Pak. J. Bot., 58(4): 873-881, April 2026.

ARTICLE | DOI: http://dx.doi.org/10.30848/PJB2026-4(6)

STUDY THE DIFFERENCES BETWEEN DIFFERENT CONCOCTIONS OF *POLYGONATUM ODORATUM* BASED ON SUGAR COMPOSITION

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Abstract

The present study aimed to investigate the variations in sugar composition among different processed forms of *Polygonatum odoratum* and establish a methodology for analyzing its carbohydrate content. This approach provides a reference for the clinical selection of processed *Polygonatum odoratum* products. Raw *Polygonatum odoratum* is bitter and astringent and is typically consumed after processing. However, research on processed *Polygonatum odoratum* products remains limited. Therefore, this paper examines the differences among various processed slices of *Polygonatum odoratum*, focusing on sugars as the primary active ingredient. The results demonstrate that processing reduces the total polysaccharide content and the relative molecular mass. Meanwhile, the free sugar content increases in all cases, with the degree of increase following the order: processed *Polygonatum odoratum* > stewed *Polygonatum odoratum* > wine-processed *Polygonatum odoratum* > honey-processed *Polygonatum odoratum*. While the composition of monosaccharides remains consistent before and after processing, the molar ratios change significantly. These findings indicate that different processing methods result in substantial alterations in the sugar composition of *Polygonatum odoratum*, with each processed product exhibiting unique characteristics. Notably, the stewed method shows significant advantages, providing a foundation for developing clinically relevant stewed *Polygonatum odoratum* products.

Key words: *Polygonatum odoratum*; Fabricate; Sugar

Introduction

Polygonatum odoratum is the dried rhizome of Polygonatum, family Liliaceae, which is sweet and flat in nature and enters the lung and stomach meridians. The main chemical components of *Polygonatum odoratum* are polysaccharides (Jiang *et al.*, 2018; Jing *et al.*, 2022; Zong *et al.*, 2022) and saponins (Bi *et al.*, 2023; Zhao *et al.*, 2023). Modern research has shown that it has anti-aging, cardiomyocyte protection, and other pharmacological effects (Zhao *et al.*, 2019; Li *et al.*, 2023; Liu *et al.*, 2023). The raw taste of *Polygonatum odoratum* is bitter and astringent, and it usually needs to be concocted for consumption (Yang *et al.*, 2024). Research on the concocted products of *Polygonatum odoratum* is still shallow, and only *Polygonatum odoratum* slices are included in the 2020 edition of the Chinese Pharmacopoeia. Literature studies have only optimized the preparation process of honey *Polygonatum odoratum* and wine *Polygonatum odoratum* (Wang e*t al.*, 2012). The stewed method is one of the characteristic methods of preparation of Jianchang school, one of the "four major schools of Chinese medicine preparation", and the stewed method will play a significant role in increasing the effectiveness of the preparation of tonic Chinese medicines. At present, the stewed method has been applied to Chinese herbal medicines such as *Polygonati Rhizoma* (Huang *et al.*, 2021), *Radix Rehmanniae* (Zong *et al.*, 2022), *Polygalae radix* (Li *et al.*, 2022b), *Polygoni Multiflori radix* (Wang *et al.*, 2023b), etc., and achieved more significant results of "reducing toxicity and increasing efficiency". The research of this group on the sugar composition of stewed *Polygonati Rhizoma* shows that stewed *Polygonati Rhizoma* can not only improve the numbness of *Polygonati Rhizoma* compared with other *Polygonati Rhizoma* concoctions but also effectively enhance the antioxidant property of *Polygonati Rhizoma* (Huang *et al.*, 2021). *Polygonatum odoratum* and *Polygonati Rhizoma* are plants of the same family and are widely used Chinese medicines with the same source of food and medicine (Wang *et al.*, 2023a). Their main active ingredients are polysaccharides, therefore, this paper is the first to adopt the braising method for the concoction of *Polygonatum odoratum* and take the sugar composition of *Polygonatum odoratum* as the research index, to explore the differences in the sugar composition of stewed *Polygonatum odoratum*, wine *Polygonatum odoratum*, honey *Polygonatum odoratum*, processed *Polygonatum odoratum*, and raw *Polygonatum odoratum*. It is intended to provide a data basis for the development of stewed *Polygonatum odoratum* and to provide a reference for the clinical application of *Polygonatum odoratum*'s concoctions.

Materials and Methods

Materials

Controls: Rhamnose (99.9%, 111683-201502), glucose (99.9%, 110833-201707), xylose (99.9%, 111508-201605), mannose (99.4%, 140651-201504) galactose (99.5%, 190090-201501), arabinose (111506-200202), fructose (99.7%, BCY-000366), sucrose (99.7%, GBW10067), dextrose molecular weight standards (set) (control dextrose

Received: 03-06-2025 | Revised: 18-09-2025 | Accepted: 19-09-2025 | Online: 19-12-2025

D3 Mp 9750, dextrose D4 Mp 13050, dextrose D5 Mp 36800, dextrose D6 Mp 64650 Dextran D7 Mp 135350, Dextran D2000 Mp 2000000 Batch No. 140637-201203) were supplied by the China Academy of Food and Drug Control.

Reagents: Acetonitrile (chromatographic purity, AQA Sinopharm Group Chemical Reagent Co., Ltd.); hydrochloric acid, sulfuric acid, methanol, anhydrous ethanol, petroleum ether, ethyl ether, acetone, trichloromethane, n-butanol (analytical purity, Shanghai Pinchot Chemical Co., Ltd.); other reagents, such as sodium chloride, sodium sulfate, and sodium hydroxide (Xilong Science Co., Ltd.).

