_4Ac buffer (pH 7.0) were added to 1 mL of 7.5 mmol/L neocuproine solution; then 1 mL of 10 mmol/L $CuCl_2$ solution and 0.6 mL of deionized water were added. The mixture was incubated at room temperature for 1 h. The absorbance was measured at 450 nm. The results are expressed as mmol trolox equivalents (TE)/kg dry weight sample.

2.9. Statistical Analysis. All experiments were performed in triplicate, and the data are expressed as mean ± SD (standard deviation). Data were subjected to one-way analysis of variance (ANOVA) followed by Duncan's test. Tests on correlation between antioxidant capacity and the total phenolic and flavonoid contents were made using the Pearson correlation coefficient (r). Statistical analysis was carried out using SPSS 17.0. Differences with p values of <0.05 were regarded as significant.

3. Results and Discussion

3.1. Proximate and Mineral Analyses. The proximate composition of *O. japonicus* tuber is presented in Table 1. The carbohydrate was the predominant component (63.52 g/100 g), followed by protein (23.05 g/100 g). According to the data reported by Basu et al. [28] and Noman et al. [29], the carbohydrate content of *O. japonicus* tuber is significantly higher than that of *Alocasia indica* tuber (45.58 g/100 g), *Pachyrhizus erosus* L. tuber (14.90 g/100 g), and potato (19.23 g/100 g). The protein content is similar to peanuts (22.82 g/100 g) [30] and is higher than that of *Alocasia indica* tuber (3.03 g/100 g) [28] and *Pachyrhizus erosus* L. tuber (1.23 g/100 g) [29]. Dietary fibres could promote human health by reducing the risk of constipation, diabetes, and cardiovascular disease. The total dietary fibre content of *O. japonicus* tuber was 4.02 g/100 g and was higher than that of sweet potato (*Ipomoea batatas* L.) tubers (1.89–3.48 g/100 g) [31]. Moisture, ash, and fat contents of *O. japonicus* tubers were 9.19 g/100 g, 2.48 g/100 g, and 0.23 g/100 g, respectively.

Table 2: Mineral contents of *O. japonicus* tubers (mg/100 g DW).

Minerals	Tubers
Cu	0.32 ± 0.00
Zn	0.42 ± 0.02
Fe	10.26 ± 0.14
Mn	0.36 ± 0.00
K	251.50 ± 3.69
Na	11.66 ± 0.13
Mg	36.85 ± 0.32
Ca	241.58 ± 1.34

Values are expressed as mean ± SD of three determinations.

The mineral composition (Cu, Zn, Fe, Mn, K, Na, Ca, and Mg) of *O. japonicus* tuber is shown in Table 2. Among the minerals, the most abundant mineral was K (251.50 mg/100 g DW), followed by Ca (241.58 mg/100 g), Mg (36.85 mg/100 g), Na (11.66 mg/100 g), and Fe (10.26 mg/100 g). Ca is the main component of bones and teeth. Inadequate intake of K from the diet causes hypokalemia, which may lead to cardiac arrhythmia and acute respiratory failure, and low levels of Mg are associated with several diseases such as asthma, diabetes, and osteoporosis [32]. Our results indicated that *O. japonicus* tubers are abundant in K, Ca, and Mg and could be used as a potential food resource for taking in K, Ca, and Mg.

3.2. Amino Acid and Fatty Acid Compositions of O. japonicus Tubers. Amino acids are the basic material required to constitute animal nutrition protein and also have some good biological activities. Previous studies reported that aspartate and glutamate owned antioxidant properties, and supplements rich in glutamate, histidine, leucine, and lysine could reduce the body weight in high-fat diet fed mice [33, 34]. Amino acid composition of *O. japonicus* tubers is presented in Table 3. In this study, sixteen amino acids were found in *O. japonicus* tubers. The essential amino acid content (9.40 mg/g DW) was lower than the nonessential amino acid content (18.49 mg/g DW) in *O. japonicus* tubers. The essential amino acid content comprised 33.72% of the total amino acid content (27.88 mg/g DW). The most abundant amino acid was

Table 3: Amino acid composition of *O. japonicus* tubers (mg/g DW).

Amino acid	Tubers
Isoleucine[1]	1.05 ± 0.10
Threonine[1]	0.66 ± 0.10
Valine[1]	1.71 ± 0.22
Methionine[1]	3.05 ± 0.13
Leucine[1]	1.39 ± 0.20
Phenylalanine[1]	0.73 ± 0.15
Lysine[1]	0.81 ± 0.12
Aspartate	2.50 ± 0.11
Serine	1.79 ± 0.20
Glutamate	5.16 ± 0.21
Proline	2.09 ± 0.15
Glycine	0.75 ± 0.12
Alanine	1.37 ± 0.14
Tyrosine	0.45 ± 0.11
Histidine	0.47 ± 0.11
Arginine	3.91 ± 0.28
Essential amino acid content	9.40 ± 0.87
Nonessential amino acid content	18.49 ± 0.50
Total amino acid content	27.88 ± 0.80

Values are expressed as mean ± SD of three determinations.
[1]Essential amino acid.