CS101-2E electric blast drying oven (Chongqing Wanda Instrument Co., Ltd.), HH-S6 thermostatic water bath (Gongyi IYUHUA Instrument Co., Ltd.), AB104-N one hundred thousandth balance (MettLer-Toledo, MS205DU), Milli-Q ultrapure water meter (Millipore Corporation, USA), UV-2550 UV- Visible Spectrophotometer (Shimadzu, Japan), SHIMADZU LC-20AT High - Performance Liquid Chromatograph - UV Detector (Shimadzu, Japan), LC-20AD High-Performance Gel Chromatograph-Differential Refractive Index Detector (Shimadzu, Japan), Waters 2695 - Alltech ELSD2000 - High-Performance Liquid Chromatograph - Evaporative Light Scattering Detector (Waters, USA). Waters Corporation).

All the *Polygonatum odoratum* herbs used in this study were provided by Jiangxi Jianchang school Pharmaceutical Co., Ltd. and identified by Professor Xie Xiaomei of Jiangxi University of Traditional Chinese Medicine as *Polygonatum odoratum* plants of the genus *Polygonati Rhizoma*, family Liliaceae. The *Polygonatum odoratum* herbs is harvested in autumn.The stewed *Polygonatum odoratum* slices were made concerning the stewed *Polygonatum odoratum* concoctions of " Jiangxi Provincial Standards for the Concoction of Chinese Medicinal Pieces" and "Jianchang school Concoctions," The stewed *Polygonatum odoratum* slices were store in a dry place. The *Polygonatum odoratum* herbs numbered from Y1 to Y10, and the stewed *Polygonatum odoratum* samples corresponding to the numbers of WY1 to WY10, and the wine, honey *Polygonatum odoratum* and made *Polygonatum odoratum* were concocted from Y10. The samples were processed by Y10, with JY10, MY10, and ZY10 numbers, respectively. The basic information of the samples is shown in Table 1

Methods

Stewed method of the concocting process: Take the original medicine, remove impurities, wash, bleach with clean water for about 1 day, remove, drain, put into stewed medicine jar, each jar of medicine 2/3, add warm water, cover, move to the stove, pile dry chaff, ignite stewed for 1 day, until the medicine is cooked and juice is exhausted, removed, dry; spray evenly with wine, smothered, to be sucked up, steamed for 6 hours, simmering overnight, to the turn black, remove, dry to half dry! Cut diagonal thick slices and dry.

Honey *Polygonatum odoratum* concoction process: Take net *Polygonatum odoratum* slices, add yellow wine, mix well, smother, steam, remove, and dry.

***Polygonatum odoratum* wine concoction process:** Take the refined honey and dilute it with the appropriate amount of cold-boiled water. Add the net *Polygonatum odoratum* slices, mix it well, and put it into the frying container. Fry it with mild fire until it doesn't stick to the hand. Take it out and let it cool down.

***Polygonatum odoratum* concoction process:** The original medicine to remove black grease and other impurities, quick wash, placed in the steamer, steamed to the inside and outside of the moistened black, sun or dry to the outside of the dry inside of the moistened, cut thick slices, will be steamed when the juice obtained into the mix, so that it sucked out, drying.

Determination of total polysaccharide content of *Polygonatum odoratum* herbs and tablets: Reference was made to the Chinese Pharmacopoeia (2020 edition), a "content determination" under the item "*Polygonatum odoratum*". D-Anhydrous glucose was used as the control, and the phenol-sulphuric acid color development method was adopted as the method—determination of polysaccharides in *Polygonatum odoratum* schidigera.

Table 1. The basic information of the samples.

Source	*Polygonatum odoratum*		Artillery products	
	Serial number	The source (of a product)	Serial number	Source (of information etc.)
Polygonatum odoratum	Y1	North-eastern	WY1	Y1 stewed
	Y2		WY2	Y2 stewed
	Y3		WY3	Y3 stewed
	Y4	Longhui, Hunan	WY4	Y4 stewed
	Y5		WY5	Y5 stewed
	Y6		WY6	Y6 stewed
	Y7	Shaodong, Hunan	WY7	Y7 stewed
	Y8		WY8	Y8 stewed
	Y9		WY9	Y9 stewed
	Y10	Shaodong, Hunan	WY10	Y10 stewed
			JY10	Y10 Manufactured alcohol products
			MY10	Y10 Manufactured honey products
			ZY10	Y10 manufactured

Determination of free sugar content of *Polygonatum odoratum* herbs and *Polygonatum odoratum* tablets

Preparation of control solution: Separately weigh the appropriate amount of fructose, glucose, and sucrose control product dried to constant weight under reduced pressure. Place in the same 10 mL volumetric flask, add water to dissolve and dilute the volume to the scale and shake well. Fructose concentration of 1.107 mg/mL, glucose concentration of 0.518 mg/mL, and sucrose concentration of 0.712 mg/mL of the mixed control solution.

Preparation of test material: Precisely weigh 0.20 g of this product, add 50 mL of ultrapure water, tightly plug, weigh, heat reflux for 30 min, cool, weigh again, and make up the weight. Shake well, and pass through the 0.22 μm aqueous microporous filter membrane that is obtained.

Chromatographic conditions: Instrument: Waters2695-Alltech ELSD2000-High Performance Liquid Chromatograph-Evaporative Light Scattering Detector; Column: Sepax HP-Amino (5 μm 4.6×250 mm); Mobile phase: Acetonitrile-water (85∶15); Column temperature: 30℃; Flow rate: 1.0 mL/min; Drift tube temperature: 80℃; Carrier gas flow rate: 2.0 mL/min.

Determination of the molecular weight of *Polygonatum Odoratum* and *Polygonatum Odoratum* tablets

Preparation of controls: Weigh an appropriate amount of known molecular weight dextran molecular weight standard (set) D3, D4, D5, D6, D7, D2000 series control, and make a 10 mg/mL control solution by dissolving with 0.71% sodium sulfate mobile phase solution.

Preparation of test solutions: Weigh 50 g of crude powder, put in a round-bottomed flask, add 150 mL of petroleum ether, and reflux extraction at 66℃ for 4 h degreasing. After evaporating the solvent, the sample was extracted with 150 mL of ether overnight for further degreasing. Volatile dry solvent added 150 mL of 80% ethanol 84℃ reflux for 4 h. The sample was poured off the upper layer of liquid, and placed in an oven at 60℃ drying to constant weight, to get degreasing Polygonatum odoratum. Take the above-defatted Polygahatous, add 400 mL of ultrapure water, 100℃ water bath for 2 h, and take the upper layer of liquid. Then add 300 mL of ultrapure water, and 100℃ water bath for 2 h. Combine the two upper layers of liquid, concentrated to 100 mL, and add the appropriate amount of 80% ethanol, precipitation overnight. Take the upper layer of alcohol precipitation, concentrate, add the appropriate amount of 80% ethanol, precipitation overnight, and repeat 2 times. The three precipitates, washed with acetone, placed in an oven at 60℃ drying to constant weight, the Polygahatous crude polysaccharide. Take the crude polysaccharide of Polygahatous processed above, add appropriate amount of ultrapure water to re-dissolve, add Sevage (trichloromethane: n-butanol = 4:1) reagent in the ratio of 4:1, shake well, centrifuge for 20 min (4000 r/min), discard the lower layer of denatured protein precipitation, take the supernatant, repeat the above operation for 2 times, dry and get the polysaccharide of deproteinisation. Add an appropriate amount of activated carbon particles and zeolite, heat to micro-boiling on the electric heating jacket, keep micro-boiling for about 1 h, and remove the pigment, to get the refined polysaccharide. Precision weighing of the above preparation of refined polysaccharide appropriate amount, with 0.71% Na2SO4-0.02% NaN3 dissolved and diluted shaking well, to obtain 2.5 mg/mL of test solution.

Chromatographic conditions: Instrument: LC-20AD-High Performance Liquid Chromatograph (HPLC) - Oscillometric Refractive Detector (ORD), Lab Solutions with GPC software; Column: Shodex Ashipak GF-7M HQ (9 μm 7.6×300 mm); Mobile phase: 0.71% sodium sulfate solution; Flow rate: 0.5 mL/min, Column temperature: 40℃, Injection volume: 10 μL. The column temperature was 40℃, and the injection volume was 10 μL. The cell temperature of the oscillometric refractive detector was 40℃.

Analytical study on the composition of monosaccharides in *Polygonatum odoratum* and its slices

Preparation of control solution: Take an appropriate amount of mannose, rhamnose, glucose, arabinose and galactose dried to constant weight under reduced pressure, put them in the same 10 mL volumetric flask, dilute with water and make the volume to the scale, and then make a mixed control solution containing mannose at 0.1058 mg/mL, rhamnose at 0.1055 mg/mL, glucose at 0.1024 mg/mL, arabinose at 0.1074 mg/mL and galactose at 0.1049 mg/mL. galactose concentration of 0.1049 mg/mL, and mixed control solution.

Preparation of test solutions: Precisely weigh 0.50 g of this product, placed in Soxhlet extractor, add 80% ethanol appropriate amount, heating reflux extraction for 4 h, discard the liquid, dregs of ethanol evaporation, the filter paper cartridge split in a beaker, add 100 mL of water, reflux for 1 h, mixing, centrifugation, take up the supernatant 1.0 mL, placed in an ampoule, add 3.0 mol/L hydrochloric acid solution 0.5 mL, seal, mix, hydrolysis at 110℃ for 3 hours. Hydrolyse for 3 hours at 110℃, cool, and adjust the pH to neutral with 3.0 mol/L sodium hydroxide solution. Aspirate 400 μL, add 0.5 mol/L PMP (1-phenyl-methyl-5-pyrazolone) methanol solution and 0.3 mol/L sodium hydroxide solution 400 μL each, mix well, 70℃ water bath reaction for 100 min. and then add 0.3 mol/L hydrochloric acid solution 500 μL mix well, wash with trichloromethane three times, 5 mL each time, and discard the trichloromethane solution. The aqueous layer was obtained and centrifuged.

Chromatographic conditions: Instrument: SHIMADZU LC-20AT high-performance liquid chromatography with ultraviolet detector; Column: Agilent Eclipse XDB-C18 (5μm 250mm×4.6mm); Mobile phase: acetonitrile-0.02 mol/L ammonium acetate (20∶80); Detection wavelength: 250 nm; Flow rate: 1.0 mL/min; Column temperature: 30 The column temperature was 30℃.

Results and Discussion

Free sugar content determination: The free sugar content in *Polygonatum odoratum* was determined with reference to the aforementioned free sugar content determination method, and the chromatogram is shown in Fig. 1. Quantitative analysis results revealed significant differences in free sugar content among different processed samples. Compared with the raw Polygonatum odoratum (with a total polysaccharide content of 11.70%), the stewed *Polygonatum odoratum* exhibited significantly increased contents of fructose (40.34%) and glucose (18.65%), while the total polysaccharide content decreased to 6.62%. The results are shown in Table 2. These results indicate that the stewed method applied to *Polygonatum odoratum* can promote the hydrolysis of polysaccharides.