Table 4: Fatty acid composition of *O. japonicus* tubers (mg/100 g DW).

Fatty acid	Weight
Hexadecanoic acid	413.4 ± 10.2
Heptadecanoic acid	8.1 ± 0.9
Linoleic acid	643.3 ± 11.7
Linolenic acid	112.1 ± 7.3
Octadecanoic acid	41.9 ± 4.1

Values are expressed as mean ± SD of three determinations.

glutamate (5.16 mg/g DW), followed by arginine (3.91 mg/g DW), methionine (3.05 mg/g DW), and aspartate (2.50 mg/g DW). Our results indicated that *O. japonicus* tubers were rich of amino acids and represent a good source of amino acid supplementation.

Fatty acids are one of the major human nutritional requirements. The fatty acid composition of *O. japonicus* tubers is presented in Table 4. Five fatty acids were detected in *O. japonicus* tubers: linoleic acid was the principal fatty acid followed by hexadecanoic, linolenic, octadecanoic, and heptadecanoic acids in decreasing order. Linoleic acid is an indispensable nutrient. Deprivation of linoleic acid can result in scaly skin lesions, growth retardation, and altered plasma fatty acid patterns and thrombocytopenia [35].

3.3. Total Phenolic and Total Flavonoid Contents of the Extracts of O. japonicus Tubers. Phenolic and flavonoid compounds are ubiquitous in plants, and they possess good α-glucosidase inhibitory activity and antioxidant function [36–38]. They are considered as potentially health-promoting substances. Our results on extraction yield, total phenolic and flavonoid contents of different extracts of *O. japonicus* tubers are presented in Table 5. As a result, the extraction yield of methanol extract (ME) was significantly higher than that of other extracts. The total phenolic content in the extracts ranged from 6.1 to 42.5 mg/g. Total flavonoid content varied from 4.1 to 26.7 mg/g. The highest total phenolic and flavonoid contents were found in the n-butanol fraction (nBF), followed by chloroform/methanol extract (CME). The crude polysaccharides (OJP) did not detect phenolic and flavonoid contents. The results indicated that n-butanol and chloroform/methanol (1 : 1, v/v) were more suitable solvents to extract phenolic and flavonoid substances from *O. japonicus* tubers.

3.4. α-Glucosidase Inhibitory Activity of the Extracts of O. japonicus Tubers. α-glucosidase inhibitors can retard the uptake of dietary carbohydrates and manage postprandial hyperglycemia [39]. α-glucosidase inhibitors from natural food sources can be useful for treating diabetes. Chen et al. [40] reported that the polysaccharide from *O. japonicus* exhibited protective effect on diabetic rats. However, there are no reports about the α-glucosidase inhibitory activity of *O. japonicas* tuber. In this study, three concentrations (1 mg/mL, 2 mg/mL, and 4 mg/mL) of ME, CME, nBF, and OJP obtained from *O. japonicus* tubers were tested to determine levels of α-glucosidase inhibition.

As shown in Table 6, the α-glucosidase inhibition of the extracts at three concentrations decreased in the order of nBF > CME > ME > OJP. It was in agreement with the results of total phenolic and flavonoid contents in this study. Among the extracts, nBF and CME exhibited excellent α-glucosidase inhibitory activity. When at a concentration of 2 mg/mL only nBF inhibited more than 50% of α-glucosidase inhibitory activity, while CME and acarbose inhibited 31.6% and 43.4%, respectively. At the concentration of 4 mg/mL, nBF exhibited the highest α-glucosidase inhibition (74.4%), which was significantly higher than that of acarbose (61.3%, $p < 0.05$). CME inhibited 53.0% of α-glucosidase inhibitory activity, which was slightly lower than that of acarbose at 4 mg/mL concentration. The results demonstrate that nBF and CME of *O. japonicus* tubers have potential as α-glucosidase inhibitors, and the α-glucosidase inhibitory activity of nBF is much higher than that of acarbose.

3.5. Antioxidant Activity of the Extracts of O. japonicus Tubers. The antioxidant activities of the extracts of *O. japonicus* tubers are shown in Table 7. The antioxidant activity of the extracts decreased in the order of nBF > CME > ME > OJP, according to the DPPH, ABTS, FRAP, and CUPRAC assays, and it was in agreement with the results of total phenolic and flavonoid contents. Among the extracts, nBF exhibited the strongest antioxidant activity while OJP exhibited the lowest antioxidant activity. As shown in Table 8, the antioxidant activityofthe extracts was significantly correlated with the total phenolic and flavonoid contents, according to the DPPH, ABTS, and CUPRAC assays. Ferric reducing antioxidant capacity (FRAP) of the extracts was significantly correlated with the total phenolic content. Wang et al. [41] and

Table 5: Extraction yield, total phenolic and flavonoid contents of *O. japonicus* tubers extracts.