Molecular weight determination: With reference to the established method for determining the molecular weight of *Polygonatum odoratum* polysaccharides described above, representative chromatograms are shown in Fig. 2, including the standard calibration curve, blank solvent spectrum, and spectra of each sample. The molecular weight parameters for the two major chromatographic peaks in each sample—weight-average molecular weight (Mw), number-average molecular weight (Mn), and polydispersity index (Mw/Mn)—were calculated, and the results are summarized in Table 3. The results indicate that the stewed method can significantly reduce the molecular weight of *Polygonatum odoratum* polysaccharides. For instance, compared with the raw sample (7437.00 kDa), the weight-average molecular weight of stewed Polygonatum odoratum (WY10) decreased drastically (236.37 kDa for Peak 1), indicating that extensive chain breaking of *Polygonatum odoratum* polysaccharides occurred during processing. The polydispersity index also decreased, suggesting a narrower molecular weight distribution of the polysaccharides after processing.

Monosaccharide composition determination: To evaluate the structural changes of polysaccharides induced by different processing methods, the monosaccharide composition of *Polygonatum odoratum* was analyzed. With reference to the established method for determining monosaccharide composition described above, the chromatogram is shown in Fig. 3, where distinct peaks correspond to mannose, rhamnose, glucose, galactose, and arabinose, respectively. The molar ratios of these monosaccharides were calculated and summarized in Table 4. The results indicate that processing with the stewed method significantly alters the monosaccharide composition, characterized by increased contents of galactose and rhamnose and a decreased glucose content. These changes suggest that partial hydrolysis and rearrangement of glycosidic linkages occur during the simmering process, leading to modifications in the polysaccharide structure.

The molar ratios of the monosaccharide composition of the herbs and slices were analyzed and are shown in "Fig. 4". As the color in the heat map increases, the value of the molar ratio of monosaccharides increases. The results showed that the raw *Polygonatum odoratum* herbs and stewed *Polygonatum odoratum* tablets were divided into two categories, the processed *Polygonatum odoratum* and stewed *Polygonatum odoratum* were in one category, and the honey *Polygonatum odoratum* and wine *Polygonatum odoratum* were in one category with the raw *Polygonatum odoratum* herbs. This indicates that different concoctions have their characteristics for the biological activity of polysaccharides, in which the systematic method and the stewed method are divided into one category, and the honey *Polygonatum odoratum* and wine *Polygonatum odoratum* are divided into one category, suggesting that the systematic method and the stewed method of concoctions are similar. The monosaccharide composition of polysaccharides is the basic structural feature reflecting the polysaccharide activity (Sun *et al.*, 2021; Wang *et al.*, 2020; Wang *et al.*, 2016; Wang *et al.*, 2023d). By analyzing the composition of monosaccharides in *Polygonatum odoratum* before and after concocting, its polysaccharides consisted of mannose, glucose, galactose, and arabinose monosaccharides. There was no obvious difference in the composition of monosaccharides before and after stewed. Still, the molar ratio of glucose in stewed *Polygonatum odoratum* decreased and that of galactose increased (Gross *et al.*, 2023; Gross *et al.*, 2024), indicating that the composition of monosaccharides in *Polygonatum odoratum* changed before and after stewed. The bioactivity changed, which was more conducive to *Polygonatum odoratum* to play the role of immunity enhancement.

Table 2. Determination of polysaccharide content and free sugar content before and after stewed.

Name (of a thing)	Sample name	Total polysaccharide content %	Sucrose content %	Fructose content %	Glucose content %
Raw *Polygonatum odoratum*	Y10	11.7	1.14	1.28	0.14
Stewed *Polygonatum odoratum*	W10	6.62	3.62	40.34	18.65
Liquor *Polygonatum odoratum*	J10	6.07	2.94	4.85	1.01
Honey *Polygonatum odoratum*	M10	6.01	0.97	2.71	3.00
Decoction *Polygonatum odoratum*	Z10	6.35	8.27	26.62	4.94

Table 3. Molecular weight and distribution of *Polygahatous* before and after stewing.

Norm	Serial number	Molecular weight size of polysaccharides and their distribution					
		Mw (KDa)		Mn (KDa)		Mw/Mn	
		Peak 1	Peak 2	Peak 1	Peak 2	Peak 1	Peak 2
Raw *Polygonatum odoratum*	S10	7437.004	1.727	2952.564	0.938	2.512	1.842
Stewed *Polygonatum odoratum*	WY10	236.374	0.559	154.200	0.363	1.532	1.537
Liquor *Polygonatum odoratum*	JY10	3184.650	1.200	1907.873	0.646	1.669	1.856
Honey *Polygonatum odoratum*	MY10	2987.671	1.939	1683.391	1.086	1.774	1.786
Decoction *Polygonatum odoratum*	ZY10	186.169	0.672	105.636	0.418	1.762	1.609

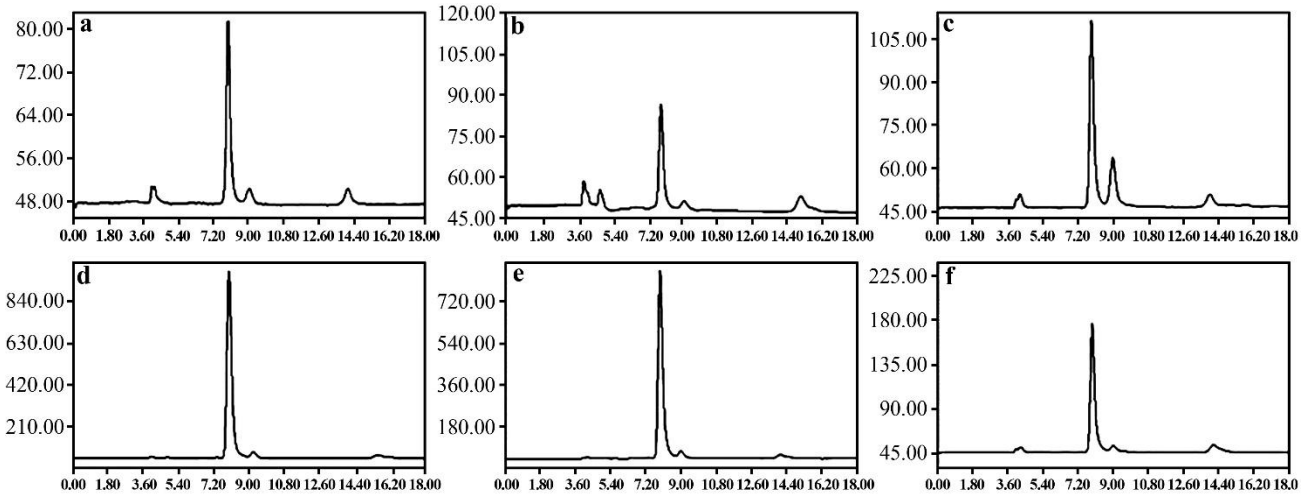

Fig. 1. Free sugar HPLC spectra of different processed products of *Polygonatum odoratum*
(a) Fructose, glucose, sucrose mixed reference; (b) Raw *Polygonatum odoratum*; (c) Honey *Polygonatum odoratum* (d) stewed *Polygonatum odoratum*; (e) Decoction *Polygonatum odoratum*; (f) Liquor *Polygonatum odoratum*

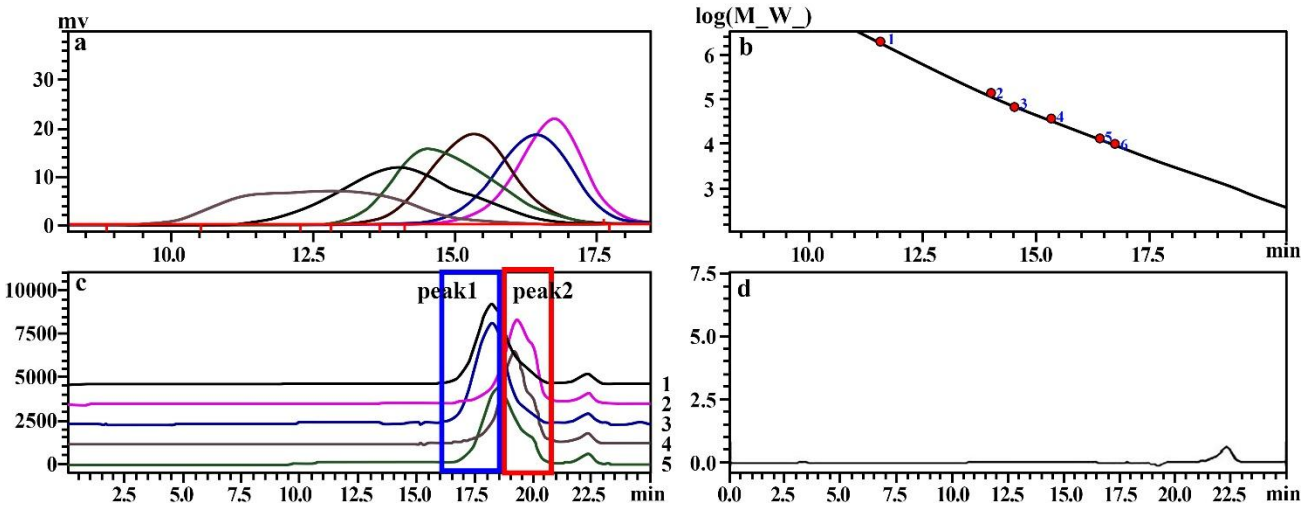

Fig. 2. Determination of molecular weight of *Polygonatum* japonica before and after processing
(a) Standard map; (b) Standard curve; (c) Map of *Polygonatum* Medicinal materials and decoction pieces; (d) Blank solvent spectrum
(1) Raw *Polygonatum odoratum*; (2) Liquor *Polygonatum odoratum*; (3) Honey *Polygonatum odoratum*; (4) Stewed *Polygonatum odoratum*; (5) Decoction *Polygonatum odoratum*