Sample	Extraction yield (w/w, %)	Total phenolic content (mg GAE/g)	Total flavonoid content (mg RE/g)
ME	26.4 ± 1.4^{c}	6.1 ± 0.5^{a}	4.1 ± 1.0^{a}
CME	3.9 ± 0.2^{a}	19.6 ± 1.6^{b}	16.3 ± 1.3^{b}
nBF	2.6 ± 0.3^{a}	42.5 ± 1.7^{c}	26.7 ± 1.6^{c}
OJP	19.4 ± 1.1^{b}	ND	ND

Values are expressed as mean ± SD of three determinations.
Means within a column with different letters (a~c) indicate significant differences at $p < 0.05$.
ME: methanol extract; CME: chloroform/methanol extract; nBF: n-butanol fraction; OJP: crude polysaccharides; ND: not detected.

Table 6: α-glucosidase inhibitory activity of *O. japonicus* tubers extracts.

Sample	Inhibition (%) of α-glucosidase		
	1 mg/mL	2 mg/mL	4 mg/mL
ME	7.4 ± 0.4^{b}	7.9 ± 0.7^{b}	10.6 ± 0.8^{b}
CME	16.4 ± 1.0^{c}	31.6 ± 0.7^{c}	53.0 ± 1.3^{c}
nBF	36.2 ± 0.5^{e}	56.8 ± 0.5^{e}	74.4 ± 0.4^{e}
OJP	1.1 ± 0.4^{a}	1.2 ± 0.5^{a}	4.3 ± 0.4^{a}
Acarbose	25.3 ± 0.8^{d}	43.4 ± 0.8^{d}	61.3 ± 1.0^{d}

Values are expressed as mean ± SD of three determinations.
Means within a column with different letters (a~e) indicate significant differences at $p < 0.05$.

Table 7: Antioxidant activity of *O. japonicus* tubers extracts determined by the DPPH, ABTS, FRAP, and CUPRAC methods.

Sample	DPPH (mmol TE/kg)	ABTS (mmol TE/kg)	FRAP (mmol TE/kg)	CUPRAC (mmol TE/kg)
ME	12.1 ± 2.0^{b}	25.9 ± 3.4^{b}	20.7 ± 2.7^{b}	46.7 ± 4.6^{b}
CME	31.0 ± 1.1^{c}	85.4 ± 3.7^{c}	53.8 ± 1.6^{c}	104.1 ± 2.8^{c}
nBF	62.6 ± 3.7^{d}	119.7 ± 1.7^{d}	161.9 ± 3.1^{d}	247.9 ± 3.6^{d}
OJP	4.2 ± 1.1^{a}	13.0 ± 2.3^{a}	8.2 ± 3.4^{a}	18.1 ± 4.7^{a}

Values are expressed as mean ± SD of three determinations.
Means within a column with different letters (a~d) indicate significant differences at $p < 0.05$.

Table 8: Correlation coefficients (r) between the total phenolic and flavonoid contents and the antioxidant activity of *O. japonicus* tubers.

	DPPH	ABTS	FRAP	CUPRAC
Total phenolic content	1.000^{**}	0.971^{*}	0.985^{*}	0.996^{**}
Total flavonoid content	0.987^{*}	0.996^{**}	0.946	0.968^{*}

*Correlation is significant at $p < 0.05$; **correlation is significant at $p < 0.01$.

Xiong et al. [42] reported that the purified polysaccharides of *O. japonicus* tubers showed strong DPPH radical and hydroxyl radical scavenging activity. Their results indicated that the purified polysaccharides of *O. japonicus* tubers have strong antioxidant activity. In this study, our results demonstrated that the antioxidant activity of *O. japonicus* tubers is more correlated with its phenolic and flavonoid contents compared to polysaccharides.

4. Conclusions

In this study, the nutritional composition and α-glucosidase inhibitory activity of *O. japonicus* tubers were determined for the first time, and the antioxidant activity of *O. japonicus* tubers was also evaluated. In conclusion, *O. japonicus* tubers are rich in carbohydrates, proteins, minerals, and amino acids. Linoleic acid was the principal fatty acid. nBF and CME of *O. japonicus* tubers exhibited excellent α-glucosidase inhibitory and antioxidant activities. Our results suggest that nBF and CME of *O. japonicus* tubers could be used as α-glucosidase inhibitors. The results obtained in this study might contribute to further investigation of *O. japonicus* tuber on its potential application values for food.

Conflict of Interests

The authors declare no conflict of interests.

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