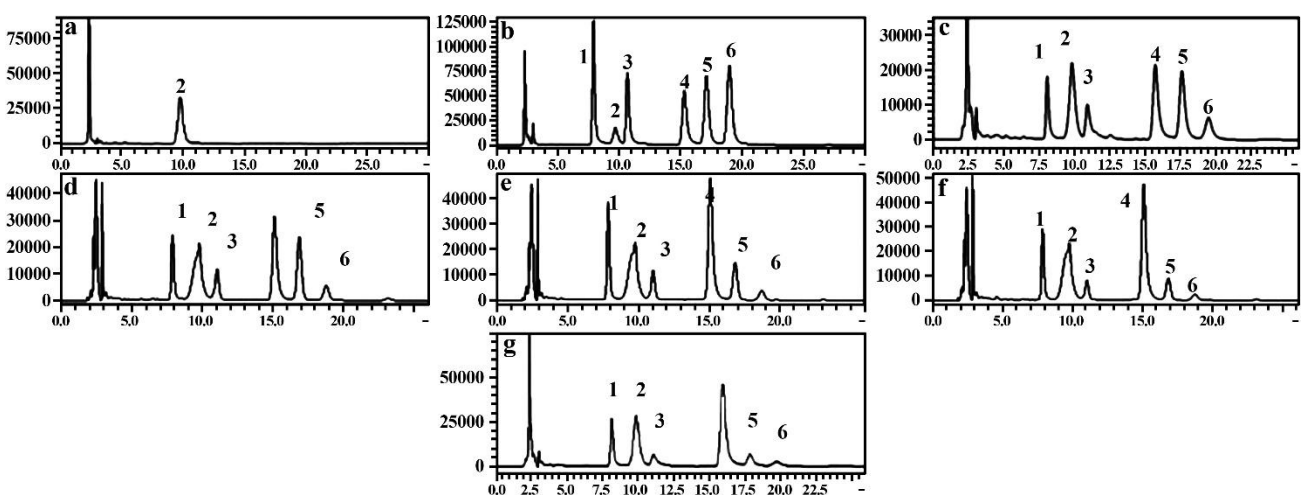

Fig. 3. Chromatogram of monosaccharide composition of *Polygahatous*
(a) Blank map; (b) Spectrum of 5 monosaccharide mixed label reference substances; (c) Stewing *Polygahatous;* (d) Decoction *Polygahatous*; (e) Liquor *Polygahatous*; (f) Honey *Polygahatous*; (g) Raw *Polygahatous*; (1) Mannose; (2) PMP reagent Peak; (3) Rhamnose; (4) Glucose. (5) Galactose; (6) Arabinose

Table1. Molar ratios of monosaccharides before and after stewed of *Polygahatous*.

Name (of a thing)	Serial number	Monosaccharide composition and molar ratio				
		Mannose	Rhamnose	Glucose	Galactose	Arabinose
Polygonatum odoratum	Y1	0.1047	0.0650	0.3561	0.0606	0.0136
	Y2	0.1515	0.0742	0.6964	0.0640	0.0140
	Y3	0.1960	0.1362	0.4275	0.2018	0.0384
	Y4	0.1970	0.0750	0.3457	0.0666	0.0157
	Y5	0.1488	0.0959	0.1903	0.1347	0.0303
	Y6	0.1604	0.0886	0.6591	0.0786	0.0133
	Y7	0.1568	0.0734	0.6714	0.0848	0.0136
	Y8	0.1847	0.0005	0.7248	0.0774	0.0126
	Y9	0.1630	0.0641	0.6884	0.0680	0.0165
	Y10	0.1721	0.0096	0.6521	0.0741	0.01591
Stewed *Polygonatum odoratum*	WY1	0.1151	0.0894	0.2530	0.1158	0.0264
	WY2	0.1417	0.1384	0.4474	0.2320	0.0403
	WY3	0.1440	0.1104	0.4881	0.2221	0.0352
	WY4	0.1728	0.0969	0.1625	0.1369	0.0307
	WY5	0.1323	0.0623	0.3409	0.0527	0.0116
	WY6	0.1956	0.2035	0.1487	0.3984	0.0536
	WY7	0.1492	0.1359	0.3888	0.2828	0.0431
	WY8	0.0795	0.1657	0.1251	0.2024	0.0272
	WY9	0.1306	0.1331	0.3125	0.3661	0.0575
	WY10	0.1029	0.1241	0.3659	0.3251	0.0649
Liquor *Polygonatum odoratum*	JY10	0.1620	0.0505	0.7033	0.0747	0.0096
Honey *Polygonatum odoratum*	MY10	0.1519	0.0923	0.5180	0.2126	0.0252
Decoction *Polygonatum odoratum*	ZY10	0.1970	0.0837	0.6047	0.1005	0.0141

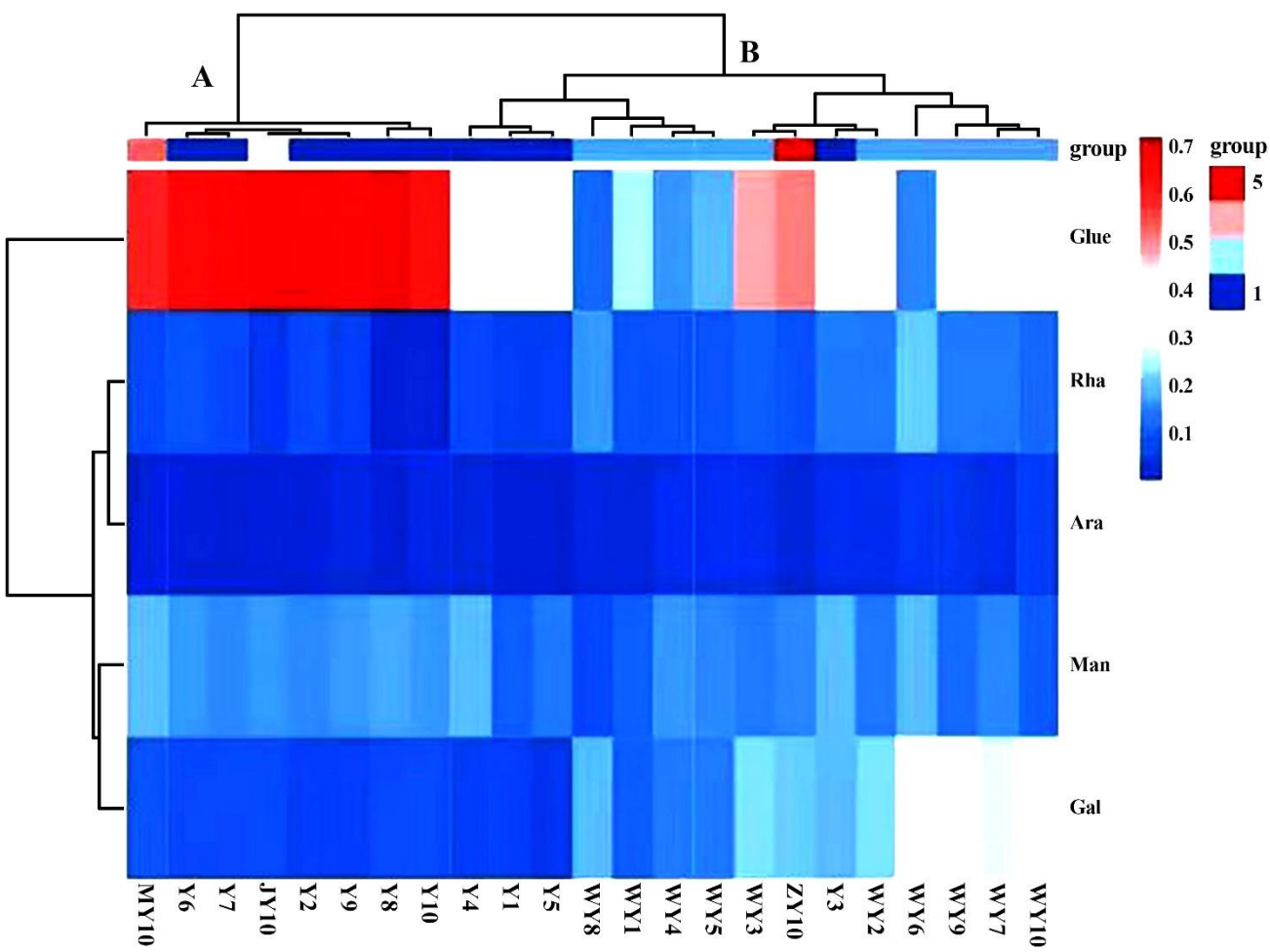

Fig. 4. Heat map of monosaccharide group analysis before and after processing of *Polygonatum odoratum*.

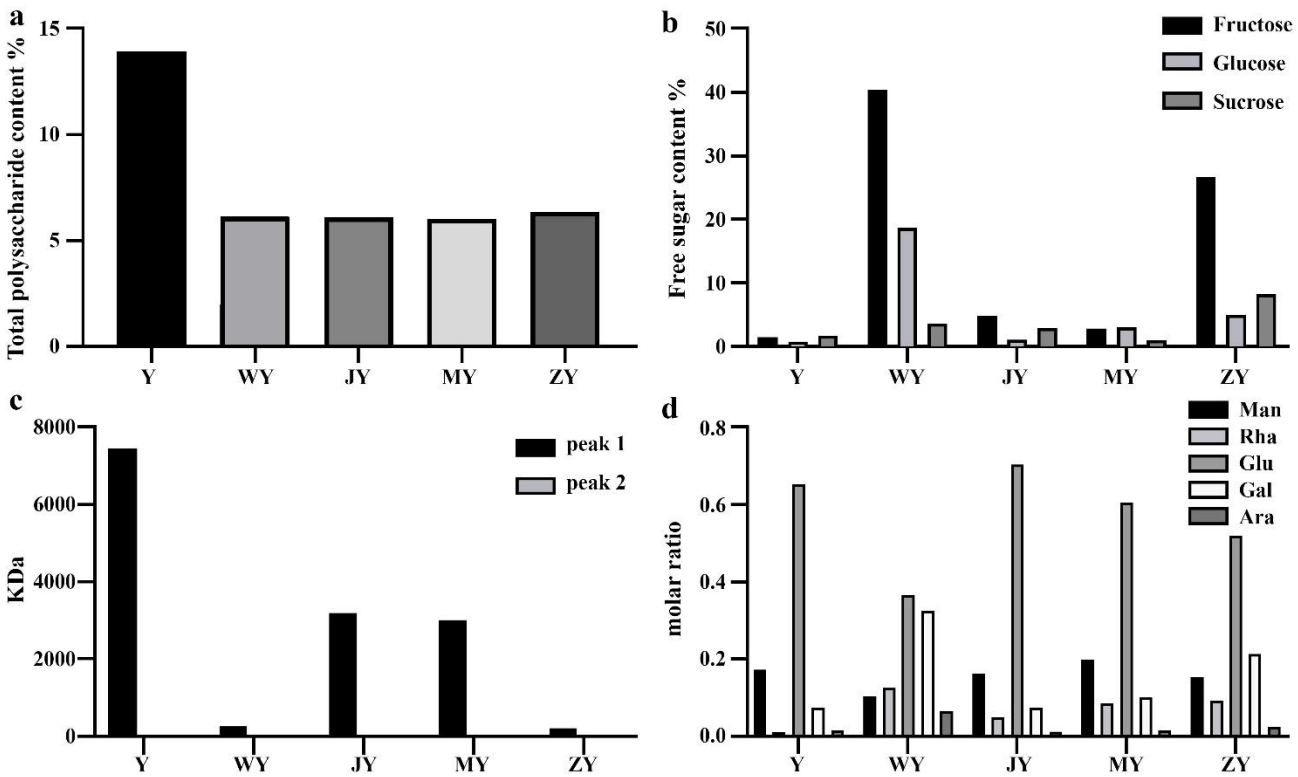

Fig. 5. Tendency of total polysaccharide content, free sugar content and molecular weight *Polygonatum odoratum* before and after stewed. a-Total polysaccharide content; b-Free sugar content; c-Molecular weight was measured at peak 1; d-Molar Ratio of Monosaccharides

Figure 5 shows the trend graphs of the changes in total polysaccharide and free sugar (sucrose, fructose, and glucose) contents and the changes in molecular weight determination of *Polygonatum odoratum* before and after concocting. As can be seen from the figure, the total polysaccharide content decreased, the total free sugars increased, the relative molecular weight mass decreased, and the monosaccharide composition types were the same before and after concocting of *Polygonatum odoratum*, but the molar ratio changed significantly. It can be speculated that the polysaccharides in *Polygonatum odoratum* polysaccharides, in the process of the stewed method of concocting, polysaccharides undergo more intense hydrolysis. Polysaccharide as the main active ingredient in the *Polygonatum odoratum* plant was determined as the total polysaccharide content of different concoctions of *Polygonatum odoratum*, and the contents were, from high to low, wine *Polygonatum odoratum*>stewed *Polygonatum odoratum* > honey *Polygonatum odoratum* > made *Polygonatum odoratum*, but the differences in the contents of the four were not obvious. In addition, both the content and molecular weight size of polysaccharides affect the bioactive effects (Ma *et al.*, 2021; Wang *et al.*, 2023c; Wang *et al.*, 2023e; Zeng *et al.*, 2023; Liu *et al.*, 2024). The exertion of polysaccharide efficacy is related to its molecular weight (Sun *et al.*, 2018; Li *et al.*, 2020; Li *et al.*, 2022a; Pan *et al.*, 2024), the smaller the relative molecular weight of polysaccharides, the smaller the molecular volume, which is more favorable for the polysaccharides of *Polygonatum odoratum* to enter into organisms across the membrane to exert their biologically active effects. The molecular weights of the raw *Polygonatum odoratum* herbs were reduced after the concoction, but the degree of reduction of the stewed *Polygonatum odoratum* was slightly larger than that of the wine *Polygonatum odoratum*, honey *Polygonatum odoratum* and processed *Polygonatum odoratum*. This suggests that the biological activity of stewed Mullein is easier to be absorbed and utilized by the human body, thus exerting a greater therapeutic effect.

Based on the study of the glycan composition of the *Polygonatum odoratum*, we systematically compared the differences in the monosaccharide composition, total polysaccharide content, free sugar content, and relative molecular mass of the *Polygonatum odoratum* concoctions with different concoctions of the *Polygonatum odoratum*, taking the different concoctions of the *Polygonatum odoratum* as research objects. The study showed that *Polygonatum odoratum* exhibited significant differences after being treated with several different concoctions, which revealed that different concoctions were able to endow *Polygonatum odoratum* with their respective unique characteristics of biological activity changes, and further proved the important influence of processing on the properties and efficacy of the Chinese herbal medicines (Wu *et al.*, 2021). In addition, further comparisons suggested that the bioactivities of the stewed method were more readily absorbed and utilized by the human body than those of other *Polygonatum odoratum* concoctions.

The stewed method is a unique concoction technique of Jianchang school, with unique tools and auxiliary materials, and the quality of the product is carefully selected (Hong-Min *et al.*, 2020). The color and luster of stewed *Polygonatum odoratum* are black and bright, the smell is pure and thick but not greasy, and the tonic effect is excellent. In this paper, the stewed method is first applied to the concoction of *Polygonatum odoratum*, which can effectively improve the

problem of the bitter taste of *Polygonatum odoratum* (F. Liu *et al.*, 2023). In this paper, the study's results on the sugar composition of stewed *Polygonatum odoratum* showed that the total polysaccharide content of *Polygonatum odoratum* decreased after stewed, the relative molecular weight size reduced, and the free sugar content increased. The above results are because the macromolecular polysaccharide of *Polygonatum odoratum* breaks the chain to become monosaccharides or disaccharides by using a specific temperature profile and auxiliary materials during the stewed process. The free sugar is the soluble sugar in the body, which is the direct energy-supplying material in the human body and can play the role of improving the taste and harmonizing the flavors, which indicates that the *Polygonatum odoratum* is more suitable to be developed into a ready-to-eat product after stewed. The results of this study not only laid a solid material data foundation for the subsequent development of stewed *Polygonatum odoratum* products but also contributed to the technical support for the quality study of *Polygonatum odoratum* tablets and provided a useful reference basis for clinicians when selecting *Polygonatum odoratum* concoctions.

Acknowledgements

The authors would like to gratefully acknowledge the School-level scientific research project of Jiang Xi University of Technology (23ZRZD04); Jiangxi Province Natural Science Foundation (20232BAB206019); the School-level scientific research project of Jiang Xi University of Technology(23ZRZD05) for funding this project.

Conflict of Interest: The authors declare no conflict of interest.

Author's contribution: Huihui Zhan: Conceptualization, resources, visualization, writing—original draft preparation; Chunjuan Fang: Validation, writing—review and editing; Zhenyao Yu: Methodology, data curation, supervision, writing—review and editing; Hui Wu: Software, project administration, writing—original draft preparation; Wenwen Jiang: formal analysis, writing—original draft preparation; Yanling Liu: Investigation, writing—review and editing

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